



Curriculum Units by Fellows of the Yale-New Haven Teachers Institute  
2014 Volume IV: Engineering in Biology, Health and Medicine

---

## **Generation GMO: The Good, the Bad and the Genetically Modified**

Curriculum Unit 14.04.08  
by Larissa Giordano

### **Introduction**

---

I teach second grade at Nathan Hale School in New Haven, Connecticut. My second grade classroom is composed of a diverse, multicultural community of learners that encompass a wide spectrum of achievements, interests, learning and social needs. As mentors and role models for children it is extremely important that we not only teach academics but help students understand who they are and why certain things happen to them.

This unit will focus on genetically modified organisms or 'GMOs' and their affects on human health and the environment. Genetically modified organisms are making headlines. More and more, as consumers we are purchasing and eating foods that contain food that has been genetically altered or contains ingredients that have been modified without knowing it. GMOs are plants or animals that have been genetically engineered with DNA from bacteria, viruses or other plants and animals. Nearly all GMOs are engineered to withstand herbicide and/or to produce insecticide. Despite what the industry promises, many GMO traits currently on the market, do not enhance nutrition or provide any other consumer benefit. Meanwhile, some evidence connects GMOs with health problems, environmental damage and violates farmers' and consumers' rights.

Genetically modified plants may grow faster and yield more, but the quality of the plant, which is later consumed, can cause a disruption of the body and in nature itself. Disruptions like immune activation and allergic responses, an increase in autoimmune diseases, respiratory and digestive imbalances to name a few. GMO's contribute negatively to human body systems which can lead to sickness and allergies. This is because proteins in foods trigger most allergic reactions. When foreign proteins that have not yet been consumed or tested for safety are spliced into common foods they present entities to the human body to which the immune system can not defend leading to immune activation. If the United States' Food and Drug Administration continue to allow plants and animals to be genetically modified, human and environmental health issues will rise. Environmental issues like crosspollination from GM crops to wild crops, increased toxicity to aquatic life living in nearby streams and the development of super weeds can wreak havoc on our world. "Several animal studies indicate serious health risks associated with GM food," including infertility, immune problems, accelerated aging, insulin regulation, and changes in major organs and the gastrointestinal system. They conclude, "There is more than a casual association between GM foods and adverse health effects. There is causation," as defined by recognized scientific criteria. "The strength of association and consistency between

GM foods and disease is confirmed in several animal studies." (Doctors Warn- Avoid Genetically Modified Foods <http://www.responsibletechnology.org/doctors-warn>) This explains why other countries do not allow the use of genetically modified products. GMO's do more harm than good and should be properly labeled on all food products, so to not violate consumer rights. Italy, France and Germany are just a few among the numerous countries with regions banning GMO food and crops. Through their investigations, students will gain a deeper appreciation for nature's cycle in an attempt to make improvements. Students will understand that with change, there are also consequences, some that can not be undone.

## Overview of Objectives and Activities

---

This unit is designed to help students understand how simple daily decisions like what they eat or reading food labels can affect their future. Students will understand the pros and cons of genetically engineered foods. First, they will learn about what it means to genetically modify a plant or animal. Surprisingly, this is a very simple concept to communicate based on common day-to-day things. An analogy can be made to modifying a brick wall by replacing a few bricks with some other bricks. How does this impact the overall structure and how does it depend on what has been replaced? Can we expect that the structure remains the same and what changed and how will it affect everything else. In the same manner, I intend to tackle the subject with my students. Specifically, students investigate genetically modified seeds and non-genetically modified seeds, observe their growth and test the water and soil quality of each type prior to and after planting. In this, students will observe that although visually the genetically modified plant grows quicker and fuller, it is not the healthy choice when it comes to human consumption and the environment. This will be determined by the variations noted in the results of the soil and water testing. Students will focus on the dangers that genetically modified organisms pose to our health, particularly on human body systems and disease as they research the impact that antibiotics and pesticides have on the immune system and how altering nature's cycle can change an ecosystem permanently.

The students will recognize themselves as consumers and take responsibility for making informed decisions such as whether to buy foods that contain genetically modified ingredients or not. Field trips to a grocery store, a farm and inviting scientists to come to the class to discuss environmental and water safety in places GM crops are just a few of the engaging opportunities that students will be awarded as they recognize through food tastings that GM food may not look or taste different, but it's what they can't see that counts. Some genetically engineered foods pose health risks as an increase in toxins and allergens. Students will investigate various case studies that showing that inhaled Bt corn pollen can trigger disease in humans as well how the simple grazing on GM crops resulted in the deaths of sheep and cows.

This unit will be taught over an eight week period. Weeks one and two will focus on what genetically engineering food is, its history and how it affects us personally as consumers. Students will compare and contrast samples of genetically modified foods with those that have not been modified. Students will learn how to read food labels, discuss their importance and note whether or not an ingredient listed on the label has been modified and begin to question why certain foods are modified and what those modifications imply. They will understand this concept through an in depth study of DNA, genes and the human body systems as it relates to an ecosystem and the life cycles of plants from seed to table. Students will comprehend DNA as the building blocks of life through an analogy of using Legos, that when you change one piece by replacing it with another, it can then cause a domino effect where other changes result as well.

During week three, students will delve deeper into the health risks that GMOs pose to the human body. They will study the various body systems, paying close attention to the immune system and understand how the body recognizes foreign objects and defends itself against them in an effort to protect against sickness and disease. Week four will continue to address the human body systems but introduce the health risks and potential for disease that GMOs cause. Students will recognize what the hygiene hypothesis is and its role in the changes the last few decades have undergone in our pursuit of a sterile, germ-free lifestyle. The idea explains that if your child is not exposed at a young age to various forms of bacteria, the immune system does not develop immunity to it to protect you later in life, and as you get older the body recognizes the bacteria being introduced as foreign and activates an immune response. This is one theory that supports the rise of allergies.

Weeks five through eight will find the students planting genetically modified and non- genetically modified corn and soybean seeds and observing their growth. Students will examine these seeds in particular because soy and corn dominate the United States market in terms of their percent of modifications. In 2012, 88 % of corn and 94 % of soy grown had been modified. Additionally, corn is a core ingredient in many different products beyond food. GM corn not only impacts health, but spurs other effects. This is related to the "Law of Unintended Consequence," which states that the actions of people and/or government and regulations always have effects that are unanticipated or unintended. These effects generally stem from economics. The connection with GM corn and soy is clear. By modifying crops to produce more, farmers make more money but the unintended consequences to our health and the environment are only now coming to light. In addition to noting the similarities and differences, students will now look at the environmental impact of genetically engineered seeds. Prior to planting, students will test the water quality and soil quality. After having observed the plant growth for at least three weeks, students will test the water quality again, looking for any evidence of change in the level of present bacteria, lead, pesticides, nitrite/ nitrates, nitrite, chlorine, hardness or PH in the water. Next, students will conduct the soil testing, looking for any changes in the levels of nitrogen, phosphorus, potassium and PH. By the end of the unit, students should be able to recognize that although seeds that are genetically modified may grow quicker, fuller and thicker, the quality of the food is compromised. This will be accessed by examining the changes that occurred between the before and after soil and water testing and connecting it with how your immune system would react when introduced to these changes in addition to reading and writing a persuasive argument based on case studies in lab animal tests where genes are altered in animals which then cause an adverse reaction often linked to disease. Students should be able to recognize that genetically modified seeds are less healthy for human consumption and the environment because when the DNA of a plant or animal is changed, the traits that are added, such as the ability to resist herbicide or create an insecticide is not necessarily what we want to be putting into our body. These traits also upset the balance in nature's water cycle as well as impact the quality of the soil and the living organisms that inhabit it.

Students will also understand why the FDA is currently re-evaluating food labels including the recent mandate that Connecticut must properly label all products if an ingredient within it, has been modified. Students should then be able to apply their knowledge and improve the quality of their health by making more informed decisions about what they choose to eat. Students will conclude that genetically engineered foods, not only disrupt their health, but the sustainability of the environment as well.

