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*BIO*TECHNOLOGY

AND FOOD

LEADER AND PARTICIPANT GUIDE

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BIOTECHNOLOGY AND FOOD
LEADER AND PARTICIPANT GUIDE

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Statements in this publication reflect federal and state legislation and regulations in effect as of 1994. States may have different rules; information and wording based on case studies may not apply to all states.

Reference to products is not intended as an endorsement to the exclusion of others that may be similar. Information about biotechnology products and processes is available from many sources, a few of which are listed in this guide. Information is provided as a convenience to readers. It is not an endorsement by University of Wisconsin-Extension, nor is it exhaustive.

Cooperative Extension Publications, University of Wisconsin-Extension
Madison, Wisconsin 1994

INTRODUCTION

This guide contains materials that can be used in a variety of ways, including:

- Leader training for volunteers working with adults
- Leader training for 4-H and youth leaders
- Presentations for service clubs, farm organizations, community groups or government officials
- Professional development sessions for school teachers

Review the objectives on the following pages to determine which modules are most suitable for your audience. We recommend that you do not use this entire packet in one session. Specific learning activities and background information are provided for each module.

Some modules may require additional teaching aids as indicated on the instruction sheet. Most modules can be done in about half an hour. A glossary at the end explains technical and scientific terms you may find in information about biotechnology, or notice in bold type in this guide or its companion poster, *Biotechnology: Tools for Genetic Ingenuity* NCR 570.

Some worksheets — such as in Module B — are marked for use by participants. However, we encourage leaders and teachers to share with participants and students as many of the materials as can legally and affordably be photocopied — please do not copy any of the material that is indicated to be copyrighted. We want to avoid a "teacher version/student version" mentality.

For information on how to get University of Wisconsin-Extension and UW Biotechnology Education Program materials electronically, contact:

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Note: *This address valid until October 1995, when the UW Biotechnology Center address will be 25 Henry Mall, Madison, WI 53706.*

For information on ordering the video "Biotechnology and Food: A Public Issue for Extension Education" see page 85.

OBJECTIVES

MODULE A — DEFINING BIOTECHNOLOGY

Participants will be able to write a simple definition of biotechnology and list examples of both old and new biotechnology techniques (e.g., plant breeding, genetic engineering).

MODULE B — DNA AS VIDEOTAPE: A QUICK TEACHING ANALOGY

Participants will be able to provide an analogy of genetic engineering (e.g., copying a new scene into a videotape).

MODULE C — FOODS FROM AGRICULTURAL BIOTECHNOLOGY

Participants will be able to list three or four examples of foods from plants modified through genetic engineering.

Participants will be able to list analogies and purposes for linking marker genes to antisense genes.

Participants will be able to list possible reasons for the difference in public reaction to the introduction of genetically engineered chymosin and BGH/BST in the U.S. food supply.

MODULE D — VALUING A NEW FOOD PRODUCT

Participants will be able to list three government agencies that regulate biotechnology and three criteria they consider.

Participants will be able to list criteria currently used by diverse groups to examine the value of a new food product.

Participants will be able to list factors that affect consumers' judgment about the use of specific biotechnology applications.

Participants will identify factors most important to themselves.

MODULE E — BIOTECHNOLOGY AND FOOD LABELING ISSUES

Participants will be able to list one advantage and one disadvantage of labeling foods that have been genetically engineered.

MODULE F — ANALYZING NEWS ARTICLES

Participants will be able to analyze news articles about the use of biotechnology.

MODULE G — SUPPLEMENTARY ACTIVITIES

Participants are encouraged to contact businesses and government agencies about new biotechnology products, regulations and careers.

MODULE A — DEFINING BIOTECHNOLOGY

INSTRUCTIONS

OBJECTIVE:

Participants will be able to write a simple definition of biotechnology and list examples of both old and new biotechnology techniques (e.g. plant breeding, genetic engineering).

ACTIVITIES:

- Have participants write a simple definition of biotechnology.
- Discuss examples of biotechnology techniques.
- Make a list of biotechnology products in the food supply.

MATERIALS INCLUDED:

LEADER & PARTICIPANT

Biotechnology Applications

What Tools Does Biotechnology Use? *(overhead)*

What Biotechnology Products Are in Our Food Supply? *(overhead)*

How Old Is Biotechnology?

How Can You Remember the Uses of Biotechnology? *(overhead)*

SUPPLEMENTARY ACTIVITIES:

YOUTH

Supervise youth in a "scavenger hunt" at a grocery store, searching for clues on food labels about the use of biotechnology (e.g. enzymes, yeast) or for foods in which biotechnology is used (e.g. milk, cheese, yogurt, bread, vinegar, marinades, soy sauce). Look on cheese labels for the enzyme rennet (chymosin) — most cheese makers now use chymosin made from genetically engineered microbes. Look on packages that say "sugar free" or "low calorie" for the ingredient aspartame (brand names Equal® or NutraSweet®).

Collect foods you find, or keep a list to make a display later.

ADULTS

Prepare a list of biotechnology foods available in their local grocery store.

See What Biotechnology Products Are in Our Food Supply? *page 13, Module E supplementary activity, page 49; also Module G, page 77.*

BIOTECHNOLOGY APPLICATIONS

Tom Zinnen, University of Wisconsin-Extension and UW Biotechnology Center

DEFINITION

The root words of biotechnology are ancient Greek:
- *Bios:* "life"
- *Technikos:* "skillfully made," "tool"
- *Logos:* "study of," "word," "essence"

Biotechnology — "the study of living tools" — is used in agriculture, food processing, industrial production, environmental cleanup and medicine.

Some aspects of biotechnology are as ancient and familiar as adding yeast to bread dough. Others are as recent and unfamiliar as genetic engineering and monoclonal antibodies.

See How Old Is Biotechnology, *page 15.*

Biotechnology can mean different things to different people. Because biotechnology has been a politically charged term, it is important to understand a range of definitions:
- The simplest definition of biotechnology is "applied biology."
- Another is "using living organisms to make a product or run a process."
- Some people consider biotechnology to be only genetic engineering.

These definitions include activities as familiar as using bacteria to make yogurt and cheese, vinegar and marinades. The older biotechnologies have been used by plant and animal breeders, bakers, wine-makers and brewers for thousands of years. These broad definitions of biotechnology also include the new techniques of "genetic engineering" — using new biotechnology to modify the genetic material of living cells to produce new substances or perform new functions.

The newer tools of genetic engineering have been developed since 1973. Genetic engineering is also called recombinant DNA technology, because a copy of a piece of DNA containing one or a few genes can be transferred between organisms or recombined within organisms. This technology allows researchers to move genetic information between unrelated organisms. For example, microbes given a copy of the gene for human insulin can make insulin, which can be purified and used to treat diabetes in humans. Other microbes may be genetically engineered to clean up oil spills or toxic chemicals.

Most scientists consider recombinant DNA techniques to be more precise than older methods of manipulating genes. For example, corn breeders have been mixing thousands of genes from two different types of corn into one hybrid. While transferring beneficial traits, many undesirable traits may also be carried along. With genetic engineering, biologists can add one or two specific genes not only from corn, but from wheat or soybeans — even from bacteria or animals.

Older methods did not allow moving genes between different organisms that do not mate with each other. Moving genes between unrelated organisms concerns some people. The concerns include questions about the ethics of moving genes from one species to another, and the safety of such gene transfers. While scientific research cannot answer the ethical concerns, several scientific agencies (National Academy of Sciences, National Research Council, World Health Organization) have concluded that the risks of genetic engineering are no greater than the risks of traditional genetic manipulations.

AUTHOR'S NOTE:
For more information, ask your library for:

National Academy of Sciences. 1987. *Introduction of Recombinant DNA-Engineered Organisms into the Environment: Key Issues.* National Academy Press: Washington, D.C.

National Research Council. 1989. *Field Testing Genetically Modified Organisms: Framework for Decisions.* National Academy Press: Washington, D.C.

World Health Organization. 1991. *Strategies for assessing the safety of foods produced by biotechnology.* World Health Organization, Geneva.

RECOMBINANT DNA — *You can think of gene splicing like cutting a circle of tape. You can cut it once, insert a different piece, and join both ends.* ▼

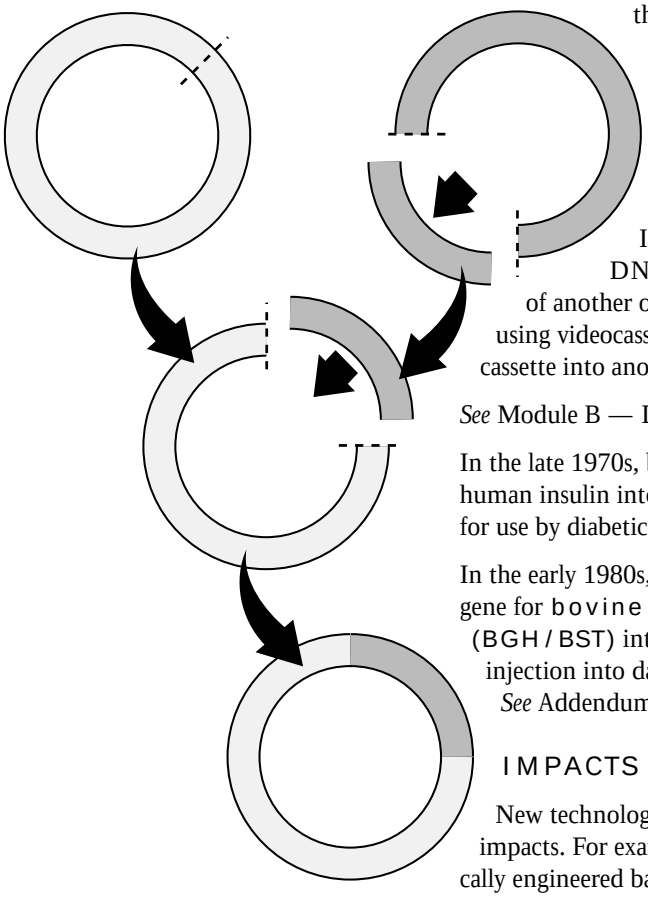


Illustration by Betsy True
UW Medical School

GENETIC ENGINEERING

From bacteria to humans, all organisms are composed of cells. The information needed to grow and maintain a cell is encoded in a chemical called DNA (deoxyribonucleic acid). In several ways, DNA is like videotape. Both are linear tapes that carry information. Both can be copied. The information on both cannot be read directly, but rather must be translated. With videotape, the information is translated into pictures and sounds. With DNA, the information is translated into proteins, including enzymes and hormones that regulate the cell.

Most significantly to biotechnology, both videotape and DNA can be rearranged, new material inserted and the new version can be copied.

In the early 1970s, biologists discovered how to cut a piece of DNA — a gene — from one organism and splice it into the DNA of another organism. This recombinant DNA technology is analogous to using videocassette recorders (VCRs) to copy a scene from one movie on a videocassette into another movie on a second cassette.

See Module B — DNA as Videotape: A Quick Teaching Analogy.

In the late 1970s, biologists used gene-splicing techniques to insert the gene for human insulin into microbes, which then produced large amounts of human insulin for use by diabetics.

In the early 1980s, several chemical companies used the same strategy to insert the gene for bovine growth hormone / bovine somatotropin (BGH / BST) into a bacterium. The bacterium could then produce BGH/BST for injection into dairy cows to increase milk production.
See Addendum — Milk Pricing, *pages 41-42.*

IMPACTS

New technologies usually bring social, economic, environmental and technical impacts. For example, in the mid-1980s, the first outdoor field trials of a genetically engineered bacterium generated a protracted controversy in California. In the late 1980s, the development of recombinant BGH/BST generated concern about the role of genetic engineering in the food supply. The concerns ranged from possible effects on the health of cows and the safety of milk from treated cows, to the economic impacts on dairy farmers resulting from an increase in the milk supply.

These cases illustrate that the public will have a role in the decisions to develop and market a new biotechnology product or process, especially one involving recombinant DNA.

AGRICULTURAL BIOTECHNOLOGY: PLANTS

Using the broad definition, many aspects of the agricultural sciences — especially food processing — are included in biotechnology. For example, compare popcorn and beer. Popcorn is prepared by cooking in vegetable oil. Making popcorn is food processing, but most people would not consider it biotechnology. On the other hand, brewing beer requires chemicals called enzymes

from barley to convert starch to sugar (malting), and yeast to ferment the sugar into alcohol and carbon dioxide. Both malting and fermentation are examples of classical biotechnology — technology that has been around for 6,000 years.

Biotechnology can speed the selection and breeding of crops with desired traits. For example, using DNA markers allows corn breeders to detect even in seedlings the genes that encode complex traits such as drought resistance. Gene transfers permit crop breeders to use genes from any source — plant, animal or microbe — in developing new varieties. And plant tissue culture enables biologists to quickly propagate large numbers of plants grown in test tubes (micropropagation).

Biotechnology is being tested to increase crop yields by inserting genes for resistance to diseases or pests using genetic engineering techniques. For example, from 1992 to 1994, the Monsanto Company tested potatoes that produce an insect-killing protein originally found in a bacterium. The plants resisted the Colorado potato beetle.

See also Module C case studies, and Module F news coverage of Calgene, Inc.'s FLAVR SAVR™ tomato.

Potatoes are also being modified to improve the tuber quality to make better French fries or potato chips. Crops such as soybeans and canola (a *Brassica* related to turnips and kale) are being modified to produce oils lower in saturated fat, to have a longer shelf life, or to increase their usefulness as industrial lubricants and detergents. These experimental varieties may be available for commercial use by the mid-1990s.

AGRICULTURAL BIOTECHNOLOGY: ANIMALS

Used commercially in the United States since the 1930s, artificial insemination is an early example of biotechnology applied to animals. Dairy scientists today routinely use methods to produce many calves from one embryo (cloning), and are developing methods to better characterize the milk-producing potential of heifers. Vaccines to protect animals against disease, including swine pseudorabies, are being developed using recombinant DNA techniques.

See Module C case studies, and Module F news coverage of BGH/BST.

BGH/BST dominated the public's concerns about biotechnology during the late 1980s, in part because of BGH/BST's perceived impacts on the wholesomeness of milk and on the sustainability of small dairy operations. Porcine somatotropin (PST) is a similar hormone that has been tested as a way to increase the leanness of pork.

Some analysts emphasize that while BGH/BST would only increase milk production, PST would improve pork quality. In November 1993, the U.S. Food and Drug Administration (FDA) approved recombinant BGH/BST for use. As of 1994, FDA has not approved PST for use.

Animals have been modified to produce drugs that can be recovered from their milk. This experimental use of biotechnology has been labeled "pharming." This approach means humans use animals rather than test tubes to make pharmaceuticals. Benefits include a greater drug supply, possibly at lower production costs. However, some consumers are concerned that milk from such animals would be included in the regular milk supply, and some ethicists question whether this is a justifiable use of animals.

INDUSTRIAL BIOTECHNOLOGY

Chemical companies have long used microorganisms as a source of biological catalysts called enzymes. Many laundry detergents contain enzymes to aid in removing stains. Microbes are also a source of amino acids that serve as sweeteners — aspartame; brand names Equal® or NutraSweet® — or as food additives and animal feed supplements. The microbes that produce these compounds can be modified by traditional selection for more desirable strains, or by recombinant DNA techniques.

Instead of petroleum, biorenewable materials such as starch from corn, or whey from cheese-making, can be used to make plastics. Industry uses biomass as feedstocks — building blocks for biodegradable plastics, industrial solvents and specialty lubricants. Oils from crops such as canola or soybean can be modified to produce lubricants that resist extreme temperatures or pressures.

In the food industry, plant cells grown in fermenters can produce flavors such as vanilla. And to confirm food safety, researchers are developing tests to detect foodborne bacteria and toxins using several biotechnologies. One example uses lightning bug (firefly) chemistry to give off light by combining four chemicals: oxygen, ATP (a kind of biological battery), luciferin, and a protein enzyme called luciferase that catalyzes the reaction that makes light.

Bacteria in food also have ATP. The more bacteria in a sample, the more bacterial ATP. In this test, luciferin and luciferase are added to a food sample, and a machine measures the amount of light given off. A sample with few bacteria will have few ATP "batteries" and will give off less light than another sample with many bacteria that will have many ATP batteries and enable the luciferin and luciferase to give off light.

ENVIRONMENTAL CLEANUP

Microbes break down many chemicals in the environment. Bioremediation uses organisms to remove toxins. For example, U.S. Department of Agriculture (USDA) researchers have selected a fungus that detoxifies a mutagenic wood preservative called pentachlorophenol that contaminates soil at old sawmills and wood treatment sites.

Other microbes are used to clean up contaminants such as oil and fuel spills from gas stations, military bases, electric utilities and industrial complexes, and heavy metals in water from mines. Sewage treatment plants harness these microbial recyclers to clean up waste water before it returns to streams, lakes and groundwater.

Microbes can also be used to reduce the production of toxins and to offer alternatives to industrial chemicals. Biopulping is an experimental way of using a fungus to pretreat wood chips before making paper pulp. Biopulping reduces both energy use and water-polluting byproducts.

Biotechnology allows the use of renewable resources such as biomass as a feedstock in the production of solvents, plastics and fuels — preferable to dependency on nonrenewable fossil fuels. For example, yeasts ferment corn to yield ethanol for gasohol; bacteria decompose sludge, manure or landfill wastes to produce methane. Some sewage plants collect methane to fuel generators, digesters and air compressors.

MEDICAL BIOTECHNOLOGY

This technology is usually the least controversial, in part because consumers believe the direct benefits outweigh the risks of using biotechnology.

DIAGNOSIS of both infectious diseases and genetic disorders has been improved by assays (tests) using biotechnology. For example, strep throat can now be diagnosed in 20 minutes rather than in two days. Donated blood and organs can be screened for a number of viral infections. The gene responsible for cystic fibrosis can be detected before the disease develops. In general, a more rapid and reliable diagnosis assists a physician in prescribing a treatment.

