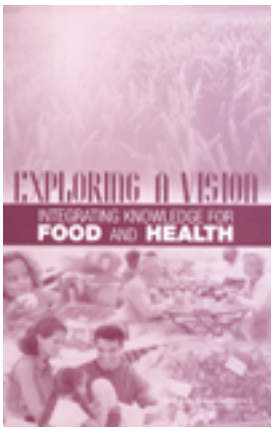

Exploring a Vision: Integrating Knowledge for Food and Health

Tina I. Rouse and Debra P. Davis, Planning Group for a Workshop on Exploring a Vision: Integrating Knowledge for Food and Health, National Research Council

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EXPLORING A VISION:

INTEGRATING KNOWLEDGE FOR FOOD AND HEALTH

A WORKSHOP SUMMARY

By
Tina I. Rouse and Debra P. Davis

Planning Group for A Workshop on Exploring a Vision: Integrating Knowledge for Food and Health

Board on Agriculture and Natural Resources

Division on Earth and Life Studies

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Preface

On June 9, 2003, the Board on Agriculture and Natural Resources of the National Academies' Division on Earth and Life Studies held a workshop entitled "Exploring a Vision: Integrating Knowledge for Food and Health." The workshop's purpose was to provide a neutral forum for open communication among scientists, administrators, policy-makers, and others engaged in the agriculture and health systems. It was hoped this would foster discussion of imaginative approaches to more effectively address the public-health challenges that are changing the nature of the nation's agricultural system. The workshop was sponsored by the Kellogg Foundation, the National Association of State Universities and Land-Grant Colleges, the U.S. Department of Agriculture's Cooperative State Research, Education, and Extension Service, the U.S. Food and Drug Administration, and the U.S. Environmental Protection Agency.

A planning group assisted National Academies' staff in developing the workshop. It consisted of W. R. Gomes (chair), University of California; Corrie Brown, University of Georgia; L. Dennis Smith, University of Nebraska; Charles J. Arntzen, Arizona State University; and Barbara Schneeman, University of California, Davis. The planning group suggested topics and speakers and provided comments on the drafts of the workshop agenda; they did not participate in the preparation of this workshop summary.

This summary has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this

independent review is to provide candid and critical comments that will assist the institution in making its published summary as sound as possible and to ensure that the summary meets institutional standards of objectivity, evidence, and responsiveness to the workshop charge. The review comments and draft manuscript remain confidential to protect the integrity of the process. We wish to thank the following for their review of this report: W. R. Gomes of the University of California; Arthur Liang of the Centers for Disease Control and Prevention; Gilbert Leveille of Cargill, Inc.; Carla Carlson of the University of Minnesota; Clinton Bristow, Jr., of Alcorn State University; Judith S. Stern of the University of California, Davis; Diane Bellis of the United Soybean Board; and Leigh Sawyer of the National Institutes of Health.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations offered by the speakers, nor did they see the final draft of the summary before its release. The review of this summary was overseen by Dr. Michael Doyle of the University of Georgia. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this summary was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this summary rests entirely with the authors and the institution.

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Statement of Task

A steering committee will convene a one-day meeting to bring together leaders of relevant programs from a wide range of scientific disciplines, public and private organizations, and global perspectives to explore current education and research efforts regarding the food supply and its impact on public health. The meeting will provide a neutral forum for open communication among scientists, administrators, policy-makers, and others engaged in the agriculture and health systems, which have become inextricably linked. The goals of the meeting will be to illuminate issues—not resolve them—and to foster discussion of imaginative approaches to more effectively address the public health challenges that are changing the nature and impact of the nation's agricultural system. During the meeting, participants will identify areas of research and education gaps in the current system, explore areas of opportunity for collaboration, and discuss potential actions that can improve integration of agriculture and health sciences for societal benefit. The meeting participants will consider ways to enhance the efforts of relevant federal agencies within and outside the federal system, clarify areas where joint efforts can lead to greater advances, and discuss mechanisms to enhance investment of limited financial and human resources in programs of importance to the integration of the nation's food system with its health system.

1

Introduction

America's abundant food supply has been both a blessing and a curse to the nation's health throughout its history. The hard physical labor that was required to found and forge the nation was fueled by the plentiful, safe, and diverse offerings of American agriculture, providing energy and nutrients for growth and health. Science over the centuries has served to increase the quantity, quality, and variety of the food supply. New technologies have allowed us to determine that chemical compounds found in some foods, such as antioxidants, can promote good health and combat disease. Agricultural biotechnology has allowed the extension of traditional crop-improvement practices to the molecular level, and further increased the nutrient quality and overall productivity of food plants and animals. Advances in food processing and storage techniques have reduced the incidence of foodborne illness. Economically, national and global market unification has introduced new foods and new cuisines into the American diet, and seasonal foods, such as fresh vegetables and fruits, have become available year-round.

While these changes have allowed malnutrition and hunger to be a concern of the past for most Americans and the average caloric intake has been increasing (see Figure 1-1), the nation has become increasingly sedentary. The very abundance of food and traditional eating habits that were so beneficial now

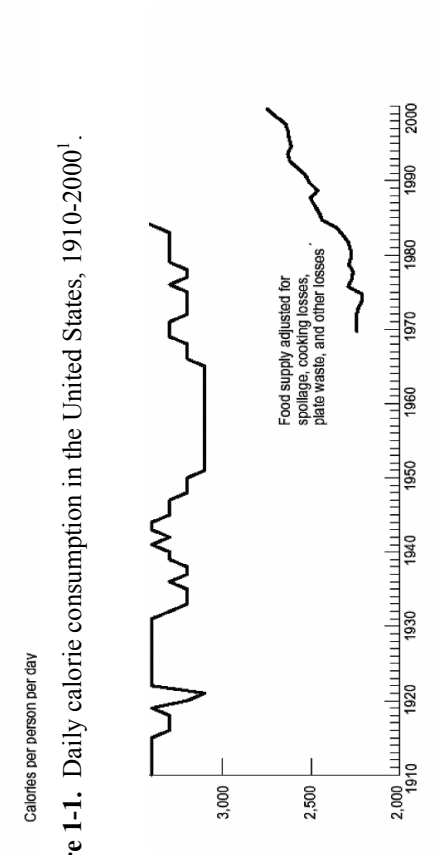

Figure 1-1. Daily calorie consumption in the United States, 1910-2000[1].

