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Biotechnology INSTITUTE

The Biotechnology Institute is an independent, national, nonprofit organization dedicated to education and research about the present and future impact of biotechnology. Our mission is to engage, excite, and educate the public, particularly young people, about biotechnology and its immense potential for solving human health, food, and environmental problems. Published biannually, *Your World* is the premier biotechnology publication for 7th- to 12th-grade students. Each issue provides an in-depth exploration of a particular biotechnology topic by looking at the science of biotechnology and its practical applications in health care, agriculture, the environment, and industry. Please contact the Biotechnology Institute for information on subscriptions (individual, teacher, or library sets). Some back issues are available.

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Biotechnology & You

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Changing for the Better

What's up with "genetically modified organisms"?

You're holding a magazine made of paper. No duh. Maybe you don't know how tough on the environment making paper is—or how altering aspen trees could help the situation.

Separating the useful tree fibers—the cellulose—from the stuff that binds them together, called lignin, requires harsh alkaline chemicals and high heat. It's surprisingly expensive, pollutes the air, takes enormous amounts of water that reduce fresh water sources for fish and other organisms, and raises the temperature that they live in to unsafe levels.

Main Points

Genetic exchange takes place in nature all the time. Humans have been employing biotechnology—using living organisms to solve problems and create products—for thousands of years in such ways as breeding animals and plants and making bread and wine. This work went to a molecular level when scientists figured out how to pluck a gene for a specific trait from one living organism and place it into another organism in a way that transferred that gene's capabilities to the other organism.

Animals, microbes, and plants can be genetically changed. A genetically modified, gene-altered, or biotech organism is sometimes called transgenic, which means that the organism's genome has been altered by the transfer of a gene or genes from another species or breed. The gene(s) become part of the sex cell and can be passed on to future generations.

Broadly speaking, the introduction of genetically modified organisms into agriculture in the last 10 years has been accompanied by controversies over their potential impact on human health, the environment, and farming systems. Issues of managing these powerful new technologies have engaged both advocates and opponents of their use. Understanding the science and safety assessment framework involved is an important foundation for deciding how, when, and where to use the technology.

Careers related to this growing field range far and wide, from safety assessment to foreign policy to ethics. Think about how your interests can play a part in the wide world of biotechnology.