## Background Knowledge

---

### A Growing Population

Due to advances in science, fewer and fewer farmers are needed to feed the growing population. In many parts of the world only 1 in every 200 people grow plants or raise animals for food while the other 199 buy what we need to eat. Most of us never give a thought to the growing, processing, packaging, shipping and in some cases, even the safety, of what we eat. Tinkering with nature, through science, in order to grow more, and yield more produces consequences for human health and the environment unbeknownst to the consumer. In order to change a wild plant into a food plant, a change in the plants' genes is needed. This helps to boost the plants' yield, but at the same time modifies the plants' genetic make-up.

Over the last one hundred years the Earth's population has doubled and redoubled. In 1950 the population reached three billion, while in a little less than a single human generation rose to six billion. Farmers needed to keep pace with the growing population and began to modify plants' genes based on information provided by nitrogen chemists. With new crop varieties and an expanded use of fertilizer, the amount of grain harvested jumped from 692 million tons in 1920 to 1.9 billion tons by 1992, all without any real increase in the amount of farmland. With the addition of approximately 80 million more humans per year, the question that remains; is the Earth is too small to sustain us in the ways that it did for our ancestors? If so, the challenge lies in limiting the destructive effects of agriculture as we continue to alter the state of the food we eat and the environment from which it is harvested. (Federoff 2004)

Although the population is increasing there have been some disparities among the health and life expectancy of those living in rural areas versus those living in urban areas. This may be partially explained by the changes our world has undergone over the last few decades in terms of our move toward becoming more sterile as well as decreasing the use of farmland due to genetic engineering and increasing industrialization and the green energy movement.

"Americans residing in major cities live longer, healthier lives overall than their country cousins—a reversal from decades past." (City vs Country <http://online.wsj.com>) This is primarily due to access to medical care. With better access, this statement may not hold true. With GMO there is the added dimension of less resources expended and with less resources comes less attention to issues.

Rural living has many great advantages. Children who grow up on farms have fewer cases of asthma, allergies and autoimmune disorders than urban dwellers. This can be explained by the hygiene hypothesis because children are exposed to a variety of microorganisms, their immune systems are stronger and well-functioning. Those living in urban areas have higher mental health problems including mood disorders and anxiety. "People who move from a city environment to the country or vice versa generally bring their health habits with them. Leigh Young grew up on a tiny farm in rural Michigan, eating only what her family grew or slaughtered. Ms. Young, 55, now lives in urban Grand Rapids, where she says she isn't tempted by soda, chocolate or processed food. Her upbringing "made me far more aware of what I put into my body," she says." (City vs Country <http://online.wsj.com>)

## What is a Genetically Modified Organism?

---

Food that has been genetically modified means that its DNA structure has been changed. DNA is the basic blueprint of all living things, and by altering it, its quality and characteristics are also changed. For years, humans have been purposely manipulating the evolution of organisms. Farmers use selective breeding to improve the livestock and crops so that cows can produce more milk, hens will lay more eggs and disease-resistant plants will produce more. Genetically Modified Organisms or "GMO's" are plants or animals that have been created by altering the genetic material through gene splicing of genetic engineering. Genetic engineering, however targets manipulations in an unprecedented way. "Transgenic plants and animals are generated with characteristics that cannot be obtained using traditional breeding. Unlike organisms generated by selective breeding, transgenic organisms contain genes from other species. Genetic engineering techniques are used to generate recombinant DNA which contains sequences from different organisms. This DNA then becomes incorporated into a host so that it can be passed to subsequent generations" (Rediscovering Biology [www.learner.org](http://www.learner.org).) Such techniques have become commonplace. For example, bacteria produce human insulin and hepatitis vaccines, while some crops can be altered to resist herbicides and insects. Although the economy warrants the process, genetically modifying bacteria, plants and animals comes with its own set of risks. Modifying one segment of DNA does not produce a single result, but one that causes a spiraling of various unwanted consequences.

## Where it All Began Monsanto Chemical

---

Bacteria were first to be genetically engineered, being used for replicating and modifying genes that were later introduced into plants or animals. Because of their rapid reproduction rate, bacterial systems lend themselves to genetic manipulation. A clone of bacteria can be produced in a short period of time. The cells are then lysed and DNA can be isolated. Bacteria are used to produce non- bacterial proteins used in vaccines. Scientists therefore have taken advantage of nature to modify bacteria. As with bacteria, in order to genetically modify plants, one must obtain genetically identical populations and readily manipulating DNA. Many plant species undergo fragmentation, where parts from the parent plant regenerate a new plant. Other methods include growing plants in culture from small explants or culturing plants from totipotent cells found in the plants meristems. These plant cells can divide and differentiate into various specialized cells.

Several concerns surround transgenic crops. Genetic engineering may inadvertently generate new allergens or toxins that can affect human health. "In March 1996, researchers at the University of Nebraska showed that an allergen from Brazil nuts had been transferred into soybeans. Individuals sensitized to Brazil nuts make antibodies (IgE) specific to certain proteins in the nuts. Engineered soybeans reacted with such antibodies invitro. If allergic individuals consumed the transgenic soybeans, they would have likely experienced IgE-mediated reactions, ranging from itching to anaphylaxis." (Rediscovering Biology [www.learner.org](http://www.learner.org)) Expressing known allergens in food is dangerous and challenging. It is difficult to predict whether or not a protein in a novel organism will cause allergies. Additionally, the introduced genes from engineered crops can move into other organisms in the environment. The development of insecticide resistant plants disrupts the beneficial insects that are affected by the engineered plants.

The Monsanto Corporation is a multi-billion chemical company and is among the largest pesticide and biotechnical corporations in the world today who produce genetically engineered crops. Their products are used in many areas of agriculture, landscaping and markets throughout the United States. The Monsanto promise is to create new, safer pesticides and stronger bio-engineered crops. Despite this, what Monsanto actually produced and marketed were products that are potentially toxic and sold for a profit. During its early years, Monsanto produced Polychlorinated biphenyl, known as PCBs, later proven to be a carcinogenic, highly toxic and corrosive to skin or mucus membranes. Another product, "Agent Orange" was used to destroy jungles in Vietnam. Together with dichlorodiphenyltrichloroethane or DDT, another pesticide that caused massive damage to living things as well as the environment. Prior to being known as too dangerous for use, many lives and ecosystems were already negatively impacted. This damage may have meant big profits for Monsanto, but the effects are irreversible. Today, Monsanto is the producer of Round-up, whose most active ingredient is glyphosate salt, a highly toxic weed repellent. This ingredient has the potential to kill "super weeds," just as antibiotics do to "super germs." "This pesticide kills all but the strongest pests, leaving only the hardest members of the population to repopulate the area. Eventually, once the weaker pests are killed from the gene pool, super weeds are all that remain; at this point, modern pesticides will become nearly useless and far stronger and more toxic ones will need to be employed." (From Agent Orange to Pesticides and Genetically Engineered Crops, <http://www.globalresearch.ca>)

A large portion of Monsanto's business is concentrated in the field of genetically modified organisms. GMO's have an altered genetic structure with the intent to yield more and repel more pests. This however may have introduced many unintended consequences and side effects of genetic mutation making them harmful to consume as well as for the ecosystems in which they are grown. Although some of Monsanto's products may be safe, many have a history of being toxic. The issue of concern is that genetic engineering is relatively new and its consequences though some known have yet to be completely discovered. (From Agent Orange to Pesticides and Genetically Engineered Crops," <http://www.globalresearch.ca>)

## **GMO - The Good, The Bad and the Ugly**

---

Genetically modifying microorganisms, plants and animals commonly began to either further scientific research or increase food supply. The most common genetic modifications include adding antibacterial genes to plants, introducing genes to make the plant fuller and stronger, making new foods by adding genes from existing foods and by adding animals' genes to plants and the reverse. The percentage of crops grown in the United States for Americans that are modified is growing rapidly, and most have yet to be labeled as such.

