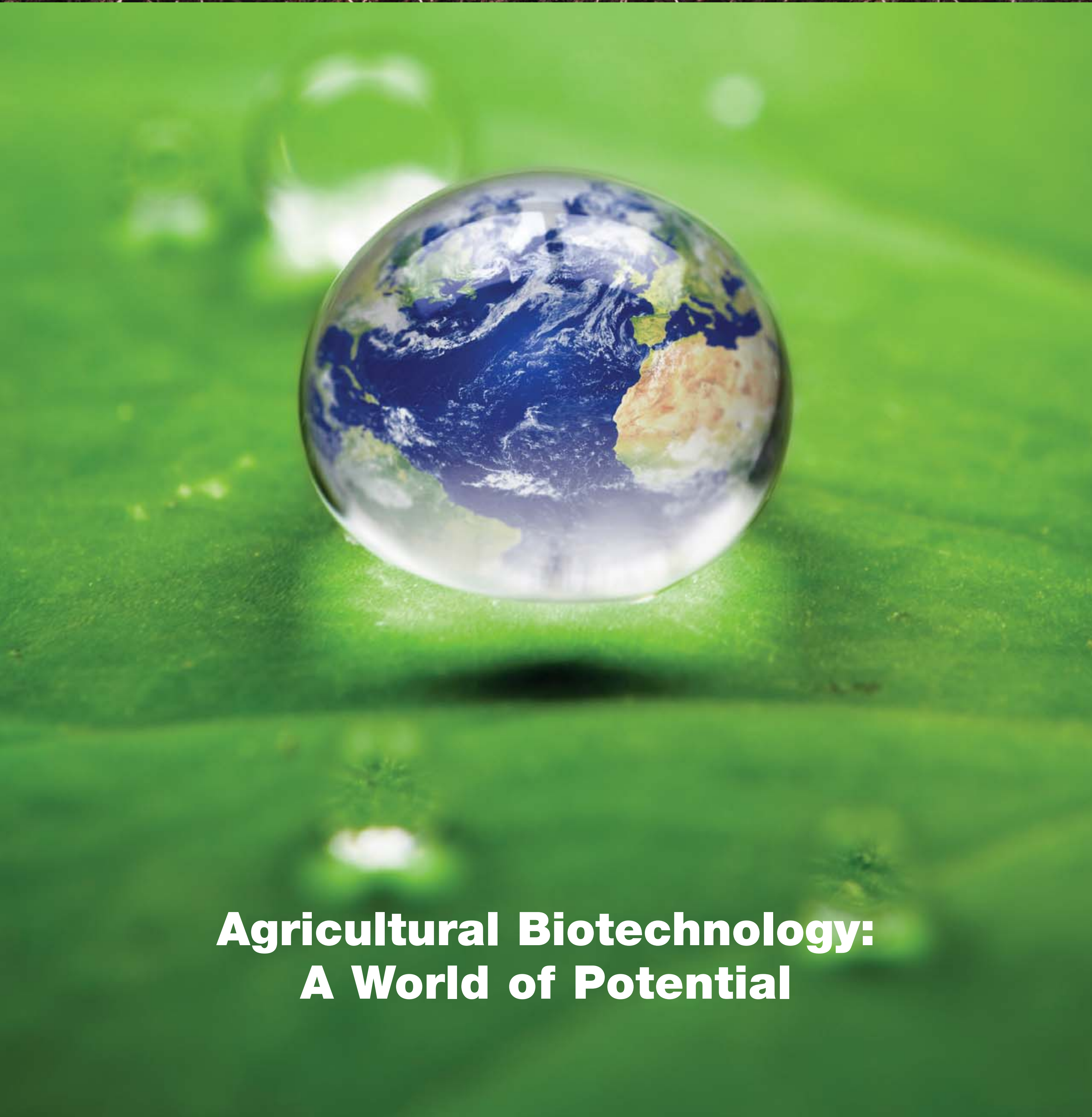
YOUR WORLD

Biotechnology & You

Biotechnology Institute

A magazine of biotechnology applications in health care, agriculture, the environment, and industry

Vol. 18, No. 1 Fall 2009



Agricultural Biotechnology: A World of Potential

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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. *Your World* is the premier biotechnology publication for 7th-to 12th-grade students.

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Welcome to the Issue!
A Growing Field

In this issue of *Your World*, we look at agriculture biotech crops—the science involved, the benefits possible, and the concerns people have toward them.

All over the world, farmers are choosing to plant modified crops to earn more money with their harvest. Biotech crops are helping with other goals, too, particularly to protect the environment. Crops developed by plant scientists with biotechnology are making it possible to farm on land that has been unsuited for cultivation, to produce food with increased nutritional value, to make it possible for farmers to leave rain forests alone, and to reduce applications of chemicals to fields.

If you care about food and the environment, a career in agricultural biotechnology may be for you.

Sincerely,

Paul A. Hanle
President
Biotechnology Institute

Photo Credits
If no credit is given for a photograph, it is a stock or company photo.
p. 2: These blue seeds will produce biotech corn.
p. 6: Enclosures like this in the Philippines are used for growing Golden Rice and drought-resistant rice strains (Deb Carstoiu/ CropLife Asia).
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p. 10: Left photo: Scientist screening plants in a greenhouse in Germany (copyright © BASF). Right photo: Men compare yield between Bt corn and traditional corn (AfricaBio).
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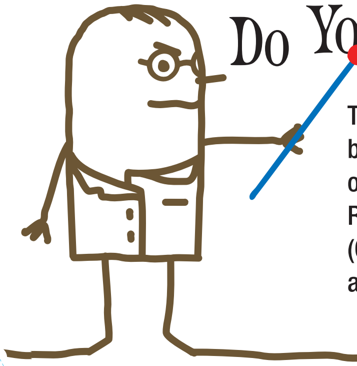
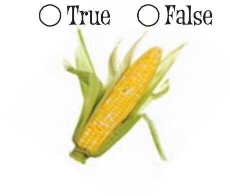
How Much Do You Know?

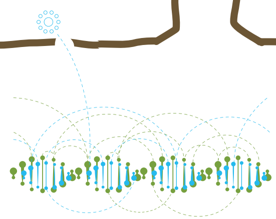


Take a quick quiz to check your biotech crop IQ. Decide whether each of these statements is true or false. Read the article to see if you're right. (Or for instant gratification, answers are at the bottom of page 15.)

1. Corn has always looked the same as it does now.
   ◯ True ◯ False



2. Biotech crops can help protect the Earth.
   ◯ True ◯ False



3. Biotechnology can add nutrients to crops.
   ◯ True ◯ False

4. Only the United States plants biotech crops.
   ◯ True ◯ False

5. Hawaii used biotechnology to save its papaya industry.
   ◯ True ◯ False

6. Organic farming has nothing in common with biotech crops.
   ◯ True ◯ False

7. The United Nations has declared biotech crops are safe.
   ◯ True ◯ False

Planting for a Brighter Future

Think people ought to leave things alone? A lot of the food we eat today would be unrecognizable if no one had harnessed the potential of what they found in the wild.

Corn, for example, comes from an ancient plant called teosinte. Originally grown in Mexico, Guatemala, Honduras, and Nicaragua, it produced a seed-stalk with only a few small, hard kernels on it. For hundreds of years, farmers mixed and matched the seeds they sowed to improve their crops—as a result, we now have corn that produces an ear full of tender kernels.

This method of crossing plants takes time because you have to grow out each plant to determine if it is better than the original. With modern science, we can now add, subtract, and change the genetic code of plants, in addition to using traditional plant-breeding methods. Most of the corn you eat today has been changed by humans into hybrid or biotech-derived varieties to provide a wide range of benefits, including improved taste and nutrition for consumers and higher yields and income for farmers.

By Joene Hendry, a freelance writer. Her favorite topics include medical news, health and lifestyle topics, and gardening.

Back in the Day

Starting out, people used simple selection to breed plants—saving favorite seeds from one growing season to the next. Then breeders started cross-pollinating and grafting plants (grafting is splicing pieces of two plants together so they grow as one). Breeders commonly graft citrus, peaches, walnuts, and grapes and tissue culture strawberries, potatoes, and garlic to meet the growing demand for food crops.

