Position of the American Dietetic Association: Agricultural and Food Biotechnology

ABSTRACT
It is the position of the American Dietetic Association that agricultural and food biotechnology techniques can enhance the quality, safety, nutritional value, and variety of food available for human consumption and increase the efficiency of food production, food processing, food distribution, and environmental and waste management. The American Dietetic Association encourages the government, food manufacturers, food commodity groups, and qualified food and nutrition professionals to work together to inform consumers about this new technology and encourage the availability of these products in the marketplace.
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The American Dietetic Association (ADA) has had a position on biotechnology since 1992. The Association's position was updated in 1995 and reaffirmed in 1998. Since that time, the Institute of Food Technologists expert panel report, *IFT Expert Report on Biotechnology and Foods,* and an International Life Science Institute Task Force comprehensive review have been published. The Institute of Food Technologists' report provides a thorough overview of the scientific status of agricultural and food biotechnology, safety issues, labeling requirements, and benefits and concerns. The International Life Science Institute Task Force review presents a comprehensive assessment of nutritional and safety issues associated with food produced by this technology. The ADA refers readers to these publications for in-depth discussion of the issues.

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POSITION STATEMENT

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According to the Codex Alimentarius Commission, modern biotechnology refers to the applications of in vitro nucleic acid techniques including recombinant deoxyribonucleic acid (rDNA) and direct injection of nucleic acid into cells or organelles, or fusion of cells beyond the taxonomic family that overcome physiological reproductive or recombination barriers (1). These techniques enable plants, animals, and microorganisms to be genetically modified with novel traits beyond what is possible through traditional breeding and selection. Techniques such as tissue culture and market-assisted breeding are also often considered modern biotechnology. Foods produced through modern biotechnology can be categorized as:

1. foods consisting of or containing living/viable organisms (eg, corn);
2. foods derived from or containing ingredients derived from genetic modification (eg, corn meal containing protein or oil from genetically modified soybeans);
3. foods containing single ingredients or additives produced by genetically modified microorganisms (eg, colors, vitamins, or essential amino acids); and
4. foods containing ingredients processed by enzymes produced through genetically modified microorganisms (eg, high-fructose corn syrup produced from starch using the enzyme glucose isomerase [a product of genetic modification], or cheese produced using the enzyme chymoson [a genetically modified equivalent of rennet]) (2).

Research indicates that consumers prefer the term *biotechnology* over *genetic modification* and *genetic engineering* (3). Therefore, this document will refer to these modern techniques as biotechnology.

Biotechnology, or genetic engineering, means different things to different people. The simplest definition of biotechnology is "applied biology." Another definition is "the use of living organisms to make a product or run a process" (4). Government agencies and research entities refer to biotechnology as "the application of biological systems and organisms to the production of useful goods and services" (5). This definition encompasses application in biology, genetics, and biochemistry to advance technical and industrial processes and techniques ranging from drug development, fish farming, forestry, crop development, fermentation, and oil spill clean up. See Figure 1 for terms commonly used in biotechnology.

The classic techniques used for plant and animal breeding, fermentation, and enzyme purification could all be considered genetic engineering or biotechnology. Food and agricultural examples include use of plant or animal selective breeding techniques to produce new generations with enhanced qualities and use of bacteria and enzymes to make yogurt, cheese, and vinegar. Modern biotechnology techniques include rDNA technology, in which a copy of a piece of DNA containing one or a few genes is transferred between organisms or recombined within an organism. The rDNA

Amplification—The increase, spontaneous or induced, of the number of the same gene within a cell.

Antibiotic resistance—A trait incorporated into vector DNA as a marker; only those cells within which the vector DNA is incorporated are resistant to antibiotics.

Bioreactors—Vessels or mechanisms used for conversion of substrates to products using genetically modified organisms.

Bioremediation—Degradation of industrial waste by indigenous or genetically modified microorganisms.

Clone—A group of genetically identical cells or organisms asexually descended from a common ancestor.

Genetic engineering—The process of modifying the genetic material of a cell using restriction enzymes.