The reasons behind the need to genetically modify organisms, stems from the government and agribusiness' plea that it enhances food supply to help underfed nations and assist farmers. When using genetically modified seeds, farmers no longer have to spray herbicides and pesticides because the crops are already resistant. Some crops are said to carry additional nutrients and minerals which can then aide people in other countries that do not have an adequate supply of nutrients. Because fewer pesticides are used, it is claimed to be better for the environment. Lastly GMOs are said to be safe for human consumption. Their evidence lies in 1, 783 studies about the safety of genetically modified foods from 2002 - 2012. Genetically engineering crops is relatively about 30 years into the making and studies exist over a 10 year period .The question remains, "Is this enough time to determine long term safety?" ("GMOs - Pros and Cons" <http://ireport.cnn.com>)

Despite the goal of genetically modifying plants; to allow them to be resistant to herbicides, such that the weeds surrounding the plants will die, yet the crop itself will remain unaffected sounds good in theory, the consequences outweigh the good. Researchers are concerned about the long term effects of changing DNA sequences and what happens to the humans and animals that eat them. Prior to the introduction of genetically engineered foods, there were no tests available to test the long term risks to humans and animals. Following their introduction, cancer rates, autism and allergies have steadily inclined. This is because, not only are we consuming a genetic structure, never before recognized, but we are also consuming the herbicides and pesticides that these plants were engineered to withstand. Many plants even contain glyphosate, known as Round up that kills friendly bacteria in our stomach and binds to minerals. Therefore when humans eat the gm plants or the animals that were fed gm grains, our bodies become susceptible to multiple mineral deficiencies and abnormal gut flora. These two responses alone cause immune system dysregulation and sensitivity to certain foods ("What are GMOs?" [www.nourishingmeals.com](http://www.nourishingmeals.com).) There are several types of health effects that can arise from the insertion of one or several genes into an organism. Primary concerns are the production of new entities that may function as new allergens, have increased toxicity because these newer substances are not as easily cleared from the body, decreased nutrition and antibiotic resistance. ("Genetically Modified Organisms," <http://enhs.umn.edu>)

### **Food Allergy**

Allergic responses in humans occur when a regularly occurring harmless protein enters the body and elicits an immune response. If a protein from a GM food comes from a food that is known to cause allergies or is from a source that has never been consumed as human food, an increased immune response is often elicited. Today, the percentage of the United States population that is affected by at least one allergen is 55%. Food allergies account for up to 15 % of the United States population ("Genetically Modified Organisms," <http://enhs.umn.edu>.)

### **Increased Toxicity**

Most of the plants that humans consume produce low levels of toxins, so not to cause any adverse health effects. Inserting genes into a plant however could cause an increase in toxicity, making them dangerous to humans. The plant's production of toxins can also be altered if one or more of the genes in the plant are become damaged through the process of inserting the gene. Additionally, the new gene may also interfere with the plant's metabolism, causing the stressed plant to produce more toxins. For example, potatoes, bred for increased disease resistance have produced higher levels of glycoalaloids ("Genetically Modified Organisms," <http://enhs.umn.edu>.)

### **Decreased Nutritional Value**

A genetically modified plant could have a lower nutritional value because at times, its nutrients are modified to make them indigestible to humans. For example, a common compound found in grains and seeds, known as phytate, can bind with minerals, making them unavailable to humans. Inserted genes can cause a plant to produce an increased level of phytate, decreasing the nutritional value of the plant. Another study showed that gm soybeans produced lower levels of phytoestrogen compounds which are believed to protect against heart disease and cancer ("Genetically Modified Organisms," <http://enhs.umn.edu>.)

### **Antibiotic Resistance**

Antibiotic resistant genes from GM foods are taken up by bacteria during digestion. If the bacteria carrying the

resistant gene were to cause an infection, it would be very difficult to treat. Due to the recent incline of bacterial strains that are showing resistance to antibiotics, health professionals are becoming increasingly alarmed. The bacteria living in the stomach of animals and humans could pick up an antibiotic resistant gene from that of a GM plant before the DNA gets completely digested ("Genetically Modified Organisms," <http://enhs.umn.edu>.)

## Why is this So? A Peak Inside Our Body

---

### The Immune System- How It Works

The human body is made of an amazing protection mechanism that defends against the intrusion of millions of bacteria, microbes, viruses, toxins and parasites. Through a series of steps, known as the immune response, the immune system attacks organisms and substances that enter our body and cause disease. The immune system is a network of special cells, proteins, tissues and organs to ward off these invaders every day. The special cells are called leukocytes or white blood cells that seek out and destroy the organisms or substances that cause disease. Leukocytes are produced or stored in many locations throughout the body, such as in the thymus, spleen and bone marrow. They are known as the lymphoid organs. There are also groups of lymphoid tissue throughout the body known as lymph nodes that are home to leukocytes. Leukocytes circulate throughout the body between organs and nodes by means of the lymphatic vessels or through the blood vessels in order to monitor the body for germs or substances that may cause problems. The two types of leukocytes are phagocytes, cells that chew up the invading organisms and the lymphocytes, cells that help the body recognize, remember and help destroy the invaders. Neutrophil is the most common type of phagocytes which primarily fights bacteria. There are two types of lymphocytes: B lymphocytes and T lymphocytes. B lymphocytes seek out the invaders and notify the defenders, while the T cells destroy them. Lymphocytes begin in the bone marrow and either remains there to mature into B cells or leave to go to the thymus gland where they mature into T cells.

Antigens are the foreign invaders that sneak into the body. These cells work together to detect them and respond. The B cell responds by producing an antibody against it. These antibodies remain in the system in the case that the body is attacked by the same antigen they can protect the body. This prevents a person from getting sick from the same illness twice. ("The Immune System" <http://kidshealth.org>)

This is just like the way immunizations work. When a person is immunized to prevent a certain disease, it introduces the body to the antigen in order to prevent the body from becoming sick. The body responds by creating the antibodies for protection. T cells then destroy the antigens that have been tagged by the antibodies. Another role of the antibody is to neutralize the toxins produced by various organisms. They can also activate another set of proteins, known as the complement to kill bacteria, viruses or infected cells.

Humans have three types of immunity, innate, adaptive and passive. Innate immunity is what we are born with and provides a general layer of protection. It includes exterior barriers to the body such as mucous membranes and the skin, the body's first line of defense in preventing disease from entering the body. Adaptive immunity is built up over time, involving lymphocytes and immunizations. Passive immunity is passed from another source, but is short term. As people get older, their bodies' immune system has learned to recognize and attack viruses. Although amazing, the immune system is not problem free. The immune



system is distinguished by two key hallmarks, namely specificity and memory. In the case of GMO, memory has never been formed. ("The Immune System" <http://kidshealth>)

Some disorders of the immune system include immunodeficiency disorders, auto immune disorders, allergic disorders and cancers of the immune system. Immunodeficiency occurs when a part of the immune system is not properly working. You can be born with an immunodeficiency or acquire it through infections or produced by drugs. Auto immune disorders happen when the immune system mistakenly attacks the body's healthy organs and tissues as if they were invaders. When the immune system over-reacts to exposure to antigens in the environment, an allergic disorder occurs. Cancers of the immune system contradict autoimmune disorders and are present when the cells of the immune system are weakened by parasites or microbes in the body's organs that have been undetected by the defense system. ("The Immune System" <http://kidshealth>)

### **The Immune System- How It Responds to GMOs**

Plenty of evidence shows that the Bt-toxin produced in genetically modified Bt crops like corn and cotton plants is toxic to humans and mammals and triggers immune system responses. For example, a government sponsored research study in Italy, fed mice Monsanto's Bt corn and various responses were triggered, including an elevation in IgE and IgG antibodies, which are typically associated with allergies and infections. This study also showed an increase in cytokines, which are associated with allergic and inflammatory responses. Interleukins were also elevated. Elevated interleukin- IL-6 is associated with rheumatoid arthritis, inflammatory bowel disease, osteoporosis, multiple sclerosis, multiple myeloma and prostate cancer. Interleukin IL- 13 is associated with allergies, allergic rhinitis, and Lou Gehrig's disease. Interleukin MIP -1B is connected to colitis and autoimmune disease, while IL-12p70 also plays a part in the onset of inflammatory bowel disease and multiple sclerosis. (Jones 2013)

"Because genetically engineered crops are infected with a virally activated foreign gene complex it is seen by the immune system as foreign protein material or antigen. The result is a defensive immune response." (Jones 2013) In addition to an increased exposure to Roundup, a glycosophate pesticide, other diseases like Parkinson's, infertility and various cancers are triggered. In another study, rats fed another of Monsanto's Bt corn called MON 863, experienced higher numbers of basophils, lymphocytes, and white blood cells. These indicate allergies, infections, toxins, liver and kidney toxicity and cancer (Jones 2013.)