It has taken a lot of generations—of plants and people—to get tastier, healthier crops that are easier to grow. Sometimes, these methods still don't yield plants with characteristics we want, keep out characteristics we don't want, or produce crops reliably. Biotechnology is helping plant scientists reach the goal of improved crops.

Studying the genes that make up every living organism gives researchers a constant stream of new information about how plants grow and ways to choose characteristics to leave in and leave out.

Scientists can now transfer desirable traits that offer special benefits to farmers and consumers from one plant to another, leaving behind unwanted traits. They can change the sequence in a plant's unique living code, called deoxyribonucleic acid (DNA), to tweak a rice gene so it will flower earlier, for example, or a spinach gene so it will flower later. Scientists use marker-assisted selection (MAS) to identify desirable genes in one plant variety for transfer to another variety of the same plant, such as corn to corn, thereby improving how it grows or how much it produces.

They have even learned how to transfer genes from another species into a plant's DNA so the plants can protect themselves against insects, disease, and poor growing conditions, such as drought and fields flooded with saltwater. People often use the term genetic engineering (GE) or genetic modification (GM) to describe plants that have been improved by modern tools, such as biotechnology.

TOOLS OF THE TRADE

All plant breeding is genetic modification, but GM is a term that covers more than biotechnology. Plant genes can be altered by:

SIMPLE SELECTION. Selecting only seeds of plants with desired traits for replanting, like keeping the seeds from a prize-winning pumpkin.

CROSS-POLLINATION. Brushing flower pollen from one variety onto a different variety of a plant—say, Granny Smith apples to Red Delicious apples—to create a combination of genes from both plants (sometimes called a hybrid).

GRAFTING. Slicing a bud from one variety to splice into the lower woody stem and roots (rootstock) of another.

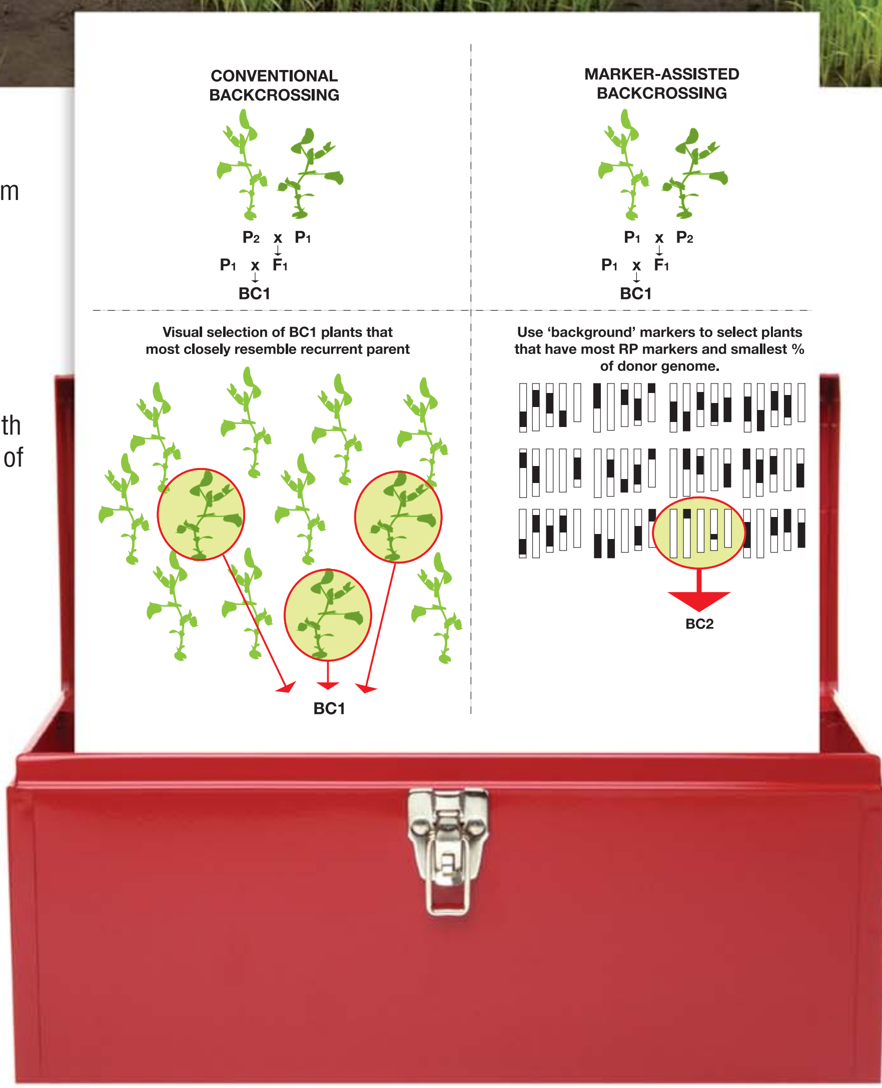
TISSUE CULTURE. Cutting tissue from growth tips (often free of disease) to dissect and grow into many plants.

EMBRYO RESCUE. Culturing the seed embryo from a plant that has naturally cross-pollinated so it will grow in a laboratory for further study or propagation.

DNA SEQUENCING. Decoding the sequence of a plant's genes to unveil those that trigger or suppress flowering, height, taste, or other characteristics.

MARKER-ASSISTED SELECTION. Reading DNA to identify the exact genes—usually two or three—responsible for a specific trait so they can be precisely transplanted into another variety of the same type of plant.

TRANSGENIC. Inserting a gene from any species into genes of the same or a different species.



Moving Along

For the first generation of biotech crops, scientists concentrated on developing biotech crops that could better resist disease, pests, and weed-killing herbicides. These traits helped farmers by increasing their yield or lowering their farming costs. For example, by reducing the number of times farmers have to drive over their field with their equipment, biotech crops lower the cost of fuel and machinery, as well as reduce greenhouse gas emissions. Scientists initially worked with corn, cotton, canola and soybeans, and then moved on to squash, sugar beets, papaya, sweet peppers, and tomatoes.

In some crops, scientists have been able to "stack" traits. That is, they have combined multiple desired traits into a single plant—such as putting herbicide tolerance and insect resistance into a single seed. Many of these crops have been planted in fields all over the world.

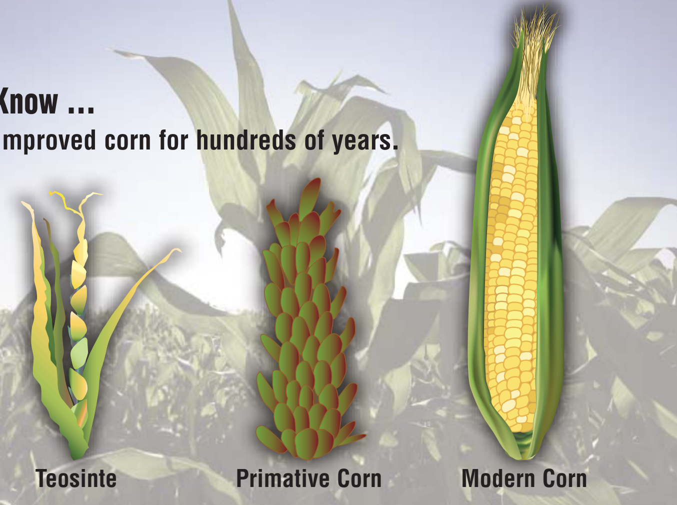
Researchers are now working on second-generation biotech crops. They are working to produce, among other things:

- Plants that produce even larger harvests.
- Crops that survive in various poor growing conditions such as drought, extreme heat or other climate and environmental stresses.
- Crops that are better at using nitrogen from the soil so they require less fertilizer.
- Plants that produce healthier foods, such as adding healthy omega-3 fatty acids to plant-based foods that don't have them now.

For example, the HarvestPlus Challenge Program uses marker-assisted selection to guide conventional breeding of beans, cassava, corn, pearl millet, rice, sweet potato, and wheat so they contain a bigger nutritional punch than current varieties. This program is promoted by the Consultative Group on International Agricultural Research (CGIAR), whose goal is to reduce poverty in developing countries through scientific research in agriculture.

Did You Know ...

We have improved corn for hundreds of years.