PREVENTION of infectious diseases is being improved by vaccines and antibiotics produced by animals or microorganisms.

TREATMENTS can include antibiotics, anti-toxins and other medicines such as insulin for diabetics and human growth hormone to counteract dwarfism, and therapeutics produced by plants — Taxol™ paclitaxel and trichosanthin.

GENE THERAPY means treating genetic disorders by supplying a new, working copy of a defective gene. For example, in tests to cure muscular dystrophy, researchers are moving a working gene into muscles with the defective gene that causes the disease. Genetic counselors help current and prospective parents assess the probabilities of inherited diseases occurring in their children, and get information about diagnosis and treatment of such diseases (see example on the next page).

Recombinant DNA technology was first used commercially to produce human insulin from bacteria. In 1982, genetically engineered insulin was approved for use

by diabetics. People with certain types of diabetes inject themselves daily with insulin, a protein hormone that regulates blood sugar. Insulin is normally produced by the pancreas, and pancreases of slaughtered animals such as swine or sheep were used as a source of insulin.

To provide a reliable source of human insulin, researchers obtained from human cells the DNA carrying the gene with the information for making human insulin.

Researchers made a copy of the DNA carrying this insulin gene and moved it into a bacterium. When the bacterium was grown in the lab, the microbe split from one cell into two cells, and both cells got a copy of the insulin gene.

Those two microbes grew, then divided into four, those four into eight, the eight into sixteen, and so forth. With each division, the two new cells each had a copy of the gene for human insulin. And because the cells had a copy of the genetic "recipe card" for insulin, they could make the insulin protein. In this way, special strains of *Escherichia coli (E. coli)* bacteria or yeast given a copy of the insulin gene can produce human insulin.

E. coli bacteria given copies of the genetic "recipe card" for human insulin can then make insulin protein for diabetics.

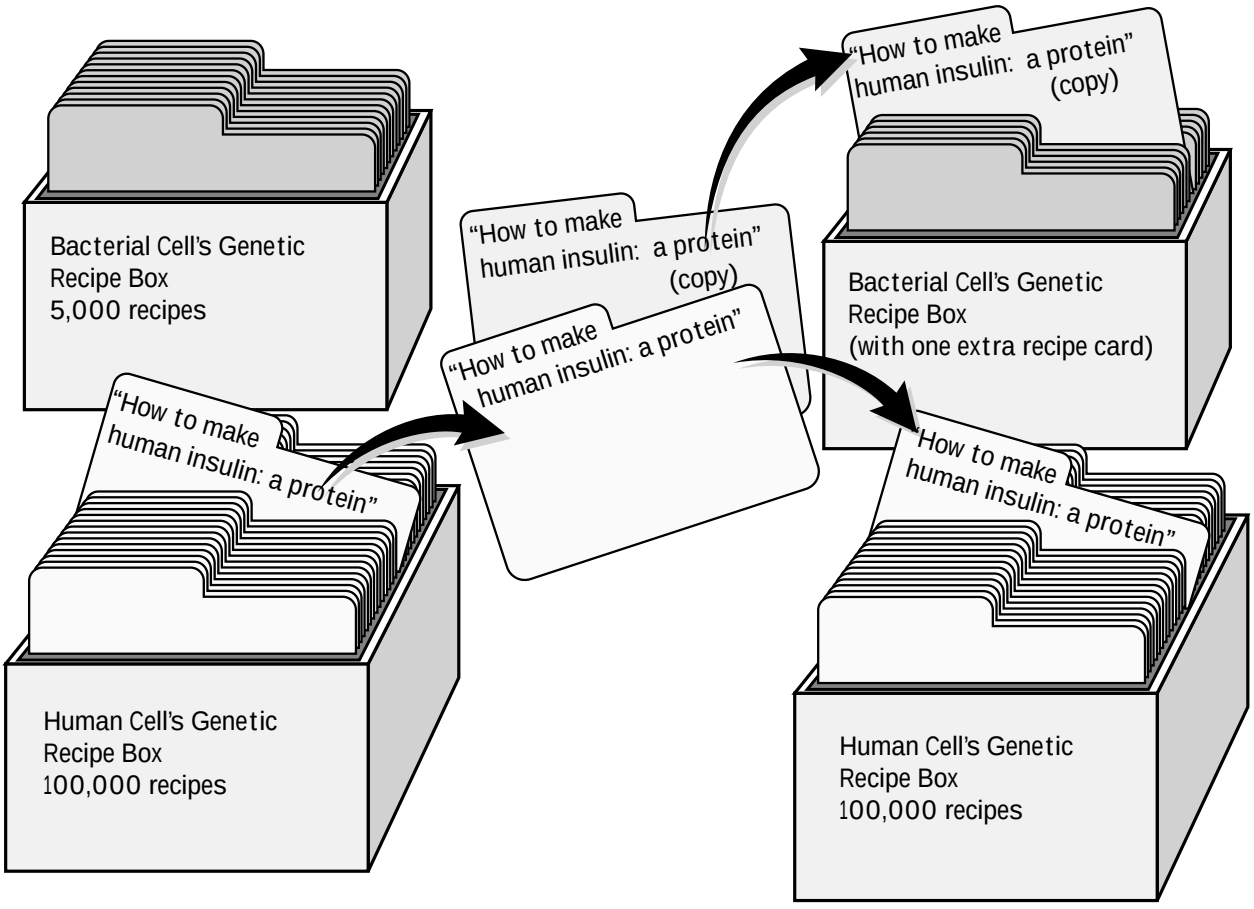


Illustration by Betsy True
UW Medical School

Using the same approach as in the insulin example, researchers found and transferred a copy of the gene for human growth hormone (HGH) to bacteria. The bacteria can produce large amounts of HGH, which can be purified and used to treat certain kinds of human dwarfism.

The case of a human disease caused by a defective gene uses nearly all the tools of medical biotechnology. Cystic fibrosis is a disease of mucous glands throughout the body that usually develops during childhood and makes breathing increasingly difficult. If a child receives two copies of the defective gene called the CF gene — one copy from each parent — then the child will develop the disease.

Biotechnology is used to detect, diagnose and treat cystic fibrosis:

FIRST, genetic testing or "screening" enables healthy people to know whether they carry one copy of the CF gene. If both potential parents have one copy each of the CF gene, then the genetic counselor can provide information and help assess whether the couple may have a child who will develop cystic fibrosis.

SECOND, genetic testing can alert parents their child has two copies of the CF gene, permitting diagnosis even before the disease develops in the child.

THIRD, children with cystic fibrosis can enjoy some relief from the mucus buildup in their lungs by breathing in a mucus-breaking drug made with recombinant DNA technology. The drug contains a protein that chews up the DNA so the mucus is easier to remove from the lungs by coughing.

FOURTH, an experimental approach to curing cystic fibrosis uses a genetically engineered cold virus that delivers to the patient's lung cells a working version of the defective gene. The new gene enables lung cells to make the protein that is lacking in cystic fibrosis patients.

CONCLUSION

See Module C case studies, and Module D criteria.

Biotechnology, including recombinant DNA techniques, is being used today in agriculture, food processing, industrial production, environmental cleanup and medicine. It will play a greater role in the future. The public needs to be informed about the technical, environmental, economic and social issues of biotechnology so as to make wise decisions concerning its uses.

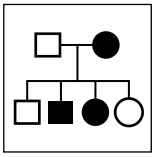
What Tools Does Biotechnology Use?

Biotechnology researchers apply the tools below to living organisms:

Microbes — organisms you can only see with a microscope

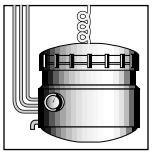
Plants

Animals



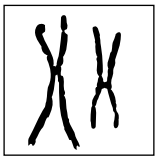
SELECTION AND BREEDING

Manipulating microbes, plants or animals, and choosing desirable individuals or populations as breeding stock for new generations.



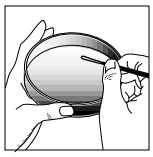
FERMENTATION

Using microbes to convert a substance such as starch or sugar into other compounds such as carbon dioxide and ethanol.



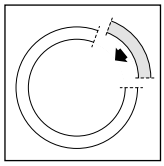
GENETIC ANALYSIS

Studying how traits and genes for traits are passed from generation to generation, and how genes and the environment interact to result in traits.



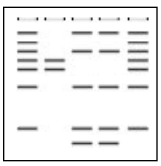
TISSUE CULTURE

Growing plant or animal tissues or cells in test tubes or other laboratory glassware, without other contaminating organisms, for propagation, chemical production and medical research.



GENETIC ENGINEERING — RECOMBINANT DNA (rDNA)

Transferring a copy of a DNA segment from one organism and inserting it into the DNA of another organism. The two organisms can be totally unrelated.



DNA ANALYSIS

Polymerase chain reaction (PCR) makes many copies of a DNA segment. RFLP mapping (restriction fragment length polymorphism) detects patterns in DNA that can indicate the presence of a gene for a trait. Both PCR and RFLP analysis can be used in "DNA fingerprinting" for genealogical studies and forensics.

Illustration by Betsy True
UW Medical School

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What Biotechnology Products Are in Our Food Supply?

Classical fermentations for preserving and flavoring food

- Fungi, yeast and molds in specialty cheeses (blue, Brie), bread, wine, beer and soy sauce
- Bacteria in yogurt, acidophilus milk, cheese, summer sausage, sauerkraut and kimchee, vinegar and marinades

Enzymes

- Lactase tablets to remove lactose from milk (for people who are lactose intolerant)
- Chymosin (rennet) for cheese-making
- Amylase in dry beer

Hormones

- Bovine growth hormone/bovine somatotropin supplements used in milk production
- Vitamin D added to milk

Whole foods

- Tomatoes that can ripen on the vine and be shipped with less bruising (brand name FLAVR SAVR™)

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HOW OLD IS BIOTECHNOLOGY?

The word "biotechnology" can be traced to 1917, when it was used to refer to large-scale production of materials from microbes grown in vats. But the roots of the technology are as familiar and ancient as baking yeast breads — traceable back 6,000 years.

4000 BC Classical biotechnology: Dairy farming develops in the Middle East; Egyptians use yeasts to bake leavened bread and to make wine.

3000 BC Peruvians select and cultivate potatoes.

2000 BC Egyptians, Sumerians and Chinese develop techniques of fermentation, brewing and cheese-making.

500 BC Mediterraneans develop marinating and Europeans develop salting, which leads to curing and pickling to flavor and preserve food.

1500 AD Acidic cooking techniques lead to the development of sauerkraut and yogurt — two examples of using beneficial bacteria to flavor and preserve food. Aztecs make cakes from *Spirulina* algae.

1859 *On the Origin of Species* — English naturalist Charles Darwin's theory of evolution — is published in London.

1861 French chemist Louis Pasteur develops pasteurization — a way of preserving food by heating it to destroy harmful microbes.

1865 Austrian botanist and monk Gregor Mendel describes his experiments in heredity, founding the field of genetics.

1879 William James Beal develops the first experimental hybrid corn.

1910 American biologist Thomas Hunt Morgan discovers that genes are located on chromosomes.

1917 The term "biotechnology" traces to this year, referring to large-scale production of materials from microbes grown in vats.

1928 Fred Griffith discovers genetic transformation — genes can transfer from one strain of bacteria to another.

1941 Danish microbiologist A. Jost coins the term "genetic engineering" in a lecture on sexual reproduction in yeast.

1943 Oswald Avery, Colin MacLeod and Maclyn McCarty use bacteria to show that DNA carries the cell's genetic information.

1953 James Watson and Francis Crick describe the double helix of DNA, using x-ray diffraction patterns of Rosalind Franklin and Maurice Wilkins at King's College, England.

Early 1970s Paul Berg, Stanley Cohen and Herbert Boyer develop ways to cut and splice DNA, introducing recombinant DNA techniques.

1975 Scientists organize the Asilomar conference to discuss regulating recombinant DNA experiments. Also, George Köhler and César Milstein show that fusing cells can generate monoclonal antibodies.

1982 First genetically engineered product — human insulin produced by Eli Lilly & Company using *E. coli* bacteria — is approved for use by diabetics.

1984 Kary Mullis develops polymerase chain reaction (PCR) to mass-produce specific DNA fragments.

1986 First release into the environment of a genetically engineered plant (a tobacco).

1987 First release of genetically engineered microbes in field experiments.

1990 Pfizer, Inc., introduces CHY-MAX® chymosin, an enzyme used in cheese-making — first product of recombinant DNA technology in the U.S. food supply.

1993 After nearly 10 years of scientific review and political controversy, the U.S. Food and Drug Administration (FDA) approves Monsanto Co.'s version of rBGH/rBST to increase milk production.

1994 Calgene, Inc. markets the FLAVR SAVR™ tomato — first genetically engineered whole food in the U.S. food supply.

Timeline expanded and adapted with permission from: *Biotechnology in Perspective* by Dr. David B. Sattelle (Washington, D.C.: Industrial Biotechnology Association), 1990, copyright © 1988 by Hobsons Publishing PLC, Bateman Street, Cambridge CB2 1LZ UK; *The Emergence of Bacterial Genetics* by Thomas D. Brock (Cold Spring Harbor, N.Y.: Cold Spring Harbor Laboratory Press), 1990; "Food Biotechnology: History of Food Development" by the International Food Information Council, Washington, D.C., 1993; *Brief Book: Biotechnology and Genetic Diversity* by Steven C. Witt, Agricultural Lands Project, 1985; and *Brief Book: Biotechnology — Microbes and the Environment* by Steven C. Witt (San Francisco: Center for Science Information), 1990.

How Can You Remember the Uses of Biotechnology?

Here's an easy way to remember ways we use biotechnology. Think of them as "The Five Fs" — five broad categories, beginning with an [f] sound, of products from living microbes, plants or animals:

- **Food** — for humans and feed for livestock.
- **Fiber** — cotton, wool, silk, linen, leather, lumber and paper.
- **Fuel** — ethanol (gasohol), methane, wood.
- **Feedstocks** — building blocks for polymers (for example, to make biodegradable plastics) and industrial lubricants. Microbes are also essential in treating wastewater, and can be used to clean up oil and toxic spills.
- **Pharmaceuticals** — diagnostics for detecting diseases or pathogens; vaccines for preventing illness; antitoxins for blocking poisoning; antibiotics for fighting infections and therapeutics for treating disease.

  Medical biotechnology also includes genetic testing and counseling for predicting susceptibility, and gene therapy for correcting disorders caused by defective genes.

For use as an overhead

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MODULE B — DNA AS VIDEOTAPE: A QUICK TEACHING ANALOGY

INSTRUCTIONS

OBJECTIVE:

Participants will be able to provide an analogy of genetic engineering (e.g., copying a new scene into a videotape).

ACTIVITIES:

DISCUSSION

Display the "DNA from a Disrupted Bacterial Virus" picture, or use an overhead projector for viewing. Explain that chromosomes are made of DNA. Hold up a videotape and lead a discussion about the similarities and differences between DNA and the videotape. Emphasize the fact that both DNA and the videotape contain encoded information, but to access the information, a VCR (for the tape) or a cell in a living organism (for the DNA) is needed.

WORKSHEET

Have the participants list similarities and differences between DNA and videotape.

MATERIALS INCLUDED:

LEADER

DNA from a Disrupted Bacterial Virus *(overhead)*, *Biotechnology: The Science and the Business*, Harwood Academic Publishers

DNA as Videotape Introductory Fact Sheet

DNA as Videotape Similarities and Differences Summary *(overhead)*

PARTICIPANT

DNA as Videotape Similarities and Differences Worksheet

ADDITIONAL MATERIALS NEEDED:

Overhead projector (optional)

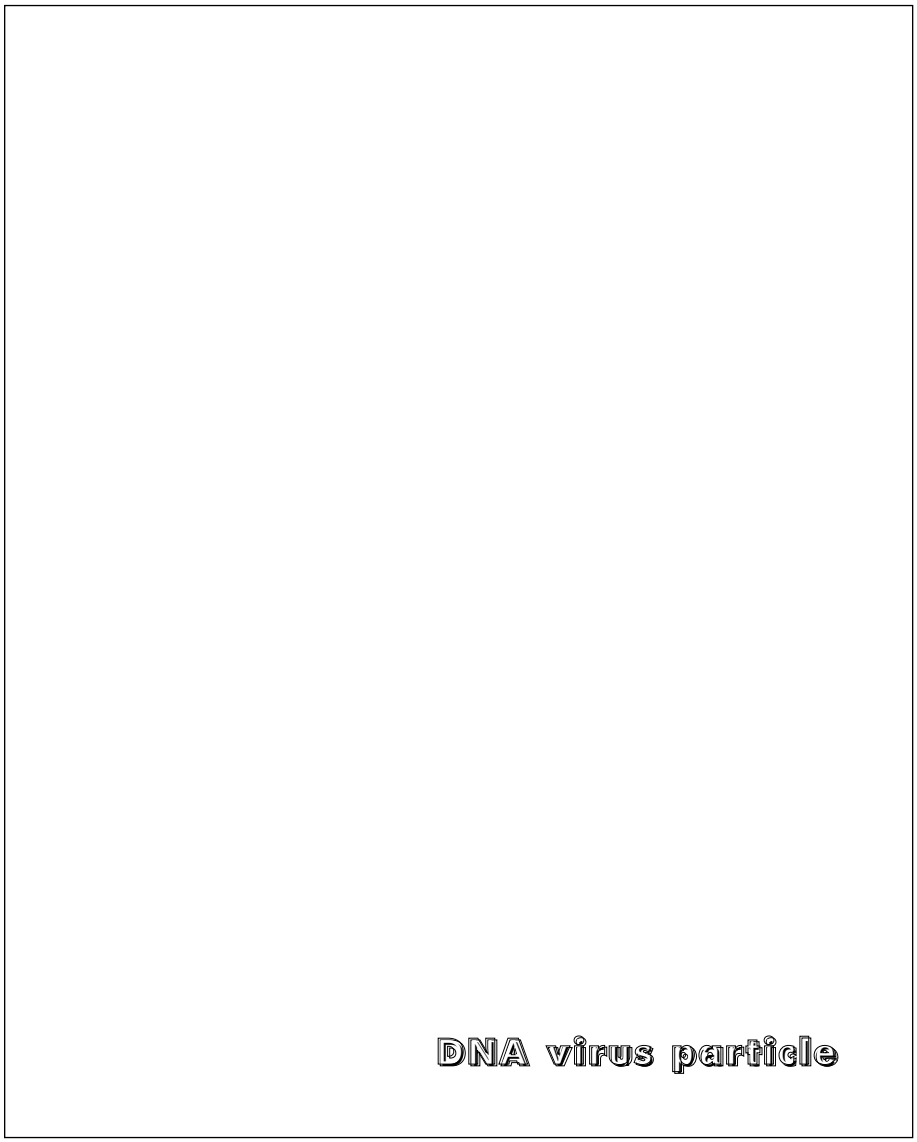
Video or audio cassette

VCR and TV, or cassette player (optional)

DNA from a Disrupted Bacterial Virus

All organisms are composed of cells, and cells have chromosomes. The chromosomes are made of DNA and protein, and DNA is the genetic material. The cells contain chromosomes with a copy of all the genes of that organism.