Recombinant DNA (rDNA)—DNA produced using genetic engineering techniques. Techniques involve transferring a DNA segment from one organism and inserting it into the DNA of another organism. The two organisms can be unrelated.

Replication—The formation of new strands of DNA from existing DNA, permitting the reproduction of an identical new cell as the result of the division.

Restriction enzymes—Enzymes that recognize specific sequences in DNA and cleave the DNA strand at those points.

Transgenic organism—An organism that contains both parental and foreign DNA sequences within its basic genome.

Vector—A transmission agent; for example, a DNA vector is a self-replicating DNA molecule that transfers a piece of DNA from one host to another.

Figure 1. Terms commonly used in food and agricultural biotechnology.

technology or "gene splicing" may be likened to cutting a circle of tape, inserting a different piece, and rejoining both ends to the new piece (4).

POTENTIAL BENEFITS OF AGRICULTURAL PLANT APPLICATIONS OF BIOTECHNOLOGY

Currently the main crops produced from modern biotechnology include corn, soybeans, cotton, potatoes, and rapeseed (grown for canola oil) that have been modified to resist insects or increase herbicide tolerance. Crops with these improved agronomic characteristics have been safely grown and used on a large scale in an increasing number of countries (6). In recognition of these benefits, an increasing number of farmers are planting genetically modified crops. The worldwide acreage of modified crops increased by 20% to 81.0 million hectares in 2004 (7). Over half of the world's population lives in countries where biotechnologically modified crops have been officially approved by governmental agencies and grown.

Although the majority of biotechnologically modified crops are grown in the United States, use of this technology is not exclusive to farmers in the United States and other developed countries (7). Many developing countries are investing in agricultural biotechnology (8). Opportunities specifically designed for local needs are targeted by foundations and research institutions (9). Applications are widespread in China, where poor farmers are cultivating more areas of modified plants than are small farmers in other developing countries (10).

A newly emerging class of biotechnologically modified crops is being developed that provides improved human or animal nutrition. Agronomic traits that increase yield, extend growing season, widen growing region, or impart pest resistance traits are being applied to agricultural crops used for human food or animal feed. A number of crops have reached the field trial stage and are advancing through the regulatory approval process before commercialization (6). These nutritionally enhanced crops have the potential to lessen nutrient deficiencies; improve the nutritional value of food and feed; promote well-being through elevated levels of beneficial compounds; lower levels of natural toxins, toxic metabolites, or allergens; improve processing; and enhance taste (6,11-13). Corn modified to resist insect attack, for example, has been shown to have lower levels of mycotoxin than conventionally grown corn (14). The most widely known example of nutritional modification is rice containing a high level of beta carotene, a precursor of vitamin A, called "golden rice" (15). A number of strategies have been suggested to address vitamin A deficiency, including food fortification and supplementation (2). Rice and maize varieties with enhanced vitamin A that can be absorbed efficiently in the human gut is being developed for cultivation in developing countries with the goal that 300 g modified rice can provide a significant contribution to the human daily vitamin A requirement (16). Other examples include modifying vegetable oil to avoid *trans*-fatty acids, altering the chain length and saturation level of fatty acids, and reducing the levels of expression of the thioredoxin gene, thus reducing the allergenic response from wheat and other cereals. Applications that may be useful in animal feed include cereal grains in which the fatty acid and/or amino acid profiles are improved; legume seeds for crops modified to have improved protein and/or amino acid profiles; and crops modified for improved enzyme, mineral, and vitamin composition. Reducing phytate in animal feed enhances nutrient absorption and reduces phosphate excretion, thereby benefiting the environment. Analysis by the Economic Research Service indicates a reduction in pesticide use resulting from increased adoption of modified crops (17). The decline in pesticide use was estimated at 19.1 million acre-treatments. Total active ingredients declined by 2.5 million pounds. Although glyphosate applied to soybeans increased slightly, the pesticide substituted for other synthetic herbi-

cides that are three times as toxic to humans and persist in the environment nearly twice as long as glyphosate.