Under Cultivation

The U.N.'s Food and Agriculture Organization has an interactive map that lets you compare how much land has been under cultivation over the years, as far back as 1984 in some cases. Check out the difference between maize production in South America, for example: **www.fao.org/landandwater/agll/agromaps/interactive/page.jspx.**

Researchers have created Golden Rice—biotech-derived rice with greater levels of vitamins A and E, iron, zinc, and protein. Their goal is a more nutritional rice crop that is adapted to areas tilled by low-income farmers in developing countries.

Other scientists are working to increase vitamin A and E in cassava and bananas—staple foods in sub-Saharan Africa—while building in traits that make these plants produce bigger harvests and ward off disease. Private, public, and not-for-profit groups are also developing new varieties of corn, canola, soybeans, tomatoes, papaya, apples, lettuce, potatoes, rice, strawberries, cabbage, cauliflower, mustard, okra, watermelon, and a form of eggplant grown in India called brinjal.

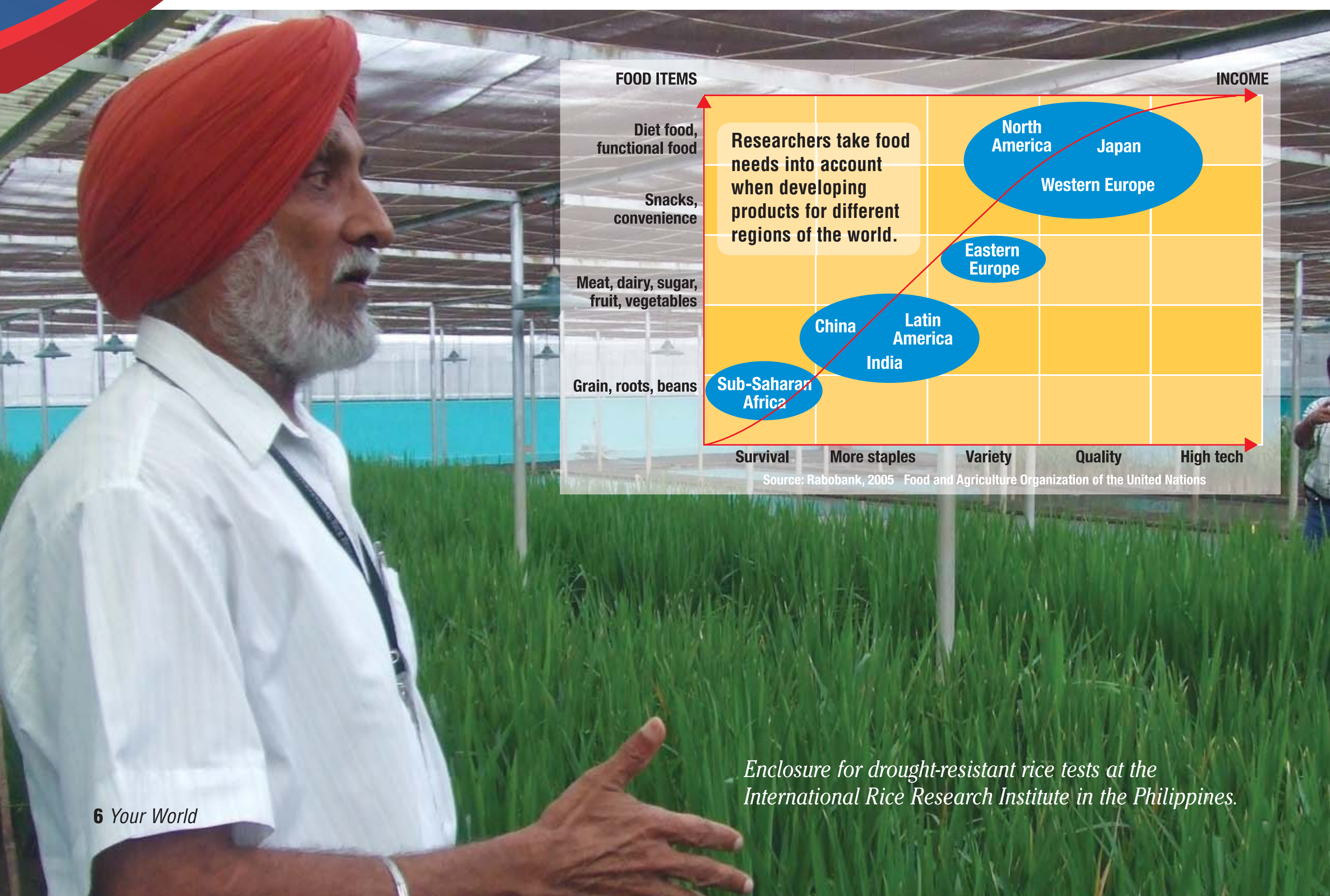
Good for the Environment

A healthy Earth is naturally diverse. It has regions that are wooded and without woods, wet and dry, mountainous and flat, hot and cold. To maintain diversity, lands not already tapped for farming must be protected in their natural state.

But people need to eat. Estimates place world population in 2050 at 9 billion people—up from 6.7 billion now. To meet these growing demands, farmers need to grow more food. Because the most fertile soils are already planted, it's vital to find, use, and encourage methods that increase per-acre food production while protecting natural resources.

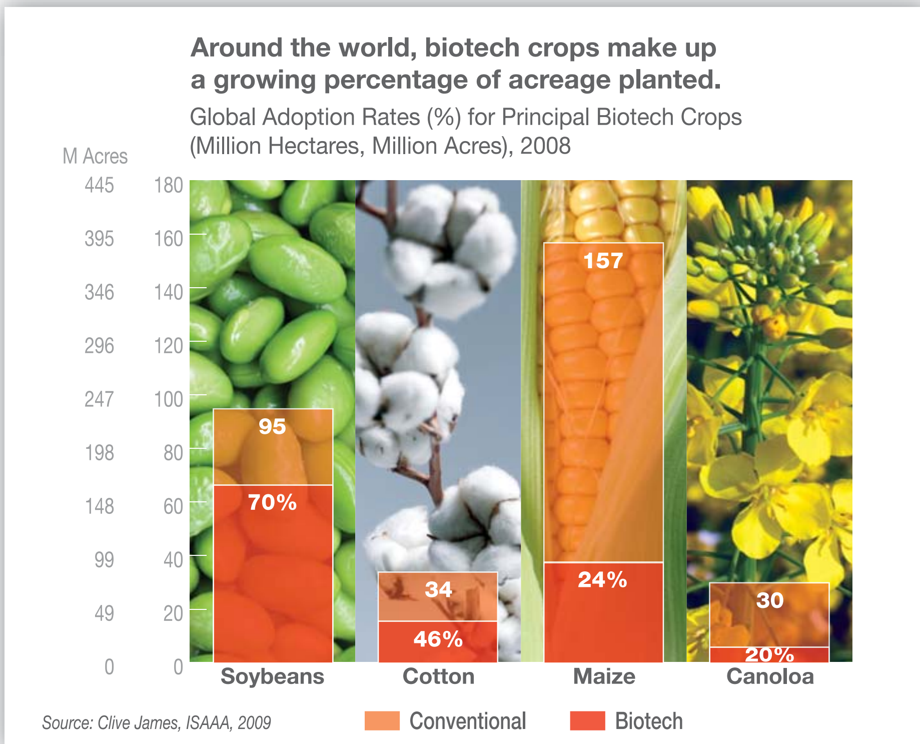
Because biotech plants are often healthier and resistant to pests and disease, they typically have increased crop yields. By producing more crop per farmed acre, we do not need to convert natural resources into additional farmland. For example, if biotech traits had not been available in 2007, to produce the same amount, farmers would have had to plant an additional 5.89 million hectares of soybeans, 3 million hectares of corn, 2.54 million hectares of cotton, and 0.32 million hectares of canola.

Better yet, biotechnology can help protect existing farmlands by helping farmers take better care of the soil and efficiently use water. Conservation tillage—a practice only made possible through biotechnology—allows farmers to grow crops with little or no soil cultivation. The result is reduced soil erosion, improved soil quality, and fewer greenhouse gas emissions. Biotech crops also contribute to more efficient use of water in agricultural production—an important consideration in the face of expected shortages of this precious resource. Efficient water use is essential, especially since the United Nations estimates that by 2025, about 1.8 billion people will be living in countries or regions with absolute water scarcity.