DNA is a tape — it's linear.



The thread-like strands shown in this picture are DNA from a virus. The virus was osmotically shocked to spill out the DNA.

For use as an overhead

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DNA AS VIDEOTAPE INTRODUCTORY FACT SHEET

DNA is often called the "genetic blueprint" of an organism. But DNA is more like videotape than a blueprint.

VIDEOTAPE IS A TAPE — IT'S LINEAR.

- Videotape carries information — electronic information.
- The information is encoded.
- The information has to be translated.
- We use a VCR and a TV to translate the information on a videotape.
- The information on a videotape produces sounds and pictures — scenes.
- Tapes of two different movies are composed of the same kind of tape, but the information recorded in them is different (information on the tape determines whether you see a historical documentary or romantic comedy).
- We can make copies of a videotape.
- We can edit videotape. For example, we can take a scene from one movie and copy it electronically into a second movie.
- Copies of an edited tape will contain the same information.
- Videotapes can be recorded in different formats, such as VHS, Betacam or 8 millimeter. Each different videotape format can only play on a VCR made for that format.
- Videotape is lifeless metal particles. The new copy cannot replicate itself.

DNA IS A TAPE — IT'S LINEAR.

- DNA carries information — genetic information.
- The information is encoded.
- The information has to be translated.
- Cells translate the information in DNA.
- The information in DNA codes for traits — the products of genes and the environment.
- Genetic information for two species is composed of the same kind of DNA, but the information stored is different (information in DNA determines whether the species is a Colorado blue spruce or Colorado potato beetle).
- Cells can copy DNA (DNA replication).
- DNA can be edited. For example, we can take a copy of the DNA containing one gene from an animal — the gene for insulin from humans — and splice it biologically into the DNA of microbes (recombinant DNA).
- Copies of these edits will contain the same information (cloning).

Continued next page

- DNA from different organisms is chemically much the same format, so a gene from a microbe can also be inserted into and may be expressed in a plant or an animal.
- DNA is part of living cells: The microbes can multiply, and offspring will contain the insulin gene. In this example, those new microbes can make the insulin protein.

As with all analogies, this one eventually breaks down. Cells are alive and grow and multiply, and organisms evolve — videotapes are static, not living organisms; the information content stays the same until you edit or copy over it. But the analogy is useful because of all the other similarities between DNA and videotape.

DNA as Videotape

Similarities and Differences Summary

VIDEOTAPE	DNA
Linear tape	Linear molecule
Carries information	Carries information
Information is encoded	Information is encoded
Information must be translated	Information must be translated
Use VCR and TV to translate	Cells translate
Produces sounds and pictures — *scenes*	Codes for traits — *products of genes*
Can be copied	Can be copied (DNA replication)
Can be edited	Can be edited *(recombinant DNA)*
Can make copies of edits	Can make copies of edits *(cloning)*
Comes in many formats *(e.g., VHS, Betacam, 8 mm)*	Essentially one format
Static — *not a living organism*	Evolves — *living cells grow and multiply*

For use as an overhead

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DNA as Videotape

Similarities and Differences Worksheet

VIDEOTAPE	DNA

MODULE C — FOODS FROM AGRICULTURAL BIOTECHNOLOGY

INSTRUCTIONS

OBJECTIVES:

Participants will be able to list three or four examples of foods from plants modified through genetic engineering.

Participants will be able to list analogies and purposes for linking marker genes to antisense genes.

Participants will be able to list possible reasons for the difference in public reaction to introducing genetically engineered chymosin and BGH/BST into the U.S. food supply.

ACTIVITIES:

- Discuss the information in the materials listed below.
- Discuss analogies and questions and concerns in using an antisense gene to turn off a gene in developing a new food product.
- Describe the examples given on the "Examples of Foods from Plants Modified Through Genetic Engineering" fact sheet.
- Read "The BGH/BST Controversy: A View from Wisconsin" and "Wisconsin Dairy Industry History: 1860s to 1990s."
- Discuss food additives and people's attitudes toward food.
- Discuss possible reasons for the difference in public reaction to genetically engineered chymosin and BGH/BST.
- Have participants list potential uses of genetic engineering in food.

MATERIALS INCLUDED:

LEADER & PARTICIPANT

Uses of Biotechnology in Plants Case Studies:
- Plants Genetically Engineered to Resist Viruses: "Cross-Protection"
- Starch Gene in Potatoes
- FLAVR SAVR™ Tomatoes: Some Teaching Analogies for Communicating About Technical and Social Issues
- Bt Toxin Story

Examples of Foods from Plants Modified Through Genetic Engineering, *The Gene Exchange (overhead)*

Uses of Biotechnology in Animals Case Studies:
- The BGH/BST Controversy: A View from Wisconsin
- Wisconsin Dairy Industry History: 1860s to 1990s
  Addendum — Milk Pricing
- Comparing Public Reaction to the Use of CHY-MAX® Chymosin and Posilac™ BGH/BST in the Food Supply

USES OF BIOTECHNOLOGY IN PLANTS

MAJOR USES

- Accelerated plant breeding
- Disease and pest resistant plants
- Frost and drought resistant plants
- Herbicide tolerant plants
- Improved storage/shelf life
- Modified oils
- Modified nutrient content
- Increased starch content
- Production of useful products in cell culture

CASE STUDIES

Plants Genetically Engineered to Resist Viruses: "Cross-Protection"

A plant infected with a mild strain of a virus often resists infection by a severe strain of the same virus. Plant virologists first discovered this in the 1920s. For decades, some farmers have intentionally infected their crops — citrus trees in orchards, or tomatoes grown in greenhouses — with mild viruses to "cross protect" them from severe strains.

In 1982, two University of Wisconsin-Madison researchers showed that the virus's protein "coat" was involved in cross-protection. This meant healthy plants engineered to make a viral coat protein might resist infection by a virus.

In the mid-1980s, plant scientists in St. Louis, Missouri, and Madison, Wisconsin, transferred the gene for virus coat protein to plants. These transgenic plants made a coat protein, even though they were not infected. More important, they resisted infection by the virus. This was the first example of using genetic engineering to make plants resist disease.

Starch Gene in Potatoes

Potatoes with high starch content make better French fries and potato chips because they absorb less oil when frying. Potato processors pay farmers a premium price for high-starch potatoes. Breeders have been developing high-starch potatoes for decades using traditional techniques.

In 1992, plant scientists at the Monsanto Company announced that they had used genetic engineering to insert a gene from a bacterium into the Russet Burbank potato. The gene increases the starch content of the transgenic Russet Burbank potato tubers. Monsanto scientists say the new potato won't absorb as much oil during frying as other potatoes, thereby lowering the cost of frying and reducing the oil (and calories) in French fries and potato chips.

FLAVR SAVR™ Tomatoes: Some Teaching Analogies for Communicating About Technical and Social Issues

Calgene, Inc., of Davis, California, has developed a tomato variety they call FLAVR SAVR™. Calgene's objective is to provide a tasty, vine-ripened red tomato that stays firm enough to ship. The tomato stays firm because a tomato gene that controls the softening of the tomato fruit has been turned off.

Most people are familiar with pectin — it's used to make jellies gel. Pectin naturally occurs in many fruits. In tomatoes, pectin keeps the fruit firm. When tomato fruit ripen, they become tastier, turn red and grow soft. They grow soft because a protein the tomato makes called polygalacturonase (PG) chews up the pectin.

One way to keep tomatoes firm even when ripe is to keep the PG protein from chewing up the pectin.

One way to prevent pectin from being chewed up is to keep tomatoes from making PG protein as fruit ripen.

One way to keep tomatoes from making PG protein is to turn off the gene that carries the information that the tomato fruit uses to make PG protein — that is, to turn off the genetic "recipe card" that tells the tomato fruit how to make PG protein.

One way to turn off the gene is to insert an antisense version of the PG gene — the "recipe card" to make PG protein, not the PG protein itself. The antisense PG gene is an inverted copy of a normally occurring tomato gene. You can imagine how this works in several ways.

One way is to think of a Velcro™ fastener — the antisense PG gene as Velcro fuzz, and the regular PG gene as Velcro hooks. The fuzz will stick to the hooks and prevent the gene from being expressed, blocking production of the PG protein.

Another analogy is to use right and left hands. Say the regular PG gene is a right hand, which can work fine to make PG protein — unless the left hand gloms onto the right hand, keeping it from making PG protein.

The California company that developed the FLAVR SAVR tomato has inserted two genes into these tomatoes using recombinant DNA techniques: the antisense PG gene — which is difficult to detect — linked to a marker gene that makes plant cells resist an antibiotic called kanamycin.

This kanamycin-resistance gene is easy to find. Cells that have it make a protein that chews up kanamycin, so those cells can grow in a laboratory dish containing a gelatin-like growth medium that contains kanamycin, which normally prevents cell growth. Cells that do not have the "kan-resistance" gene do not make the kanamycin-eating protein, and cannot grow on the medium that contains kanamycin.

The two genes — one easy to spot, the other difficult — are linked for the same purpose you put a reflective collar on a dog. It's easy to see the collar at night, even if you cannot see the dog. But if you see the collar, you know where the dog is most likely to be.

Another analogy is to think of the kan-resistance gene as a large steel sewing needle, and the antisense PG gene is a wooden toothpick. If you tape the steel sewing needle to the wooden toothpick and throw them into a haystack, you can use a magnet to

find the wooden toothpick. If you throw just the wooden toothpick in a haystack, you cannot use a magnet to help find it. So the kan-resistance gene is linked to the antisense PG gene to make it easy to find those cells that both resist the kanamycin and have the antisense PG gene that keeps tomato fruit firm.

Plant scientists can grow entire normal-looking transgenic tomato plants from these selected cells that have the two added genes.

QUESTIONS AND CONCERNS

The U.S. Food and Drug Administration (FDA) regulates new foods from genetically modified plants, such as the FLAVR SAVR tomato. FDA also regulates food additives. Criteria the FDA uses to evaluate food additives:

- Safety to humans
- Efficacy — the additive must work as intended
- Demonstrated quality assurance — consistently potent and pure product

Most citizens think FDA does the testing of new foods or new food additives. Actually, FDA does little testing. Rather, it oversees tests run by the company submitting a new food or a new additive, and evaluates the results of the tests before approving or blocking a new commercial product.

Calgene, Inc. asked FDA to review the FLAVR SAVR tomato as a food from a genetically modified plant. In January 1993, Calgene also asked FDA to review the kanamycin-resistance marker gene and its protein as a food additive in tomato, cotton and canola. So commercialization required two separate approvals:

- FLAVR SAVR tomato as a genetically modified plant; and
- Kanamycin-resistance marker gene and its protein as a food additive.

Note that only the kanamycin-resistance gene — not the FLAVR SAVR tomato — was reviewed as a food additive. Some food safety and quality questions include:

- What effects will the kan-resistance gene and the protein it makes have on people who eat tomato fruit?
- Will the kan-resistance gene protein cause food allergies in some people?
- Will the kan-resistance gene protein affect kanamycin's usefulness as an antibiotic for humans?
- Did experiments address these questions?
- Who did the experiments?

Some people also criticize using genetic engineering to develop firmer tomato fruit because it will encourage shipping tomatoes long-distance. These people contend that using locally grown tomatoes is a better use of resources. However, this alternative would not supply tomatoes to most U.S. consumers who want tomatoes but cannot grow them outdoors in winter or spring.

In April 1994, the FDA convened an advisory panel of scientists and consumer advocates. The panel concluded that the FLAVR SAVR was as safe as other tomatoes. On May 18, 1994, FDA approved the FLAVR SAVR tomato. Several organizations, most notably Jeremy Rifkin's Pure Food Campaign, objected to these tomatoes and announced plans to boycott companies that use them. Calgene reported early sales were strong.

See Bt Toxin Story, *page 33, and Module F news coverage.*

Bt TOXIN STORY

Tom Zinnen, University of Wisconsin-Extension and UW Biotechnology Center, UW-Madison

Organic farmers and gardeners grow plants using less chemical insect-killers. Yet they often spray their plants. So what are they spraying?

Instead of synthetic chemicals, they are spraying a bacterium that can kill many plant-eating insects, such as the green caterpillar called tomato hornworm or the striped Colorado potato beetle. The insects eat the leaves sprayed with the bacterium and the ingested bacteria kill the insects. The bacterium's name is *Bacillus thuringiensis*. It is most commonly known by its initials, Bt. Bt kills by producing a protein that is toxic to certain insect larvae. Several companies mass-produce Bt as a microbial insecticide.

Organic growers like the bacterium because it kills some plant-eating insects but not others such as bees. The bacterium doesn't affect humans, livestock or pets and it doesn't pollute the groundwater the way some chemical insecticides can.

Plant scientists have been doing research to see if they could make plants produce their own Bt toxin. They want to find out if crop plants that make their own Bt toxin would not have to be sprayed as much with chemical insecticides or with Bt bacteria. Farmers would benefit by spending less money and time on sprays. The use of chemical insecticides would decrease, keeping groundwater cleaner and less contaminated by pesticides. This is why farmers who grow cranberries in the bogs of central and northern Wisconsin are supporting research to develop cranberries that make their own Bt toxin.

The Bt bacterium has the gene that encodes the Bt toxin. The information is stored on the DNA of Bt. DNA in many ways is like videotape — it's a tape that stores information in a code that can be translated. It can be copied and it can be edited. People who work with video can take a scene from one movie on videotape and put it into another movie on another videotape. Biologists who work with DNA can take a copy of the piece of DNA that has the information for the Bt toxin from Bt bacteria and put it into the DNA of plants.

Plants that have the DNA for making Bt toxin can actually make the toxin — so they don't need to be sprayed with Bt bacteria. Agricultural scientists have inserted the Bt DNA into selected lines of many crop plants: potato, cranberry and spruce are just three common plants that now may have the Bt gene.

Researchers are testing whether the Bt potatoes can kill Colorado potato beetle. They grow the Bt potatoes right next to other potatoes that don't have the DNA for Bt and don't make the toxin. When Colorado potato beetles chew on the plants, the beetles that eat the plants without the Bt toxin live and continue to eat the plants' leaves. But beetles that chew on the potato that makes its own Bt toxin soon die. The scientists conclude that the Bt potatoes can resist some insects because the plants make their own Bt toxin.

There are always some drawbacks to any new technology. Populations of insects may become resistant to the Bt toxin, just as some insects can now resist chemical insecticides that once killed them. That would mean that even spraying crops with Bt bacteria would not protect those crops from resistant insects. Farmers would then have to choose between spraying with chemical insecticides or using other methods to control insects.

Possible alternative methods include growing different crops every year — crop rotation — and using other natural ways to kill or reduce crop-eating insects.

For example, some insects eat other insects. If farmers can learn to grow the wasps that eat tomato hornworm, farmers might be able to control the hornworm without having to use chemicals.

However, researchers who have developed the Bt potatoes and other crops believe that these crops can be useful for many years. They point out that the Bt bacteria has been sprayed for 30 years, yet only a few insects have become resistant to Bt toxin.

People who oppose the use of Bt plants say that resistant insects will become a problem if too many farmers use Bt plants year after year. They also fear that farmers will use only the potato variety that makes Bt toxin, and not other potato varieties. Such monocultures are vulnerable to loss should a new virulent pest arise, such as the southern corn leaf blight in the 1970s.

The use of these Bt plants is still for research only. If approved by the federal government, potatoes producing Bt toxin could be available in supermarkets in the late 1990s.

Examples of Foods from

Plants Modified Through Genetic Engineering

The Gene Exchange, April 1992

These examples are currently being developed and some will be available within the next few years.

Food	Source of New Genes	Purpose of Engineering
Potato	Chicken	Increase disease resistance
	Giant silk moth	Increase disease resistance
	Greater waxmoth	Reduce bruising damage
	Virus	Increase disease resistance
	Bacteria	Increase herbicide tolerance
	Bacteria	Increase starch content
Corn	Wheat	Reduce insect damage
	Firefly	Introduce marker genes
	Bacteria	Increase herbicide tolerance
Tomato	Flounder	Reduce freezing damage
	Virus	Increase disease resistance
	Bacteria	Reduce insect damage
	Tomato	Improve flavor
Rice	Bean, pea	Introduce new storage proteins
	Bacteria	Reduce insect damage
Melon	Virus	Increase disease resistance
Apple	Bacteria	Reduce insect damage

For use as an overhead

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USES OF BIOTECHNOLOGY IN ANIMALS

MAJOR USES

- Artificial insemination
- Better characterize the milk-producing potential of dairy heifers
- Produce many calves from one embryo — cloning
- Increase milk production
- Produce vaccines to protect animals against disease, including swine pseudorabies
- Produce drugs recovered from animal milk — "pharming" (experimental)
- Increase leanness of pork and improve pork quality (experimental)

CASE STUDIES

The BGH/BST Controversy: A View from Wisconsin

Bovine growth hormone/bovine somatotropin (BGH/BST) is the first biotechnology product challenged on social and economic grounds, and not solely on the basis of human safety or environmental impact.