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Paul A. Hanle
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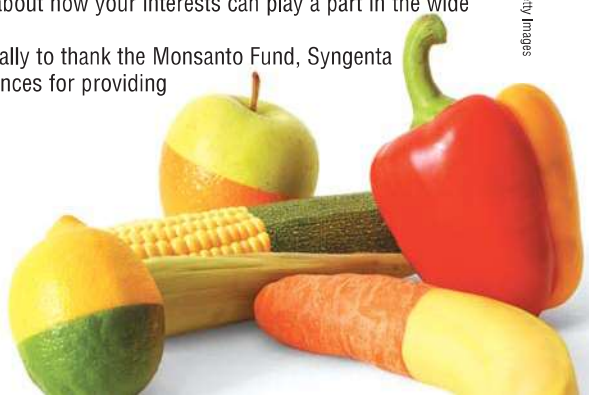
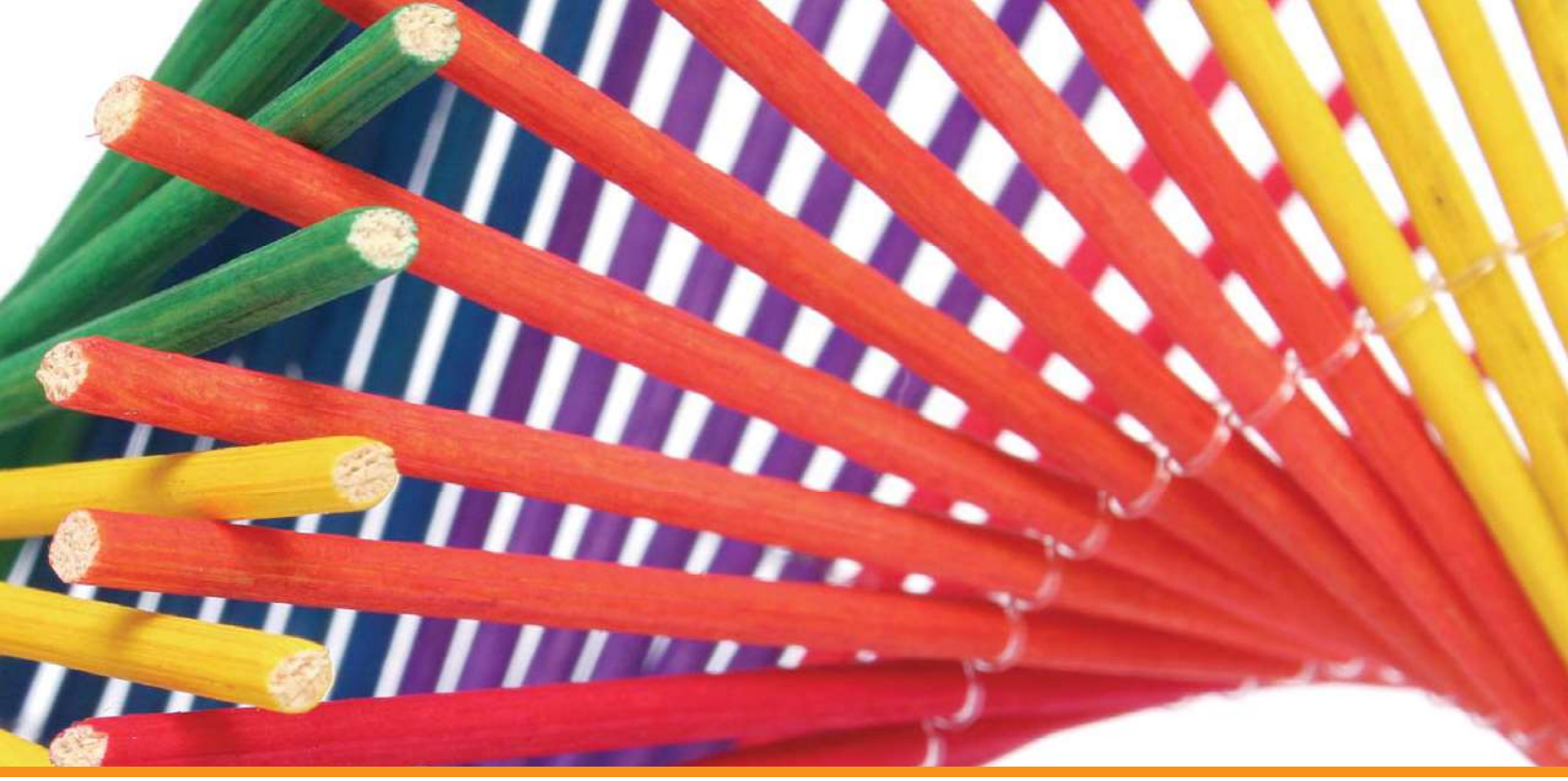


Photo: Dan Burn-Forti/Getty Images



But modifying the output (expression) of two genes in aspen trees can reduce the lignin by about half, produce more cellulose, and make the trees grow faster. Producing fast-growing, low-lignin trees as "crops" would also help conservationists save existing forests.

This technology is called genetic modification, and its products sometimes are called genetically modified organisms, or GMOs.

A dazzling variety of organisms have been genetically modified (GM) and in as many different ways. Plants, animals, and microbes that have been changed include soybeans, corn, tobacco, mice, fruit flies, and *Escherichia coli*. Sometimes genes from one species's genome are inserted into the genome of another species. Sometimes a gene is changed to make it produce more, less, or a different product than it would naturally.

What do you think about eating foods that have been bioengineered? It's been happening for a long time. Because genetic modification has become so useful in developing hardy crops, most packaged foods contain the products of biotechnology.

Uses of bioengineering include boosting production; protecting species from disease (including human illnesses), pests, or extinction; and protecting the environment.

In agriculture, researchers have used bioengineering, for example, to increase the vitamin A content of rice, to allow corn to produce a natural insecticide known as Bt toxin, and to make soybeans resistant to weed-killing chemicals.

In animals, among other things, transgenic mice are helping scientists as they search for answers to biological questions. Transgenic sheep and goats can produce human and other specific proteins in their milk. Biotech chickens can synthesize human protein in their eggs. A GM bacterium might serve as an oral contraceptive for feral cats, humanely solving the problem of animal overpopulation. The possible applications go on and on.

Controversies surround scientists' ability to modify the organisms' genomes. Some people worry about food safety; others predict nightmare scenarios involving humans. Genetic modifications are heavily regulated by the federal government, however. But this technology has also been used to save lives, feed expanding populations, and offer scientists insights into the workings of life. Changing an organism's genome is therefore one of the most important, and one of the most visible, parts of modern biotechnology.

—Lois M. Baron

Genetic Modification Is Not the Same as Cloning

GENETIC ENGINEERING

- **Produces a totally unique set of genes**
- **Genes can be swapped across species**

CLONING

- **Produces exact copies**
- **Genes replicated within the same species**