Another serious reaction involves autoimmune diseases, when the immune system becomes confused causing it to not only attack the invaders, but attack parts of the healthy tissue as well. Because it takes the human body thousands of years to adapt to environmental stresses and in the past hundred years many new toxins have been added to our environment, it enables the immune system to differentiate between our own body and the invaders. This rise in toxins within our environment therefore makes it more likely to make mistakes than in years past where the environment was in a much more "natural" state. Director of the Autoimmune Disease Research Center at Johns Hopkins, describes autoimmunity and our immune system's attempt to adapt to the many unrecognizable agents as "An unsuccessful adaptation, but it's our body's way of trying to fight back" (Jones 2013.) According to the National Institute of Health, more than 23.5 million Americans suffer from one of 24 autoimmune diseases. When considering all 80-100 autoimmune diseases, however the number increases to over 50 million or twenty percent of the population. Once a person is diagnosed with an autoimmune disease that person is more likely to develop another. Although genetics can account for some autoimmune conditions, the rise in exposure to environmental toxins and chemicals including PCBs, dioxins, insecticides and mercury is also a key factor. The increasing incidence of "Leaky Gut," where the intestinal tract lining becomes damaged through repeated exposure to toxins, processed food, genetically modified

food, stress and medication is yet another hindrance to the immune system. For people whose immune systems are compromised, in some part due from ingesting genetically modified foods, a non GMO free diet compromises that person's immune system tenfold (Jones 2013.)

### **The Hygiene Hypothesis - What Are We Exposing Our Body To?**

Although staying germ free can prevent the spread of sickness, a cleaner lifestyle may be responsible for an increase in allergies among children. "It's called the hygiene hypothesis," says Marc McMorris, M.D., a pediatric allergist at the University of Michigan Health System. "We've developed a cleaner lifestyle, and our bodies no longer need to fight germs as much as they did in the past. As a result, the immune system has shifted away from fighting infection to developing more allergic tendencies."

("The Hygiene Hypothesis: Are Cleaner Lifestyles Causing More Allergies for Kids?" [www.sciencedaily.com](http://www.sciencedaily.com)) This is because the human body's immune system is built to fight bacterial and viral infections as well as parasites. The problem however is that the body also recognizes foreign substances as "immune stimulators" otherwise known as allergens. Thanks to medical advances such as vaccines and antibiotics, the immune system no longer needs to fight off life threatening diseases like polio and the measles. Even common bacterial infections that used to burden the system are held at bay with the use of antibiotics. It doesn't stop there though. Not only are we living a cleaner personal lifestyle supported by medical advances even our homes have changed the function of the immune system. Energy saving, air -tight doors and windows have increased the concentration on indoor allergens. Change in the family dynamic also contributes to the hygiene hypothesis. Over the last two or three decades, there has been a decrease in family size which lessens children's exposure to germs and infections. Families with three or more children tend to have less allergies because the larger the family, the more exposure to bacteria and viruses.

"The natural immune system does not have as much to do as it did 50 years ago because we've increased our efforts to protect our children from dirt and germs," says McMorris. Allergies are on the rise because our society has changed the way we live. As a result, people with allergies are having children with others who have allergies, which in turn creates a natural increase in the prevalence of allergies in our society." ("The Hygiene Hypothesis: Are Cleaner Lifestyles Causing More Allergies for Kids?" [www.sciencedaily.com](http://www.sciencedaily.com) )

### **The Digestive System- How It Works**

The job of the digestive system is to break down the food that we eat into their smallest parts so that they can be used as energy for existing cells as well as build new ones. The nutrients in the food we eat such as carbohydrates, vitamins, proteins fats, and minerals provide the body's cell with the energy it needs for growth, work and repair. There are four stages of the digestive process that takes about one to two days to complete. The first step begins with ingestion when the food or drink enters the mouth, followed by digestion which is the physical grinding and chemical breakdown of the food from large molecules into smaller molecules as it moves through the digestive tract. The third step is absorption, which is when the molecules passing through the tract are passed into the bloodstream and carried throughout the body. This process involves many organs working together, known as the gastrointestinal tract, made up of the mouth, throat, stomach, small and large intestines. Additionally, the liver, pancreas and gallbladder assist in the digestion by providing digestive juices and enzymes in the small intestines through tubes. The liver then stores the nutrients after they have been absorbed. Even our nerves and blood play an important role in the digestive system (Hoffmann 2009.)

The important role of the organs in the digestive system begins in the mouth after food has been ingested

where the teeth are designed to crush, grind and mash the food prior to swallowing it, the tongue and saliva also assist in the process. After having been chewed, it is swallowed and passes via a tube known as the esophagus that connects the mouth to the stomach. The esophagus is lined with a mucosal layer that contains glands that produce juices to help digest the food and protect the organ walls from damage. Once the food reaches the stomach, it has several jobs to perform. The stomach also produces juices that digest food and kills potentially harmful bacteria. The stomach that is shaped like the letter J is expandable. It also is lined with millions of glands that produce an acidic gastric juice containing hydrochloric acid that activates certain digestive enzymes and can kill bacteria. Additionally, the stomach is lined with three layers of muscle in its wall to crush and squeeze the food into a paste so that it can alter be absorbed by the small intestine. Generally the food exits the stomach in about two hours depending on the quality. Healthy choices, like fruits and vegetables take a shorter period of time that foods that contain allot of fat or have been fried. (Hoffmann 2009.)

By now the food is almost a paste or liquid substance called chime when it reaches the small intestine, where the mechanical and chemical digestion happens in order for the nutrients from the food to be readied for absorption. The small intestine produces its own intestinal fluid as well as receives digestive juices from the pancreas and liver to break down the complex food molecules even further to then allow the nutrients to be absorbed through cells and passed into the bloodstream. By the time the digestive products reach the large intestines, nearly all of the nutritionally useful products have been removed. Its role then is to absorb water and prepare the waste to be expelled from the body. (Hoffman 2009)

### **The Digestive System- How It Responds to GMOs**

"Ever since GMOs have entered the food supply, numbers of irritable bowel syndrome, Crohn's disease, ulcerative colitis, leaky gut syndrome, constipation, and acid reflux have sharply risen. While no causal relationship has been found, one argument claims that a likely culprit is the Bt toxin (Bacillus thuringiensis )." (Do GMOs Cause Digestive Disorders?" <http://stellametsovas.com>.) This bacteria is registered as a pesticide with the EPA, yet is the added to food crops, like corn, so that insects who eat the crop will die from the toxin. When humans consume the plants, the Bt toxin enters their digestive tract causing digestive illnesses like leaky gut syndrome, an inflammation of the digestive tract. Further research suggests that the pesticide, Roundup in GM crops contain xenoestrogens, that are linked to "carcinogenic transformation through the disruptions of human hormonal metabolism . You are basically bombarding your digestive system with undesirable amounts of estrogen-promoting hormones" (Do GMOs Cause Digestive Disorders?" <http://stellametsovas.com>.)

Crop modifications can also be linked to gluten sensitivity. Celiac disease is an autoimmune disease where immunity recognizes Gluten as a foreignsubstance. This may have started with these kind of modifications. "One possible reason may lie in the fact that genetically modified wheat is not actually wheat in its natural state. Instead, it's altered wheat that could technically be considered fake food - deeming it potentially allergenic and irritating to the digestive tract. Also, genetically modified wheat may have more gluten than regular wheat, aggravating gluten sensitivity even more" (Do GMOs Cause Digestive Disorders?" <http://stellametsovas.com>.)