ASSESSMENT OF THE SAFETY OF AGRICULTURAL AND FOOD BIOTECHNOLOGY

Numerous professional organizations, academic research entities, and regulatory bodies have stated or reaffirmed support for agricultural and food biotechnology (5). In addition, many organizations have published new statements of policy or reaffirmed or approved existing statements related to food or agricultural biotechnology. These include the American Medical Association (18), the Council for Agricultural Science and Technology (19,20), the Food and Agriculture Organization (21), the National Academy of Sciences (22-24), the National Center for Food and Agricultural Policy (25), the Pew Charitable Trusts (26), the Society of Toxicology (27), the International Life Science Institute (6), and the World Health Organization (28).

In contrast, the US Department of Agriculture's (USDA) National Organic Program, a marketing program that specifies guidelines for products that can be labeled organic, has prohibited use of this term on products produced from rDNA, cell fusion, and microencapsulation and macroencapsulation (29). The term organic can be used on products produced from traditional breeding, conjugation, fermentation, hybridization, in vitro fertilization, and tissue culture.

Reports examining the global perspective and outlook for biotechnology have cited benefits, cautions, opportunities, and barriers to the use of biotechnology in food and agriculture to feed the developing world (16,30). The World Health Organization (28) notes that genetically modified crops have the potential for increasing agricultural productivity and improving nutritional value. They can contribute directly to enhancing human health and development through reduced use of agricultural chemicals, enhanced farm income, greater crop sustainability, and improved food security, particularly in developing countries. Genetically modified products may also involve potential risks for human health and development because some have not previously been in the food supply (28). However, through use of science-based evaluations and approaches, concerns can be reduced or eliminated as biotechnology-derived products are developed before commercialization and introduction in farming (16). Genetically modified foods currently available on the international market have passed safety assessments and are not likely to present significant risks to human health (28).

Two reports of note from the National Academy of Sciences outline recommendations on regulatory oversight for animal and plant biotechnology (23,24). These reports recognize that some unanswered questions are typical of new as well as traditional fields.

It is well recognized that absolute safety is not achievable in any area. This concept is particularly relevant when ingesting complex substances such as food. The safety of food and feed derived from crops modified by biotechnology is assessed through the concept of substantial equivalence (6). Under this concept, food or feed derived from a modified crop must be shown to be as safe as its conventionally bred counterpart. Application of the principle of substantial equivalence involves identifying the similarities and differences between a product and its closest traditional counterparts and subjecting the differences to a rigorous safety assessment. The analysis includes measurement of: (a) the agronomic/morphological characteristics of the plant, (b) macronutrient and micronutrient composition and content of important antinutrients and toxicants, (c) molecular characteristics and expression and safety of any protein added to the crop, and (d) the toxicological and nutritional characteristics of the novel product compared with its conventional counterpart in appropriate animal models. To aid in this comparison, a database that contains detailed information on the composition of conventionally bred crops has been developed and made available by the International Life Science Institute at www.cropcompositon.org (6). The similarities noted between the new and traditional crops are not subject to further assessment because this approach provides evidence showing that the newly developed crop is as safe as the traditional crop with a history of safe consumption. Any identified differences are subjected to further scientific procedures as needed to clarify any safety issues. By following this process, the safety assessment strategies for biotechnologically modified crops have shown over the past 10 years to be scientifically robust. Approximately 30,000 field trials have been conducted with more than 50 modified crops in 45 countries. More than 300 million cumulative hectares of modified crops have been grown commercially over the past decade with no documented adverse effects to humans or animals.

The US National Research Council (22) determined that there is no difference in risk when crops are modified through modern molecular techniques when compared with those modified by conventional breeding. In a 2003 position paper, the Society of Toxicology (27) concurred, noting that there is no reason to suppose that the process of food production through biotechnology leads to risks of a different nature than those produced in conventional breeding. An extensive review of the health and food products of animals fed genetically modified feedstuff found no difference between animals fed transformed plants compared with animals fed the control or isogenic plants (31,32).