[1] Putnam, J., Allshouse, J. and L. S. Kantor. 2002. U.S. per capita food supply trends: more calories, refined carbohydrates, and fats. Food Review 25(3):2-15.

contribute to an epidemic of overweight and obesity. Rates of overweight[2] in adults in the United States increased from 33 to 37 percent and the rate of obesity[3] increased from almost 12 to over 22 percent[4] (see Table 1-1 for U.S. obesity trends in 1991-2001). Diet and overweight have been linked to secondary health consequences, including heart disease, stroke, diabetes, and some cancers of the colon and rectum, breast, endometrium, prostate, esophagus, and kidney.[5] The medical cost of overweight and obesity has been estimated at $92.6 billion in 2002 dollars, and annual medical spending attributable to overweight and obesity now rivals that attributable to smoking.[6]

Although data indicate that American diets are becoming healthier and Americans are becoming more active (see Figure 1-2), the average diet still fails to meet the U. S. Department of Agriculture (USDA) recommendations for daily alcohol, fruit and vegetable, and fat consumption. Activity and diet remain the personal choice of consumers, but programs to expand and disseminate knowledge for better health fall in the public and private sector. Whether we see food as medicine or as the cause of disease, medical and agricultural research have the potential to come together in innovative ways to help consumers and producers understand and face the challenges of following a healthful diet. Government, universities, foundations, and industry can support such efforts through the research infrastructure they provide and the priorities they set. Research is needed on foods (both beneficial and detrimental to health) on consumer knowledge and behavior, and its motivation, and on the economics of food- and health-related activities, including food pricing, health-care costs, and agricultural support programs.

Agricultural research has traditionally focused on improving production quantities and quality, usually of single crops or animal species. USDA, with its mission to support American agriculture and a safe and affordable food supply

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[2]Defined as a Body Mass Index (BMI) between 25.0 and 29.9 in adults 18 and older. BMI is defined as weight in kilograms divided by height in meters squared (w/h**2).

[3] Defined as a Body Mass Index (BMI) of 30.0 or more in adults 18 years old and older.

[4] Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion. (n. d.). Behavioral Risk Factor Surveillance System, Trends Data Nationwide. Available on-line at http://apps.nccd.cdc.gov/brfss/Trends/trendchart.asp?qkey=10080&state=US, http://apps.nccd.cdc.gov/brfss/Trends/trendchart.asp?qkey=10010&state=US [January 2004].

[5] World Cancer Research Fund in association with American Institute for Cancer Research. 1997. Food, nutrition and the prevention of cancer: a global perspective. Washington, DC: American Institute for Cancer Research. Available on-line at http://www.wcrf.org/report/index.lasso [January 2004]

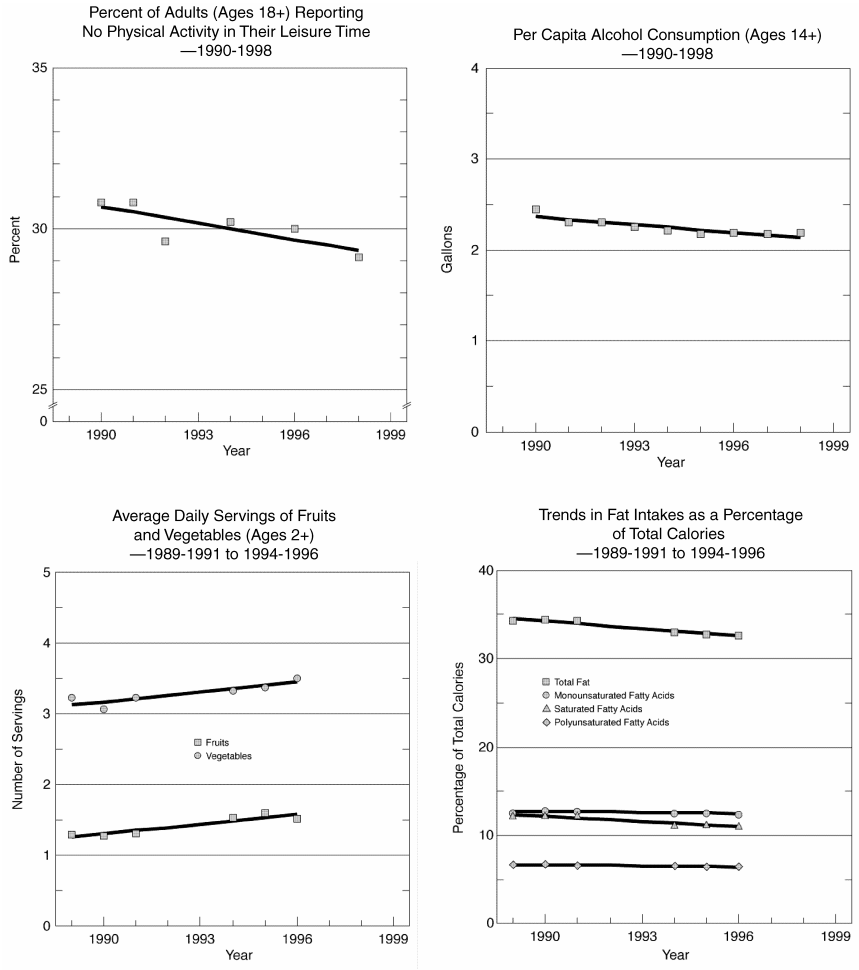
[6] Finkelstein, E. A., Fiebelkorn, I. C., and G. Wang. 2003. National medical spending attributable to overweight and obesity: how much, and who's paying? Health Affairs Web Exclusive, May 14, 2003. Available on-line at http://content.healthaffairs.org/cgi/reprint/hlthaff.w3.219v1.pdf [January 2004].

