Since the release of the first genetically modified (GM) crop in the US in 1996, scientists have debated the use of these crops because of potential health and environmental risks. GM foods are foods that contain components of GM crops—plants that have been genetically modified by the insertion of foreign genetic material. The foreign genetic material may have come not only from another plant but possibly from a species of another kingdom (e.g., animal, fungal, bacterial). The foreign genetic material is usually a gene that codes for a protein that gives the plant an advantage over similar crop plants. Examples of conferred traits include pest resistance, herbicide tolerance, delayed fruit ripening, improved fruit yield, increased nutrient content, etc.

How Do You Genetically Modify a Crop?

The first step in the genetic modification process is to identify a protein that has the potential to improve a crop. One popular class of GM crops has a gene from the soil bacterium *Bacillus thuringiensis* (Bt) inserted into their genomes. Bt crops produce a protein called delta-endotoxin that is lethal to European corn borers, a common pest on corn plants. Farmers who plant Bt crops do not have to apply pesticide because the plants produce the toxic protein inside their cells. Bt toxin was first identified on silk farms as a toxin that kills silkworms (which are in the same genus as European corn borers).

The second step is to isolate (clone) the gene that codes for the protein. The entire gene must first be localized within an organism's genome; then it must be copied so that it can be isolated or cloned out of the organism. Although a gene's coding region may just be a few hundred or thousand base pairs long, the gene itself may be tens of thousands of base pairs long, due to its introns (noncoding sequences). The cloning of an entire gene can be very laborious and can take many years.

Genes contain signals that regulate their expression in their host's cells, but these signals are often not understood by another organism's cells. Thus, the third step is to engineer the gene so that the crop plant's cells will read it correctly and manufacture the protein of interest. This is done by streamlining the gene to remove unnecessary introns, and adding or changing sequences that will enable the gene to be expressed within the crop's cells, including a promoter and a terminator (see Figure 1). The promoter serves as a docking site for RNA polymerase and a signal for where it should start transcribing a gene. The terminator is the signal to stop transcription. The native promoters and terminators of unmodified genes interact with other components of a host cell to turn genes on or off depending on cell type and situation, but scientists can engineer the constructs for GMOs so that the foreign gene is continually transcribed and the foreign protein is produced throughout the entire plant. The most common promoter used in GM crops is the 35S promoter from the cauliflower mosaic virus (CaMV 35S). This promoter is chosen because it is already designed by nature to activate transcription in all plant cell types. The most common terminator used in GM crops is the nopaline synthase (NOS) terminator from *Agrobacterium tumefaciens*. The GMO Investigator kit can identify both of these genetic modifications in grocery store food products. One or both of these genetic elements are present in ~85% of all GM crops currently approved around the world.