Source: Rabobank, 2005 Food and Agriculture Organization of the United Nations

Enclosure for drought-resistant rice tests at the International Rice Research Institute in the Philippines.

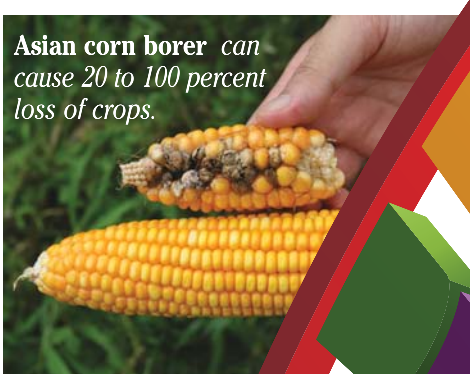


Making Farmers Happy

In addition to all these environmental benefits, there are benefits for farmers, too. Biotech tools help them uniquely combat pest problems. Bt corn, for example, is a biotech seed that carries the *Bacillus thuringiensis* (Bt) toxin. Bt is a natural insecticide that doesn't harm mammals, birds, fish, or humans. Bt, by itself, is used by all types of corn growers, including organic ones. Bt corn produces more corn and requires fewer insecticide applications in areas with corn borer and corn rootworm infestations. Likewise, biotech squash yields more per acre by carrying genes that make the plant resistant to common squash viruses. By increasing a plant's resistance levels, farmers can decrease crop losses.

Modern biotech tools allowed Hawaii's papaya industry to rebound after a devastating outbreak of ringspot virus. Conventional methods to combat disease failed to control a deadly outbreak, so scientists used biotechnology to develop a virus-resistant papaya. Doing so avoided the potential loss of the entire Hawaiian papaya industry.

Controlling weeds is a major job for farmers. Weeds choke out crops, and they use nutrition that food-producing crops need. When scientists produce a herbicide-resistant crop, it means that a farmer can treat an entire field with a substance that the crops will survive but the weeds won't. When farmers don't have to plow weeds under, it lowers farming costs (by using less fuel and equipment), reduces carbon dioxide emissions, and helps preserve soil.



Asian corn borer *can cause 20 to 100 percent loss of crops.*

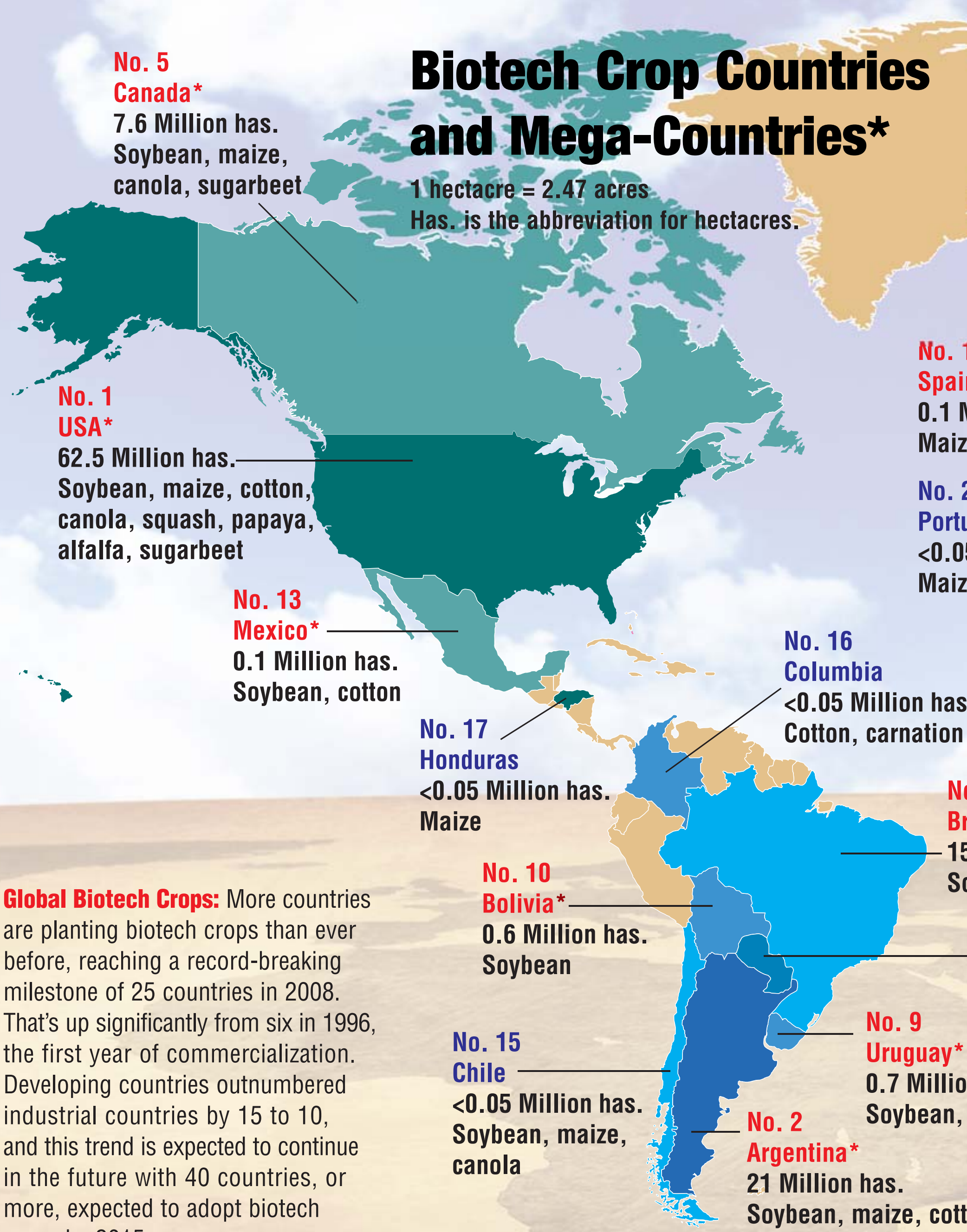
STARTING SMALL

Arabidopsis thaliana—mouse ear cress—is a small, annual weed that may be a nuisance to farmers, but is music to a genome scientist's ears. It matures in just six weeks and has one of the smallest genomes of all plants—its DNA collection holds *only* 135 million or so base pairs. In genome-speak, this is tiny. Wheat and corn DNA have billions of base pairs. Thousands of researchers from all over the world completed the *Arabidopsis* genome map in 2000. Now scientists are matching each *Arabidopsis* gene to its role, such as making roots, leaves, flowers, or fighting disease. Researchers already found an *Arabidopsis* gene that allows it to grow in salty soil. Biotech scientists hope to gain a better understanding of how this gene relates to other *Arabidopsis* genes, and genes in other plants, to help create crops that will grow in salty soils.

Check out the complete genome sequence at **www.arabidopsis.org/.**

Biotech Crop Countries and Mega-Countries*

1 hectacre = 2.47 acres
Has. is the abbreviation for hectacres.



Global Biotech Crops: More countries are planting biotech crops than ever before, reaching a record-breaking milestone of 25 countries in 2008. That's up significantly from six in 1996, the first year of commercialization. Developing countries outnumbered industrial countries by 15 to 10, and this trend is expected to continue in the future with 40 countries, or more, expected to adopt biotech crops by 2015.

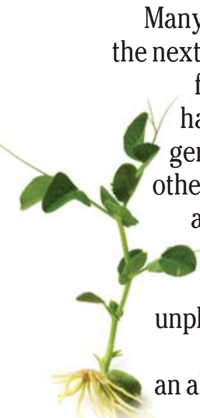
Biotech Impacts

Between 1996 and 2007, biotech crops reduced pesticide applications by an estimated 359 million kilograms —that's almost 790 million pounds. For comparison, WikiAnswers.com shows an 84-passenger school bus weighs between 22 thousand and 28 thousand pounds.

In 2007, scientists estimate that biotech-derived crops produced nearly 30 percent more soybeans and 8 percent more corn than would have been produced otherwise.

From 1996 to 2007, global farm incomes have benefited by $44 billion from the enhanced productivity and efficiency gains of adopting biotech crops. In 2007 alone, the direct global farm income benefit from biotech crops was $10.1 billion. Developing countries earned 58 percent of this benefit.