The two names reflect the controversy — those who oppose commercial use usually call it bovine growth hormone, while those who support its use prefer to call it bovine somatotropin.

BGH/BST is a protein produced in the pituitary gland of cattle. There are four subtypes, each 190 to 191 amino acids long. A fifth version, with one extra amino acid added at the end, was submitted by the Monsanto Company for review by the Food and Drug Administration (FDA) and approved for use in 1993.

Is the BGH/BST controversy about biotechnology, or is it more about the myth or mystique of milk? Take a look back through 150 years of Wisconsin dairy industry history (page 38) to compare the introduction of biotechnology product BGH/BST with the introduction of a food technology product: oleomargarine.

The BGH/BST controversy in Wisconsin can be explained in part by keeping in mind certain attitudes generally held in the state:

- Milk is uniquely wholesome.
- Dairy and politics are inseparable.

One generally held attitude shifted significantly during the mid-1980s. Before, increasing milk *production* was viewed as the goal of dairy research. This goal has shifted to increasing dairy *profitability*.

With the BGH/BST controversy in historical context, what can we conclude?

- **The Wisconsin BGH/BST controversy is not solely or even primarily about biotechnology**. Public response to recombinant BGH/BST is in many ways parallel to the reaction to margarine — both were seen as an economic threat to the dairy industry. Other products of recombinant DNA technology have not been similarly challenged. Note that Wisconsin produces and uses CHY-MAX®, a recombinant chymosin (rennet) used in most cheese production (see page 42). Also, Wisconsin has streamlined regulation of agricultural biotechnology, including the release of genetically engineered bacteria and plants.
- News coverage of the movement to legalize yellow margarine emphasizes that the issue was impact on the health of the dairy industry — not of consumers. Wisconsin policies on margarine illustrate historical concern for protecting dairy

farmers and the industry. These concerns are not unique to biotechnology. Although some opponents of BGH/BST challenged its safety, the scientific community concluded that milk from cows treated with BGH/BST was as safe as milk from untreated cows.

- **Attitudes about the purpose of agricultural research have fundamentally shifted.** Instead of increasing *production*, research is now expected to increase sustainable *profitability* as part of rural economic development, which may favor large or well-managed farms at the expense of small farms.
- **Improving communications between farmers and land-grant universities is essential.** Many farmers feel such communication had degenerated to a one-way process of agricultural colleges prescribing a solution to farmers.

Wisconsin Dairy Industry History: 1860s to 1990s

1860: Wheat is the dominant Wisconsin agricultural product. The U.S. Civil War keeps prices high and labor short.

1864-65: The chinch bug causes wheat failure in Wisconsin. The end of the Civil War causes price collapse. Other wheatlands farther west open up.

1869: In France, Hippolyte Mege Mouries invents oleomargarine, and other European chemists develop ways to make oleo from vegetable oils.

1870s: Dairy is promoted as the "Solution of the 1870s" — similar to the promotion of biotechnology in the 1980s. Three events key to Wisconsin dairy industrialization take place:

- Cattle are imported from Germany.
- Alfalfa seed is imported from Russia.
- The silo is invented.

1880s: William Dempster Hoard (of *Hoard's Dairyman* magazine) and the Wisconsin Legislature establish an agricultural school at the University of Wisconsin in Madison, including a short course for farmers.

- The Agricultural Experiment Station opens for research.
- Dairy grows; butter and cheese are the key products. Wisconsin bans oleomargarine.

1890s: Stephen Moulton Babcock develops the butterfat test, still the most common basis for milk payments farmers receive from dairy processors.

- The first tuberculin testing finds most dairy cattle have the disease; even top-producing cows are destroyed.
- The Wisconsin ban on oleomargarine is overturned by federal courts. The Wisconsin Legislature bans margarine dyed yellow.

1914: The Cooperative Extension Service is established. Land-grant universities such as the University of Wisconsin now have three missions in agriculture: teach, do research, and ensure communication between researchers and farmers.

1914-1918: World War I brings high prices for farm products and shortage of labor.

1919: The end of WWI brings a drop in farm income. The farm economy is in depression several years before the rest of the economy collapses.

1930s: Geneticist L.E. Casida and extension dairyman George Werner introduce artificial insemination (AI) to Wisconsin using fresh bull semen.

- The first AI cooperative in Rock County inseminates about 1,000 cows.
- To protest margarine and other threats to dairy, 5,000 farmers march on the state capitol. As a result, oleo is taxed and still cannot be dyed yellow.

1950s: The first calf is born in Rock County as a result of artificial insemination with frozen semen. The trend in agriculture is increased productivity — fewer farms, bigger farms, more mechanization, communication and transportation. The "Technology Treadmill" accelerates after World War II.

Early 1960s: Urban consumers move to legalize yellow margarine.

1965: Assemblyman Earl Elfers opposes legalization, noting that almost a quarter of Wisconsin land is suited only to dairy farming and free sale of oleo would prove harmful to those farmers who have little choice in their agricultural operations. Assemblyman Merrill E. Stalbaum also stresses the economic straits of Wisconsin farmers in arguing against legalizing oleo: "The oleo ban is the last weapon farmers have."

1967: Yellow oleo is legalized, but the oleo tax remains and proceeds go to build the University of Wisconsin Animal Sciences Building, which houses the Department of Dairy Science.

1974: The new biotechnology age is just beginning — recombinant DNA techniques are just being developed.

- The last state to do so, Wisconsin repeals the oleo tax.

1980: Biotechnology is being touted as the next wave of agricultural research.

1982: Recombinant insulin is on the market. Recombinant BGH/BST (rBGH/rBST) is being produced experimentally in bacteria and tested in cows. Companies involved are Monsanto, Eli Lilly, Upjohn and American Cyanamid.

1984: Dale Bauman of Cornell University reports his results on injecting rBST into cows, reported by Ken Smith in the December 13, 1984, *Agri-View*, a weekly Wisconsin farm paper. The story is that rBST is a protein; the protein is encoded by a cow gene; the cow gene is transferred to a bacterium; the bacterium makes rBST; the hormone is purified from the bacterial culture and injected into cows — increasing milk production significantly. The article does not mention human health concerns. Bauman's analysis was that:

- Early adopters would benefit.
- After a while, nearly all farmers would use rBST, eroding early adopters' edge.
- Increased milk production would reduce the farm population.
- Others at Cornell would analyze the "full impact" of this biotechnology.

Advocates of rBST suggest that increased production at lower cost would drive down the price of dairy products, making them more price competitive with oleo and meat — thereby increasing the market share of dairy products.

1985: The Wisconsin Legislature commissions a report on the social and economic impact of biotechnology on Wisconsin agriculture. FDA approves human consumption of milk and meat from test animals injected with rBST. Farm publications cover rBST, but it's not considered a prominent consumer issue.

1987: The U.S. Department of Agriculture Economic Research Service publishes an analysis of the economic impact of rBST.

1988: An election year, and rBST makes headlines. Jeremy Rifkin leads national opposition using diverse arguments. The UW-Madison report commissioned in 1985 says rBST would most likely accelerate the existing trend of fewer and larger farms. State Senator Russell Feingold, with several biotechnology companies in his district, identifies BGH/BST as a populist issue to distinguish himself to voters. The issue is not so much safety, but the public's perception of safety; hence, labeling milk is proposed. Feingold argues that if "rBST-free" milk would bring a premium price, then making all Wisconsin milk synonymous with "rBST-free" could mean a premium price for all.

Chemical companies' public relations efforts focus on veterinarians and veterinary medicine supply companies — not consumers, farmers or dairy processors.

1989: AMPI, the largest U.S. dairy cooperative, announces that none of its member farmers will participate in whole-herd rBST tests. U.S. Senator Patrick Leahy of Vermont expresses concern that rBST could lead to a production surge that would collapse the federal price support system.

1989-90: With funding from the four rBST companies, the Animal Health Institute releases information that rBST has no detected affect on human health. In spring 1990, the Wisconsin Legislature passes two rBST moratoria. Gov. Tommy Thompson vetoes one. He signs the other, which passed 30 to 3 in the Senate and 97 to 0 in the Assembly, to:

- Ban the use of recombinant BST in Wisconsin for one year until June 1, 1991;
- Provide money for more research on the effects of rBST on cattle health;
- Establish the Agricultural Technology and Family Farm Institute to evaluate the effects of new technologies;
- Commission a report on labeling milk produced with rBST; and
- Establish a UW-Extension program in biotechnology education.

1991: The moratorium lapses on June 1. In the fall, the Legislature passes another moratorium on a much closer vote and the governor vetoes it. The Legislature sustains the veto, but the governor is accused of being unduly influenced by chemical companies and ignoring the will of the people.

1992: In August, the federal General Accounting Office issues a report critical of FDA review of BGH/BST, and recommends that approval be delayed until issues of mastitis in treated cows are resolved.

1993: In March, FDA convenes an advisory panel to review mastitis issues, and concludes that sufficient safeguards are in place to prevent unsafe levels of antibiotic residues from entering the milk supply. In August, an amendment to the Omnibus Budget and Reconciliation Act delays commercial sale for 90 days following FDA approval. On November 5, FDA announces approval of the Monsanto Company's rBGH/rBST product; commercial sales are delayed until February 3, 1994.

1994: On February 3, Monsanto's BGH/BST product goes on sale, accompanied by considerable media attention. In early March, the Dairy Council of Wisconsin announces that demand for milk rose 1 percent in February 1994 over February 1993. Organic milk distributors report strong sales increases.

ADDENDUM — MILK PRICING

Robert Cropp, dairy marketing specialist, University of Wisconsin-Madison

Farm level milk prices are supported by the federal dairy price support program. The 1994 support level is $10.10 per hundredweight for milk with 3.67 percent butterfat, or $10 for 3.5 percent butterfat. This support is directly on milk used for manufactured dairy products — butter, milk powder and cheese. The price consumers pay for manufactured products determines what price milk plants making these products are able to pay farmers for milk.

So when farm level milk price for manufacturing purposes falls to or below the support level, through the Commodity Credit Corporation (CCC) the government purchases butter, nonfat dry milk and cheddar cheese at specified prices that will enable the manufacturing plants to pay farmers at least the support price for manufacturing milk. The dairy products CCC removes from the market are used for domestic and international food programs. If prices rise 10 percent or more above the purchase price, CCC may offer the products back to the commercial market.

The formal dairy price support program has been in existence since 1950. During the late 1970s and early 1980s, CCC dairy product purchases reached unacceptable levels in both quantity and federal costs. For example, in the early 1980s, CCC was purchasing dairy surpluses equal to about 10 percent of total milk supplies at a cost of nearly $2.5 billion. In response, Congress reduced the support level from $13.10 per hundred pounds of milk in 1981 to just $10.10 per hundredweight in 1990, where it remains. At this level, market forces of supply and demand determine farm level milk prices, rather than the dairy price support program.

When farm level prices drop near the support level, some dairy farmers and milk cows exit the industry, bringing supply and demand back into balance. Since 1989, CCC farm level purchases run about $270 million a year — most in butter, due to a surplus butterfat problem. There is no longer a milk surplus per se.

The $270 million is paid from tax dollars — not as part of the federal dairy price support program, but as a requirement of the Omnibus Budget and Reconciliation Act, all dairy producers face a refundable assessment that is applied to the federal budget deficit. The assessment is designed to collect from dairy farmers about $720 million over the period of 1991-95. Dairy farmers who do not increase the amount of milk they sell from the previous year can apply for a refund of the assessment.

On January 1 of each year, the assessment is 11.25 cents per hundredweight. Then on May 1, the U.S. Secretary of Agriculture increases the assessment for the remaining 8 months by an amount sufficient to collect and refund the prior year's assessments to those farmers who did not increase marketings. This procedure occurs each year. Hence, the total of $720 million will be collected at the end of 1995 from dairy farmers who have increased milk marketings during the 1991-95 period.

Adoption of commercial BGH/BST by dairy farmers will increase milk production, as have other technologies. Farm level milk prices will decline initially and could reach support, but will not remain at support level for long. Milk production will adjust to put supply and demand more in balance, and farm level prices will once again be above support. The federal government could experience some increased cost for the dairy price support program, but costs would remain far below early 1980s levels.

Comparing Public Reaction to the Use of CHY-MAX Chymosin and Posilac BGH/BST in the Food Supply

If you read newspapers or watch TV, you know that the U.S. public reacted very differently to the adoption of two commercial animal proteins in the food supply — CHY-MAX® chymosin and Posilac™ BGH/BST.

BGH/BST has been on the front pages, chymosin has not. Some BGH/BST opponents question its safety and reject Food and Drug Administration (FDA) assurances that commercial BGH/BST poses no threat to human health; no concerns about CHY-MAX's safety have been raised since its approval by FDA.

Both are products of "new" food technology subject to FDA review, so what explains the striking difference in public attitude and media coverage?

Chymosin is the active enzyme in rennet, used in making cheese. Making cheese involves adding a "starter culture" of lactic acid bacteria to milk. The bacteria convert lactose (milk sugar) to lactic acid. Cheesemakers add chymosin, a protein enzyme that chews up a milk protein called casein. This causes the acidified milk to coagulate, eventually forming curds and whey. CHY-MAX chymosin — made by Pfizer, Inc. Dairy Ingredients Division of Milwaukee, Wisconsin — is the first product of genetic engineering in the U.S. food supply.

Bovine growth hormone/bovine somatotropin (BGH/BST) are two names for one cattle protein hormone. Commercial BGH/BST may now be injected into dairy cows to increase milk production. Posilac™ is the Monsanto Company's trade name under which it sells recombinant BGH/BST.

Both commercial products have been approved for use by FDA — CHY-MAX chymosin in 1990, and Posilac BGH/BST in November 1993. CHY-MAX chymosin is now used to produce more than half of all U.S. cheese (60 percent), and other companies also market chymosin produced through genetic engineering.

Both chymosin and BGH/BST are proteins. Both are made by cattle — chymosin in the stomach, BGH/BST in the pituitary gland.

Both can also be made in the laboratory by purifying the protein from genetically engineered bacteria that have been given a copy of the gene for chymosin or for BGH/BST.

Why have some people spoken out against commercial BGH/BST, but not CHY-MAX chymosin? One reason may be semantics — what different words, signs and symbols mean to people. BGH/BST is a hormone, while chymosin is an enzyme. The word hormone may cause greater concern among the public than does the word enzyme.

Another reason may be that while cheese is "full of the goodness of milk," the image of milk is such that it is widely regarded as the most wholesome of foods. One feeds babies milk — not cheese.

Also, as an animal hormone, BGH/BST could theoretically have secondary physiological effects on the cows, and on cows' milk; such secondary physiological effects are not possible in the case of chymosin.

A fourth reason may be economics. BGH/BST is injected into cows to increase their milk production; many economic analysts predict this increased production will drive down income to farmers (see *Addendum — Milk Pricing*, page 41). CHY-MAX chymosin is added to milk to make cheese, maintaining the supply of high-quality cheese with no predicted loss of income to farmers. Another difference may go as deep as people's ethical and spiritual beliefs. Animal rights activists criticize commercial BGH/BST as a threat to animal health. CHY-MAX chymosin has not been criticized because it is made in bacteria, and therefore suckling calves need not be slaughtered to obtain rennet. Some vegetarians and members of religious groups who will not eat cheese containing chymosin from calf stomachs have found cheese made with genetically engineered chymosin acceptable to their personal beliefs.

So while Posilac BGH/BST and CHY-MAX chymosin are both made using genetically engineered bacteria, CHY-MAX chymosin appears to have avoided controversy because it seems to fit in the vision of agriculture embraced by many of the people who oppose Posilac BGH/BST.

4 4

MODULE D — VALUING A NEW FOOD PRODUCT

INSTRUCTIONS

OBJECTIVES:

Participants will be able to list three government agencies that regulate biotechnology and three criteria they consider.

Participants will be able to list criteria currently used by diverse groups to examine the value of a new food product.

Participants will be able to list factors that affect consumers' judgment about the use of specific biotechnology applications.

Participants will identify factors most important to themselves.

ACTIVITIES:

LEADER

- Discuss and complete the exercises given on "Diverse Bases for Examining the Value of New Technology Including Biotechnology." Module C is also needed for this exercise.

  Note: *Although this information was prepared for studying adoption of a product produced with the use of biotechnology, the same type of criteria applies to other innovations (e.g., marketing kiwi fruit, or using margarine, bulk tanks, rural electrification or microwave ovens).*

- Divide participants into groups of two or three, and assign each group a case study from Module C.

PARTICIPANT

- Use the "Examples of Foods from Plants Modified Through Genetic Engineering" fact sheet from Module C, page 35, to examine the value of the food product assigned based on the diverse criteria.
- Summarize the discussion relating to each criterion.

MATERIALS INCLUDED:

LEADER & PARTICIPANT

Diverse Bases for Examining the Value of New Technology Including Biotechnology

Module C, pages 30-34 and 37-43

DIVERSE BASES FOR EXAMINING THE VALUE OF NEW TECHNOLOGY INCLUDING BIOTECHNOLOGY

Products of new technologies including biotechnology have an impact on a variety of people and many aspects of life. As a result, diverse criteria have emerged for examining the development of a new product.

CRITERIA FOR REGULATION

Agricultural biotechnology products may be regulated by a combination of three federal agencies: The U.S. Department of Agriculture (USDA), the Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA). Together, these agencies are empowered by law to use three general criteria when assessing new products: safety, efficacy and quality. This means the agencies answer these questions for each new product:

1. Is the product sufficiently safe to humans and the environment?
2. Does the product work as intended?
3. Can the quality of the product be assured?

Some people have suggested that new products be reviewed by a fourth criterion:

4. What are the potential or probable social and economic impacts of the product?

DIRECTIONS

Many other criteria could be considered. Please read the diverse criteria in the six groups listed below.