There is support for a system approach to ensure that the benefits of biotechnology are realized while the risks are minimized (33). Issues related to water quality, gene transfer, and insect management are under constant review (34,35).

Support for the US position on biotechnology safety evaluation is not universal. Some believe that use of the precautionary principle is more appropriate for innovations that include scientific uncertainty. This approach seeks to minimize the risk of new technologies by avoiding implementation of the innovation until all potential risks are thoroughly tested (36). Opponents of this approach point out that the precautionary principle is not scientifically sound because decisions are made without adequate scientific justification, that the current regulatory process is cautious, and an overly cautious approach stifles innovations. Those critical of the Food and Drug Administration's (FDA) current safety review process recommend that Congress mandate that companies submit detailed safety testing data on all com-

mercial and pending applications for FDA and public review (37).

US REGULATORY RESPONSE TO APPLICATIONS OF BIOTECHNOLOGY

The FDA, USDA, and the Environmental Protection Agency (EPA), as well as state governments, have jurisdiction for monitoring the development and testing of plant and plant products produced through biotechnology (5). The USDA approves and oversees field testing of agricultural biotechnology crops. The EPA regulates pesticides and sets environmental tolerances. In regard to biotechnology crops, the EPA ensures that any adverse effects on the environment or any beneficial, nontarget organism are minimal. Specific pesticides requiring review by the EPA include those not derived from a known food source; any pesticide consumed in a different way; or any having a different structure, function, or composition. Review and approval of applications for genetically enhanced crop plants containing pesticidal properties must be conducted by the EPA before field testing. Plants containing pesticides must also be registered with the EPA before being sold. The FDA has broad authority to regulate the introduction of new foods and food additives into the food supply. Producers are held legally responsible by the FDA for the safety and wholesomeness of any food in the marketplace.

In 1992, the FDA declared that foods derived from new plant varieties produced through biotechnology will be regulated in the same fashion as those created through traditional means (38). If the new food is derived from nonfood sources, the FDA requires it to go through a full safety evaluation. A full evaluation also applies to food containing significantly altered nutrients, significantly different composition, allergenic proteins, new antibiotic resistant markers, or levels of toxicants significantly higher than those found naturally in edible varieties of the same food. In 2001, the FDA proposed additional rules to further strengthen the regulation of foods derived from biotechnology (39). Currently, review by the FDA is advisory; however, all products have undergone review before marketplace introduction to date.

In 2001, the FDA issued draft guidance for voluntary labeling of foods developed using bioengineering (40). The draft guidance reiterates the FDA's 1992 requirements for labeling products that have a significant change in nutrient content, contain a proven allergen, or have a material difference from the conventional counterpart. The FDA's draft guidelines will assist manufacturers, who wish to voluntarily label food products as being made with or without bioengineering or the use of bioengineered ingredients, to ensure that label statements are truthful and not misleading. The FDA indicates that commonly used terms such as "GMO" (genetically modified organism) are misleading because most foods do not contain organisms. The FDA notes that terms such as "GM free" or "GMO free" are misleading because all foods have been modified, either by traditional or newer technologies (40). The FDA is seeking comment regarding whether labeling statements such as "biotech free" or "not genetically engineered materials" can be made without being false or misleading. The ADA has taken no formal position on these FDA regulatory proposals, but commented to the FDA during public meetings in 1999 in support of approaches that provide useful, scientifically based information about biotechnology to health professionals and consumers (41).

US REGULATORY SYSTEM IN A GLOBAL SETTING

From an international perspective, mandatory labeling and traceability of biotechnologically modified foods varies from no regulatory or labeling framework to highly specific regulatory frameworks (42). Those countries that have specific frameworks may or may not require mandatory labeling of all or specific products based on compositional differences. Countries may incorporate a variety of rules or protocols under which specific products may be exempted from labeling requirements. At this time, only the European Union has instituted a requirement for both mandatory biotechnology-specific labeling and biotechnology-specific traceability.