### **The Respiratory System- How It Works**

The lungs are part of a group of organs and tissues that work together to help you breathe. The main job of the respiratory system is to move fresh air into the body and get waste gases out. The human respiratory system is made of many different tissues and organs that help us to breathe. Besides the lungs, this system

also includes the nose, mouth, pharynx, larynx, trachea, bronchi alveoli and diaphragm. In order to breathe the body must take air in through the mouth or the nose. Most of the respiratory system is lined with mucous membranes that secrete a clear fluid called mucous. Mucous helps trap particles such as dust, bacteria and viruses to prevent them from reaching the lungs. Air coming in through the mouth doesn't get filtered as it does when you breathe through the nose. This can then lead to respiratory infections or lung damage if bacteria, viruses or foreign particle matter is inhaled. The nose and mouth are connected to a passageway known as the pharynx, commonly referred to as the throat. The pharynx receives air through the mouth and nose to then allow the respiratory system to do its work. The pharynx then splits into two passages, the esophagus and the trachea. The esophagus takes the food to the stomach, while the trachea diverts the air from the nose and mouth to the lungs. A flap of tissue called the epiglottis covers the opening of the trachea during swallowing to prevent food from going down it. Below the pharynx lies the larynx, otherwise known as the voice box which houses the vocal chords that vibrate as air is expelled from the lungs. The trachea or windpipe is the major airway for the body, made of hard cartilage that sits below the larynx. Also lined with mucous membranes to help trap foreign particles from entering the body, and expel them from the body through coughing or sneezing (Lew 2010.)

The air that comes into the body through the lungs contains oxygen and other gases. The oxygen is moved into the bloodstream and then filtered throughout the body. Oxygen cells are exchanged for carbon dioxide which is then returned to the lungs via the bloodstream and expelled through the exhaling. Additional roles to the breathing process include bringing air to the appropriate body temperature, protecting the body from harmful substances and the sense of smell ("The Respiratory System" [www.lung.org](http://www.lung.org))

### **The Respiratory System- How It Responds to GMOs**

Many different things can affect breathing. If respiratory organs are damaged or improperly developed respiratory illness will occur. Illness or disease however is the most common cause for breathing problems. One of the more common illnesses known as asthma, a chronic inflammation of the airways causes those who suffer from it to become very sensitive and react strongly to irritants like dust, pollen and smoke. Different people respond differently to such triggers also linked to mold, certain foods, or respiratory infections. Family history and allergies are closely related to the onset of asthma. Another possible link is genetically modified crops and the dust that affects crop producers as well as the food itself. A common factor in crop production for many places in rural America is dust. A study done in northwest Iowa, sampled dust from inside hog buildings and corn fields during harvest times. These samples were taken from fields where Liberty, an herbicide that contains glufosinate, was commonly used. The samples were sent to Midwest labs for a mold count and an identification test (Dust Study, Is there More to the story About GMOs? <http://farmandranchfreedom.org>.)

"The results are as follows: Hog dust Liberty Link Corn Dust Roundup Ready corn dust Total mold count 14,000 cfu/g 7,200,000 cfu/g 5,600,000 cfu/g; Aspergillus 10,000 cfu/g 7,000,000 cfu/g 15,600,000 cfu/g and Penicillium 3,000 cfu/g 200,000 cfu/g ." (Dust Study, Is there More to the story About GMOs? <http://farmandranchfreedom.org>.)

After having received the results concerns around the quality of the air being breathed in and around these areas called for caution. The labs strongly suggested that workers in these areas needed to wear a protective breathing apparatus, because if Aspergillus spores infect a person's lungs, there is no antibiotic that can stop the mold from spreading. This infection can result in a persistent cough, respiratory discomfort and in some cases death. One cause of this mold stems from a decrease in beneficial fungi in soil as a result of the

glyphosate herbicide. This decrease in the fungi causes an increase in disease causing fungi infecting not only the environment from which the food grows but the people who later ingest it. Additional stories about people in agriculture production developing respiratory problems associated with grain dust. Some examples include, "One gentleman has a job unloading grain (soybeans and corn) at a local elevator at harvest time. Within days of beginning to unload grain in the fall he comes down with a bad head cold that lasts for more than a month. Before the widespread use of Roundup Ready corn and soybeans he did not have this problem. Another farmer shared that his brother came down with pneumonia after cleaning out his grain bin which contained Roundup Ready corn." "Dust Study, Is there More to the story About GMOs?" <http://farmandranchfreedom.org>

These are just a few examples of how the respiratory system reacts when organisms are genetically modified, grown and ingested. For the most part, breathing is automatic and although some problems cannot be avoided, paying attention to your diet and practicing healthy habits and preventative care can help.

## **Tinkering With Nature- A Slippery Slope**

---

This tinkering with nature in crop production not only affects human health, but the health of the environment from which it grows and its dependent ecosystem. "Perhaps the most poignant risk from genetically modified plants occurs at the environmental level" ("What you should know About Genetically Modified Foods" <http://environmentalcommons.org>.) As noted in the study of the soil from the genetically modified crops above, once genetically modified seeds are introduced to an area, there is nothing known to science today on how to reverse the effects of its contamination. This is because GMOs cross pollinate and can spread throughout the environment by means of the wind, insect pollination or other methods of transfer. "The foreign genes can cross with and contaminate these other species, resulting in a hybridization of the genetically modified crop plant with a non-GMO plant. This could radically alter entire ecosystems if the hybrid plants thrived" (The Dangers of GMOs <http://www.naturalnews.com>.)

Other studies have proved that pesticide producing crops can contaminate nearby streams, therefore effecting aquatic life. Because the BT toxin that is produced by genetically modified crops are stronger than any found in nature, beneficial insects such as bees and butterflies are harmed. "Bees are hugely important in the pollination of many food crops, but are unfortunately extremely endangered by modern agricultural techniques, such as GM crops. Monarch butterflies are specifically at risk from GMO maize plants. In addition to bees and butterflies, birds are also at risk from pesticides, and work as biological control agents and pollinators" (The Environmental Impact of GMOs" <http://www.onegreenplanet.org>.) The connection lies in genetically modified seeds lead to genetic modification of the flower pollen. The pollen that is modified can cause the bees to become malnourished and die due to lack of nutrients and an interrupt the bee's digestion process.

Finally, biodiversity is put at risk by GMOs because when they are planted, many heritage seeds are no longer used. "The nature of GMOs means fewer weed flowers and, therefore, less nectar for pollinators. Toxins released into the soil through the plants' routes mean fewer soil bacteria, which are integral to healthy soil for plants to grow without the use of chemical fertilizers. Toxic residues are left in the soil of GM crops. Nutrients are not returned to the soil in mono crops and from GMO foods, meaning that soil is becoming dry and void of all nutrients, generally integral to the growing process. A cycle of dependence on GMO seeds and chemical fertilizers, pesticides, and herbicides is then created in order to grow a single crop. In addition to soil issues,

the irrigation used to grow GM foods naturally carries all of these problems into water sources and into the air. This exposes different bacteria, insects, and animals to the same problems" ("The Environmental Impact of GMOs" <http://www.onegreenplanet.org>.)

## **The Consumer's Right to Know - How to Avoid GM foods?**

---

Genetically engineered foods saturate our diet. Over eighty percent of all processed foods in the U.S. alone contain them. Other products such as rice, corn, wheat, soy products, vegetable oils, soft drinks, salad dressings, fruits, vegetables, dairy products, eggs, meat and animal products contain a hidden array of additives. Independent studies have shown the potential dangers these modifications have towards our health. Consumers however, are often left in the dark because most parts of the United States are prohibited from including them on food labels. Although over 67 bills are currently being written or are under investigation waiting to be passed among 25 states, only 2 states, Connecticut and Maine have passed into law proper identification of any food or ingredient to be labeled if it was genetically engineered. In some municipalities in Burlington, Vermont bans on GE crops are in affect but the state legislation has not been passed as like some counties in California. Those legislations opposed to labeling GM products do so mostly for financial reasons and argue that the changes will also affect the cost of food, allowing the consumers' shopping bill to increase by as little as a few dollars to nearly a 10 % increase in the total cost of the bill. ("The Price of Your Right to Know" <http://www.slate.com>)