Table 1-1. Percentages of adults in the United States who are obese, by gender, age, race, education, and smoking status, based on Behavioral Risk Factor Surveillance System data (Obesity defined as a Body Mass Index (BMI = Kg/m2) greater than or equal to 30.). [7,8,9,10]

Characteristics	Fraction Obese, % (BMI, kg/m^2)					
	1991	1995	1998	1999	2000	2001
Total	12.0	15.3	17.9	18.9	19.8	20.9
Gender						
Men	11.7	15.6	17.7	19.1	20.2	21.0
Women	12.2	15.0	18.1	18.6	19.4	20.8
Age groups, years						
18-29	7.1	10.1	12.1	12.1	13.5	14.0
30-39	11.3	14.4	16.9	18.6	20.2	20.5
40-49	15.8	17.9	21.2	22.4	22.9	24.7
50-59	16.1	21.6	23.8	24.2	25.6	26.1
60-69	14.7	19.4	21.3	22.3	22.9	25.3
>70	11.4	12.1	14.6	16.1	15.5	17.1
Race ethnicity						
White, non-Hispanic	11.3	14.5	16.6	17.7	18.5	19.6
Black, non-Hispanic	19.3	22.6	26.9	27.3	29.3	31.1
Hispanic	11.6	16.8	20.8	21.5	23.4	23.7
Other	7.3	9.6	11.9	12.4	12.0	15.7
Educational level						
Less than high school	16.5	20.1	24.1	25.3	26.1	27.4
High-school degree	13.3	16.7	19.4	20.6	21.7	23.2
Some college	10.7	15.1	17.8	18.1	19.5	21.0
College or above	8.0	11.0	13.1	14.3	15.2	15.7
Smoking status						
Never smoked	12.0	15.2	17.9	19.0	19.9	20.9
Ex-smoker	14.0	17.9	20.9	21.5	22.7	23.9
Current smoker	9.9	12.3	14.8	15.7	16.3	17.8

[7] Mokdad AH, Serdula M, Dietz W, et al. 1999. The spread of the obesity epidemic in the United States, 1991–1998. Journal of the American Medical Association 282:1519–1522.
[8] Modkad AH, Serdula M, Dietz W, et al. 2000. The continuing obesity epidemic in the United States. Journal of the American Medical Association 284:1650–1651.
[9] Mokdad AH, Bowman BA, Ford ES, et al. 2001. The continuing epidemics of obesity and diabetes in the United States. Journal of the American Medical Association 286(10):1195–1200.
[10] Mokdad AH, Bowman BA, Ford ES, et al. 2003. Prevalence of obesity, diabetes, and obesity related health risk factors, 2001. Journal of the American Medical Association 289:76–79.

Figure 1-2. Trends in diet and activity levels in the United States.[11]



[11] National Cancer Institute. 2001. 2001 Cancer Progress Report. Available on-line at http://progressreport.cancer.gov/trend [January 2004].

for the American public, is a primary sponsor of agricultural research, both intramural through the USDA Agricultural Research Service, and extramural through the National Research Initiative (NRI). The NRI focuses on research that bridges the basic and applied sciences, including nutrition, food safety, and health; it has begun to encourage multidisciplinary and interagency efforts in recognition of the added value of interdisciplinary science. Competition for NRI support is open to scientists at all academic institutions, federal research agencies, and private and industrial organizations. In FY 2001, the NRI awarded a total of $99 million to the top 597 proposals submitted. The average grant award for new standard research projects was $188,116 for 2.4 years.[12] USDA expects that about $120-150 million will be available for new awards for the FY 2004 award cycle[13] (see Table 1-2).

The National Institutes of Health (NIH) is the primary sponsor of biomedical research in the United States, and has traditionally operated with a disease-combating paradigm, rather than a health-promotion one. This has resulted in exploration of individual diseases and treatments, not of possibly shared etiologies. Obesity, with a role in many serious chronic illnesses, received only about $274 million of the FY 2000 NIH research budget of over $27 billion. In contrast, heart disease and diabetes, known outcomes of overweight and obesity, each received over $1 billion.[14]

The National Academies brought together representatives of USDA and NIH, along with the other public and private funding institutions, in the hope of sparking exploration of a more efficient and effective system for conducting food and health research geared to improving, maintaining, and promoting health. A discussion of new structures, policies, programs, and roles may encourage research and education into these novel, interdisciplinary avenues.

STRUCTURE OF THE MEETING

To address the need for a better understanding of the linkages between food and health, the National Academies invited leaders in agriculture and public health to gather at a workshop in Washington, DC, on June 9, 2003. In her

[12] U.S. Department of Agriculture, Cooperative State Research, Education, and Extension Service. n.d. NRI Annual Report: Fiscal Year 2001, National Research Initiative Competitive Grants Program. Available on-line at http://www.reeusda.gov/nri/pubs/annreport/2001.pdf [January 2004].
[13] U.S. Department of Agriculture, Cooperative State Research, Education, and Extension Service. n.d. National Research Initiative Competitive Grants Program. Available on-line at http://www.reeusda.gov/1700/funding/04/rfa_nri_04.htm [January 2004].
[14] NIH Computer Retrieval of Information on Scientific Projects (CRISP) System n.d. Available on-line at http://crisp.cit.nih.gov/ [January 2004].

Table 1-2. NRI Funding Allocations[a], FY 2001[15]

Research Area/Program	Number of Grants	Total Dollars Awarded[b]
Natural resources and environment		
Plant responses to the environment	18	$3,090,000
Watershed processes and water resources	18	4,124,049
Soils and Soil Biology	23	4,380,600
Total	59	$11,594,649
Nutrition, food safety, and health		
Improving human nutrition for optimal health	22	4,774,458
Food safety[c]	31	5,976,378
Epidemiological approaches to food safety[c]	6	5,486,155
Total	59	$16,236,991
Animals		
Animal reproduction	22	3,888,726
Animal health and well-being[d]	55	10,988,912
Animal genome and genetic mechanisms	15	2,700,000
Animal growth, development, and nutrient utilization[e]	26	3,928,146
Total	118	$21,505,784
Biology and management of pest and beneficial organisms		
Entomology and nematology[f]	33	5,593,143
Biology of plant-microbe associations[g]	26	5,349,010
Biologically based pest management[h]	17	2,494,593
Biology of weedy and invasive plants	11	2,630,000
Total	87	$16,066,746
Plants		
Plant genetic mechanisms[i]	34	4,833,571
Plant growth and development[j]	28	3,646,000
Agricultural plant biochemistry[k]	34	3,914,847
Total	96	$12,394,418
Markets, trade, & rural development		
Markets and trade[l]	21	1,984,000
Rural development[m]	14	1,483,333
Total	35	$3,467,333

(continues)

[15] U.S. Department of Agriculture, Cooperative State Research, Education, and Extension Service. n.d. NRI Annual Report: Fiscal Year 2001, National Research Initiative Competitive Grants Program. Available on-line at http://www.reeusda.gov/nri/pubs/annreport/2001.pdf [January 2004].