When US products are shipped to countries with regulatory frameworks without mandatory biotechnology-specific labeling requirements, products are delivered using existing commodity and finished-product markets without special identification related to use the of biotechnology (42). In countries where there are mandatory biotechnology-specific labeling requirements, food manufacturers generally avoid labeling their products by using nonbiotech grain and grain products. When nonmodified grains are required and special procedures are required to avoid commingling of nonmodified grain with bulk commodity grain, the flexibility of the production systems is reduced and increased costs are absorbed somewhere along the supply chain. The greater the commercial requirements for documentation and segregation from the commodity chain, the greater the costs associated with originating and manufacturing a particular food or feed ingredients.

Two international groups, the Codex Alimentarius and the Cartagena Protocol on Biosafety, are also involved in the issue of biotechnology labeling and traceability (42). Codex, which establishes international quality and food safety standards, is currently addressing traceability and labeling. The Cartagena Protocol on Biosafety, which establishes requirements for the movement of "living modified organisms" between countries, is in the process of setting forth documentation requirements for commodity shipments of living modified organisms for food and feed purposes. The United States is not a party to the Cartagena Protocol. Regulations relating to documentation of the presence of living modified organisms in shipments of products in international commerce could present a challenge for US exporters because traceability and market segmentation may be required.

CONSUMER ATTITUDES TOWARD FOODS MODIFIED BY BIOTECHNOLOGY

Many consumers in the United States and elsewhere are unaware of the widespread use of biotechnology, the potential advantages of the genetic techniques, and the safety and regulatory procedures used before a product is approved for commercial use. Between 32% and 58% of US consumers indicate that they have heard at least something about biotechnology

or genetic modification, and about 35% are aware that the modified products are in the supermarket (43-45). Because over 80% of the soybeans, 32% of the corn, and 54% of rape seed (source of canola oil) grown in the US are genetically modified, foods containing these ingredients are in the supermarket. Not only are people unaware that they are consuming foods that may have come from modified plants, consumers are also unsure what plants have been modified. Vegetables modified by biotechnology are mentioned by 30% of consumers, 19% mention corn, 18% identify fruit, and 18% identify tomatoes (43).

When asked about their attitudes toward plant foods modified by biotechnology without identifying the purpose of the modification, only 27% of consumers support biotechnology (44). After potential benefits are briefly described, most US consumers have a positive attitude toward biotechnology, with 62% believing biotechnology will benefit themselves and their family, 64% indicate they would purchase produce modified by biotechnology to reduce pesticide use, and 50% say they would purchase products modified for better taste (43).

Few US consumers perceive modifications by biotechnology as risky, and labeling food as genetically modified is not a priority for most consumers. When asked in an opened-ended question about food safety concerns, less than 1% volunteered concerns about genetically modified food (43). In contrast, concerns about handling/preparation and disease/contamination were mentioned by 42% and 28%, respectively. When asked whether there was information not currently on a food label that they would like to see added, only 1% asked for information indicating whether the food was genetically altered (43). When asked to select one item from a list of potential label additions, only 17% chose labeling whether the product were genetically altered (46). In contrast, consumers typically respond positively when labeling is suggested (47). When asked whether they support labeling all foods that have been genetically modified, 80% responded affirmatively (45). Consumers were not told that all foods were genetically modified to some degree (40).

The perception of potential environmental benefits and risks influences perception of the technology. When asked whether a series of potential risks were very, somewhat, or not at all important, several environmental risks, such as the potential for contamination of plant species by genetic transfer, were considered very important by 64% of consumers (26). Other potential risks and the percentage of consumers considering the risk very important include the potential to create super weeds, 57%; to develop pesticide resistant insects, 57%; to reduce genetic diversity, 49%; and the potential that modified plants could harm others, 48%.

Many consumers value potential benefits made possible through biotechnology. When specific benefits are identified, 74% rated cleaning toxic pollutants as very important (26). Other potential benefits and the percentage of consumers considering the benefit very important include reducing soil erosion, 73%; using less fertilizer, 72%; developing drought resistant plants, 68%; developing disease-resistant trees, 67%; and using fewer pesticides, 61%. Attitudes toward nutritional benefits were not included in the survey. More recently, when asked about good reasons to pursue biotechnology, 54% considered use of biotechnology to produce affordable pharmaceuticals a very good reason, and 52% noted that using biotechnology to produce less expensive food to reduce worldwide hunger was a very good reason (45).