- Discuss the following six groups of criteria, and list any criteria that you think should be added.
- Circle the number of each criterion that you feel should be applied when judging a new technological development.
- Discuss the specific biotechnology case study assigned from Module C, pages 30-34 and 37-43.
- Place an X by eight of the criteria that are most important to you in assessing that case study.

OTHER CRITERIA TO CONSIDER

Consumer or Other Ultimate User:

____ 1. Safe for human consumption

____ 2. Does what it is supposed to do (efficacy)

____ 3. Is needed

____ 4. Contribution to the user is as great or greater than its cost

____ 5. Attractive to the consumer

____ 6. Nutritive value is increased, or at least not decreased

Farming and Agribusiness:

____ 7. Safe for animals; does not subject animals to health risks

____ 8. Provides economic benefit to farmer

____ 9. Increases yields

____ 10. Decreases labor involved

____ 11. Does not involve high start-up costs

____ 12. Does not require more capital or farm investment

____ 13. Does not create undue reliance on one product

____ 14. Results in less highly mechanized farms

____ 15. Is useful to small farmers

____ 16. Maintains individual farmer autonomy and self reliance

Physical Environment:

____ 17. No significant negative impact on the environment now or in the future

____ 18. Long-range environmental risks and implications are known

____ 19. Reduces use of chemical products — fertilizers, pesticides, herbicides, medications — adversely affecting the environment

____ 20. Reduces use of fossil fuels

____ 21. Does not contribute to erosion or to loss of soil fertility or tilth

____ 22. No threat to wildlife or wildlife habitat

____ 23. Does not result in reducing genetic diversity

____ 24. Does not result in genetic vulnerability of hybrid strains

Social Conditions in Rural and Urban America:

____ 25. No apparent negative effect on social conditions in farm communities

____ 26. No delayed or cumulative negative effects on social conditions

____ 27. Requires little or no regulation

____ 28. Social impacts are clear and known

Economic Development:

____ 29. Helps the United States remain competitive in a world market

____ 30. No players unfairly financially disadvantaged

____ 31. Promotes a fair market system

____ 32. Reduces taxpayer spending for commodity programs

____ 33. Reduces or does not increase regulatory costs

____ 34. Can be marketed easily at reasonable profit

____ 35. Provides adequate return to the manufacturer of the genetic material

Ethical or Religious Beliefs:

____ 36. Is in line with beliefs about responsibility for plants and animals

____ 37. Does not run counter to religious or spiritual beliefs and sanctions

____ 38. Improves quality of life for people and animals

____ 39. Does not impose costs on people excluded from decision making

MODULE E — BIOTECHNOLOGY AND FOOD LABELING ISSUES

INSTRUCTIONS

OBJECTIVES:

Participants will be able to list one advantage and one disadvantage of labeling foods that have been genetically engineered.

ACTIVITIES:

Read or role-play the short story titled "A Discussion of Label Options for Genetically Engineered Products."

Debate the need for labels on food produced using biotechnology.

MATERIALS INCLUDED:

LEADER

Discussion: Labeling Food Produced Using Genetic Engineering

Food and Drug Administration (Docket No. 94D-0025) "Interim Guidance on the Voluntary Labeling of Milk and Milk Products from Cows That Have Not Been Treated with Recombinant Bovine Somatotropin," *Federal Register*

PARTICIPANT

A Discussion of Label Options for Genetically Engineered Products (short story)

SUPPLEMENTARY ACTIVITY:

See Module A supplementary activities, page 3, and What Biotechnology Products Are in Our Food Supply? *page 13.*

Make a display of products produced using biotechnology to provide participants an opportunity to study food labels. Examples include milk, cheese, yogurt, bread, sausage, marinades, soft drinks with high fructose corn syrup or aspartame (brand names Equal® or NutraSweet®). Use the food list or products gathered from the scavenger hunt.

DISCUSSION: LABELING FOOD PRODUCED USING GENETIC ENGINEERING

CONSUMER CONCERNS

Labeling food from genetically modified plants and animals has become a significant issue among some consumer groups. Reasons for asking for such special labeling include the following.

- Some consumers believe they have a right to know if genetic engineering was used in developing the plants or animals.
- Some consumers want to be able to choose food based on how it was produced.
- Some food scientists believe such labels are needed to notify consumers of potential allergens.

REGULATORY AGENCY CONCERNS

Food label claims must be both true and not misleading. Because labels are powerful ways to inform, persuade, frighten or misinform consumers, federal and state agencies closely regulate many aspects of labels. These agencies have the following concerns when deciding whether to place special labeling requirements on food from genetically modified plants or animals.

- Just the appearance of a special label gives the impression that these foods carry risk significantly greater than the risk of other foods.
- In many cases, there are no tests a regulator can use to detect whether genetic engineering has been used at some stage of food processing.
- Traditionally, labels have included only information proven to have an influence on health or nutrition. Warning information is required only when warranted by experimental or clinical evidence. And if label information makes claims that the product enhances health, that information must also be verified by evidence.

LABEL INFORMATION

Label information can be divided into three types: compulsory, permitted and prohibited.

- Compulsory information must be supplied. For example, as of May 1994, all ingredients must be listed, as well as sodium and fat content.
- Permitted information may be supplied. For example, a dairy processor seeking to sell cheese to vegetarians might include the statement on the cheese: "Made using microbial enzymes; no animal rennet used."
- Prohibited information includes statements that are misleading, even if true. For example, Food and Drug Administration (FDA) guidelines currently do not allow a milk bottler to solely state: "Milk from cows not injected with BGH," because that implies milk from other cows or other processors is not as safe or wholesome. Therefore, FDA guidelines require a further statement on the label that no significant difference has been shown between milk from BGH-treated cows and untreated cows.

See Interim Guidance on the Voluntary Labeling of Milk and Milk Products from Cows That Have Not Been Treated with Recombinant Bovine Somatotropin, *page 52*.

Interim Guidance on the Voluntary Labeling of Milk and Milk Products from Cows That Have Not Been Treated with Recombinant Bovine Somatotropin

CONTACT
Sarah Castello
UW Biotechnology Center

Note: *FDA refers to recombinant BGH/BST (rBGH/rBST) as rbST, and to BST as bST.*

Food and Drug Administration (Docket No. 94D-0025)
Federal Register, *February 14, 1994*

Agency: Food and Drug Administration, HHS [Health and Human Services]

Action: Notice

Summary: The Food and Drug Administration (FDA) is publishing interim guidance on the labeling of milk and milk products from cows that have not been treated with recombinant bovine somatotropin. Several states and industry and consumer representatives have requested guidance from FDA on this issue. This interim guidance is intended to respond to these requests.

DATES: Written comments by March 14, 1994.

ADDRESSES: Submit written comments on the interim guidance to the Dockets Management Branch (HFA-305), Food and Drug Administration, Rm. 1-23, 12420 Parklawn Dr., Rockville, MD 20857.

FOR FURTHER INFORMATION CONTACT: Shellee A. David, Center for Food Safety and Applied Nutrition (HFS)-306). Food and Drug Administration, 200 C St., SW, Washington, DC 20204; (202) 205-4681.

SUPPLEMENTARY INFORMATION: On November 5, 1993, FDA approved a new animal drug application providing for the subcutaneous use of sterile sometribove zinc suspension — recombinant bovine somatotropin (rbST) or a recombinant bovine growth hormone (rbGH) — in lactating dairy cows to increase the production of marketable milk (58 FR 599446, November 12, 1993). FDA approved the product because the agency had determined after a thorough review that rbST is safe and effective for dairy cows, that milk from rbST-treated cows is safe for human consumption, and that production and use of the product do not have a significant impact on the environment. In addition, the agency found that there was no significant difference between milk from treated and untreated cows and, therefore, concluded that under the Federal Food, Drug and Cosmetic Act (the act), the agency did not have the authority in this situation to require special labeling for milk from rbST treated cows. FDA stated, however, that food companies that do not use milk from cows supplemented with rbST may voluntarily inform consumers of this fact in their product labels or labeling, provided that any statements made are truthful and not misleading. Several states and industry and consumer representatives have asked FDA to provide guidance on the labeling of milk and milk products from cows that have not been treated with rbST.

FDA agrees that with the expiration of the congressional moratorium on the commercial sale of rbST on February 3, 1994, the issuance of guidance would help prevent false or misleading claims regarding rbST. FDA views this document primarily as guidance to the states as they consider the proper regulation of rbST labeling claims. Given the traditional role of the states in overseeing milk production, the agency intends to rely primarily on the enforcement activities of the interested states to ensure that rbST labeling claims are truthful and not misleading. The agency is available to provide assistance to the states.

The guidance presented here reflects FDA's interpretation of the act and may be relevant to states' interpretation of their own similar statutes. This document does not bind FDA or any state, and it does not create or confer any rights, privileges, benefits or immunities for or on any person. Furthermore, this document reflects FDA's current views on this matter. FDA may reconsider its position at a later date in light of any comments it receives on this guidance document.

Interested persons may on or before March 14, 1994, submit to the Dockets Management Branch (address above) written comments on the interim guidance. Two copies of any comments are to be submitted, except that individuals may submit one copy. Comments are to be identified with the docket number in the heading of this document. Received comments may be seen in the office above between 9 a.m. and 4 p.m., Monday through Friday.

The text of the interim guidance follows:

Interim Guidance on the Voluntary Labeling of Milk and Milk Products from Cows That Have Not Been Treated with Recombinant Bovine Somatotropin

Appropriate Labeling Statements

At the federal level, statements about rbST in the labeling of food shipped in interstate commerce would be reviewed under sections 403(a) and 201(n) of the act. Under section 403(a) of the act, a food is misbranded if statements on its label or in its labeling are false or misleading in any particular. Under section 201(n), both the presence and the absence of information are relevant to whether labeling is misleading. That is, labeling may be misleading if it fails to disclose facts that are material in light of representations made about a product or facts that are material with respect to the consequences that may result from use of the product. Thus, certain labeling statements about the use of rbST may be misleading unless they are accompanied by additional information. This guidance is based on the use of the false or misleading standard in the federal law, which is incorporated in many states' food and drug laws. States may also have additional authorities that are relevant in regulating such claims.

Because of the presence of natural bST in milk, no milk is "bST-free," and a "bST-free" labeling statement would be false. Also, FDA is concerned that the term "rbST-free" may imply a compositional difference between milk from treated and untreated cows rather than a difference in the way the milk is produced. Instead, the concept would better be formulated as "from cows not treated with rbST" or in other similar ways. However, even such a statement, which asserts that rbST has not been used in the production of the subject milk, has the potential to be misunderstood by consumers. Without proper context, such statements could be misleading. Such unqualified statements may imply that milk from untreated cows is safer or of higher quality than milk from treated cows. Such an implication would be false and misleading.

FDA believes such misleading implications could best be avoided by the use of accompanying information that puts the statement in a proper context. Proper context could be achieved in a number of different ways. For example, accompanying the statement "from cows not treated with rbST" with the statement that "No significant difference has been shown between milk derived from rbST-treated and non-rbST-treated cows" would put the claim in proper context. Proper context could also be achieved by conveying the firm's reasons (other than safety or quality) for choosing not to use milk from cows treated with rbST, as long as the label is truthful and not misleading.

States should evaluate any labeling statement about rbST in the context of the complete label and all labeling for the products, as well as of any advertising for the product. Available data on consumers' perceptions of the label statements could also be used to determine whether a statement is misleading.

Substantiation of Labeling Claims

There is currently no way to differentiate analytically between naturally occurring bST and recombinant bST in milk, nor are there any measurable compositional differences between milk from cows that receive supplemental bST and milk from

cows that do not. Therefore, to ensure that claims that milk comes from untreated cows are valid, states could require that firms that use such claims establish a plan and maintain records to substantiate the claims, and make those records available for inspections by regulatory officials. The producer of a product labeled with rbST claims should be able to demonstrate that all milk-derived ingredients in the product are from cows not treated with rbST. Failure to maintain records would make it difficult for a firm to defend itself in the face of circumstantial evidence that it is using rbST or selling milk from treated cows. In some situations (e.g., dairy cooperatives that only process milk from untreated cows), states may decide that affidavits from individual farmers and processors are adequate to document that milk or milk products received by the firm were from untreated cows.

States should consider requiring that firms that use statements indicating that their product is "certified" as not from cows treated with rbST be participants in a third party certification program to verify that the cows have not been injected with rbST. States could seek to ensure that certification programs contain the following elements:

- Participating dairy herds should consist of animals that have not been supplemented with rbST.
- The program should be able to track each cow in the herd over time.
- Milk from non-rbST herds should be kept separate from other milk by a physical segregation, verifiable by a valid paper trail, throughout the transportation and processing steps until the finished milk or dairy product is in final packaged form in a labeled container.

The physical handling and recordkeeping provisions of such a program would be necessary not because of any safety concerns about milk from treated cows, but to ensure that the labeling of the milk is not false or misleading.

Dated: February 7, 1994
Michael Taylor
Deputy Commissioner for Policy

A DISCUSSION OF LABEL OPTIONS FOR GENETICALLY ENGINEERED PRODUCTS

Chris Young is having a discussion with grocer Pat Brown about the need for food labels — labels that state whenever genetic engineering has been used in producing milk.

Chris is very opposed to the use of recombinant bovine growth hormone (rBGH) in milk, because Chris believes commercial BGH — also called bovine somatotropin (BST) — will put small dairy farmers out of business. Chris wants to support small dairy farmers and not buy this milk. How can this be done if the milk is not labeled?

Pat Brown says that it is unfair to add the cost of the labels to the price of milk bought by consumers who don't care whether recombinant BGH is used or not. Pat says it would be more fair to have a label saying, "Recombinant BGH has NOT been used in this milk." Then the consumers who care about this issue would be paying for the costs of the label.

Fran Smith comes into the store, and says the U.S. Food and Drug Administration (FDA) states that there is no difference between milk produced in the traditional way and milk produced using recombinant BGH. Because of this, Fran questions the use of any label on milk about the use of recombinant BGH.

Fran also notes that there is no reliable way to test to ensure an unscrupulous farmer didn't use BGH. So how would the FDA or a state's department of agriculture ensure the truthfulness of an "rBGH-free milk" label?

Chris says it doesn't matter, and points out that many foods that have been organically grown are labeled "organically grown." Chris believes it is our right to know about the use of genetic engineering in milk, and everyone should help share the cost of these labels.

DISCUSSION

1. Discuss labeling options.

2. Which of these three opinions most closely matches yours? Why?

3. What other concerns are being overlooked?

MODULE F — ANALYZING NEWS ARTICLES

INSTRUCTIONS

OBJECTIVE:

Participants will be able to analyze news articles about the use of biotechnology.

ACTIVITIES:

- Discuss the biotechnology media coverage background information.
- Divide participants in groups of two or three, and assign each group a news article that presents a specific view about the use of biotechnology. Following each article is a series of questions. After participants answer the questions, have them report back to the entire group.

Note: *The articles included serve as case studies useful in developing inquiry skills regarding coverage of biotechnology*.

- Collect additional news articles on biotechnology and food.

MATERIALS INCLUDED:

LEADER

Media Coverage About Biotechnology

Biotechnology Backgrounder, U.S. Food and Drug Administration

PARTICIPANT

News articles with worksheets:

1. "Tasty flounder tomatoes," *USA TODAY,* and University of Wisconsin Biotechnology Center graphic illustration
2. "Diet dilemma: Mixing food genes," *USA TODAY*, and *USA TODAY* graphic
3. "Gene-altered food held by the FDA to pose little risk," *New York Times*
4. "Send BGH back to the lab," *Capital Times*, Madison, Wisconsin
5. "Reports circulate that FDA is ready to approve BST," *The Country Today*, Eau Claire, Wisconsin
6. "FDA fools Mother Nature and allows genetically engineered foods," *Environmental Nutrition*

Note: *Under fair use provisions of the copyright law, photocopying news articles is only allowed for certain timely material in classroom settings. Other uses require advance permission from the copyright owner.*

SUPPLEMENTARY ACTIVITY:

Reproduce current news articles about the use of biotechnology in foods. The enclosed worksheets could be used as a guide for creating questions.

MEDIA COVERAGE ABOUT BIOTECHNOLOGY

Suzanne Pingree, professor, Department of Agricultural Journalism, University of Wisconsin-Madison

Many of us get our information about science issues from television, news magazines, newspapers or books. But just as for every other sort of mediated information — whether it is advertising claims, television portrayals of violence, or even the daily reporting of news — consumers need to approach this information with caution. Consumers need to question what is there, why it is there, and how it is reported and interpreted for them. They need to learn how to evaluate science reports so that what they learn is information, not misinformation. This is an especially challenging task for consumers of science information, because of the nature of science, of scientists, and of the reporters who cover science.

Science and technology are fast-changing and extremely complicated, and scientists are reluctant to discuss the results of their work in the simple, clear terms that journalists (and the public) desire. They use language that lay people call "jargon," but which has clear and specific meaning to them. They speak about findings using conditional language and often do not like to generalize about a broader meaning that their work might have. Scientists act this way to preserve the integrity of their research, not to keep the public from knowing about what they do. To scientists, the world often works in very small scale, complicated and convoluted ways. And these relationships are extremely difficult to explain, even to other scientists. The fact that science is like this poses a number of problems for reporters who want to inform the public about science.

First, where the scientists themselves don't agree about the meaning or validity of an area of research, to report it fairly the reporters need to be nearly as expert as the scientists involved in the research. Fair treatment of an issue is hard to define, but standard practice for reporters is to find out if there is another side to an issue, and report that, too. But a reporter who covers both sides of a scientific controversy may be unreasonably elevating a largely untenable position. That is, unless the reporter is extremely knowledgeable, she or he may write a story that legitimizes bad science or even creates a controversy where none reasonably exists, simply by following the standard journalistic practice of getting more than one source on a story.

Second, reporters may not quite grasp the details of the science, and miss or misreport some crucial elements that change the meaning of the story. It is not common practice for journalists to have the scientists they interview check their stories, although they more commonly doublecheck specific facts and the language in quotes with interviewees. It is easy to see how fairly serious errors can creep in.