Table 1-2. ***(continued)***

Research Area/Program	Number of Grants	Total Dollars Awarded[b]
Enhancing value and use of agricultural and forest products		
Food characterization/process/product research	21	3,367,883
Non-food characterization/process/product research	16	2,453,217
Improved utilization of wood and wood fiber[n]	16	2,025,166
Total	53	$7,846,266
Other		
Agricultural systems	11	2,535,289
Strengthening programs[o]	75	3,514,458
Metabolic engineering program – interagency[p]	2	250,000
U.S. rice genome project – interagency	2	2,000,000
Total	90	$8,299,747
Awards to be determined[q]		**$1,620,267**
Grand total	**597**	**$99,032,201**

[a]The content of this table varies slightly from tables provided in documents supporting the President's budget to Congress each year in the following ways: 1) while the documents supporting the President's budget include data only for funds from the 2001 appropriation, this table includes data on all awards from proposals submitted to the 2001 proposal cycle, regardless of the year the funds were appropriated (as noted in the table) and 2) awards are arranged in this table under program area (to which proposals are submitted and reviewed) as opposed to relationship to appropriated budgetary lines.
[b]Includes awards still in process.
[c]Includes $304,672 in funds from the FY 2000 appropriation.
[d]Includes $13,239 in funds from the FY 1996 appropriation, $6,759 in funds from the FY 1997 appropriation, and $2 in funds from the FY 1999 appropriation.
[e]Includes $1,000 in funds from the FY 1996 appropriation and $5,000 in funds from the FY 2000 appropriation.
[f]Includes $2,132 in funds from the FY 1996 appropriation, $21,981 in funds from the FY 1997 appropriation, and $4,030 in funds from the FY 1998 appropriation.
[g]Includes $30,000 in funds from the FY 1997 appropriation and $479,010 in funds from the FY 2000 appropriation.
[h]Includes $3,974 in funds from the FY 1997 appropriation.
[i]Includes $10,864 in funds from the FY 1996 appropriation, $498 in funds from the FY 1997 appropriation, $2,638 from the 1998 appropriation, and $114,571 in funds from the FY 2000 appropriation.
[j]Includes $5,000 in funds from the 1997 appropriation.
[k]Includes $2,298 in funds from the 1997 appropriation and $549 in funds from the FY 1998 appropriation.
[l]Includes $2,293 in funds from the 1996 appropriation, $5,596 in funds from the FY 1997 appropriation, $1 in funds from the FY 1998 appropriation, and $2,110 in funds from the FY 1999 appropriation.
[m]Includes $12,666 in funds from the FY 1996 appropriation, $47 in funds from the FY 1997 appropriation, $21 in funds from the FY 1998 appropriation and $2,646 in funds from the FY 1999 appropriation.
[n]Includes $4,308 in funds from the FY 1996 appropriation and $37,666 in funds from the FY 1998 appropriation.
[o]Includes $88,187 in funds from the FY 1996 appropriation, $41,133 in funds from the FY 1997 appropriation, $54,702 from the FY 1998 appropriation, and $6 from the FY 1999 appropriation.
[p]Includes $100,000 in funds from the FY 2000 appropriation.
[q]As of December 17, 2001.

introductory remarks to the participants, Moderator Barbara Glenn, a member of the National Academies Board on Agriculture and Natural Resources, tasked the roughly 100 decision-makers in agricultural and health research, education policy, and industry to meet this challenge. Their mission was to share and build upon their scientific and organizational backgrounds, with the goal of developing innovative means of improving the integration of the nation's food system with its health system to promote better health. Meeting participants drew on their past experiences with other integration attempts and their future needs in research and education fields where food and the food supply intersect with health, such as food biotechnology, nutrition, cancer, obesity, diabetes, food safety, food-animal health, and zoonotic diseases. These contributions served as a springboard for a broader examination of the education and research infrastructure in agricultural colleges, medical schools, and funding institutions.

To provide background for an exploration of these challenges, the opening keynote address was followed by plenary presentations by key government scientists. Two panels were then introduced to begin the discussions; the presentations of the first focused on academic, industrial, and philanthropic infrastructure for food and health research, and those of the second on the experience of researchers at the nexus of these topics. Each presentation session was interspersed with audience questions. In the final session of the workshop, participants were divided into groups and asked to discuss five questions related to food and health integration. The discussion format provided an opportunity for participants to respond to earlier presentations and to offer their own ideas and recommendations on the subject. A rapporteur in each group took notes and presented a summary of the group's discussion to the entire gathering.

The five questions for discussion were:

- Are food and health research and education currently conducted and managed to maximize scientific progress, incentives for collaboration, and benefits to the public health?
- What activities, programs, or initiatives currently exist in your institution, organization, or agency to address the challenges of improved integration of agriculture and health sciences? What gaps remain?
- What potential national initiatives could be implemented to address the challenges of improved integration of agriculture and health sciences?
- How can education and outreach contribute to improved research integration?
- Which technical research fields would be most amenable or of high importance to initial integration efforts?

WORKSHOP SUMMARY

This workshop summary extracts the key technical issues from the presentations and discussions. Many issues were touched upon repeatedly by several speakers in different sessions, and this format is intended to allow readers who did not attend the workshop to gain an understanding of the discussions in the context of the entire workshop.

The workshop was intended to illuminate issues, not to resolve them. By its nature, any workshop is necessarily incomplete, and a workshop summary can report only on what was said. All the information reported here emerged from presentations and discussions during the workshop. This summary is intended to reflect the variety of opinions expressed by the speakers. The contributors have reviewed it and affirmed that it accurately reflects the events and discussions at the workshop.

2

Government Initiatives on Food and Health

The federal government, as a major sponsor of research in health and agriculture, was represented at the meeting by a number of speakers and discussants. John H. Marburger III, President Bush's science adviser and Director of the White House Office of Science and Technology Policy (OSTP), delivered the keynote address "Meeting the Nation's Food and Health Challenges," to open the workshop. Joseph J. Jen, Under Secretary for Research, Education, and Economics at the U.S. Department of Agriculture (USDA) shared his thoughts on "The Changing Landscape of the Food and Fiber System: Responses to the Public Health Challenges" during the luncheon address. Van S. Hubbard, Director of the National Institutes of Health (NIH) Division of Nutrition Research Coordination, launched the discussion session with "Incentives for Multidisciplinary Science." Tommy G. Thompson, Secretary of Health and Human Services (HHS), which includes NIH and the Food and Drug Administration (FDA), marked the closing of the workshop with remarks on "Science to Improve Public Health and the Food System: Bridging the Divide."

GOVERNMENT PROGRAMS AND THE HUNGER-OBESITY EQUATION

Marburger, Jen, and Hubbard touched on a wide array of issues related to food

and health, focusing primarily on hunger and obesity. They discussed programs to tackle food-related health problems, at times challenging participants to help devise solutions, and responded to questions and suggestions from participants, including proposed changes in government policy and practice that could facilitate nutrition-related research and education.