Since 1997, the percentage of the public having a positive view toward biotechnology has decreased and those expressing concern when specifically asked has increased (43). This change could be related to negative media coverage and the perception that potential risks were not under control (48,49). Almost three quarters (72%) of consumers are unaware that modified crops are evaluated for human safety, and similarly, 77% do not know that the crops are tested for environmental safety (44). Hefferman and Hiller's study in Washington State confirmed consumers' desire for education about agriculture and food biotechnology (50).

When community leaders are informed about the potential benefits and risks of biotechnology, their attitudes toward the value of these innovations to society increase significantly (51). When told that more than half of the food in the supermarket is produced using some form of biotechnology or genetic modification, belief that genetically modified food was safe increased from 30% to 48% (45). Santerre and Machtmes found that a short consumer training session on food biotechnology dramatically increases acceptance of the technology and the regulatory process (52). After training, 90% of participants would eat genetically modified foods or serve them to their family and 90% believed that they or their family would benefit from these new crops within the next 5 years. After training, 83% believed biotechnologically modified crops were properly regulated, compared with only 31% initially. This study shows the importance of science-based consumer education programs for public acceptance of new technologies such as food biotechnology.

Consumer understanding about labeling requirements is low, and survey results range from comfort about current labeling policy for biotechnology foods to a desire for required labeling. If labeling is included, it should indicate the reasons for modification (3,40,43,53,54). Whether for a conventional food product, one derived from biotechnology, or food containing biotechnology-derived ingredients, consumers principally desire information about taste, nutrition, safety, convenience, and price (54).

Hallman and colleagues (44) at Rutgers University indicate that because most Americans have given little thought to the issue of genetic modification, their opinions are often highly malleable. Some opponents of biotechnology have successfully launched voter initiatives to prohibit farmers from planting biotechnologically modified plants in specific growing regions (55). The impact of these measures will be to limit farming practices that may retard efforts of environmental stewardship as well as deny the public potential benefits. This shows the need for dietetics professionals and other health professionals to respond to consumer questions on potential benefits and risks of this technology. Some will continue to avoid food products modified by these newer methods, whereas others will be comfortable with these innovations and seek the benefits that their application provides.

Agriculture, food, and health information

Biotechnology Industry Organization
http://www.bio.org/er/

Colorado State University
Transgenic Crops: An introduction and resource guide
http://www.colostate.edu/programs/lifesciences/TransgenicCrops/

Consumer Federation of America
http://www.consumerfed.org

Consumers Union
http://www.consmersunion.org

Council for Agricultural Science and Technology
http://www.cast-science.org

Greenpeace
http://www.greenpeace.org

Institute of Food Technologists
http://www.ift.org/govtrelations/biotech/

International Food Information Council Foundation
http://ific.org

Iowa State
http://www.biotech.iastate.edu

Pew Initiative on Food and Biotechnology
http://www.pewagbiotech.org/

PubMed
http://www.eatright.com/healthorg.html

Union of Concerned Scientists
http://www.uscusa.org/agriculture/0biotechnology.html

University of California Center for Consumer Research
http://ccr.ucdavis.edu

University of Maryland AgNic
http://agnic.umd.edu

University of Nebraska at Lincoln
Nutrition and Biotechnology Education Module
http://citnews.unl.edu/nutrition/

University of Wisconsin
http://www.biotech.wisc.edu

US government information

Centers for Disease Control and Prevention
http://www.cdc.gov

Environmental Protection Agency
http://www.epa.gov

Food and Drug Administration
http://www.fda.gov

US Department of Agriculture (USDA)
http://www.usda.gov

USDA Animal and Plant Health Inspection Service
http://www.aphis.usda.gov/bbep/bp