Some Oppose Biotech Crops

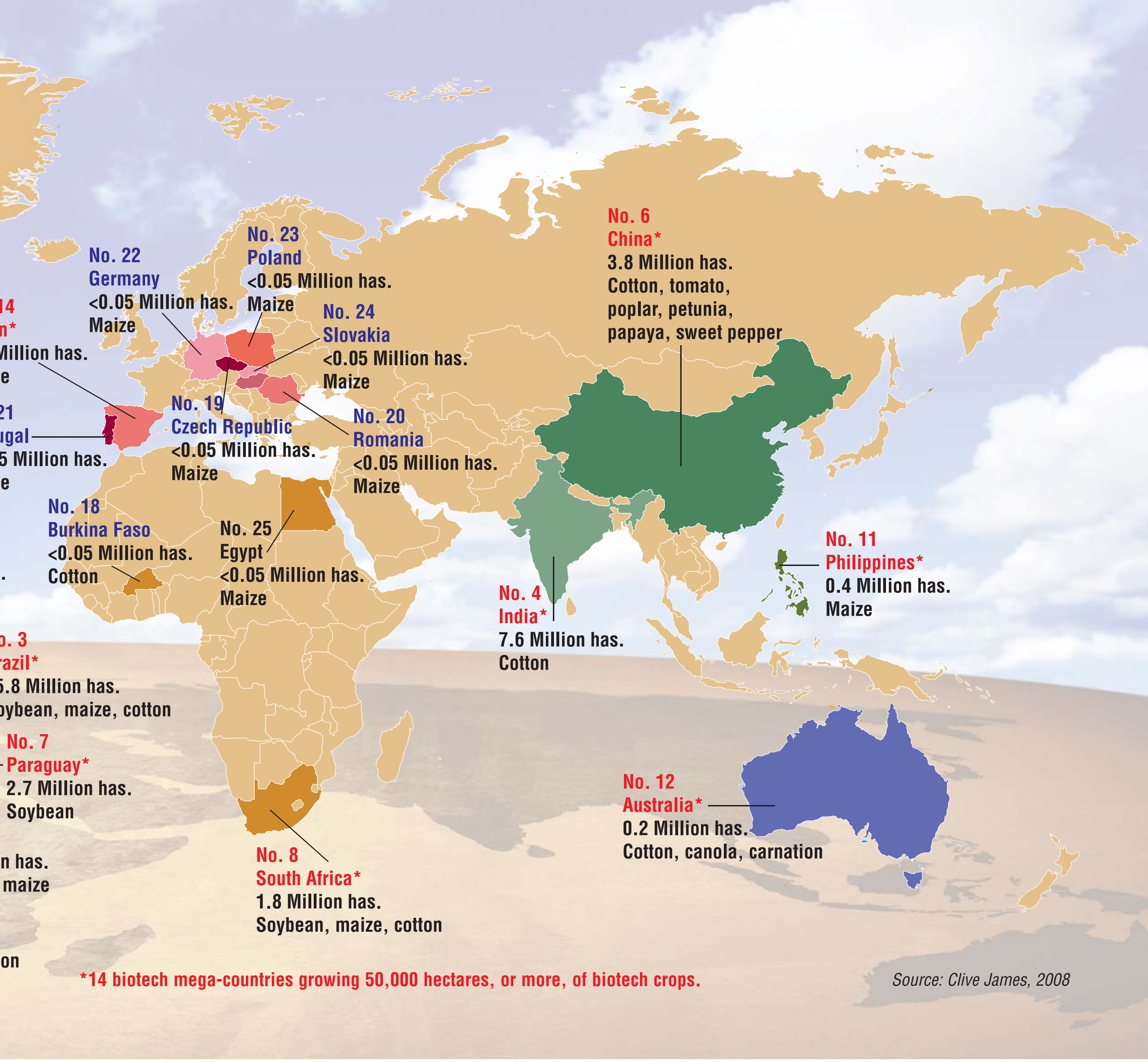


Many people believe biotech crops are the next logical step toward increasing food production. On the other hand, because these crops blend genes from different species, some others oppose them as "unnatural" and worry that growing or eating biotech crops could bring unintended and unpleasant consequences.

Some worry that any transfer of an allergy-causing gene to a food crop might cause an allergic reaction in people who eat the food. There is also unease that a bacteria gene from a biotech-derived food might unintentionally change the body of those eating the food. Genes transferred from a virus or bacteria might spread, through natural cross-pollination (outcrossing), from the biotech to nearby crops. Biotech corn, for example, can cross-pollinate and breed with non-biotech corn.

Another worry stems from the chance that a biotech crop might cross-pollinate with a closely related weed and create a superweed resistant to the same herbicide or insecticide as the biotech crop. People wonder whether insects that pollinate biotech crops will become resistant to the very toxin transferred into some of these plants. Some suggest that beneficial insects might be harmed by exposure to insect-resistant biotech crops.

It's important to understand that all of these worries and concerns are not based on scientific evidence—there is no evidence that biotech-derived crops carry any more or any less risk than non-biotech crops. In fact, biotech crops have



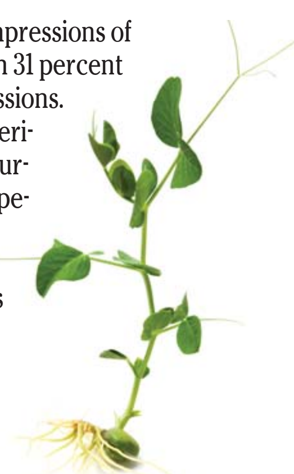
*14 biotech mega-countries growing 50,000 hectares, or more, of biotech crops.

Source: Clive James, 2008

been grown for almost 15 years with no negative effects on health or the environment. Scientific organizations and regulatory agencies around the world have declared biotech foods safe for people and the environment, including the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations, the Organization for Economic Cooperation and Development (OECD), the U.S. National Academy of Sciences, the Royal Society of London, as well as national academies in China, Brazil, India, and Mexico.

There's also concern that large corporations doing biotech research—and therefore holding the resale rights for biotech-derived seeds—will gain control over what farmers plant. But large corporations have been developing, holding rights to, and selling seeds to farmers for many, many years, with no control over what gets planted.

A 2008 survey commissioned by the International Food Information Council found that 71 percent of American consumers have heard or read something about biotechnology. The majority (53 percent) have neutral impressions of plant biotechnology, with 31 percent holding favorable impressions. Also, the majority of Americans would be likely to purchase biotech foods for specific benefits, with the most popular benefits being more healthful fats like omega-3 and those that require fewer pesticide applications, each with 78 percent likely to purchase.



Does Biotech Fit with Organic?

Many people who dislike the idea of biotech-derived food crops promote organic farming as a more environmentally friendly agricultural alternative. Organic farmers rely on crop rotation, animal manures, and other soil-preserving and soil-building practices to make sure crops grow and produce. They also encourage beneficial insects as deterrents to crop-attacking insects, and they avoid using synthetically produced fertilizers and pesticides. Rather than using herbicides, organic farmers rely on tilling the soil or applying mulch—often dry hay, grass, or other plant-based products—to smother weeds and protect the soil.

In spite of these practices, organic farming does not produce the same amount of food per acre as conventional farming. In the United States, organic crops account for less than 3 percent of all crops.

The question is not whether organic is better, but whether these methods can and should coexist. Dr. Pamela Ronald is a plant pathologist at the University of California, Davis. In her lab, she isolated a gene that makes rice plants tolerant of stress. Her collaborators at the International Rice Research Institute in the Philippines used marker-assisted selection to introduce this gene into locally adapted rice. Combining the gene with locally grown rice helps farmers grow more rice in their flood-prone fields. (Flooding destroys an estimated 30 million tons of rice every year in India and Bangladesh.)

While Dr. Ronald studies how plant genes respond to environmental stresses, her husband runs an organic farm. They have a deep, firsthand understanding of how biotech-derived crops and organic farming can benefit food production. They even wrote a book on the subject called *Tomorrow's Table: Organic Farming, Genetics and the Future of Food*.