Third, reporters may add their own spin to a story that a scientist would not wish to see. The science may belong to the scientist, but the story belongs to the journalist. Once the scientist is interviewed, the information is the property of the journalist. Most work hard to stay close to the intent of the scientists, but a competing pressure is a desire to make the information relevant and interesting to the reading public. This pressure can help journalists create compelling, wonderful pieces of work that draw together research from a variety of sources in an intelligent and useful way. Or it can elevate a small detail of little consequence into a huge issue that alarms the public and has serious economic consequences.

Fourth, because even highly trained science reporters are not experts in all of the specialized areas of science in which they report (and not all of them are highly trained in science), it is also possible for them to be misled by those they interview. Some scientists don't want their research to be covered, some want it to be covered in a very particular way, and so on.

But reporters and scientists are not the only sources of potential misinformation or bias in science reporting. Mass media institutions as organizational structures also affect science reporting. They control what gets reported and where it is placed. A carefully done science story may not make the newspaper or television program because it simply does not meet the criteria of the system for "newsworthy." Media definitions of news can set the public agenda for what scientific issues are worth thinking about and understanding.

Where large blocks of text or time are devoted to an issue, to that extent the issue seems important. Where the issue is placed is also important. Some information may get covered, but may not fit the prevailing news culture well enough to get mainstream coverage. For example, a great deal of critical information about nutrition and health gets reported in the food/living/leisure sections of the newspapers. It is rarely front page news, or the subject of an entire news program on television.

Thus, for a variety of reasons, the information presented to the public through the media might be incomplete, incorrect or even misinformation. In addition, for those scientists or reporters/editors/publishers who do have an axe to grind, the information might be intentionally biased. And the issues raised by the information, as well as the information itself, might be fully or only selectively covered.

Thoughtful consumers will recall these constraints on science, scientists, journalists and the mass media whenever they encounter science information in the mass media, and think for themselves while they read.

BIOTECHNOLOGY BACKGROUNDER

U.S. Food and Drug Administration, 1992

NOTE: *In May 1992, FDA announced its proposed policy to regulate foods from genetically manipulated plants.*

This FDA Biotechnology Backgrounder *describes the policy.*

Many of the news stories in Module F refer to this policy.

In the development of agriculture, the selection and breeding of plants that provide greater yields of food and fiber or that have other desirable traits has been repeated many times. These include corn with high yield and oil content, tomatoes that resist pests, and genetic hybrids such as tangelos [grapefruit-tangerines].

During recent decades, plant breeders have made advances in crossing sexually incompatible species of the same family; thus, genes have been moved from one species to another or even one genus to another. Now there exist even newer and more promising methods for developing superior plants: the molecular techniques of the "new biotechnology," such as recombinant DNA (or "gene splicing").

These advances in biotechnology mark an important evolutionary step in the development of new plant varieties. The new technologies give producers powerful, precise tools to introduce improved traits in food crops, opening the door to improvements in foods that will benefit food growers, processors and most important — consumers.

Store-bought tomatoes that taste home-grown, fruit trees resistant to the cold, pest-free crops without applying pesticides are just a few of the many improvements consumers will see.

Companies are ready to bring some of these advancements to the nation's grocery shelves. To do so, however, they need to know how their products will be regulated — what tests need to be done and what data collected, and when to consult the Food and Drug Administration (FDA).

This is critical not only to provide producers with a predictable guide to government oversight, but also to help the public learn about these new foods, the exhaustive careful process by which they were developed and that all safety questions will be answered before these new products are marketed.

Governed by the federal Food, Drug, and Cosmetic Act [the act], FDA watches over most foods sold in our food stores under the adulterated food provisions, section 402 (a)(1), of the act. This "post market" authority enables FDA to remove from the marketplace promptly any food "ordinarily injurious to health" or any added component of food "which may render it injurious to health." Substances that are intentionally added to food as a result of genetic modification by any technique and that raise safety questions (because they are not substantially similar to substances commonly found in food such as proteins, fats, and carbohydrates, or that have no history of safe use in food) may be regulated as "food additives" under section 409 of the act, thus requiring "pre-market" approval.

It is anticipated that many substances currently being introduced into new plant varieties will not require pre-market approval by FDA. However, to assure the safe introduction of these new varieties into the food supply, FDA has included as the core of its policy statement a comprehensive "guidance to industry" section to assist companies with their own internal review of these new foods. The guidance section outlines a "decision tree" approach to safety assessment, identifying scientific questions that raise sufficient concern to warrant consultations with FDA. This section also describes the objective characteristics of substances introduced into foods that will trigger "pre-market" regulation under section 409.

The questions companies must resolve while developing foods from new plant varieties include the following:

- Has the concentration of any naturally occurring toxicants in the plant been increased?
- Has an allergen not commonly found in the plant been introduced?
- Have the levels of important nutrients changed?
- Have new substances been introduced into food that raise safety questions?
- What are the environmental effects?
- Have the genetic material and its "expression products" been well characterized?
- Have accepted, established scientific practices been followed?

The approach and provisions of the FDA policy are consistent with the policy on "scope of regulation" published by the White House Office of Science and Technology Policy for a risk-based, scientifically sound approach to oversight of planned introductions of biotechnology products. FDA's policy is consistent with recommendations of expert panels on this subject convened by the National Academy of Sciences, and the joint Food and Agricultural Organization (FAO)/World Health Organization (WHO) consultation on food safety and biotechnology. The policy also responds to the interest of the President, industry, Congress and the public in assuring the safe development of new biotechnology products in the United States.

1. Tasty flounder tomatoes

USA TODAY editorial, May 27, 1992

Note: *This editorial was in response to the May 1992 announcement of the FDA policy on food from genetically modified plants.*

Two years later, on May 18, 1994, FDA approved the FLAVR SAVR™ tomato featured in this article and mentioned in several that follow.

The FLAVR SAVR tomato is the first genetically engineered whole food in the U.S. food supply.

This article and those following refer to the FLAVR SAVR tomato as FlavrSavr.

On another topic, *USA TODAY* says people should know if they're getting fish genes in French beans.

A spud is a spud is a spud — unless, genetically, it's part chicken. In that case, it's likely to be a plumper potato.

Welcome to better living through biotech, in which DNA is transferred from one organism to another to improve it.

The Food and Drug Administration ruled Tuesday that many altered foods can be marketed without federal testing — a sensible idea after a decade of testing failed to uncover problems.

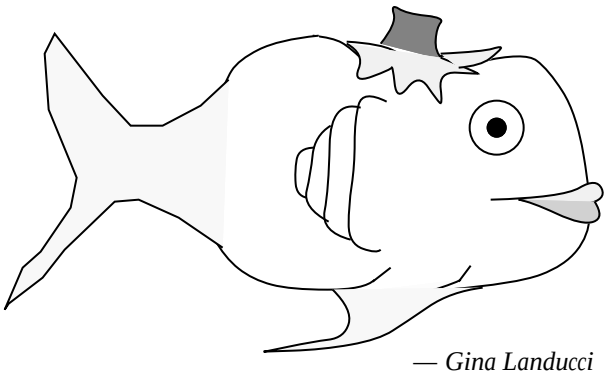
Unfortunately, the FDA omitted any requirement for labels that would, for instance, tell consumers that the juicy tomato in their BLT — deep red even in February — really is part flounder.

Such a cavalier omission serves no one — especially the biotech producers the FDA ruling is supposed to help by down-sizing regulatory costs. To succeed, their startling new products need confident customers — not shoppers scared of how many firefly genes are buzzing inside those ears of corn.

That's not hyperbole. These vegetables are among 70 altered foods already awaiting the FDA marketing guidelines issued Tuesday. The first to hit supermarkets, possibly in 1993, likely will be the "FlavrSavr" tomato by Calgene, Inc.

The California firm notes accurately that genetics can offer myriad benefits — better disease resistance and longer shelf life, for starters. It says it's proud its tomato is a test-tube baby and plans to label it as such.

But nothing in the new FDA rules says other companies must follow suit. FDA should require labeling of genetically altered foods. The alternative: consumer anger that would be anything but small potatoes.



— Gina Landucci
UW Biotechnology Center

WORKSHEET

1. Tasty flounder tomatoes

USA TODAY editorial, May 27, 1992

This article is an editorial that reflects the *USA TODAY* editorial board's views. The cartoon is by a student working at the University of Wisconsin Biotechnology Center.

1. Do you think the *USA TODAY* editorial board agrees that many genetically engineered food crops can be marketed without federal testing?

   Why, or why not?

2. What is the position of the *USA TODAY* editorial board about labeling genetically engineered products?

3. What is the main reason *USA TODAY* gives to support their views about labeling?

4. List three examples of genetically engineered products named in this article.

WORKSHEET CONTINUED

5. What product is expected to come to the market first?

6. Is the company planning to label this product?

7. What does the cartoon imply about genetic engineering? Is this an accurate representation of a genetically engineered tomato carrying a flounder gene?

2. Diet dilemma: Mixing food genes

by Anita Manning, *USA TODAY*, May 27, 1992

New guidelines that raise the possibility that potatoes might someday contain genes from a chicken have vegetarians and religious scholars scratching their heads.

The Bush administration Tuesday cleared the way for biotechnology firms to produce genetically engineered vegetables, grains and fruits that, in most cases, won't require special testing or labeling.

Adding the genes of animals, insects and others might help foods resist disease, lengthen shelf life and boost size.

The consumer "will enjoy better, healthier food products at lower prices," said Vice President Quayle, announcing the FDA guidelines.

Some see problems. If a pig gene is used in another food, "I would say Muslims wouldn't eat it," says Issa Smith of the American Muslim Council.

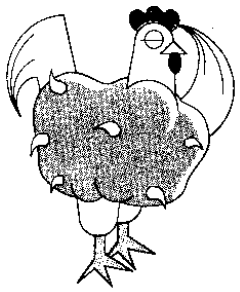
Gene-altered foods that could pose dietary problems:

- Tomatoes with Antarctic flounder genes, which reduce freeze damage.
- Tofu with a gene from cattle, to make it taste like beef.

Calgene, Inc. of Davis, California — likely to be first out next year with a tomato containing bacteria genes to keep it from ripening too fast — plans to label its product.

Most vegetarians can accept the benefits of genetic engineering, says Paul Obis, editor of *Vegetarian Times* magazine. "The use of a gene from a flounder or something does not constitute having a sentient being give its life for a meal."

But "On a personal level, it just seems pretty weird to me."



— USA TODAY

Chicken genes added to potatoes increase disease resistance.

WORKSHEET

2. Diet dilemma: Mixing food genes

USA TODAY, May 27, 1992

This article discusses guidelines announced by the U.S. Food and Drug Administration (FDA) in May 1992. This news report appeared at the top of *USA Today*' s front page, with the cartoon.

1. According to the article, what are some of the benefits of using genetic engineering in food production and processing?

2. What main concern about genetic engineering is raised in this article?

3. Do you think this is a legitimate concern?
   Why, or why not?

4. What does the cartoon imply about genetic engineering? Is this an accurate representation of a genetically engineered potato carrying a chicken gene?

5. Using the DNA analogy from Module B, how does the cartoon view of genetic engineering compare with the notion that a scene from one movie can be copied into a movie on another videotape?

3. Gene-altered food held by the FDA to pose little risk

by Warren E. Leary, Special to *The New York Times*, May 25, 1992

WASHINGTON, May 25 — In a long-awaited policy statement, the federal government plans to announce that foods developed through biotechnology are not inherently dangerous and, except in rare cases, should not require extraordinary testing and regulation before going on the market.

Some critics of genetically engineered foods have argued that they pose new safety risks, and any that contain new substances should go through the extensive testing required of new food additives. In addition, they say, any such food sold to the public should be labeled so that consumers can identify it.

By contrast, the new policy that is to be adopted by the Food and Drug Administration holds that genetically engineered foods should be regulated just like ordinary ones unless they contain ingredients not usual for the product.

Stiffer Rules for Allergens

Under the new policy, which is to be announced Tuesday by Vice President Dan Quayle and officials of the Health and Human Services Department, which includes the FDA, special review would be required only when specific safety issues are raised. For example, a review would be necessary if the gene for peanut protein, to which some people are allergic, is inserted into other foods.

Government officials say scientific evidence does not indicate that special precautions are warranted in most cases of gene-altered foods, and the new policy outlines the special circumstances that would require testing and regulation before a product goes on the market.

Officials of the federal agency said the core of the policy was based on science and the principle that industry should have to consult the agency only on decidedly novel components of food before marketing a product.

The new policy statement was requested by the budding biotechnology industry, which has several types of genetically engineered produce almost ready for market.

Protection from Lawsuits

According to the industry, more than a dozen companies in the United States have developed a total of almost 70 different crops, including cucumbers, potatoes and cantaloupes, that contain new proteins, enzymes or other substances that enhance their quality. Genetic technology holds the promise of producing foods that are more nutritious, tastier and longer-lasting while requiring less fertilizer and pesticide.

One of the first of the new products consumers are likely to see is a tomato developed by Calgene Inc., of Davis, California, that is endowed with an extra gene that confers a longer shelf life by delaying excessive ripening. Last November, Calgene became the first company to ask voluntarily for the federal agency to evaluate a genetically altered food.

“The industry has asked FDA for a policy because it wants to say to the public that the FDA knows these products and stands by their safety,” said a senior agency official who spoke on condition that he not be identified. “Industry wants the policy to help with product acceptability and, to an extent, for liability protection. It helps to say you are in compliance with government regulations.”

The debate over genetically engineered foods has continued for more than a decade. But many of the initial concerns raised by critics now seem less formidable and, after extensive discussion, a

consensus has developed in favor of moving ahead with the technology, although with appropriate precautions.

The federal agency's policy, which would go into effect when published in *The Federal Register*, was spurred by the President's Council on Competitiveness, a group headed by Vice President Quayle that is charged with reducing regulations that it believes hamper American industry.

The policy is expected to serve as a model for similar statements being prepared by other agencies that regulate the biotechnology industry, including the Environmental Protection Agency and the Agriculture Department, said a White House official who spoke on the condition that he not be identified.

Jurisdiction of Agencies

Other genetically altered food products, like livestock, fish and poultry, will be regulated by the Agriculture Department, while the environmental agency will review items like genetically engineered pesticides and disease resistant plants.

Uncertainty over how the government might regulate the products of genetic engineering is one of the last hurdles keeping the American biotechnology industry from releasing a flood of food and plant products and maintaining its lead over international rivals in the field, the White House official said.

The food policy closely follows the recommendations and rationale of a biotechnology policy report released by the competitiveness council in February and endorsed by President Bush soon afterward. The White House policy said genetically altered organisms and products should not be assumed to be dangerous because of the techniques used to produce them.

For generations, plant scientists have manipulated genes and produced desired traits through selective breeding, and new gene-splicing techniques are a different way of doing the same things, the statement said.

Genetically changed organisms and products that differ only slightly from normal ones, a category that includes the great majority of products proposed so far, need not be regulated more than conventional products, the White House policy said.

Instances of Tougher Regulation

In cases where safety questions are raised, Food and Drug Administration officials said, changes in food caused by genetic modification may be regulated under food-additives rules, which require premarket testing and approval. Safety questions would arise if modifications produced substances that were not substantially similar to things commonly found in food, like fats, proteins and carbohydrates, or if the new substances had no history of safe use in food.

The agency's policy would not require special labeling of foods produced through genetic manipulation unless, as with other food additives, the result is a change in a characteristic of the food that is noticeably different from what the consumer would expect, an agency official said.

"You would be concerned about allergens, for example," the official said. "If you transfer peanut protein to a tomato, you must state this because some people are severely allergic to peanuts."

Critics of genetically engineered foods said they opposed any policy that did not require extensive, pre-market testing of each new food and labeling to tell consumers what they were getting. Dr. Rebecca Goldburg of the Environmental Defense Fund said the FDA policy was virtually abandoning regulation of new and untested foods.

"Genetic engineers are taking genes from bacteria, viruses and insects and adding

them to fruits, grains and vegetables," Dr. Goldburg said. "They are producing foods that have never before been eaten by human beings. Without clear and consistent labeling of genetically engineered foods, consumers will have no idea what they are buying."

Jeremy Rifkin, president of the Foundation on Economic Trends, an organization critical of genetic research and its applications, said he filed a legal petition with the agency last week asking that it require tight regulation of genetically engineered food. Mr. Rifkin said he would challenge the new policy in court because "it is inadequate and does not protect the consumer."

W O R K S H E E T

3. Gene-altered food held by the FDA to pose little risk

by Warren E. Leary, Special to *The New York Times*, May 25, 1992

This *New York Times* article discusses guidelines announced by the Food and Drug Administration (FDA).

1. According to the article, when would the federal government require a special review of foods developed through biotechnology?

2. Why did Calgene Inc. ask the FDA for a policy on genetically engineered food?

3. When would the FDA policy go into effect?

4. Send BGH back to the lab

Capital Times, Madison, Wisconsin, Aug. 12, 1992

The caution light against BGH got a little brighter this week.

The General Accounting Office of the federal government said on Monday that the government should suspend the use of bovine growth hormone injections to increase milk production in cows. It also called on the Food and Drug Administration to stop the sale of beef and milk from research animals treated with BGH.

The GAO's report is advisory. The FDA will make the decisions on the use of BGH and the sale of products from cows treated with BGH. But the GAO adds considerable weight to the arguments for putting BGH back on the shelf.

The GAO study focused on the effect BGH has on cows. The agency said there is evidence that using BGH increases the incidence of inflamed udders in cows — a condition called mastitis.

Since antibiotics are often used to treat mastitis, the concern is that high levels of antibiotic residues will show up in milk and beef. That's troubling because some researchers think the residues of antibiotics already found in milk and beef are too high for human consumption.

Basically, the GAO said that before the government allows BGH to be widely used, independent researchers should get a much better idea of its impact on cows and humans. In the meantime, products from cows being tested should be kept off the market.

