

# PCR to Detect Genetically Modified Organisms (GMOs)

## *Field Trip Background*

### **Background Information**

All things change over time. This change often is driven by genetic differences in some organisms within a species providing them with an advantage. But evolution through natural selection takes a substantial amount of time. Humans have been driving evolution of some species through artificial selection (selective breeding) for thousands of years. In early farming, seeds from plants that produced desirable traits (taste, color, size, etc.) were saved and used the following season. Also, cross-bred plants or “hybrids” have been developed for many types of crops. In both natural and artificial selection, changes in the species are limited to versions of genes within the species’ genomes. More recent biotechnology has expanded the ability to alter genomes beyond the limit of a species’ genome.

A genetically modified organism (GMO) is a plant, animal, or microbe that has had its genome changed through genetic engineering. Generally, a GMO’s genome has been altered through the use of recombinant DNA technology to add in a gene that is not naturally found in that species. Reasons for creating GMOs include improving the environmental impact of farming, maintaining the health of a species, altering nutrient content of a food, pharmaceutical production, and others. A gene for tolerance of the herbicide glyphosate allows farmers to spray the entire field with the herbicide, killing weeds but the planted crop survives. This reduces competition and damage to the crop plant as well as potentially reducing the environmental impact of farming. The Hawaiian papaya crop was nearly extinct due to Papaya Ringspot Virus. Development of a genetically modified Rainbow papaya with a resistance to the virus saved the Hawaiian papaya industry. Insulin is a hormone that regulates blood sugar levels and people with Type 1 Diabetes do not produce this essential hormone. The first pharmaceutical insulin was purified from cow and later pig. These animal sources were not identical to human and caused numerous complications. Identification of the human insulin gene in the human genome enabled scientists to put a recombinant plasmid into *E.coli* bacteria so they now produce human insulin that can be purified and used as a pharmaceutical.

Today, GMOs are being developed and used world-wide. In the United States, most of our corn and soybeans have been genetically modified. There are a number of methods to introduce a new gene into a plant. The most common recombinant DNA technique utilizes *Agrobacterium*, a soil bacteria, and a plasmid (Ti) which has a promoter from the cauliflower mosaic virus (CMV). Promoters are a sequence of DNA upstream of a gene. It is where transcription of the gene begins. We assume that the presence of this promoter also indicates that the transgene is present because they would both be on the same plasmid. This means we don’t have to change any of our materials to be specific to different transgenes that could be added to the plasmid. In this field trip, we will use the Polymerase Chain Reaction to detect whether corn-based food samples have been genetically modified by amplifying a region of the 35S promoter region of the CMV (195 bp).

### Additional resources

National Geographic (written for grades 5-8): <https://education.nationalgeographic.org/resource/genetically-modified-organisms/>

Nature: <https://www.nature.com/scitable/topicpage/genetically-modified-organisms-gmos-transgenic-crops-and-732/>

GM Crop info from US FDA (includes labeling info): <https://www.fda.gov/food/agricultural-biotechnology/gmo-crops-animal-food-and-beyond>

MiniPCR DNA Dot: GMOs: <https://dnadots.minipcr.com/dnadots/genetically-modified-organisms-gmo>

### Additional GMO-based lesson plans

Grow Next Gen: <https://grownextgen.org/curriculum/gmo-breakout>

NCCSTS case study (Loosey study on *Bt* effects on Monarchs): <https://www.nsta.org/ncss-case-study/butterflies-stomach>

\*case is free through NSTA, teacher guide requires a subscription

National Agriculture in the Classroom (numerous lesson plans on GMOs): <https://agclassroom.org/>

Food Evolution Documentary: <https://foodevolutionmovie.com/>