

Will Agricultural Biotechnology Lead to the Spread of Antibiotic Resistance?

Bruce M. Chassy, Ph.D.
Professor of Food Microbiology
Professor of Nutrition
University of Illinois Urbana-Champaign
bchassy@uiuc.edu

Introducing a new trait to plants, by inserting DNA into target plant cells, can be a “long shot.” Sometimes only one in a thousand — or even one in a million — plant cells will take up the inserted DNA and incorporate the new gene. So biotechnologists need a “marker” to show up when they have hit the target.

One such marker is antibiotic resistance. If genes for antibiotic resistance are linked to genes for the desirable trait, researchers can single out plant cells that have been transformed successfully by exposing all cells to an antibiotic. Plants cells that successfully incorporated the combined genes (for the desirable plant trait and for antibiotic resistance) will survive the antibiotic test and will grow into little mounds of transformed plant cells called a *callus*. Then the researchers can isolate cells from the callus and regenerate whole plants with the newly introduced, desired trait. This means, however, that some new varieties of plants with desirable traits, such as insect resistance or herbicide tolerance, may also carry a new gene for antibiotic resistance.

Question: Will biotechnology promote the spread of antibiotic resistance?

Answer: It is natural to wonder if growing millions of acres of biotech crops containing antibiotic resistance marker genes will add to the already growing problem of antibiotic resistance. Scientists and regulatory agencies around the world look very thoroughly at this question before such crops are approved. In order to avoid this possibility, the developers of biotech crops have been asked to follow some simple guidelines with respect to marker genes. The first is that they should not use an antibiotic resistance marker gene that is not already widespread in nature. Secondly, markers that encode resistance to very important and powerful antibiotics, for which there are no good alternatives in medicine or veterinary practice, should not be used at all.

Q: Aren't there alternatives to using antibiotic resistance as a transformation marker?

A: Sometimes other marker systems can be used to detect the desired new varieties. For example, herbicide tolerance genes can be used to make transformed plants resistant to herbicide. Successful transformants can be detected by their ability to grow on media containing herbicides. Scientists are developing other marker systems that do not use antibiotic resistance genes. The trend today is for newly introduced varieties to not contain antibiotic resistance marker genes.

Q: But you're talking about plant systems. What does antibiotic resistance in plants have to do with human health and the bacteria that "bug" us?

A: While it is plausible that the DNA from antibiotic marker genes could be taken up by bacteria in the soil and passed onto other bacteria that then become antibiotic resistant pathogens that cause infection in humans, research has demonstrated that it is highly unlikely. In fact, despite repeated attempts over the last decade, scientists have been unable to demonstrate the transfer of antibiotic resistance genes from biotech crops to bacteria even under the most favorable conditions.

However, there is a second plausible scenario: The marker genes might transfer in the human gut to other gut bacteria that would then be resistant to antibiotics. While there is a remote chance that this could happen, research has again shown that it is highly unlikely. Most DNA is rapidly digested in the mouth and stomach. Very few genes remain intact. Those that do survive digestion would have to compete for entry into bacteria with the large amount DNA that humans ordinarily eat.

Finally, incorporation of a new gene into a bacterium is itself a rare event. If the new gene is inserted, the chance that it will function correctly is miniscule. Remember that many billions of bacteria in the soil and in the human gut already are resistant to the antibiotic marker that was used in the development of the new crop variety.

Q: What's the bottom line? Should I worry about antibiotic resistance in bioengineered plants?

A: It bears repeating that scientists have tried unsuccessfully for years to demonstrate the transfer of marker genes from plants to bacteria. If it occurs in nature, it occurs at an undetectably low rate. This is consistent with the observation that biotech crops containing antibiotic resistance genes have been planted for 12 years on over a billion acres with no observable effect on the incidence of resistance to the antibiotic against which they are resistant.

If you must, worry about antibiotic-resistant infections from hospitals and clinical medical practice. The misuse and overuse of antibiotics in humans, animals and agriculture are the major factors that contribute to the rise of antibiotic resistance. As mentioned earlier, antibiotic resistance genes are already widespread. As consumers, each of us needs to insure that antibiotics are taken at the prescribed dosage for the recommended period of time.

References and further reading

Antibiotic Resistance Markers in Biotechnology

Beever, D.E., and Kemp, C.F., "Safety issues associated with the DNA in animal feed derived from genetically modified crops: A review of the scientific and regulatory procedures," *Nutr. Abstr. Rev. Ser. A*, 70 (2000): 197–204.

Extremely Low Risk of GM Transfer, UK Food Standards Agency, 2002

http://www.food.gov.uk/news/newsarchive/2002/jul/gm_reports

FAO WHO 2000 Report: Safety Aspects of Genetically Modified Foods of Plant Origin. 2000. pp. 11–13 http://www.who.int/foodsafety/publications/biotech/ec_june2000/en/

IFT Expert Report on Biotechnology and Foods. 2000. pp. 16–17
http://members.ift.org/IFT/Research/IFTExpertReports/biotechfoods_report.htm

Antibiotic Resistance

Alliance for the Prudent Use of Antibiotics, <http://www.tufts.edu/med/apua/home.html>.

Antibiotics: a Growing Threat, http://www.fda.gov/oc/opacom/hottopics/anti_resist.html.

Levy S.B., “The challenge of antibiotic resistance,” *Scientific American* 278, no. 3(1998): 32–39,
<http://www.tufts.edu/med/apua/Pubs/Articles/sciAmArt.pdf>

Microbes: What Doesn’t Kill Them Makes Them Stronger, <http://whyfiles.org/038badbugs/>.