Currently the USDA's National Organic Program Standards prohibit certified organic farms from growing genetically engineered seeds (Bt corn, for example), even though the same Bt that is in the corn is allowed to be applied on organic farms. But the Standards allow other types of biotech methods—those from embryo rescue, for instance. Dr. Ronald feels farmers should be able to use the best organic farming methods and grow the most environmentally beneficial biotech seeds. Pitting one viewpoint against the other—biotech-derived crops against organic farming—prevents the very changes needed in farming to create sustainable, global agriculture.

Testing, Testing...

In the United States, the Coordinated Framework for the Regulation of Biotechnology requires that each biotech crop meet standards set by three agencies:

The Department of Agriculture (USDA) oversees field testing, through its Animal and Plant Health Inspection Service (APHIS), and determines whether release of a crop poses agricultural or environmental risk. APHIS holds biotech crops in a regulated status until years of field testing and review show each can be deregulated. Between 1987 and 2005, APHIS approved more than 90 percent of the 11,600+ applications received.

The Environmental Protection Agency (EPA), which oversees pesticides, further regulates insect-resistant biotech crops. The Food and Drug Administration (FDA) assesses biotech food crops to make sure they are safe to eat.

The European Food Safety Authority conducts all safety assessments for European Union (EU) countries. The European Commission and all member states must give biotech crops final approval. Bt corn is currently the only biotech crop permitted in Europe, but others are under scientific review and in line for approval.

While the corn you eat today may have come a long way from the original few small, hard kernels harvested in the tropics thousands of years ago, plant science innovations continue to face pressing challenges. The World Bank estimates that one hectare of land will need to feed five people in 2025—that's up from only two people in 1960.

Plant biotechnology can provide farmers around the world with the tools to meet the growing demand for food supply, in a sustainable way. In addition to food security and a green planet, we can also look forward to healthier choices—from vegetable oils with low saturated fats to fruits and vegetables fortified with extra vitamins to ward off diseases. Plant biotechnology holds great promise.

CAREER PROFILE

Motlatsi Musi, Farmer

"I was 13 when I began farming," says Motlatsi Musi of Olifantsvlei, Soweto, South Africa. "I tended our vegetable garden, and we ate what we grew. My mother's parents were successful farmers—they even exported food to Europe. I wanted to succeed like they did."

As an adult, Musi bought a plot of land and a tractor and began to grow maize.

"Farming was very labor intensive and painful even if you owned a tractor, because when the crop grows high enough you can no longer go in with the tractor, and you must go in with a hoe to remove weeds," Musi says. "The work was back-breaking."

Because his yield was low, Musi used his tractor to supplement his income by preparing soil for subsistence and emerging farmers who lacked such equipment. In 2004, one of those farmers told him about AfricaBio, an organization that was educating farmers about biotech maize seed that had the potential to increase crop yields. He soon decided to try planting biotech maize. Today, he plants five hectares (12 acres) of Bt white maize for human consumption and 18 hectares (44 acres) of herbicide-resistant yellow maize for animal feed.

"I used to get five tons (5,000 kilos) of maize per hectare (2.5 acres) using conventional seed," Musi says. "Farmers without a tractor could only get about 1.5 tons (1,500 kilos). But now that I'm planting biotech maize, I'm getting seven tons (7,000 kilos) per hectare, and my expenses are down because I've been able to reduce labor." Musi has achieved this success because herbicide-resistant maize reduces hand-weeding labor, Bt maize reduces pest damage, and this means less crop loss.

Use of biotech maize has translated into enormous financial benefits to Musi, which has radically changed his farming operations and his way of life. Biotech maize results in less crop loss from pests and weeds, less tilling and soil erosion, and lower expenses for herbicide and labor. After just his first season of planting biotech maize, Musi was able to buy a secondhand hammermill, a machine that can mill maize into powder for food or animal feed. In 2006, he was able to buy a one-row planter and a pump to get water for his crops from the nearby river. This additional equipment has enabled Musi to further increase his income, and he has expanded his land.

Musi is especially proud that in 2007 he was able to provide money to his children, including sending one of his four sons to medical school. What's more, biotechnology has increased his yields so much, he has harvested excess maize, which he donated to an organization that distributes it to homes for the elderly, child-care centers, and HIV/AIDS hospices in Soweto, fulfilling his wish to contribute to the welfare of his community as well as the food security of his country. The success he dreamed of as a boy has become a reality.

"My aim is to do South Africa proud," Musi says. "Biotechnology is the future of agriculture worldwide."

Courtesy of AfricaBio.

The WIDE World of Biotechnology

A Sampling of Biotech News

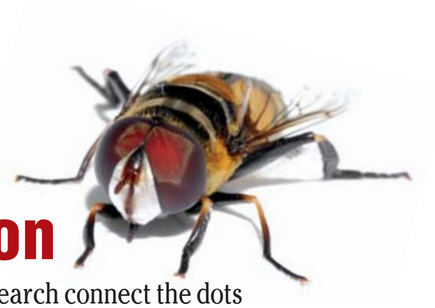
Many scientific fields use biotechnology. Here is a small sample of what researchers have been working on.

Shaping Up Against HIV

University scientists have formed a set of peptide-like molecules that blocked the human immunodeficiency virus from infecting human cells in lab experiments. Peptides are segments of proteins containing two or amino acids. A protein's shape determines what molecules it can "talk" to.

To invade a cell, human viruses such as HIV, influenza, and Ebola rely on the interactions among their own proteins and those of the host cell. The scientists built a molecule shaped to interact with the HIVprotein gp41. The shape of this "foldamer" physically keeps the virus from entering what would have been host cells.

In addition to blocking protein-to-protein dialogue, the molecule's shape holds up well against naturally occurring enzymes. This means the molecule can stay effective longer, and with lower doses. Researchers at the University of Wisconsin–Madison stress that the foldamers may never become anti-HIV drugs, but the work offers new information about designing molecules for medical uses.



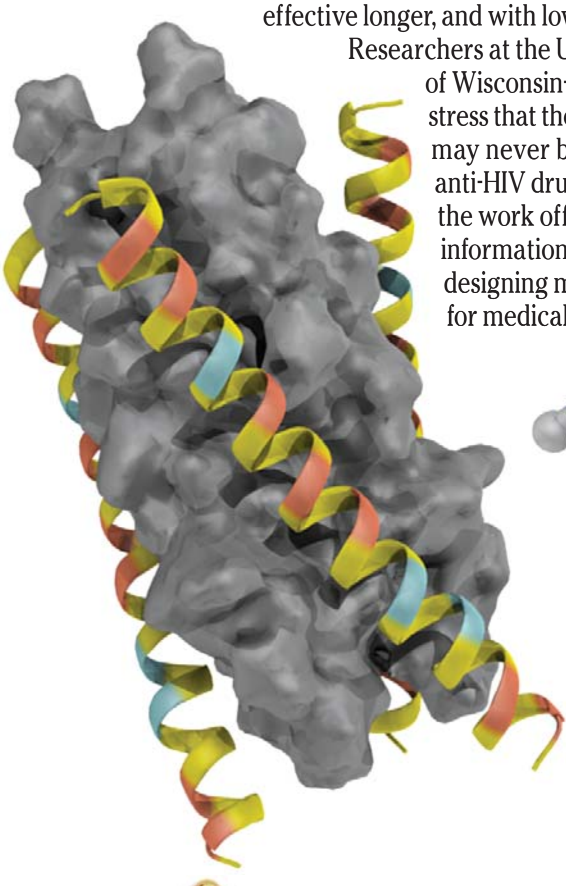
Bug-Eyed Information

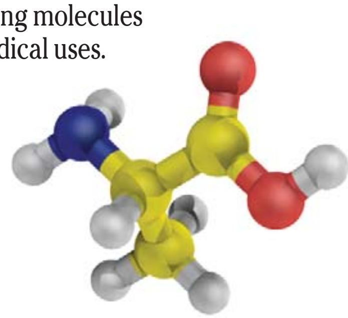
Flies are helping research connect the dots when it comes to figuring out when a gene is active and the corresponding movement.