Addressing Hunger through Technology and Education

Agriculture has experienced the most dramatic productivity gains of any human endeavor in the scientific era, but Marburger reminded workshop participants that food and health issues needed to be grounded in a social context. "The most important food and health issue is providing enough food for people to satisfy their basic nutritional needs," he told the gathering. Physical and mental well-being depends first and foremost on getting enough to eat. The problem is not lack of food—the existing food-production system is sufficient to satisfy basic hunger throughout the world. Instead, hunger is an economic problem. In the United States, the wealthiest nation in the world, at the height of the boom economy in 1998, 3.7 per cent of U.S. households were hungry at some time during the year.[16] Those who went hungry did so not because of a shortage of food, but because they did not have enough money to buy it, he said. The problem is much more acute in developing countries, where more than 800 million are undernourished.[17]

Marburger made the case that science, technology, and education have roles in solving the problems of hunger and malnutrition but cannot eliminate them entirely. In principle, existing technology may make it possible to meet the nutritional needs of a growing world population, but social and economic barriers sometimes stand in the way of acceptance. Until those barriers are eliminated, Marburger thought food–health issues, such as nutrition, foodborne disease, and genetically modified foods, should be viewed as secondary to hunger. Some of the obstacles are rooted in history and culture: Traditional patterns of land use, water-management issues, and cultural attitudes toward agricultural technology can inhibit the application of productivity-enhancing practices in regions that have growing populations, he said.

Science and technology provide important tools for fighting hunger and malnutrition, and the United States is a leader in scientific and technologic

[16] Economic Research Service (ERS). 2000. Prevalence of Hunger Declines in Rural Households. Rural Conditions and Trends. 11(2):80-86. Available on-line at http://www.ers.usda.gov/publications/RCAT/RCAT112/RCAT112M.PDF [January 2004].
[17] Food and Agriculture Organization of the United Nations (FAO). 2000. The State of Food Insecurity in the World: Undernourishment around the world. Available on-line at http://www.fao.org/docrep/x8200e/x8200e03.htm [January 2004].

innovation, but there is a risk that research will be irrelevant because it will not be acceptable, Marburger said. Bridging the gap between availability and application is crucial, he added. He stressed the importance of education to overcome resistance to new technologies. He cited, for example, international concerns about genetically modified foods, which he said are not well understood or accepted in Europe and other parts of the world.

Marburger's comments prompted audience members to point out that hunger and obesity can coexist, that hunger for calories is distinct from hunger for specific nutrients, and to question whether the support structure is in place to alleviate the latter. There may be enough food for people around the world to eat if one equates eating with energy consumption, but there may not enough to meet other nutritional needs, such as for vitamins and minerals, and the current agricultural structure may not be able to support those needs on a global basis. "The issue of overabundance of food creating health problems is an example of the mismatch between technical application and cultural practice," Marburger agreed.

Epidemic of Obesity

Americans are eating too much and exercising too little, and these behaviors are creating the serious health problems of overweight and obesity, USDA's Jen said. Food in the United States is abundant and affordable, incomes are at record levels, nutrition and health knowledge is at an all-time high, and yet many Americans are not eating a proper diet. Poor eating habits and many other factors have resulted in a health crisis unlike any in history. This crisis, Jen continued, does not center on a particular disease but is the product of our behavior and our freedom of choice. By eating too much and exercising too little, we are creating a serious public health problem–overweight and obesity. There is concern that the growing prevalence of obesity and its occurrence at earlier ages will increase the onset of chronic diseases and diabetes.

Jen presented data on the increasing trend in overweight and obesity in the United States (see Figure 2-1 for obesity trends). He noted that more than 60

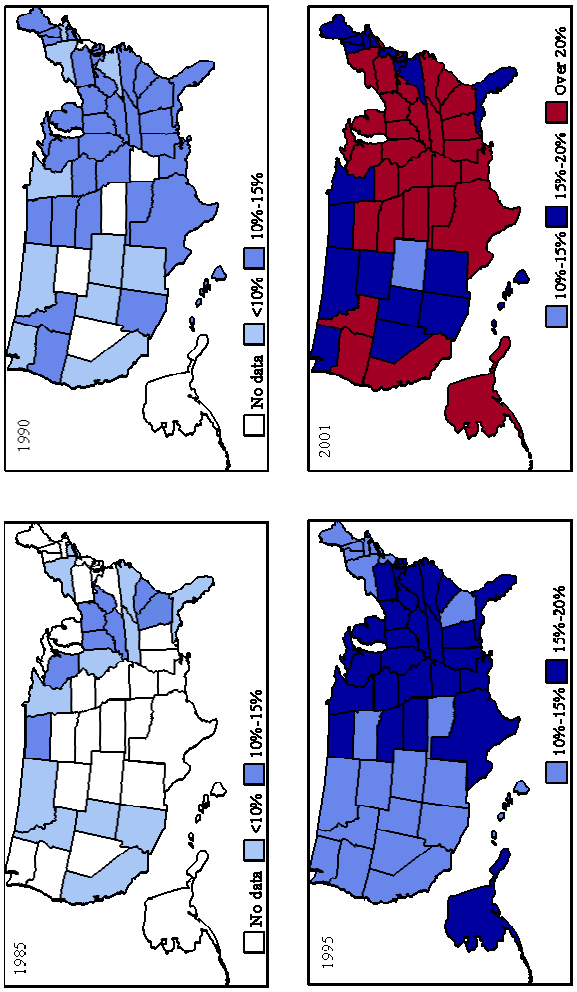


Figure 2-1. Trends in U.S. Obesity Rates in U.S. Adults, 1985[18], 1990[18], 1995[19], and 2001[18] (BMI ≥ 30, or ~30 lbs overweight (for 5'4" women).

[18] Adapted from Centers for Disease Control and Prevention. 2003. Obesity Trends Among U.S. Adults. Available at http://www.cdc.gov/nccdphp/dnpa/obesity/trend/net 2003

[19] Mokdad, Serdula, M.K., Dietz, W.H., Bowman, B.A., Marks, J.S., and J.P. Koplan. 1999. The Spread of the Obesity Epidemic in the United States, 1991-1998. Journal of the American Medical Association. 282(16):1519-1200.

per cent of the U.S. population is overweight, and 30 per cent of those who are overweight are obese. Over 15 per cent of American children are overweight or obese, Jen added, a problem that costs almost $120 billion per year. Those numbers have doubled in the last 20 years. This trend will have severe social implications and individual costs in terms of poor health over a lengthening lifespan. The growing prevalence of obesity and its occurrence at an earlier age are likely to increase the onset of chronic disease, such as diabetes. Moreover, the rest of the world is following our pattern as standards of living increase and the cost of food declines globally.