Critics of BGH in Wisconsin like state Senator Russ Feingold, D-Middleton, are often derided as raising unnecessary fears in their efforts to keep it off the market in the dairy state. The GAO report gives new credibility to their concerns.

BGH is not a product that is vital to the economic welfare of the small farmers in Wisconsin. If anything, it poses an economic threat to the dairy industry here. There is no need to rush in on behalf of anyone except the four chemical companies that hope to manufacture and market it.

Give it more tests. Keep it out of public consumption.

W O R K S H E E T

4. Send BGH back to the lab

Capital Times, Madison, Wisconsin, Aug. 12, 1992

This editorial presents the Madison, Wisconsin, *Capital Times*' opinion about whether the U.S. Food and Drug Administration (FDA) should approve use of BGH and the sale of products from cows treated with BGH.

1. What governmental agency is responsible for deciding whether beef and milk from animals treated with BGH can be sold?

2. Why did the General Accounting Office (GAO) say that use of BGH should not be permitted?

3. According to the article, who will profit from use of BGH?

4. Do you agree with these views?
   Why, or why not?

5. Reports circulate that FDA is ready to approve BST

by Judy Brown, *The Country Today*, Dec. 9, 1992

Note: *FDA approved BGH/BST on November 5, 1993 — 11 months after this article appeared.*

Bovine somatotropin, the genetically engineered growth hormone that increases dairy cow milk production, may soon be approved by the federal Food and Drug Administration, according to several speakers at last week's National Milk Producers Federation annual meeting.

"Rumor has it that BST may soon be approved by FDA," said Rep. Charles Stenholm, a Texas Democrat who serves as chairman of the House subcommittee on dairy, livestock and poultry.

Should the technology be approved, Rep. Stenholm said the market should decide its fate.

"If the regulatory system finds new products safe, then the final deciding factor should be the marketplace where they will either live or die," Rep. Stenholm said during a talk about dairy issues.

He explained that an overwhelming body of research from both the public and private sector affirms the safety of milk produced by cows treated with BST, and further research appears to support its safety regarding dairy cow health.

"I know many dairy farmers are seriously concerned about the probable adverse impact on milk prices when BST is approved and then used by producers," Rep. Stenholm said. "But the approval process must continue to be based on science."

"If we disapprove BST or any other new technology for non-science-based reasons, we risk sending the wrong signal about other developing agricultural biotechnologies, a signal which says 'no' to new science in the U.S., allowing our global competitors to develop emerging technologies and their markets."

Linwood Tipton, president and chief executive officer of the International Dairy Foods Association, Washington, D.C., agreed that bovine somatotropin is "likely to be approved."

Although he wouldn't predict when the announcement would be made, Mr. Tipton said his group would work with other trade associations to come up with a common message because of the likely questions to arise surrounding the technology.

"We are expecting that the common message will be agreeable to all those organizations," Mr. Tipton said, including NMPF as well as the Food Marketing Institute, which represents supermarkets.

Stressing the need to underscore the scientific evidence connected to the issue, Mr. Tipton said he'd communicate with the White House, suggesting that when FDA approves BST, the announcement should come out of the Health and Human Services Department instead of the White House.

"We need to rely on the scientific data," Mr. Tipton said.

WORKSHEET

5. Reports circulate that FDA is ready to approve BST

by Judy Brown, *The Country Today*, Dec. 9, 1992

This Eau Claire, Wisconsin weekly farm paper article discusses a rumor that the FDA will approve BST milk.

1. According to Rep. Charles Stenholm, what will be the final deciding factor for milk produced by cows treated with BST?

2. According to Rep. Stenholm, if we disapprove of BST or any other new technology for non-science-based reasons, what will happen to future technologies in the United States?

3. Why does Linwood Tipton want the federal Health and Human Services Department to make the announcement approving BST milk, instead of the White House?

6. FDA fools Mother Nature and allows genetically engineered foods

by Susan Male Smith, *Environmental Nutrition* Newsletter, July 1992

Authors' Note:
The Industrial Biotechnology Association no longer exists as a separate entity.

The Biotechnology Industry Organization (BIO) trade organization currently represents the biotechnology industry.

There's no denying the world could use a better-tasting supermarket tomato. But would you buy one that had been genetically altered? If the Food and Drug Administration (FDA) gets its way, you may not have a choice. Genetically altered tomatoes are around the corner and labeling won't be required.

The FDA brushed aside labels as part of its new policy for approving foods developed through biotechnology. Although criticism and cries of cover-up were immediate, biotechnology proponents put up a prompt defense. We're not talking killer tomatoes here, they say in essence, just disease-resistant crops, better tasting produce, pesticide-free yields and nutritionally improved grains.

Fooling Around With Mother Nature

Although genetically engineered foods are not yet available, several products are close to market.

One has already made headlines. The FlavrSavr tomato from Calgene, Inc. — expected to be on the market by next year — promises home-grown taste in store-bought tomatoes. By introducing a bacteria gene, scientists have silenced the enzyme that causes tomatoes to soften as they ripen. The FlavrSavr tomato can be left to ripen on the vine and then be shipped fully ripe without bruising. Tomatoes normally are packed and shipped green to prevent major wear and tear en route.

Though the FDA won't require labeling, Calgene has stated it will voluntarily label its genetically altered tomatoes.

The FDA's new policy does not allow a genetic free-for-all. The agency will require proof of safety if genetic manipulation of a food creates additional natural toxins, new allergens, altered nutritional value or any new substance not normally found in the food.

(Incidentally, the U.S. Department of Agriculture — which is responsible for the safety of animal foods — has not yet announced its policy on the new biotechnology.)

More High-Tech Foods to Come

Under the law, the FDA could treat foreign genes as additives, requiring rigorous safety testing and pre-market approval. However, FDA scientists believe that in most cases such scrutiny will be unnecessary and say it would stifle advances in technology. They argue that artificial crossbreeding of plant varieties is currently common-place. Some of the foods we eat — tangelos, for one — are the result of such efforts.

There are differences, of course. A valid concern is that genetic engineering might introduce potential allergens into foods sold to unsuspecting shoppers. For example, a gene from a food that commonly triggers allergic reactions, such as peanuts, might be introduced into another food. Some of the more unusual genetic combos that have already been tested by industry include tomatoes with a flounder gene, corn with a firefly gene and potatoes with a chicken gene. Other biotech foods waiting in the wings include potatoes that resist rotting and fruit trees that won't be damaged by the cold.

The process of genetically altering foods is actually more controlled than cross-breeding, says Richard Godown, president of Industrial Biotechnology Association, a Washington, D.C. trade organization. "In crossbreeding, you could impart as many as 100 different genes into the product. With genetic engineering, you're doing it with one or two genes at a time."

Still, the no-label policy creates dilemmas for vegetarians and some religious

groups who would not know if an animal gene is in plant foods.

Passions Aroused

Activist groups, chefs and consumers are organizing active opposition to the idea of "man-made" foods without labels.

"To treat these as foods that have been altered is a fraud," charges Andrew Kimbrell, policy director of the Foundation on Economic Trends headed by activist Jeremy Rifkin.

The foundation has started the Pure Food Campaign, a coalition of farm consumers and environmentalists opposed to gene-altered foods. "We want consumers to have a choice," explains Kimbrell, on behalf of the Pure Food group. "Those who think the genetically engineered revolution in foods is promising can advertise and convince people their foods are better."

The campaign promises to blanket the media with advertisements targeting each new genetically altered food. The group has petitioned the FDA to tighten regulations, and is drumming up support for a grass-roots write-in crusade to force the labeling issue with the FDA.

They already have the support of the cooking elite. Twenty chefs from some of the top restaurants in New York City have banded together to call for a boycott of genetically engineered foods.

As the protests grow, the FDA may pay more attention to ethical and nutritional concerns. But Godown says the concerns are unnecessary. He blames consumer ignorance of biotechnology for the growing movement against genetic engineering. "Introducing technological changes is always a problem. People have a tendency to be concerned about things they don't know anything about." He says part of the industry's job will be to educate consumers about the safety of the new biotechnology.

W O R K S H E E T

6. FDA fools Mother Nature and allows genetically engineered foods

by Susan Male Smith, *Environmental Nutrition* Newsletter, July 1992

This article appeared in a national nutrition newsletter, and discusses the May 1992 FDA regulations and some opinions about genetically engineered foods.

1. Do you think the title suggests this article is for or against genetically engineered foods? Why, or why not?

2. Do you think the author of this article favors labeling of these products? Why, or why not?

3. What is the FLAVR SAVR^{TM} tomato?

4. According to the FDA policy, when is proof of safety required for genetically engineered foods?

5. Why aren't the FDA regulations more strict?

WORKSHEET CONTINUED

6. What are some differences between foods altered by:
   a) genetic engineering; and
   b) crossbreeding?

7. Why might some religious groups or vegetarians be opposed to genetically engineered foods?

8. Why does Richard Godown, president of the Industrial Biotechnology Association, think that people are concerned about genetically engineered foods?

9. Why does Andrew Kimbrell, policy director of the Foundation on Economic Trends, think people are concerned about genetically engineered foods?

10. What do you think about these issues?

MODULE G — SUPPLEMENTARY ACTIVITIES

INSTRUCTIONS

SUPPLEMENTARY ACTIVITIES:

1. Have participants create a report about new food products being developed using biotechnology. They can start with information gathered in Module A and Module E supplementary activities, and acquire more information by contacting a:
   - Biotechnology company
   - State department of agriculture biotechnology division
   - Technical or agricultural college biotechnology program
   - Organization listed in the Resource Directory of this guide

2. Have participants create a report about the required regulations of genetically engineered food. They can acquire this information by writing to a federal or state government regulatory agency. Contact your state department of agriculture's biotechnology division, or:

   Consumer Education Staff
   Center for Food Safety and Applied Nutrition
   U.S. Food and Drug Administration
   200 C Street, S.W.
   Washington, DC 20204
   (800) FDA-4010; FAX (202) 401-2893

   David Heron, Biotechnologist
   Office of Biotechnology, Biologics and
   Environmental Protection
   Animal and Plant Health Inspection Service
   U.S. Department of Agriculture
   4700 River Road
   Riverdale, MD 20737
   (301) 734-4887; FAX (301) 734-8669
   Note: *After February 1995, call to confirm FAX number.*

   Special Assistant for Biotechnology
   Prevention, Pesticides and Toxic Substances
   U.S. Environmental Protection Agency
   401 M Street, S.W. (TS-788)
   Washington, DC 20460
   (202) 260-6900; FAX (202) 260-0949

3. Encourage participants to interview someone employed in a biotechnology field. Have participants create a report about biotechnology careers by contacting a:
   - Local biotechnology company's personnel office
   - State department of agriculture biotechnology division
   - Technical or agricultural college biotechnology program or placement office
   - Organization listed in the Resource Directory of this guide

GLOSSARY

acidophilus milk	Milk seeded with living *Lactobacillus acidophilus* bacteria used to improve the balance of beneficial bacteria in the intestines of the person who drinks the milk.
amino acids	Long chains of amino acids make up proteins. About 20 are known. Some amino acids are made in the body; those that are not are called essential amino acids and must be supplied in food.
antibiotics	Pharmaceuticals obtained from microbes to prevent or treat infections by inhibiting growth of disease-producing bacteria and fungi.
antibody	Protein produced in body tissues in response to the presence of a specific antigen. *See antigen*.
antigen	Foreign substance that when introduced into body tissues, induces an immune response by a specific antibody. *See antibody*.
antisense	Way to turn off a gene by putting a "reverse version" or "mirror image" version of the gene into a cell. *See marker gene*.
assay	Technique for measuring a biological response; a test.
bacillus	Singular for a rod-shaped bacterium (plural, bacilli). Also used as the name of a genus of bacteria, including the species *Bacillus thuringiensis* (see next entry).
Bacillus thuringiensis (Bt)	Bacterium that produces a protein called Bt toxin, a biological insecticide. Bt toxin is used to control insect pests by dusting the crop with Bt bacteria. When ingested, Bt toxin kills certain insect larvae, but is regarded as harmless to humans, pets and most beneficial insects such as bees. Inserting a copy of the Bt gene into plants enables them to produce Bt toxin protein. Such plants can resist some insect pests. *See biological control, microbial insecticide.*
bacterium	Class of single-cell organisms (plural, bacteria). One member, *E. coli*, is commonly used in recombinant DNA technology for producing proteins and other chemicals.
base	On the DNA molecule, one of the four chemical units that are linked in a series to make a strand of DNA. The four DNA bases are: adenine (A), cytosine (C), guanine (G), and thymine (T). In RNA, uracil (U) substitutes for thymine. *See DNA fingerprinting, nucleotide.*
biological control (biocontrol)	Managing pest populations by purposefully manipulating beneficial natural enemies — predatory or parasitic insects that kill pest insects, or microbes that cause insect diseases. *See* Bacillus thuringiensis *(Bt).*
biopulping	Experimental way of using a fungus to pretreat wood chips before making paper pulp. Biopulping reduces both energy use and water-polluting byproducts.
bioremediation	Using organisms to remove toxins from the environment. Examples: a fungus to detoxify a wood preservative that contaminates soil at sawmills; a bacterium to help clean up oil spills.
biotechnology	Using living organisms to make a product or run a process — as ancient as using yeast to make bread (traceable back 6,000 years), or as modern as genetic engineering.
bovine	Formal word for any animal in the cattle family.

bovine growth hormone / bovine somatotropin (BGH / BST)
Two names for one protein hormone produced in the pituitary gland of cattle. BGH/BST can also be produced by inserting a copy of the gene for BGH/BST into laboratory bacteria. Such recombinant BGH/BST is also referred to as rBGH/rBST. Purified from pituitary glands or from bacterial cultures, BGH/BST injected into dairy cows can increase milk production up to 20 percent.
Compare to porcine somatotropin (PST).

cell
Smallest unit of living matter able to grow and reproduce independently. Cells contain DNA for storing information, ribosomes for making proteins, and mechanisms for converting energy.

characterize
Describe the distinguishing traits.

chromosome
One or more microscopic rod-shaped elements in the nucleus of a cell that contain genetic information for that cell. Chromosomes are composed of DNA and protein.

chymosin
Enzyme, also called rennet, used in making cheese. Chymosin can be extracted from the stomach of veal calves, or from genetically engineered bacteria that have the gene for chymosin.

cloning
Technique of creating a group of genetically identical cells or DNA molecules from a single ancestor. In horticulture, cloned plants are reproduced asexually from a single parent.

Colorado potato beetle *(Leptinotarsa decemlineata)*
Insect pest that prefers potatoes, but will attack tomatoes and eggplants.

cross protect
Make a plant resistant to a severe virus by intentionally infecting it with a mild strain of the same virus.

culture
Cultivate cells or living organisms in a prepared medium under laboratory conditions. "Culture" is both the process and the growing cells.

cystic fibrosis
Disease of mucous glands throughout the body that usually develops during childhood, and makes breathing increasingly difficult. If a child receives two copies of the defective gene called the CF gene — one copy from each parent — then the child will develop the disease.

DNA (deoxyribonucleic acid)
Primary genetic material; complex substance of which genes are made within chromosomes. Each DNA molecule consists of two connected spiral strands in the shape of a double helix (like a twisted ladder). The biological information tape that stores genetic information in organisms and transmits it from generation to generation.

DNA analysis
See polymerase chain reaction (PCR) and RFLP mapping. Both PCR and RFLP analysis can be used in DNA fingerprinting for genealogical studies and forensics.
See next entry.