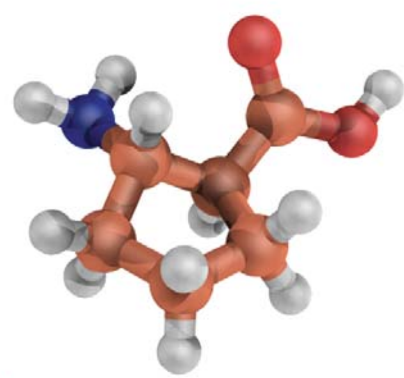
A team of researchers at the University of Southern California-LA inserted the green fluorescent protein gene (GFP) from a jellyfish into the retina or other tissue in the flies. When they shine blue LEDs at the fly, they make the gene glow green. Specially equipped cameras detect the glow and record the fly's movements. By linking the expression of the GFP to the expression of other reporter genes, the researchers can figure out whether these genes are off or on and how this is associated with the fly's behavior.

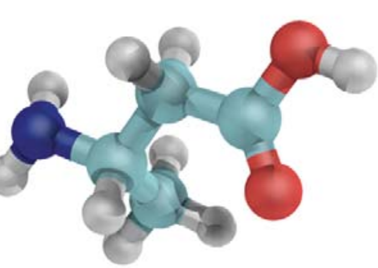
The technique, described in the open-access journal *BMC Biotechnology*, gives scientists a tool to figure out correlations between behavior, gene expression, and aging.

To see pictures of the fluorescent flies, go to biomedcentral.com/graphics/email/images/1-65DAYSOLD.jpg and biomedcentral.com/graphics/e-mail/images/2MI4HEATSTRESS.jpg.

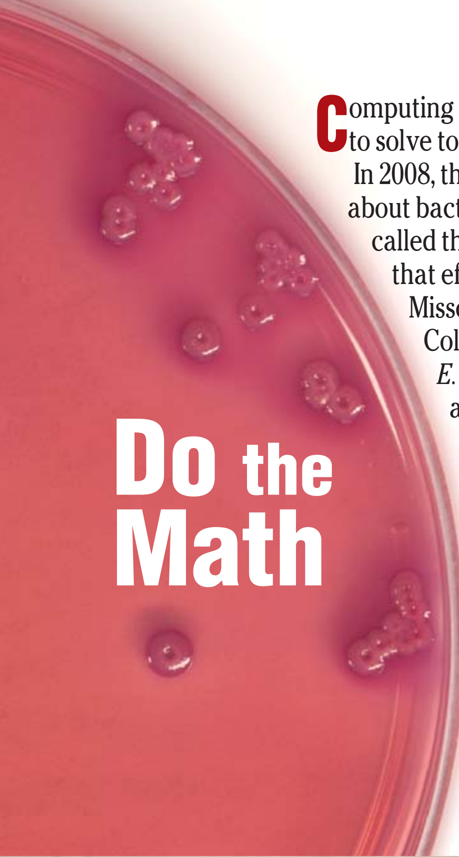






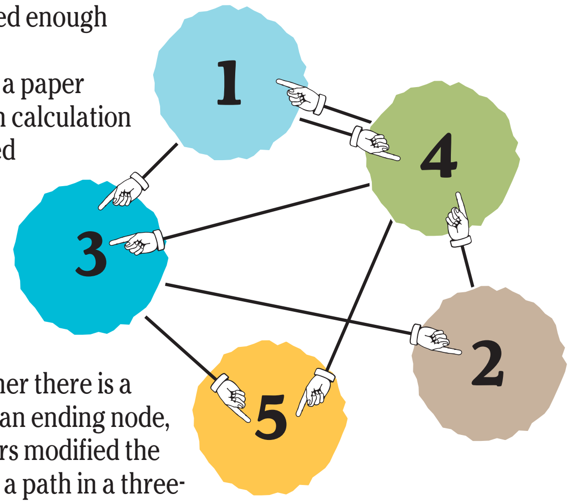


In this model, the HIV protein (gray) is blocked by the corkscrew-shaped foldamers from attaching to a cell. The foldamers are made from amino acids (the three objects on the right). Natural amino acids show up on the corkscrew as yellow; manmade ones are blue and orange.



Do the Math

Computing in living cells can be done, at levels sophisticated enough to solve tough math problems.



In 2008, the *Journal of Biological Engineering* published a paper about bacterial computers that could solve a classic math calculation called the Burnt Pancake Problem. New work continued that effort. A collaboration of faculty and students at Missouri Western State University and Davidson College in North Carolina engineered the DNA of *E. coli* bacteria into computers that could solve a classic mathematical problem known as the Hamiltonian Path Problem.

The Hamiltonian Path Problem asks whether there is a route in a network from a beginning node to an ending node, visiting each node only once. The researchers modified the genetic circuitry of the bacteria to find such a path in a three-node graph. When bacteria solved the problem, they fluoresced both red and green, resulting in yellow colonies.

This work is an example of synthetic biology, which uses molecular biology techniques, engineering problems, and mathematical modeling to design and built genetic circuits that let living cells carry out new—and often unusual—functions.

[see http://parts.mit.edu/igem07/index.php/Davidson_Missouri_W/Solving_the_HPP_in_vivo#The_Hamiltonian_Path_Problem]

New Test for Protecting Food

You might have melamine dishes in your house. No problem. For years it has been shaped into durable plastic dishes and countertops or used in concrete.

When you put melamine in food, however, it's a poison. Some idiot figured out that—as a cost-cutting measure—putting melamine in food makes tests report that the food has more protein in it than it actually does. In China, unscrupulous manufacturers decided to add melamine to milk. Six children died, and 150,000 more were hospitalized. Some children might have chronic kidney disease as a result.

Melamine can be added to any food that is more valuable when it contains more protein. In a 2007 episode, melamine-contaminated pet food killed nearly 1,000 U.S. pets.

Now biotech researchers at the University of Minnesota's BioTechnology Institute have developed an enzyme, melamine deaminase, that can be used to tell whether food contains melamine. The enzyme breaks one of the C-N bonds in melamine to release ammonia, which can be detected by a simple test that turns the liquid blue.

The test kit can detect melamine in milk, powdered milk, cream, ice cream, and chocolate drink. The institute is working to adapt the test for seafood and meat.

Stone Age Evidence

Genetic evidence is revealing that human populations began expanding in Africa during the Late Stone Age approximately 40,000 years ago.

Researchers from Arizona's Research Laboratory's Division of Biotechnology found that sub-Saharan populations increased in size well before the development of agriculture.

Figuring out the timing and magnitude of changes in the human population is important to understand human evolution. There has been a longstanding debate over whether humans began to increase as a result of innovative technologies and/or behaviors formulated by hunter-gatherer groups in the Late Pleistocene or with the coming of agriculture in the Neolithic. This research integrates empirical genetics with discoveries in paleontology and archaeology to help answer interdisciplinary questions about what kinds of innovations led to humans evolving.

KIDS+TEACHERS

Minnesota Senior Wins BioGENEius Challenge

Stephen Trusheim took first place in an international science fair with a project on antibiotic-resistant infections. Biotechnology Institute's president, Paul A. Hanle (left), presented the BioGENEius award along with Allan Jarvis from sanofi pasteur.

A high school senior won $7,500 with a science project that shows hospitals how to prevent a deadly virus.

Stephen Trusheim from the Breck School in Golden Valley, Minnesota, has won the sanofi-aventis International BioGENEius Challenge, a competition for high school students from the United States, Canada, and Western Australia. Fifteen students entered this year.

Stephen found that identifying and testing only 10 percent of patients at high risk for contracting an infection known as MRSA can allow hospitals to save 25 percent in costs and will prevent more than 70 percent of the more than 19,000 deaths that occur each year from MRSA.

Entries were displayed at the 2009 BIO International Convention, the largest global event for the industry. Winners were announced at the conference.

Stephen's project was "Engineering and Validating Predictive Infection Surveillance Strategies for Methicillin-resistant *Staphylococcus aureus* (MRSA)." MRSA infection is common in hospitals and other health-care facilities such as nursing homes and dialysis centers. It is not killed off by antibiotics commonly used to treat a wide array of infections.

"It is more important than ever to encourage innovation, especially among our nation's young students, to continue our progress toward solving some of the world's most challenging problems," says Allan Jarvis, senior vice president of corporate development at sanofi pasteur, the vaccines division of the contest sponsor. Sanofi-aventis is a global pharmaceutical company. The contest is organized by the Biotechnology Institute.