We all have a right to know what is in our foods. If you pick up any product from the shelf in a grocery store the list of ingredients should not look like an endless list. More importantly the ingredients that are in the product you are buying should be labeled if they have been or come from a source that has been genetically engineered. Avoiding GMOs is not easy but there are couple ways to exclude them from your diet. Two surefire ways include not buying processed foods, but rather certified organic. " GE ingredients. aspartame, corn flour, soy flour, sugar (unless it's cane sugar), corn syrup, maltodextrin, high fructose corn syrup, vegetable oil, xanthan gum and dozens more, are all ingredients found in thousands of processed foods that are likely made with GE components." There are also online resources such as The Center for Food Safety and the Non-GMO Project where you can print out guides on avoiding GE products. When choosing fruits and vegetables that are not often labeled can also be difficult because of cross pollination. The bottom line is that many products are strewn with GMOs whether added through production or added as a result of the food the animal it came from was fed or raised by. Among the top ten foods that would need to be avoided include meat, milk, tofu, canned foods, frozen foods, vegetable, canola and soy oils, baby formula, cereals, carbonated soft drinks and sweetened juices. (Ten Foods That You Would Have to give up to Avoid Eating GMOs [www.dailyfinance.com](http://www.dailyfinance.com))

## Food for Thought - Concluding Statements Support why Other Countries...Just Say NO!

---

Until consumers have the right to labeling is important to know which countries are growing GM crops and what foods are produced . Currently many countries have bans on GM crops. "Owing to concern about the dangers and risks posed by genetically engineered organisms, many governments have instituted total or partial bans on their cultivation, importation, and field-testing. A few years ago, there were sixteen countries that had total or partial bans on GMOs. Now there are at least twenty-six, including Switzerland, Australia, Austria, China, India, France, Germany, Hungary, Luxembourg, Greece, Bulgaria, Poland, Italy, Mexico and Russia. Significant restrictions on GMOs exist in about sixty other countries." ("Twenty Six Countries have ban GMOs- Why Won't the U.S.? <http://www.thenation.com>) Four regions in Italy: Tuscany, Molise, Lazio and Marche around 25 provinces and cities have adopted bans on GE crops. Austria, Germany, Luxembourg, Portugal, Norway, Ireland, New Zealand and Thailand have GE crop bans on at least one product- the BT corn. Other countries like France and Greece have bans on rapeseed, while still others like Saudi Arabia, Algeria and Egypt have banned food that has been genetically engineered from being imported .The planting of GE seeds is prohibited by law in Brazil and Paraguay. Switzerland has banned all GM crops, animals and plants on all fields and farms. "Restrictions on trade in GMOs based on phyto-sanitary grounds, which are allowed under the World Trade Organization, have increased. Already, American rice farmers face strict limitations on their exports to the European Union, Japan, South Korea and the Philippines, and are banned altogether from Russia and Bulgaria because unapproved genetically engineered rice "escaped" during open-field trials on GMO rice. Certain Thai exports—particularly canned fruit salads containing papaya to Germany, and sardines in soy oil to Greece and the Netherlands—were recently banned due to threat of contamination by GMOs." ("Twenty Six Countries have ban GMOs- Why Won't the U.S.? <http://www.thenation.com>.) This is not an all-inclusive list and yet this information is eye-opening and begs the question, "Why?"

One of the top five arguments that support the ban on GMO's in the countries mentioned earlier is largely due to the fact that genetic engineering disrupts the sequence of a food's genetic code, therefore disturbing the functions of genes giving rise to potentially toxic or allergenic molecules. "The Bt toxin used in GMO corn, for example, was recently detected in the blood of pregnant women and their babies, with possibly harmful consequences." ("Twenty Six Countries have ban GMOs- Why Won't the U.S.? <http://www.thenation.com>.) The second most widely used argument suggests that once a GMO crop is released in the open it can reproduce during pollination causing genetic contamination. "According to a study published in Nature, one of the world's leading scientific journals, Bt corn has contaminated indigenous varieties of corn tested in Oaxaca, Mexico." ("Twenty Six Countries have ban GMOs- Why Won't the U.S.? [www.thenation.com](http://www.thenation.com)) Other arguments have shown proof that GMO's in natural surroundings can have a toxic effect of its habitat. It is known that the benefits of GMOs have been wrongly oversold when no substantial evidence has been shown that GM crops yield more, but rather result in an infestation of new superbugs given crops, insects and nearby wildlife developing resistance to BT. This then leads to a greater use of pesticides, harmful to humans and animals alike. "A fifth argument is that patented GMO seeds concentrate power in the hands of a few biotech corporations and marginalize small farmers. "While profitable to the few companies producing them, GMO seeds reinforce a model of farming that undermines sustainability of cash-poor farmers, who make up most of the world's hungry. GMO seeds continue farmers' dependency on purchased seed and chemical inputs. The most dramatic impact of such dependency is in India, where 270,000 farmers, many trapped in debt for buying seeds and chemicals, committed suicide between 1995 and 2012. Some studies have sought to counter these accusations against GMOs, but they have been discredited by revelations that they were funded

by biotechnology firms or conducted by researchers close to them." ("Twenty Six Countries have ban GMOs- Why Won't the U.S.? <http://www.thenation.com>.)

This explains why other countries have banned the growth and sale of genetically modified crops, yet fuels the mystery as to why the United States hasn't fully adopted this plan. "The most authoritative evaluation of agriculture, the *International Assessment of Agricultural Knowledge, Science and Technology for Development* , determined that the current GMO's have nothing to offer the goals of reducing hunger and poverty, improving nutrition, health and rural livelihoods, and facilitating social and environmental sustainability" ("GMO Food Health Disaster" [www.mindbodyhealth.com](http://www.mindbodyhealth.com))

Hopefully due to spreading the word about this very heavy topic, more people will speak up and more legislatures will listen.

## Lessons

---

### Lesson 1- What is DNA? Extraction of Banana DNA

Purpose: The structure of a DNA molecule is impossible to see with the naked eye, however if you could remove DNA from a pile of your cells you would see a heap of it.

Materials: 4 teaspoons of rubbing alcohol, one banana, one quart sized zip top plastic bag, one liquid measuring cup, one fourth cup of distilled water, two tablespoons of distilled water, measuring spoons, 2 teaspoons of dishwashing soap, 2 small plastic cups, one half teaspoon of salt, one craft stick, one coffee filter, a rubber band, a thin drinking glass and a bamboo skewer. Procedure: In order for this to work, the alcohol needs to be very cold. Put the bottle of rubbing alcohol into the freezer for one or two hours before beginning. Next, peel the banana and put half of it into a zip top plastic bag. Measure and add one fourth cup of water to the bag. Seal the bag and mash the banana and water mixture for three minutes. Be sure you are left with a smooth paste. Measure and pour in the dishwashing soap into one of the plastic cups. Measure and add the salt and two tablespoons of water to the cup. Stir slowly with a craft stick until everything is well mixed and the salt is dissolved. Try to avoid bubbles as much as possible. Then measure and add 2 teaspoons of the water/ mashed banana mixture to the soap solution. Stir slowly for five minutes. Place a coffee filter on the top of another plastic cup and allow the filter to dip into the cup without touching the bottom. Place a rubber band at the top of the filter to secure it in place. Lastly, pour the banana/ soap mixture into the coffee filter. After 10 minutes remove the filter and add two teaspoons of the liquid into the drinking glass. Using the alcohol from the freezer, pour it down the side of the jar. The alcohol will make a layer on the top of the banana /soap mixture. After about five minutes a white jelly-like substance should form between the layers. Use the bamboo skewer to scoop up the jelly-like substance, otherwise known as the banana's DNA!

Conclusion: All living things contain DNA in their cells. Although an individual DNA cell is too small to see, when many clump together you can actually pick it up. Because a banana has billions of cells, mashing it can help break them apart and with the help of other chemicals, DNA can be extracted.

(Lew 2012)



## Lesson 2- From Seed to Supermarket

Purpose: Students will consider the prevalence of genetically modified seeds in the food supply, determine the relationship between biodiversity and food security and select the three most important benefits and controversies related to GMO's and write an opinion/ position paper supporting their ideas with evidence.

Materials: Computer that allows access to online video clips. Procedure: Hook the children by having them view a 10 minute clip entitled "From seed to Supermarket." The clip can be found

here:[www.youtube.com/watch?v=BIOGBkxurb](http://www.youtube.com/watch?v=BIOGBkxurb). Students should take notes on the concerns surrounding genetically modified seeds. Following the clip, discuss the following talking points: "When companies invested resources in developing genetic material, should they have the right to patent it? Why or why not? How might keeping seeds in the public domain affect biotechnology? What happens when genetically modified seeds fail or become vulnerable to certain pests or crop disease?" Conclusion: Students should review the lists of benefits and concerns of genetically modified seeds and explain the significance of the factors in their position paper.