USDA Food Safety and Inspection Service
http://www.fsis.usda.gov

International resources

Biotechnology Australia
http://www.biotechnology.gov.au

Dietitians of Canada
Modern Food Biotechnology: Principles and Perspectives
http://www.dietitians.ca/resources/Biotech_FAQs_English_May0302.pdf

European Union–US Biotechnology Consultative Forum
(European Federation of Biotechnology)
http://www.efbweb.org/public/pubview.htm

Food Biotechnology Communications Network (Canada)
http://www.foodbiotech.org

International Food Policy Research Institute
http://www.ifpri.cgiar.org

United Kingdom Agriculture and Environment Biotechnology Commission
http://www.aebc.gov.uk

World Health Organization & Food and Agriculture Organization
Biotechnology in Food and Agriculture
http://www.fao.org/biotech/index.asp?lang=en

Figure 2. Biotechnology resources for dietetics professionals.

APPLICATIONS FOR DIETETICS PROFESSIONALS

Consumers perceive dietetics professionals as reliable providers of food and nutrition information and services and as a trusted source of information about agricultural and food biotechnology (47,50,56). Dietetics professionals are uniquely positioned to listen to consumer concerns about this emerging technology and, through increased science-based information on agricultural and food biotechnology, to educate consumers about the role of this technology in the support of healthful diets. Education is critical to developing consumers' awareness and knowledge about biotechnology, and dietetics professionals should use skills in nutrition education to develop and deliver programs in this area (53,54).

Effective, unbiased communication about food and nutrition topics by dietetics professionals will strengthen their status as a most valued source of food and nutrition information (57). As with any topic related to food and nutrition information and education, registered dietitians or dietetic technicians, registered, should follow appropriate elements of the ADA's standards of practice in nutrition care and updated standards of professional performance (58). The ADA's Standards of Professional Practice provide a framework for providing quality services, applying research, and communicating with clients and the public (58).

All dietetics professionals should articulate the current science and current regulatory framework about biotechnology without bias (59). Government policies, particularly in the

United States, are based on science and risk assessment. Consumer education about food biotechnology should follow risk communication principles, including explanation of benefits and risks, uncertainty, and regulatory steps taken to reduce risks (60). With this information, consumers can make informed decisions about personal views of the technology from cultural, ethnic, religious, and environmental perspectives.

Use of the ADA's tools (and those from other science-based organizations) by dietetics professionals is critical in maintaining professional competence (61). The ADA provides a variety of resources for members to remain abreast of evolving science about food, nutrition, and health. The ADA's Scientific Summaries is a bimonthly service organized by Scientific Affairs and Research created to provide insightful Web news for ADA members (62). The ADA also provides professional development opportunities on agriculture and food issues as part of content programming for the Food and Nutrition Conference and Expo. Dietetics professionals who desire further training on food biotechnology can receive free ADA continuing education credits after completion of online training titled "Food Biotechnology: Dreams from the Fields" via X-Train, which presents information on regulation and safety of bioengineered crops as well as how bioengineered crops are created (63).

Other organizations also have useful information and are listed in Figure 2. The Institute of Food Technologists provides a scientific status summary on biotechnology published in 2000, as well as more recent papers that are available on the Web site (64). A concise description of biotechnology suitable for the lay audience is available from the International Food Information Council for download (65).

As our global society proceeds with development of foods and medicines using biotechnology, consumer acceptance will likely expand as benefits from biotechnology in food production shift from the producer to both the producer and the consumer (16,45,66,67). Dietetics professionals should maintain or enhance status as a trusted resource about food and nutrition issues by articulating science in a clear, straightforward manner and by respecting individuals' needs, concerns, and value systems regarding agricultural and food biotechnology. Furthermore, the dietetics profession should be active in the dialogue about the future of the food supply, using and applying conventional, new, and emerging technologies (67). Only when dietetics professionals understand and appreciate the complexities of these issues can they help consumers make informed choices. Improved knowledge will permit consumers to focus on substantive issues and evaluate the validity of these new technologies effectively.

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