Award Winners

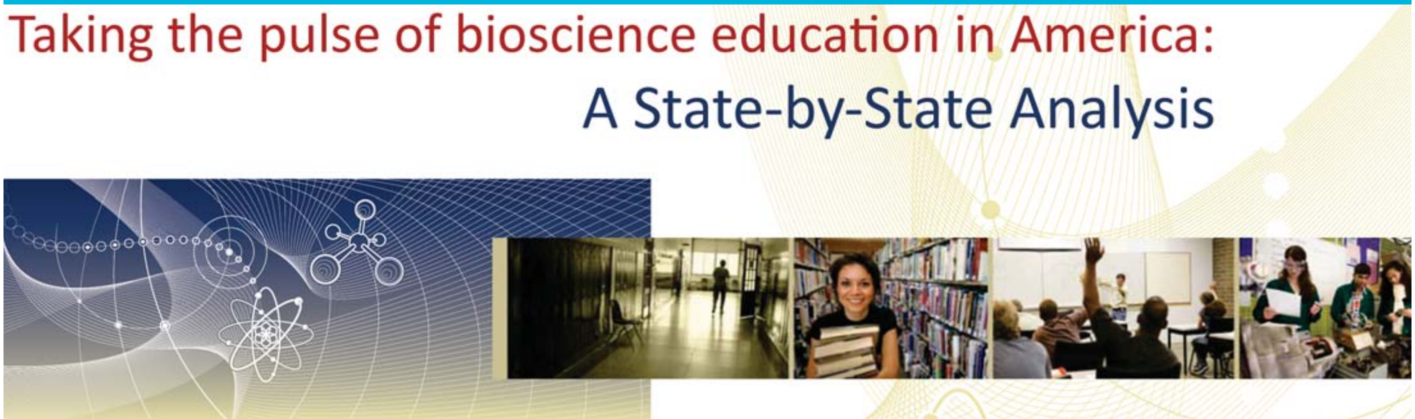
1st: Stephen Trusheim, senior, Breck School, Golden Valley, Minn. $7,500. "Engineering and Validating Predictive Infection Surveillance Strategies for Methicillin-resistant *Staphylococcus aureus* (MRSA)."

2nd: Ashutosh Patra, senior, Sunset High School, Portland, Ore. $5,000. "Low- Cost Microbial Fuel Cell for Harvesting Energy and Cleansing Waste Water."

3rd: Johnny Fells, senior, Northside High School, Warner Robins, Ga. $2,500. "Anti-Cancer Activity of Scutellaria on Aht/PKB Signaling."

4th: Tess Michaels, sophomore, Shepton High School, Plano, Texas. $1,000. "Diet and Longevity."

Other participants received an honorable mention award and $500 each.



One indication of a suffering science education, reported in a study by Battelle, BIO, and the Biotechnology Institute, is that average scores for 12th-graders in the sciences have declined from 1996 to 2005.

Bioscience Education Lags

Biology-related science offers many exciting careers. But teens aren't learning enough science to move into the field. A news study shows that states aren't preparing students to pursue biosciences in higher education—a key pipeline for developing a bioscience work force.

A report funded and researched by BIO, Battelle, and the Biotechnology Institute provides the first comprehensive study of middle and high school bioscience education in the 50 states, District of Columbia, and Puerto Rico.

The report also finds a wide gap across measures of student achievement in overall science and biosciences, an uneven record across states in incorporating the biosciences in states science standards, supporting focused bioscience education programs and higher level bioscience courses, and ensuring science and bioscience teachers are well qualified.

For example, on average, only 28 percent of the high school students taking the ACT, a national standardized test for college admission, reached a score indicating college readiness for biology, and no state reached even 50 percent.

The report also notes that nearly one in eight U.S. high school biology teachers was not certified to teach biology. The average share of biology teachers certified in a given state ranged from 50 percent to 100 percent, according to data collected by the Council of Chief State School Officers, although 88 percent of biology teachers are certified nationally on average.

The study notes that there are many examples of programs that work. Unfortunately, they are not nationwide, and not all states have committed resources to bioscience programs.

To access a copy of the report, an executive summary, or presentation about the findings, go to one of the following addresses: battelle.org/sub_pages/bioed_reports.aspx; biotechinstitute.org/programs/education report.html; or http://bio.org/battelle2009.

Dave Menshaw placed first among eight finalists for the Genzyme-Life Technologies Biotech Educator Award. He won $10,000.

California Teacher Wins National Biotech Education Award

David Menshaw, a teacher at James C. Enochs High School in Modesto, California, has been named first-place winner of the 2009 Genzyme-Life Technologies Biotech Educator Award. He receives $10,000.

The Biotechnology Institute set up the award to recognize leading high school educators who are bringing biotechnology to their classrooms and encouraging fellow science teachers to do the same.

The finalists are chosen from among the more than 2,000 teacher-leaders who participated in the Biotechnology Institute's National Biotechnology Teacher-Leader Program. Through intensive professional development, the program provides educators with the skills and strategies to introduce biotechnology to their students and educate their peers to do the same.

"All the teachers who were nominated have tirelessly mentored young scientific minds that may one day change our world for the better," says Henry Darnell, vice president of corporate community affairs for Genzyme Corporation, one of the award sponsors. Life Technologies is the cosponsor.

Page 3 Answers:
1 False; 2 True; 3 True;
4 False; 5 True; 6 False; 7 True

Biotechnology INSTITUTE

Resources

More Information

APHIS
"Protecting American agriculture" is the basic charge of the U.S. Department of Agriculture's Animal and Plant Health Inspection Service.
www.aphis.usda.gov

Biotechnology Industry Organization
The leading trade organization for the biotechnology industry keeps tabs on current events in biotech agriculture.
http://bio.org/foodag/

CropLife International
A global federation committed to sustainable agriculture through innovative research and technology in the areas of crop protection, nonagricultural pest control, seeds, and plant biotechnology.
http://www.croplife.org/

Food and Agriculture Organization of the United Nations
http://www.fao.org/biotech/index.asp?lang=en

Food Biotechnology: A Study of U.S. Consumer Attitudinal Trends, 2008 Report
Survey on public awareness and perceptions of plant and animal biotechnology.
http://www.ific.org/research/biotechres.cfm

Teaching resources

Journal of Natural Resources and Life Sciences Education
Provides the latest teaching ideas in the life sciences, natural resources, and agriculture. Updated online during the year.
http://www.jnrlse.org/

Virginia's CTE Resource Center
Virginia, national, and global documents and Web links.
http://www.cteresource.org/featured/biotechnology.html

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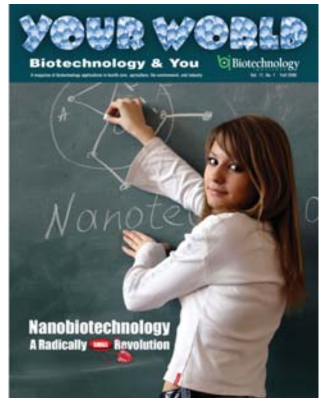

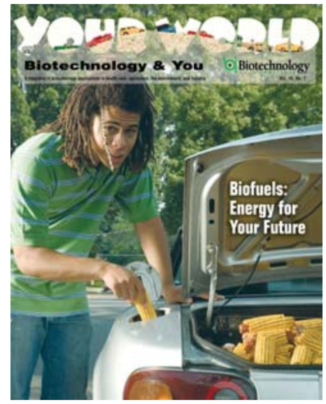

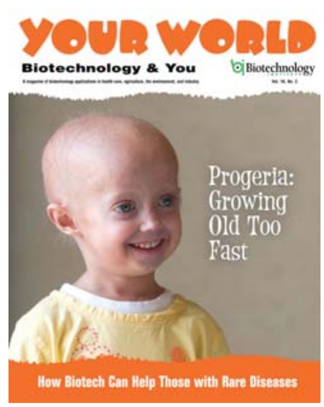

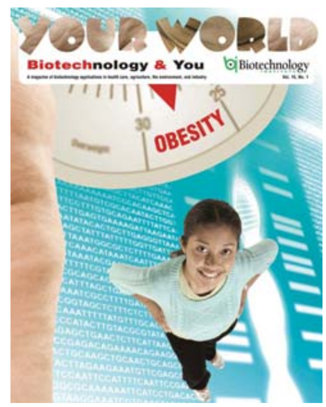

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- Gene Therapy

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