Jen noted that a host of factors influence food demand and food consumption behaviors: the types and prices of foods available, technologic advances, time pressures, attitudes and knowledge about health and diets, demographics convenience and fast foods, and changed family and social structures. Although genetic factors play an important role in obesity, it is likely that the growth in prevalence of overweight is also driven by such factors as the physical environment and human behavior. Consumer lifestyle and choice play a large role, Jen said, but many factors are outside consumer control. These include government policies on agriculture, taxes, and exports/imports; issues related to food palatability and availability; and consumer income and education.

Multidisciplinary teams made up of professionals in nutrition, economics, public health, physical education, behavioral science, food technology, marketing, medical science, political science, and other fields are the key to defining and refining the underlying research that is necessary to address the problem of obesity. Jen noted that USDA, with food stamps and school lunch programs and links to the Land-Grant Institutions and other higher education entities, has an essential coordinating role for the many-faceted disciplinary teams needed to effectively handle the research, education, and outreach programs to solve the obesity problem.

Ultimately, overweight and obesity are caused by an imbalance between energy intake and output, Jen observed. Average daily caloric availability in the food supply grew by over 230 calories per person in the last 10 years. Consuming 200 extra calories per day increases body weight by 20 pounds in a year. Burning 200 extra calories would require at least an extra 30 minutes of walking per day. Therefore, one may conclude that excessive intake of calories is the major problem. For most people, exercise alone will simply not solve the problem. Unless exercise is coupled with reduced caloric consumption, the obesity problem will go on unabated.

A concentrated research effort will be needed to develop new approaches, tools,

and technologies to motivate consumers into healthier eating patterns, Jen said. He pointed out that following a healthy diet requires confronting four tradeoffs—taste, cost, convenience, and long-term versus short-term benefit. Approaches might include creating foods that taste good but are low in sugar and fats, and conducting research into why people choose fatty diets over low-cost, healthy alternatives, he said (see Figure 2-2 and Boxes 2-1 and 2-2).

Another possible approach might be the establishment of a nutrition-information research center that could provide resources to conduct research for use by programs, states, and local agencies. Asked to elaborate on how such a center would be structured, Jen said that it could be a one-stop resource, but admitted that he did not have specifics. Asked about USDA efforts to refocus existing programs such as school lunches, food stamps, and the extension service toward the war on obesity, Jen said that the department has laid some groundwork for building a team approach toward all these issues across USDA agencies and is trying to improve interagency efforts.

Box 2-1. Cost of the Food Guide Pyramid[20]

Joseph J. Jen, USDA Under Secretary for Research, Education, and Economics, reported that American diets are improving and becoming more healthful, but that the average diet still does not meet the dietary advice recommended in the Food Guide Pyramid. To meet the federal dietary advice outlined in the pyramid would require Americans to make substantial changes to their diets and according to the United States Department of Agriculture (USDA) Economic Research Service (ERS), would result in adjustments to U.S. agricultural production, trade, nonfood uses, and prices.

According to the ERS study, the U.S. crop acreage that is used for food and feed products would have to increase by 6 million acres over the early 1990 average levels; that is, by about 2% of the average 1991-1995 agricultural cropland. However, the changes will affect some commodities more than others–specifically sweeteners, fats and oils, and citrus fruits.

[20] Young, E. and L. S. Kantor. 1999. Moving Toward the Food Guide Pyramid: Implications for U.S. Agriculture. Agricultural Economic Report. 779:36 pp. Available at www.ers.usda.gov/publications/aer779 [October 2003].

Box 2-2. Consumer Information: Clear or Confusing?

Whether consumers are receiving nutrition information and advice that are clear and consistent was discussed throughout the workshop. Participants expressed opinions ranging from "no, confusion abounds" to "yes, the messages are clear." There was also wide speculation, but few definitive answers, on the behavioral and sociologic reasons behind the failure of many consumers to follow nutrition and lifestyle guidelines,.

"There can be conflicting advice about nutrition out there," according to Marburger, of OSTP. The ever-changing stream of advice confuses the public and undermines public confidence in physicians, government agencies, and other traditional sources of authority, he said, noting the importance of addressing how we assess nutritional information, how we use it, and how we make recommendations about it.

Muscoplat, of the University of Minnesota, asserted that high-quality nutrition-research data are available to inform consumers about healthy diets. Dietary recommendations already exist, but they are not followed, he felt. He said that in addition to the conflicting messages of popular diets, consumers face some barriers to healthy eating, including availability and convenience, lifestyle and social factors, and issues of trade, government and geopolitics, and economics.

What motivates people to make the choices they do? David Mallott, of the University of Maryland School of Medicine, pointed out that most eating habits are not based on rational choices. They are heavily influenced by psychologic factors and societal values that may conflict with a healthy lifestyle, he added. Responding to a question about how doctors, given their lack of nutrition knowledge, can help consumers filter out what is valid from the ever-changing and sometimes conflicting information they receive about nutrition, Mallott noted that medical students, like most consumers, rely on the mass media for the latest in nutrition information and often are confused themselves. "One problem is that medical schools are good at teaching content but weak at teaching the process of continually gathering, incorporating, and refining knowledge," he said. Medical schools in the last 10 years have changed their curriculum to put the onus on students to evaluate the validity of on-line and print education materials, but they face an uphill battle on this issue, Mallott said.

Consumers prefer that the foods they enjoy have a health benefit, but they generally don't want to pay more for that benefit, Eric Gugger, of General Mills, contended. Consumers welcome health benefits that they understand, such as cholesterol reduction, but they do not respond well to negative messages or to unfamiliar ingredients, he said. Products specifically designed for target health areas have had a difficult time in the marketplace.

Obesity Rampant Among Minorities

Obesity and overweight is a significant problem in all populations in the United States, and worldwide, Hubbard noted, providing additional statistics on obesity. The problem is especially evident among minority women, he said, noting that one out of every two black women is considered obese. Nearly 40 per cent of Mexican American women also are obese, compared with about 30 per cent of non-Hispanic white women and 33 per cent of women overall.

