GMO or OMG?

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Just when it looked like there could be a breakthrough in the application of biotechnology to crops and food plants, a new wrinkle appeared in the form of a scientific development. Genetically modified organisms (GMOs) have been planted for years because they offer advantages for producers or consumers. For instance, there are GMO corn, soybean, and cotton crops that are immune to the effects of common herbicides that are used to control weeds; this makes them easier and more economical to grow. There are new apple varieties genetically modified to produce enzymes so that they do not turn brown when cut open; these are supposed to appeal to consumers who like to have their fruit look as good when cut open even days before as if it was freshly cut. There are vegetables genetically modified to contain higher levels of certain vitamins and other nutrients; these can help alleviate malnourishment in underdeveloped countries. There are genetic changes to crops and food plants that can tolerate climate and environmental changes such as warmer temperatures or brackish irrigation water and still thrive; these may be necessary in order to feed the many billions more people expected to live on Earth in the coming years.

These genetic modifications have come at a price. Most of the new plant (and animal) genomes created to solve these problems contain genes from unrelated species: bacteria, fungi, insects, and other higher level organisms. The fact that these genes are not native to the species in which they have been inserted makes consumers suspicious about their safety. After all, who would want to eat cornmeal or high fructose corn syrup, produced from a corn plant artificially made immune to an herbicide? What other effects might this gene have on human health?

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Many studies have shown that GMO plants are safe for human consumption, but the feeling persists among many that GMO crops are to be treated with suspicion. After all, GMO plants have not been around for a very long time, and long-term effects, if any, have not had enough time to be evaluated.

Then, along came CRISPR, the amazing new method of genetic editing that is more precise and surer than older methods of genetic modification. The old methods were somewhat haphazard in: 1) whether the desired gene was inserted at all in the target cell and 2) was it inserted at the place where it would have the desired effect (would the gene be expressed?). To assure both of these in GMO crops, a second gene was often inserted that gave immunity to the target cell against a common antibiotic. After the target cells were exposed to the two genes (the one conferring the desired primary effect, and the second conferring antibiotic immunity), the cells were exposed to the antibiotic and the only cells to survive were those for which the genetic modification had been successful. So now, the anti-GMO skeptics may have had some reason for their suspicion: there is an extra gene with some antibiotic immunity in at least some of the GMO foods that were being passed on to consumers.

CRISPR allowed genetic editing to take place. The distinction between GMO and genetic editing (GEO) is that genetic editing inserts genes from the same species into target cells. These genes are selected to confer certain characteristics usually

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present in wild relatives of the targeted domestic organisms. Thus, CRISPR can avoid at least some of the issues associated with GMO objections: there are no genes from exotic or xenobiotic species, and there is no need to include extra genes to select successful genetically modified cells from unsuccessful ones. If CRISPR can be used to make convincing the distinction between GMO and GEO, then, perhaps, GEO foods might be found acceptable for those for whom GMO foods are not welcomed.

Then, along came the news that CRISPR has been used to replace or insert, not an entire gene, but only a single nucleotide. This could produce an entirely new gene, one perhaps not present anywhere in nature, and one with unknown consequences (producing a genetically reprogrammed organism, envisioned, for now, only to be used for synthetic biology). All of a sudden, what was a simple distinction based upon using a new biotechnological method could not now be supported; use of the CRISPR method might now lead to more uncertainty and suspicion, and, certainly, many more years of testing with questionable outcomes.

Until recently, CRISPR genetic editing had to occur within the confines of a cell, but now it has been shown possible to edit genetic material in a test tube, outside of the target cell. Once the genetically edited genes have been confirmed to satisfy the goal of the process, they can be inserted into the target cell with some vector, perhaps a virus. With this approach, gene replacement instead of gene editing is possible. Again, this leads to a lot of questions from those who are skeptical of the safety of modified foods.

There is enough controversy surrounding the making of meat from animal cells grown in a reactor. This so-called “synthetic meat” or “fake meat,” as some livestock owners like to call it, is bad enough, although ultimately derived from living animal muscle cells. Imagine the commotion that would arise from the introduction of a synthetic food not originating in a naturally occurring genome related to any other living thing in existence. Although this synthetic food might be much more beneficial to health than any other available food, the stigma attached to its origin would never be acceptable to the majority of consumers.

THEREFORE, THE GMO debate will continue for many more years, until the anti-GMO crowd gives up its resistance (not likely anytime soon), or a sufficient number of years elapse of use of GMO crops without adverse effects that acceptance becomes inevitable. However, with the huge number of environmental toxins to which modern humans are exposed and will be exposed in the years to come, it is not likely that GMO or GEO foods will become universally accepted. Until that unlikely event happens, consumers will have to continue to make personal choices about the acceptability of the substances that they put into their mouths. ■

■ ***Arthur T. Johnson’s*** *research interests include human performance wearing respiratory protective masks, respiratory mechanics and measurement, and transport processes. Johnson received the Ph.D. degree from Cornell University, Ithaca, NY, USA, in 1969. He is a Founding Fellow of the American Institute for Medical and Biological Engineering (1992), Life Fellow of the American Society for Engineering Education (1996), Life Fellow of the American Society for Agricultural and Biological Engineers (2002), Fellow of the American Industrial Hygiene Association (2005), Fellow of the Biomedical Engineering Society (2005), Fellow of the Institute for Biological Engineering (2009), and the Life Fellow of the Institute for Electrical and Electronics Engineers (2010). He is a member of the honor societies including Phi Kappa Phi, Sigma Xi, Tau Beta Pi, and Alpha Epsilon.* ■