DNA fingerprinting
Detecting patterns in DNA that indicate the presence of a gene for a trait. The pattern resembles a bar code printed on a commercial product so computers can scan the price. Forensics experts can use this distinct pattern to link or clear an individual suspected of being involved in a crime, like they compare fingerprints. Breeders can use these patterns to find and select breeding stock with traits such as disease resistance.

electrophoresis
Technique for analyzing and separating molecules based on the movement of charged particles in an electric field.

embryo	Early stages of an animal's development that results when a sperm fertilizes an egg. Embryo cloning produces many calves from one embryo, for example.
enzyme	Protein catalyst that causes chemical reactions in the cell, producing compounds necessary for the cell's growth and survival.
ethanol	Alcohol; yeasts ferment corn starch to yield ethanol for gasohol. *See gasohol.*
Escherichia coli (E. coli)	Common bacterium found in human and mammalian digestive tracts. Some strains of *E. coli* are used in recombinant DNA work because they have been genetically well-characterized and are easily grown in laboratory fermenters.
expression	In genetics, manifestation of a characteristic specified by a gene. In industrial biotechnology, production of a specific protein by inserting a gene into a new host organism.
feedstock	Raw material used for chemical or biological processes, such as polymers to produce plastics.
fermentation	Chemical reaction induced by a living agent — yeast, bacterium or mold — that splits complex organic compounds to simple ones. For example, yeast converts sugar to alcohol and carbon dioxide. In biotechnology, the process of growing microbes to produce chemical or pharmaceutical compounds. Also referred to as classical biotechnology, traceable back 6,000 years.
fungus	Organisms including yeasts, molds, smuts and mushrooms (plural, fungi).
fusion	Joining the membrane of two cells of different origin to create a cell that contains the parent cells' nuclear material. Used in monoclonal antibody technology to make hybridomas — fusing an immortal cell (one that divides continuously) and an antibody-producing cell. *See monoclonal antibody.*
gasohol	Fuel; blend of ethanol and unleaded gasoline, usually 10 percent ethanol and 90 percent gasoline. *See ethanol.*
gene	For genetic engineering, the smallest portion of a chromosome that contains the hereditary information for the production of a protein.
gene splicing	Inserting new genetic information into a chromosome using recombinant DNA techniques.
genetic analysis	Studying how traits and genes for traits are passed from generation to generation, and how genes and the environment interact to result in traits.
genetic code	Information coded within nucleotide sequences of RNA and DNA that specifies the amino acid sequence in protein synthesis and on which heredity is based.
genetic counseling	Providing current or prospective parents with information on the probabilities of inherited diseases occurring in their children, and on diagnosis and treatment of such diseases.
genetic engineering	Using recombinant DNA techniques and related methods to move one or several genes from one organism to another, to rearrange one or several genes within a cell, or to alter gene-controlled processes. Transferring a DNA segment from one organism and inserting it into the DNA of another organism to modify, amplify, transform and express genetic information. The two organisms can be totally unrelated. *See recombinant DNA.*

genus	Category of organisms ranking above a species and below a family.
hormone	Chemical that acts as a messenger relaying instructions to start certain physiological activities. Hormones are synthesized in one type of cell, and released to direct the function of other cell types.
human growth hormone (HGH)	Human somatotropin, a protein hormone made in the pituitary gland. Lab-grown bacteria given a copy of the gene for human growth hormone can then produce large amounts of HGH, which can be purified and used to treat certain kinds of human dwarfism — a pathological condition of growth arrested by various causes.
insulin	Protein hormone that regulates blood sugar, made in cells of the pancreas. In the laboratory, microbes given a copy of the gene for human insulin can make insulin to treat *diabetes mellitus*, a shortage of insulin.
lactase	Enzyme in certain yeasts and mammalian intestinal tracts that catalyzes converting lactose to glucose and galactose. Lactase tablets remove lactose from milk for people who are lactose intolerant. *See next entry.*
lactose	Milk sugar; also white crystal sugar made from whey used in baby food, baked goods, candies and pharmaceuticals.
marker gene	Gene that is easy to find or observe. Attaching a marker gene to another gene that is hard to find, such as an antisense gene, is like putting a reflective collar on a dog so you can see the collar at night — even though you cannot see the dog, you know where it is. *See antisense.*
mastitis	Inflammation of milk-producing glands in a cow's udder, caused by bacteria. Mastitis can be treated with antibiotics.
methane	Odorless, colorless, flammable gas; component of natural gas and important source of hydrogen and organic compounds. Efficient anaerobic bacteria decompose sludge, manure or landfill wastes to produce methane. Some sewage plants collect methane to fuel generators, digesters and air compressors.
microbe	Microorganism; any organism that can be seen only with the aid of a microscope.
microbial insecticide	Preparation of living microbes — such as bacteria or fungi — pathogenic to specific groups of insects. Regulated as pesticides by the U.S. Environmental Protection Agency; users must follow specific labeling and use guidelines. *See* Bacillus thuringiensis *(Bt), biological control.*
mold	Various fungous growths, often causing disintegration of organic matter; fungus that causes mold.
monoclonal antibody	A protein that recognizes and attacks one specific foreign substance invading the body (antigen). A monoclonal antibody may be used for early disease diagnosis and therapy. *See fusion.*
monoculture	Producing only one type of crop over a large area of farmland.
mutagen	Agent that causes biological mutation. Examples include chemicals, radioactive elements and ultraviolet light. *See pentachlorophenol.*
mutation	Sudden random change in genetic material that may cause that cell and all cells derived from it to look or behave differently.

nucleotide	Organic compound composed of a sugar, a phosphate and a base. Two nucleotides joined crosswise by specific pairings of the bases make one rung in the DNA molecule's double helix "ladder."
pathogen	Organism able to cause disease in a certain host.
pentachlorophenol	Chemical formerly widely used to preserve wood from decay and insect damage, now a restricted-use pesticide. According to the U.S. Environmental Protection Agency, it can be an acute toxin causing such problems as burns and breathing difficulty. It may cause developmental effects such as birth defects and affect male and female reproductive capacity. It can also harm wildlife. *See bioremediation.*
plasmid	A circular piece of DNA found outside the chromosome in bacteria. Plasmids are the principle tool for inserting new genetic information into microbes or plants.
polygalacturonase (PG)	Enzyme that digests part of the pectin that forms plant cell walls. Polygalacturonase causes ripening fruit to become soft.
polymerase chain reaction (PCR)	Multiplying a particular DNA segment in repeated cycles. The "copies" made in a previous cycle are used as "originals" or templates in the next cycle. For example, PCR enables forensics experts to do DNA testing on very small blood samples.
porcine somatotropin (PST)	Pig growth hormone; a protein hormone produced in the pituitary gland of pigs. Like BGH/BST, PST can also be produced by inserting a copy of the gene for PST into laboratory bacteria. When purified from pituitary glands or from bacterial cultures, PST injected into hogs can increase the leanness of pork and improve pork quality.
protein	Composed of amino acids, proteins are a key component in many cell structures. In addition, many hormones and enzymes that regulate cells are proteins.
RFLP (restriction fragment length polymorphism)	RFLP mapping detects patterns in DNA that can indicate the presence of a gene for a trait. Both RFLP and polymerase chain reaction (PCR) analysis can be used in DNA fingerprinting for genealogical studies and forensics.
RNA (ribonucleic acid)	Molecule similar to DNA that functions primarily to decode the instructions that genes carry for protein synthesis.
recombinant DNA (rDNA)	Technique of isolating DNA molecules and inserting them into the DNA of a cell. This technique includes taking copies of genes from one organism and inserting them in another organism. The two organisms can be totally unrelated. Recombinant DNA has a variety of uses, such as studying how genes work, and producing medicines such as human insulin and other commercial products. *See genetic engineering.*
ribosome	Site of protein synthesis in the cytoplasm.
selection and breeding	Manipulating microbes, plants or animals, and choosing desirable individuals or populations as breeding stock for new generations.
somatic cells	Cells other than sex or germ cells. High somatic cell counts found in milk indicate mastitis in dairy cows. Low somatic cell counts indicate better quality milk and net a premium price from dairy processors.

sometribove	Generic name used by the U.S. Food and Drug Administration to refer to commercial bovine growth hormone/bovine somatotropin (rBGH/rBST). Posilac™ is Monsanto Company's trade name under which it sells sometribove (rBGH/rBST).
species	Group of organisms with common or similar characteristics and capable of interbreeding.
synthesis	The process whereby separate elements are combined to form a new complex product, synthetic chemical compound or material.
Taxol™ paclitaxel	Natural product approved by the U.S. Food and Drug Administration in 1992 to treat ovarian cancer after failure of first-line chemotherapy; also used experimentally to treat breast, lung and other cancers. Manufactured by Bristol-Myers Squibb U.S. Pharmaceutical Group from bark of old-growth Pacific yew (cedar) trees. Because these forests are also home to endangered spotted owls, researchers are working to synthesize paclitaxel from twigs and needles, leaving the tree standing.
technology treadmill	In rural sociology, the concept that introducing new production-enhancing technologies has not solved — and some believe has compounded — problems of farm profitability and sustainability. As farmers adopt a new technology, costs decrease and production increases, driving down prices to reflect lower per-unit costs and causing farmers to constantly seek new, cost-reducing technologies to stay ahead.
tissue culture	Growing plant or animal tissues or cells in test tubes or other laboratory glassware, without other contaminating organisms, for propagation, chemical production and medical research.
transgenic	Carrying one or more genes introduced using recombinant DNA technology.
trichosanthin (TCS)	Eight ribosome-inactivating proteins derived from Chinese cucumber *(Trichosanthes kirilowli)*, also named CHOSEN-KARASU-URI. Seeds produce triterpene, the first naturally occurring anti-inflammatory drug used in traditional Chinese medicine. Synthesized protein activates normal human serum. The plant's roots can be genetically engineered to produce potential anti-tumor and anti-AIDS virus drugs, as well as biological nematicides and fungicides for crop protection.
virus	Microscopic particle that contains genetic information, but must invade a cell to reproduce.
yeast	One-celled fungi that reproduce by budding. Some ferment carbohydrates (starches and sugars), important for baking and brewing. Many biochemical properties of yeast are similar to those of higher organisms.

RESOURCE DIRECTORY

BIOTECHNOLOGY EDUCATION HANDBOOKS, CURRICULUM GUIDES AND VIDEOS

Biotechnology and the Environment by Margaret Mellon ($11.40, includes shipping), and *Perils Amidst the Promise: Ecological Risks of Transgenic Crops in a Global Market* by Jane Rissler and Margaret Mellon ($14.40, includes shipping). Order from: Union of Concerned Scientists, 2 Brattle Square, Cambridge, MA 02238, (617) 541-5552/FAX (617) 864-9405.

Biotechnology and Food: Leader and Participant Guide NCR 569, by Tom Zinnen and Jane Voichick, companion poster *Biotechnology: Tools for Genetic Ingenuity* NCR 570, 1994, (each $3, plus shipping), and video "Biotechnology and Food: *A Public Issue for Extension Education,*" VHS, 120 minutes ($28, plus shipping). Order from: Cooperative Extension Publications, 30 N. Murray St., Room 245, Madison, WI 53715, (608) 262-3346. For information on how to get University of Wisconsin-Extension and UW Biotechnology Education Program materials electronically, contact: Tom Zinnen, Biotechnology Education Program, University of Wisconsin-Extension and UW Biotechnology Center, 1710 University Ave., Madison, WI 53705, (608) 265-2420/FAX (608) 262-6748.
E-mail: zinnen@macc.wisc.edu
Note: *Mailing address valid until October 1995, when the UW Biotechnology Center address will be 25 Henry Mall, Madison, WI 53706.*

Biotechnology in Schools: A Handbook for Teachers (ISBN 0-335-09368 X, paperback)*, by Jenny Henderson and Stephen Knutton. Order from: Open University Press, Celtic Court, 22 Ballmoor, Buckingham, MK18 1XW, UNITED KINGDOM.

Biotechnology, Microbes and the Environment ($17.50), and *Biotechnology and Genetic Diversity* ($12.50) by Steven C. Witt. Available as a set for $20 in classroom quantities or to teachers. Order from: Center for Science Information, 63 Homestead St., San Francisco, CA 94114, (415) 824-3192/FAX (415) 824-0201.

Biotechnology Units, middle, junior or high school units with two video tapes for ages 10 to 18, by the Biotechnology Education Project of the St. Louis Mathematics and Science Education Center, funded by the Monsanto Fund and National Science Foundation. Being revised for 1995 publication; 1990 editions available. About $40 for each of the three units, plus shipping charges. Also *Genetic Engineering: The Nature of Change* ($6) and *Of the Earth: Agriculture and the New Biology* ($9.50 for both videos; *Of the Earth* not sold separately). Teachers contact: Kris Sherman, Mathematics and Science Education Center, 8001 Natural Bridge Road, St. Louis, MO 63121-4499, (314) 553-5552/ FAX (314) 553-5342.
E-mail: spmarko@slvaxa.uwsl.edu

Classroom-Ready Biotechnology Activities, developed by teachers who participated in biotechnology workshops at the University of Wisconsin-River Falls, compiled by Karen Klyczek. Their goal is to develop a manual of ready-to-use tested activities. Free to teachers willing to field test and evaluate more than 40 activities. Available in print or on computer disc from: Karen Klyczek, Assistant Professor, UW-River Falls Biology Department, 410 S. Third St., River Falls, WI 54022, (715) 425-3364/FAX (715) 425-3785. E-mail: karen.k.klyczek@uwrl.edu

* ISBN = International Standard Book Number (for ordering).

DNA Science: A First Course in Recombinant DNA (catalog # 21-2211), by David Micklos and Greg Freyer, Cold Spring Harbor Laboratory Press ($32.95).Order from: Order Department, Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215, (910) 584-0381/FAX (910) 584-3399.

Mapping and Sequencing the Human Genome: Science, Ethics and Public Policy, by Biological Sciences Curriculum Study and the American Medical Association, 1992 ($4, includes shipping; call for quantity discounts). Order from: Biological Sciences Curriculum Study, Pikes Peak Research Park, 5415 Mark Dabling Blvd., Colorado Springs, CO 80918-3842, (719) 531-5550/FAX (719) 531-9104.

National Association of Biology Teachers (NABT), 11250 Roger Bacon Drive #19, Reston, VA 22090, (703) 471-1134/FAX (703) 435-5582. Membership association offers inservices and workshops, a journal and newsletter, and biotechnology sessions at the NABT annual convention. Dues are $42 a year.
Available from NABT:

- *Biotechnology: Careers for the 21st Century*, video ($8 members, $10 non-members, plus shipping)
- *Biotechnology, Genetic Engineering and Society* ($10 members, $12 non-members, plus shipping)
- *Sourcebook of Biotechnology Activities* (ISBN 0-941212-09-2), developed by NABT and the North Carolina Biotechnology Center, project co-directors Alison M. Rasmussen and Robert H. Matheson III ($29 members, $35 non-members)
- *Working with DNA and Bacteria in Pre-College Science Classrooms*, safety guidelines ($8 members, $10 non-members, plus shipping)

Science Fun with Dairy Foods (#4-H-490, $1.40, booklet, and accompanying leader's guide (#4-H-490-1GPM, $3.25). Order from: Ohio State University Extension Publications, 385 Kottman Hall, 2021 Coffey Road, Columbus, OH 43210-1044, (614) 292-2011/FAX (614) 292-2270. E-mail: scardena.1@osu.edu

Secret of Life: Redesigning the Living World by Joseph Levine and David Suzuki, 1993 (WGBH, $24.95; ISBN 09636881-0-3), companion to the WGBH/Boston and BBC eight-hour series on biology "The Secret of Life," broadcast on PBS during fall 1993 ($89.95 per video or $649 for all eight). The series explores "new biology" for both scientists and non-scientists. Geneticist David Suzuki and science writer Joseph Levine describe DNA and define the moral, financial and political implications of biotechnology. The book is available in bookstores or from: Consortium Booksales and Distribution, 1045 Westgate Dr., St. Paul, MN 55114, (800) 283-3572/FAX (612) 221-0124. Order video(s) from: Films for the Humanities and Sciences, P.O. Box 2053, Princeton, NJ 08543-2053, (800) 257-5126/FAX (609) 275-3767.

Teaching Basic Biotechnology: DNA-Based Technologies (Washington, D.C.: American Society for Microbiology Press; available in 1995), book of lesson plans and lab activities, and *Biology: Sowing the Seeds for Better Agriculture* video ($20). Teachers contact: North Carolina Biotechnology Center, P.O. Box 13547, 15 Alexander Drive, Research Triangle Park, NC 27709-3547, (919) 541-9366/FAX (919) 990-9544.

BIOTECHNOLOGY AND RELATED NEWSLETTERS

Biotechnology Notes, published by the U.S. Department of Agriculture Office of Ag Biotechnology. Order from: Marti Asner, Editor, USDA-OAB Room 1001 Rosslyn Plaza East, 14th and Independence Ave., SW, Washington, DC 20250-2200, (703) 235-4419/FAX (703) 235-4429.

Carolina Genes (free) and *Careers in Biotechnology* (up to 5 copies free, 50 cents each for more). Order from: Barry Teater, North Carolina Biotechnology Center, P.O. Box 13547, 15 Alexander Drive, Research Triangle Park, NC 27709-3547, (919) 541-9366/FAX (919) 990-9544. E-mail: barry_teater@ncbiotech.org

Carolina Tips (ISSN 0045-5865). Order from: Mailing List Dept., Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215, (800) 334-5551.

Center for Biotechnology Policy and Ethics Newsletter (probably $10). Pre-publication discussion papers ($4 each) are listed in the newsletter. Order from: Subscriptions, Center for Biotechnology Policy and Ethics, 329 Dulie Bell Building, Texas A&M University, College Station, TX 77843-4355, (409) 845-5434/FAX (409) 847-9372.

The Gene Exchange (free). Order from: Union of Concerned Scientists, 1616 P Street, NW, Suite 310, Washington, DC 20036, (202) 332-0900/FAX (202) 332-0905.

Genome, published by the Human Genome Project. Teachers contact: Dr. Paula Gregory, NIH Center for Human Genome Research, Building 49, Room 3A14, 9000 Rockville Pike, Bethesda, MD 20892, (301) 496-3978/ FAX (301) 402-4929. E-mail: edcore@nchgr..nih.gov

Human Genome News, sponsored by the human genome programs of the National Institutes of Health and U.S. Department of Energy (6 issues a year; free), and *Primer on Molecular Genetics* by the Human Genome Program, DOE Office of Energy Research, June 1992 (out of print, but available electronically). Available from: Betty K. Mansfield, Human Genome Management Information System, Oak Ridge National Laboratory, 1060 Commerce Park, MS 6480, Oak Ridge, TN 37830, (615) 576-6669/FAX (615) 574-9888. E-mail: bkq@ornl.gov

Ligase, information and activities related to biotechnology linking precollege and higher education with the biomedical industry. Order from: Boston University School of Medicine, 80 East Concord St., Room S413, Boston, MA 02118-2394, (617) 638-5629/FAX (617) 638-5621.

The Ram's Horn (11 issues a year; $20 individual, $30 institutional). Order from: Brewster and Cathleen Kneen, 125 Highfield Road, Toronto M4L 2T9, Ontario, CANADA, Phone/FAX (416) 469-8414.

Wisconsin BioIssues (free). Order from: Dedee Wardle, Managing Editor, University of Wisconsin Biotechnology Center, 1710 University Avenue, Madison, WI 53705, (608) 262-2604 or 262-8606/FAX (608) 262-6748.
E-mail: ddwardle@macc.wisc.edu
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BIOTECHNOLOGY TRADE JOURNALS

Bio/Technology, international monthly for industrial biology (13 issues; $195 institutional, $59 personal). Order from: Subscription Department, The Nature Publishing Co., P.O. Box 1721, Riverton, NJ 08077-7321, (800) 524-0328; or The Nature Publishing Co., 65 Bleecker Street, New York, NY 10012, (212) 477-9600/FAX (212) 254-9493.

Genetic Engineering News, trade publication for industry professionals (22 issues; free to industry professionals, $20 per issue or $190 a year for others). Order from: Mary Ann Liebert, Inc, 1651 Third Avenue, New York, NY 10128, (212) 289-2300/FAX (212) 289-4697.

Information about biotechnology is available from many sources, a few of which are listed in this guide. Information is provided as a convenience to readers. It is not an endorsement by University of Wisconsin-Extension, nor is it exhaustive. Prices and availability are subject to change.

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