INTEGRATED RESEARCH AND COLLABORATION

The White House Office of Science and Technology Policy was conceived to foster interagency, and therefore interdisciplinary, cooperation. No other country distributes its scientific responsibilities over so many agencies, some of them quite large, and no other country relies so heavily on its universities to provide basic research, information, and work to address problems of social importance, Marburger said. It is a complex system, but it has proved robust and effective.

The federal investment in food-related research is not officially tracked, but includes most of the USDA's programs, totaling about $2 billion, and relevant programs in agencies including NIH, the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), the Environmental Protection Agency (EPA), and the Departments of Energy, the Interior, Commerce, and Defense, which total about $0.5 billion. The total federal investment is about $2.5 billion per year in food-related research and development.

OSTP's National Science and Technology Council (NSTC), which consists of the Cabinet-level Secretaries of the agencies that have science in their portfolios, oversees interagency working groups on specific topics to enhance coordination and cooperation, and to advise the Office of Management and Budget (OMB) and the President as he prepares his budget request to Congress. A number of NSTC standing committees address food-related issues: the committee on

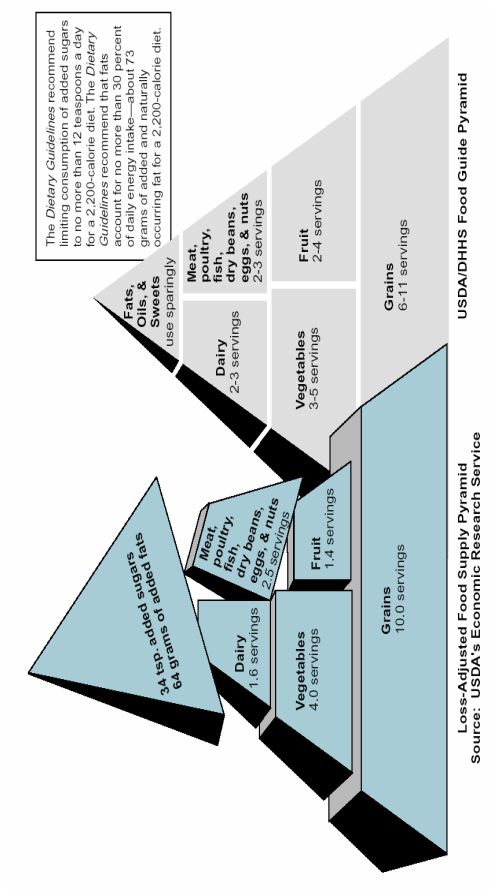


Figure 2-2. Recommended vs. actual American diets.[21,22]

[21] Putnam, J., Kantor, L.S.and J. Allshouse. 2000. Per Capita Food Supply Trends: Progress Toward Dietary Guidelines. Food Review. 23(3):2-14.

[22] The loss-adjusted Food Supply Pyramid includes adjustments for nonedible food parts and food lost

science, the committee on environment and natural resources, and the committee on technology, as well as the committee on homeland and national security, because the extensive infrastructure of the food production and delivery system could be disrupted by terrorist interventions. There are interagency efforts related to food and health issues on plant, animal, and microbial genomics; such food safety issues as dioxin and mercury in the environment; aquaculture; climate change; agricultural biotechnology and water management; and education and workforce issues.

Marburger noted that activities like this workshop on food and health helped to identify gaps in programs and important research that should be addressed. He emphasized the timeliness of the workshop, noting that it was taking place at a time of unprecedented rapid change, in attitudes, in the technology of food production, and in our understanding of health. The vulnerability of the food supply clearly is increasingly visible; catastrophic outbreaks of mad cow disease, foot and mouth disease, and other agricultural pests and viruses seem to be emerging more rapidly today as a result of increasing globalization. Marburger cited the recent monkey pox and Severe Acute Respiratory Syndrome (SARS) epidemics. He also called on the plant, animal, human biology, and medical research communities to emulate the balance that scientists working on the interrelated functions of genes, cells, and metabolism had established. In an effort to address this, OSTP, with OMB, has proposed and issued guidance that research on the molecular basis of life processes receive national priority.

The time is ripe for an integrated approach to nutrition, health, and disease prevention, Hubbard said, noting that the current political climate is favorable for providing incentives for multidisciplinary research and collaboration. Hubbard attributes this new climate to two key events: the release in March 2003 of a World Health Organization report on diet, nutrition, and the prevention of chronic disease; and the launching in June 2002 of President Bush's HealthierUS initiative, which emphasizes the importance of physical activity and nutrition in promoting good health and preventing disease. As a result of this initiative, HHS is shifting to a prevention mode, he said. The department is looking at the health-care system to see what can be done to improve it and to reduce health-care costs. The department's Public Health Service is also sponsoring a series of regional workshops that bring together federal, state, and local representatives of various programs in HHS, USDA, and state health departments to discuss what they are doing about obesity and other health problems.

Hubbard stressed the need for multidisciplinary research and the importance of partnerships in achieving HHS's public-health goals. It is imperative that federal agencies and other organizations work together to make the most of

available resources to address research needs, he said. One way is to ensure that new research proposals add value to efforts already under way rather than duplicate them.

Hubbard challenged university representatives to identify "glue investigators" in their institutions who could be liaisons on cross-disciplinary projects funded by "glue grants." "Many of the principal investigators may not have the time to interact with all the other investigators in the multidisciplinary teams," he said. "But there are usually some key people who will provide the glue to hold the different projects together. Perhaps there should be some special means of supporting that type of individual."

HHS FOOD- AND HEALTH-RELATED ACTIVITIES

The Department of Health and Human Services (HHS) has an annual budget of $525 billion—the largest of any federal department—and includes such agencies as the Centers for Disease Control and Prevention (CDC), NIH, and FDA, which all have important roles in improving integration in the food and health systems. Secretary Thompson, in his closing remarks, reinforced the government's concern about food-related diseases that are costing lives and dollars, including diabetes, which affects 18.2 million people (and another 16 million who are prediabetic) and costs $132 billion annually, and obesity, which kills 300,000 and costs $117 billion annually. He noted that diabetes is a problem in minority communities such as Native Americans, Hispanics, and African Americans, and that there has to be more public outreach about it.

The U.S. agricultural sector could do more to promote good nutrition and health, Thompson said in response to a question about what agriculture might do differently to benefit public health. Despite clear guidelines for a healthy diet, lessons about good eating behavior are not reaching schools, minority communities, and hospitals and clinics, and the food and health community needs to get the message out. He added that the National Academies through activities such as their workshops can be helpful in those efforts. Recognizing that leaders often have to lead by example, Thompson reported that he has taken a personal interest in tackling food and health problems, increasing his physical activity while wearing a pedometer and losing 15 pounds.