As an extension students can also explore the issue with food labeling and write a position paper about eating foods that have been genetically modified but are not properly labeled. Adapted from "The Impact of Genetically Modified Foods (<http://www.pbs.org/pov/foodinc/lessonplan3.php>)

## Lesson 3 - GMO Seed Investigation Purpose

GMOs, or 'Genetically Modified Organisms,' are plants or animals that have been genetically engineered with DNA from bacteria, viruses or other plants and animals. Nearly all GMOs are engineered to withstand herbicide and/or to produce insecticide. Despite what the industry promises, many GMO traits currently on the market, do not enhance nutrition or provide any other consumer benefit. Meanwhile, some evidence connects GMOs with health problems, environmental damage and violates farmers' and consumers' rights. We want to know what type of plant, genetically modified or wild type is healthier for human consumption and the environment?

Materials: Six 11 cm. planters, Six 25 cm. planters, Thirty genetically modified soybean seeds, Thirty genetically modified corn seeds, Thirty wild soybean seeds, Thirty wild corn seeds, Three bags of sterile potting soil Rulers (class set), Hand Lens (class set), Measuring Scale in grams, Plastic Wrap, Sun Lamp, Water Safe Test Kit, Soil Testing Kit. Procedure: 1) Observe and record observations of the genetically modified soybeans and corn seeds with a hand lens. 2) Observe and record observations of the wild type soybeans and corn seeds with a hand lens. 3) Trace, measure and weigh the seeds and record data. 4) Soak the soybeans in warm water for 30 minutes, prior to planting. 5) Label three 6 cm pots "GMO" and three 6 cm pots "WT" (wild type.) 6) Test the soil and water quality prior to planting, using the water safe test kit ( lead, bacteria, pesticides, nitrites, nitrates, chlorine, hardness and PH) and healthy soil test kit (PH, nitrogen, phosphorus, potassium.) 7) Fill the six 6cm pots with potting soil 8) Label three 6 cm pots "GMO soybean" and three 6 cm pots "WT soybean" (wild type.) 9) Label one 11cm pot with "GMO corn " and one 11 "WT corn" 10) Fill the two 11 cm pots with potting soil 11) Poke a hole about 4cm down in each of the pots. 12) Place two 13) GMO soybeans in each hole in each of the three pots. 14) Place two WT soybeans in each hole in each of the three pots. 15) Place two GMO corn seeds in each hole in one pot. 16) Place two WT corn seeds in each hole in one pot. 17) Cover all plants with soil and pat down 18) Feed each soybean plant with 100 ml of water. 19) Feed each corn plant with 200 ml of water. 20) Cover the plants with plastic wrap. 21) Place the plants under a "sun" lamp. 22) Observe growth and quality of plant. 23) Test the soil and water quality after 16 weeks of growth, using the water safe test kit ( lead, bacteria, pesticides, nitrites, nitrates, chlorine, hardness and PH) and healthy soil test kit (PH, nitrogen, phosphorus, potassium.) 24) Record Data and Results, Formulate Conclusions. Conclusion: Students will record and graph data throughout their observations of the plant growth as they test their hypothesis in relation to the purpose of this experiment. Through this experiment students should note that the growth of the genetically modified seeds is faster and appears stronger, but

after 16 weeks changes in the water and soil testing will occur. Extension: Following this experiment, students can further investigate how GMOs put our ecosystem at risk. Students can create 2 ecosystems within separate terrariums where students can compare and contrast how genetically modified seeds/ foods affects the living organisms that surround it . Students can use organic heirloom tomatoes including their seeds in the GMO free terrarium and use non organic tomatoes in the other. Tomatoes that have been genetically modified usually will not reproduce because they are intentionally bred to not give off many seeds so to keep the crop in need for commercial reasons. Students can be creative in their choice of living organisms from leaf matter and red worms to crickets or even a snake. This lesson has been adapted and changed from another experiment "May The Best Plant Win" found at <http://www.sciencebuddies.org>.

#### **Lesson 4: Evaluating Information on Food Labels**

This lesson plan utilizes the film and POV's website resources for Food, Inc., a documentary that examines food in the United States and the industry that produces it. Students can use these materials to explore what consumers should be able to learn about food from Nutrition Facts panels. Students' eyes will be opened at the amount of food that contains the hidden ingredient, CORN! This is especially important given that corn is one of the most highly genetically modified vegetable. Objectives: Students will use viewing skills and strategies to understand and interpret a film clip, identify corn-derived ingredients listed on Nutrition Facts panels of food packaging, analyze and discuss what details should be provided on Nutrition Facts panels and develop personal philosophy statements about what consumers should be able to learn about their food from Nutrition Facts panels. Handout that lists all the ingredients that contain corn: Alpha tocopherol, Ascorbic acid, Baking powder, Calcium stearate, Caramel, Cellulose, Citric Acid, Citrus cloud emulsion, Corn flour, Corn oil, Cornstarch, Corn syrup, Dextrin, Dextrose (glucose), Diglycerides, Ethylene, Ethyl acetate, Ethyl lactate, Fibersol-2, Fructose, Fumaric acid, Gluten, Golden syrup, High fructose corn syrup, Inositol, Invert sugar, Malt, Maltodextrin, Margarine, Monoglycerides, Monosodium glutamate (MSG), Polydextrose, Saccharin, Semolina, Sorbic Acid, Sorbitol, Starch, Sucrose, Treacle, Vanilla extract, White vinegar, Xanthan gum, Xylitol, Zein. Procedure: Hook the students by viewing the film clip- Clip from Food, Inc.: "A Cornucopia of Choices" (length 4:55) This clip can be found at <http://www.youtube.com/watch?v=xThSnJb8miQ> Teachers should view the film first to make sure it is grade level appropriate. You can always have the students listen only to the sound for the information as well. 1. For this activity, ask each student in advance to bring in a food container or a food label that has a Nutrition Facts panel on it. 2. Begin the activity either by showing the class an image of a cheeseburger, French fries and a milkshake or by placing the real thing on a table at the front of the classroom. Ask students what these three foods have in common. Let students share their ideas, and then explain that they are all made with or from corn. The meat comes from corn-fed cattle, the bun and condiments contain high fructose corn syrup and the fries are cooked in corn oil. Even the shake contains corn syrup solids and cellulose gum derived from corn. Often, people will order a soft drink with a burger instead of a milkshake, and soft drinks, too, contain high fructose corn syrup. In fact, a study of fast food published by the National Academy of Sciences found that 160 food products purchased at Wendy's restaurants across the United States all contained some form of corn. 3. Explain that many of the foods available at the grocery store also contain corn. Then, show the film clip. Set up the clip by telling students that Michael Pollan is an author who has written books about the U.S. food industry. 4. Display or distribute the list of corn-derived ingredients provided in the Materials section of this lesson plan. Have groups of three or four students examine the ingredients listed on their food packaging and make a list of any corn-based ingredients they find. If an ingredient is found on more than one package, students can add tally marks next to that ingredient on the list. Ask a member of each group to report that group's findings to the class. 5. Discuss: Which corn-derived ingredients are most commonly found in the sample of foods examined in class? What kinds of food typically contain ingredients derived from corn? Do students consider these foods "healthy"? Why or why not? How

frequently do students eat these foods? How do students feel about the idea that corn has been "hiding" in these foods, often behind different names? How frequently do students read the Nutrition Facts panels on the foods they eat? How much do students want to know about the ingredients in their food? Who should decide what information is provided on food labels? Consumers? The government? The food industry? 6. Conclude the activity by challenging students to write individual personal philosophy statements about what consumers should be able to learn about their food from Nutrition Facts panels. Extensions; Learn more about your school's cafeteria food. Develop a class set of standards to measure the quality of school lunch. Conduct an informal study that examines how menu labeling affects our eating choices. Prepare two sets of fast-food menus with a variety of typical fast-food items plus pictures, prices and names for each. On one set of menus, also show the related calories for each item. Invite some other classes or a group of students in the cafeteria to look at a menu and circle the foods they would choose for themselves. Then, analyze the resulting data and form conclusions. This lesson plan has been adapted from <http://www.pbs.org/pov/foodinc/lessonplan1.php#resources>

## Implementing District and National Standards / Common Core

---

Connecticut state standards for health and science dictate that students must make observations and ask questions about objects, organisms and the environment, use senses and simple measuring tools to collect data, make predictions based on observed patterns, read, write, listen and speak about observations of the natural world. Second grade students need also to meet standard 2.2 - How are organisms structured to ensure efficiency and survival? Students need to investigate the life cycles of living things. Additionally, students must master science standard 2.4 -Human beings, like all other living things, have special nutritional needs for survival, and be able to answer the question, "How do science and technology affect the quality of our lives?" This unit will address these standards by allowing students hands on, inquiry based learning that involves asking questions and using observation and measurement to make predications and connections to the world around us. Students will understand the life cycle of plants as well as the necessity for balance in nature.

## Reading List

---

### Books

Fedoroff, Nina V., and Nancy Marie Brown. *Mendel in the Kitchen: A Scientist's View of Genetically Modified Foods* . Washington, D.C.: Joseph Henry Press, 2004.

Mendel in the Kitchen outlines the concerns surrounding GMO.

Gardner, Robert. *Genetics and Evolution Science Fair Projects: revised and expanded using the scientific method*. Berkeley Heights, NJ: Enslow Publishers, 2010. An excellent resource for teachers to bring DNA alive through experiments and lessons.

Hoffmann, Gretchen. *Digestive System*. New York: Marshall Cavendish Benchmark, 2009. A teacher and student friendly text that outlines the digestive system.

Jones, Dara. *Foreign Invaders: An Autoimmune Disease Journey*. Kindle: Difference Press, 2013. An informative book that tracks the health risks associated with GMOs. Klosterman, Lorrie. *Reproductive System*. New York: Marshall Cavendish Benchmark, 2010. This resource helps students understand the workings of the reproductive system. Lew, Kristi. *Cool Biology Activities for girls*. Mankato, Minn.: Capstone Press, 2012. A student and teacher friendly resource explains the human body systems in a crafty way.

Lew, Kristi. *The Respiratory System*. Tarrytown, NY. :Marshall Cavendish Corporation, 2010. This text provides information about the wiring of the respiratory system.

Macaulay, David, and Richard Walker. *The Way We Work: Getting to Know the Amazing Human Body*. Boston: Houghton Mifflin, 2008. A comprehensive resource that reveals the inner workings of the human body.

Merchant, Sabeeha, Winslow R. Briggs, and Vicki L. Chandler. *Annual Review of Plant Biology*. Palo Alto, Calif.: Annual Reviews, 2008. In this review, Peggy Lemaux analyzes genetically engineered plants and foods along with their controversial issues.

Parker, Steve. *The Human Body Book*. New York: DK Pub., 2007. This guide of the human anatomy uses 3D images to reveal the complexity of the human body.

Parker, Steve. *Children's Human Body Encyclopedia: Discover How Our Amazing Bodies Work*. Bath, UK: Parragon, 2007. A clear guide as to how our body works.

Smith, Jeffrey M. *Seeds of Deception: Exposing Industry and Government Lies About the Safety of the Genetically Engineered Foods You're eating*. Fairfield, IA: Yes Books, 2003. Although some say GM food is safe, this gives evidence to prove otherwise.

Smith, Jeffrey M. *Genetic Roulette: The Documented Health Risks of Genetically Engineered Foods*. Fairfield, Iowa: Yes Books, 2007. This book describes both research studies and theoretical risks associated with GMOs.

## Online Resources

"Rediscovering Biology- Molecular to Global perspectives- Genetically Modified Organisms" [www.learner.org](http://www.learner.org). This website provides teacher professional development and classroom resources across the curriculum.

"From Agent Orange to Pesticides and Genetically Engineered Crops" <http://www.globalresearch.ca>. This educator friend website provides global research for educational outreach and humanitarian projects.

"GMOs – Pros and Cons" <http://ireport.cnn.com/docs/DOC-957532>. This website provides nutritional reports by doctors as reported by CNN.

"What are GMOs?" [www.nourishingmeals.com](http://www.nourishingmeals.com). This website provides information on what GMOs are and how to avoid them, as well as recipes for healthy non-GM food.

"Genetically Modified Organisms" <http://enhs.umn.edu>. This website is attached to a Fall semester 2003 course on exposure to environmental hazards.

"The Immune System" <http://kidshealth.org>. This website provides health care information for children, parents and educators. The educator link provides free lessons.

"Do GMOs Cause Digestive Disorders?" <http://stellametsovas.com>. This website is Stella Metsovas' personal website that provides health and nutrition research. Stella, is a globally recognized clinical nutritionist and media health expert.

"The Respiratory System" [www.lung.org](http://www.lung.org). This is the American Lung Association website that provides research on how to stay healthy and proactive in lifestyle decisions.

"Dust Study, Is there More to the story About GMOs?" <http://farmandranchfreedom.org>. Farm and Ranch Freedom Alliance (FARFA) is a national organization that supports independent family farmers.

"GMO Food Health Disaster" [www.mindbodyhealth.com](http://www.mindbodyhealth.com). International bestselling author and filmmaker Jeffrey M. Smith is the leading spokesperson on the health dangers of GMO's. Through this website you have access to excerpts from his books.

"The Hygiene Hypothesis: Are Cleaner Lifestyles Causing More Allergies for Kids?" [www.sciencedaily.com](http://www.sciencedaily.com). This journal provides information on science topics.

"May The Best Plant Win." [http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/Genom\\_p020.shtml](http://www.sciencebuddies.org/science-fair-projects/project_ideas/Genom_p020.shtml). This website provides students and educators alike with a plethora of science experiment ideas.

"Food Inc." <http://www.pbs.org/pov/foodinc/lessonplan1.php#resources> This website provides parents, children and educators free access to a variety of lesson plans.

"A Cornucopia of Choices" <http://www.youtube.com/watch?v=xThSnjb8miQ> The video clip is associated with Documentaries with a Point of View. POV offers free resources for educators, discussion guides and reading lists.

"Doctors Warn -Avoid Genetically Modified Foods." [www.responsibletechnology.org](http://www.responsibletechnology.org)

This article provides references from many case studies on the dangers of GMOs including excerpts from Jeffery Smith's book entitled Genetic Roulette.

"The Price of your Right to Know." [www.slate.com](http://www.slate.com) Slate is a daily magazine on the Web. Founded in 1996, we are a general-interest publication offering analysis and commentary about politics, news, business, technology, and culture. This website is intended for educators rather than young students.

"Twenty Six Countries have ban GMOs- Why Won't the U.S.?" [www.thenation.com](http://www.thenation.com) This website provides educators and students access to free lesson plans and teaching guides about the most up to date current events. Membership is free.

"City vs Country." <http://online.wsj.com/news/articles/SB>. This is the Wall Street Journal online database with extensive up to date information on current events.

"The Environmental Impact of GMOs" <http://www.onegreenplanet.org>. One Green Planet is an online guide that helps people, animals and the environment."

"The Dangers of GMOs" <http://www.naturalnews.com>. Natural News is a science-based natural health advocacy organization that provides research to protect human health. "Ten Foods That You Will Have to Give Up To Avoid Eating GMOs" [www.dailyfinance.com](http://www.dailyfinance.com). Daily Finance contributors give tips to help improve your finances and lifestyle.

"The Impact of Genetically Modified Seeds" [www.pbs.org/pov/foodinc/lessonplan3.php](http://www.pbs.org/pov/foodinc/lessonplan3.php). This website provides parents, children and educators free access to a variety of lessons. Video clip to assist in this lesson is located at [www.youtube.com/watch?v=BIOGBkxurb](http://www.youtube.com/watch?v=BIOGBkxurb)

---

<https://teachersinstitute.yale.edu>

©2019 by the Yale-New Haven Teachers Institute, Yale University

For terms of use visit <https://teachersinstitute.yale.edu/terms>