Thompson described some of the many health-related concerns and challenges that have come before HHS in the past few years, as well as some of its victories (see Box 2-3 for an example). Due in part to the response to increased security risks, HHS has doubled the number of its food inspectors from 750 to 1,500. As a result, about four per cent of food imports are being inspected, up from 0.5 per

cent three years ago. Food Inspectors also are using new technologies in that effort.

HHS launched a Healthy Cities campaign in September 2003 with initial funding of $15 million, he said. To encourage healthier behavior, a community or city can develop programs to reduce chronic disease and risk factors such as diabetes, obesity, asthma, and tobacco smoking, and submit them to HHS to receive funding and be declared a healthy city. HHS will seek increased funding for the campaign, to total $125 million, for next year, he said.

Looking to the future, President Bush will unveil a new food initiative shortly, Secretary Thompson told the gathering. He said the initiative would be coordinated by HHS, as well as USDA and the Department of Homeland Security, but otherwise declined to give any details, saying President Bush would be making an announcement later.

Box 2-3. Healthier US Initiative[23,24]

In 2003, President Bush announced the HealthierUS Initiative in recognition that increased exercise and better nutrition are simple measures that can prevent or delay many chronic diseases, such as obesity, diabetes, and asthma. According to HealthierUS.gov approximately 46.5 million adults in the United State smoke cigarettes, and the diabetes rate has risen by 70% in people between 30 and 39 years old, more than 25% of American adults are not physically active, and some 60% do not get enough physical activity.

The HealthierUS Initiative is designed to help Americans improve personal health and fitness. The initiative encourages Americans to follow four keys for a healthier America:

- Be physically active every day
- Eat a nutritious diet
- Get preventive screenings
- Make healthy choices

The HealthierUS program will help fund community-based programs that seek to adopt proven measures to reduce the burden of obesity, diabetes, and asthma-related complications, with a particular focus on youth. The President's 2004 budget requests $125 million for the Steps to a HealthierUS Initiative.

[23] HealthierUS. 2003. Available at www.whitehouse.gov/infocus/fitness/ [October 2003].
[24] Healthier US. 2003. Available at www.healthierus.gov/ [October 2003].

3

Integrative Research Infrastructure for Food, Agriculture, and Health

During the first panel presentation and discussion session, representatives of institutions with experience in integrative research programs spoke. The panel members were from three universities, a food manufacturer, and a private foundation, and they discussed a variety of programs in their institutions that successfully integrate research and education in traditionally independent fields, such as agriculture, food, and health. They also described recent scientific breakthroughs that have opened up new opportunities in their work, and funding and policy obstacles that hinder progress.

MODEL UNIVERSITY PROGRAMS IN FOOD–HEALTH INTEGRATION

Programs at the three universities represented on the panel—the University of Minnesota, Cornell University, and the University of Maryland—modeled some of the ideals espoused throughout the workshop: close collaboration among agricultural, medical, and ecology schools at a land-grant university; a graduate nutrition program that draws on the expertise of 35 faculty in 22 fields at a

private university; and a medical school that makes nutrition education a key component of its curriculum.

Role of the Public University

It is the role of public universities to provide students with integrated studies on nutrition and health and to collaborate with outside institutions, government agencies, and industry to advance such research, argued Charles Muscoplat, Vice President of Agricultural Policy and Dean of the College of Agricultural, Food, and Environmental Sciences at the University of Minnesota. "The constituents and genes in our food have an intimate relationship with the constituents and genes in our bodies. Similarly, the research in agriculture and food must be integrated with our research on nutrition, treatment, and disease prevention and health," he said, making the case for integrated research and collaboration.

Muscoplat added that the University of Minnesota is one of the few land grant research universities that in a single metropolitan location integrates the research strengths of its College of Agricultural, Food, and Environmental Sciences; College of Human Ecology; and the seven colleges within its Academic Health Center, and has a host of programs—including partnerships with government and industry—that integrate agriculture, nutrition, and health research to promote better public health. Those programs include a research center dedicated to microbial and plant genomics; a biotechnology research alliance with the Mayo Clinic and the state of Minnesota; a carcinogenesis prevention program focused on discovery of naturally occurring and synthetic chemopreventive agents; an obesity center; a center for studying how plants and plant products may be used to improve human health and nutrition; the Hormel Institute, which is recognized worldwide as a center for lipid research; the Center for Spirituality and Healing, which integrates medical and spiritual aspects of care; a partnership with six tribal colleges in Minnesota, North Dakota, and Wisconsin to create culture-specific nutrition-education programs in conjunction with Native American colleges; and collaborative ventures with major food manufacturers and retailers, such as General Mills and Super Value.

Colleges of agriculture and affiliated colleges and medical schools should come together to use nutrition as a focal point to enhance curriculum and preparation of students, Muscoplat suggested. They could increase the number of graduates who educate the public in nutrition as a vehicle for the prevention of disease and who work in nutrition therapy, enhance the engagement with underserved constituents, enhance education and nutrition of current students and health-care professionals, and address nutrition issues that affect selected populations, such

as the elderly, Native Americans, new immigrants, and children. Emphasis should be on outreach to the K-12 grade systems, social-service providers, and government leaders, he added, pointing out that there are opportunities for adjusting disease prevention through policies related to school-lunch programs and food-stamp programs, for example.

Multidisciplinary Model for Nutrition Education

Cornell University has established a multidisciplinary model of studies related to nutrition, according to Cutberto Garza, a Professor in Cornell University's Division of Nutritional Sciences and Director of the United Nations University's Food and Nutrition Program. Cornell has found that the core of nutrition knowledge comes at the interface of several basic disciplines, such as biochemistry, physiology, immunology, genetics, bioinformatics, and cell biology. He stressed that the problem-based rather than discipline-based nature of nutrition requires integration if nutrition is to realize its potential in improving the health of the American public (see Figure 5).

Cornell achieves such integration by bringing together about 35 faculty members in the various disciplines into one academic unit—the Division of Nutritional Sciences. Its faculty members belong to more than 20 other fields of graduate study across the university. Students receive training in the core subject of their interest and become well versed in at least two other minor subjects of study (see Figure 3-1). In the 60 years that the integrative model represented by the Division of Nutritional Sciences and its predecessor, the Graduate School of Nutrition, has been in place at Cornell, it has proved to be successful in achieving integration of the biologic, physical, and social sciences. Garza said that research at the university is similarly integrated, thus attracting funding from diverse sources, including USDA, NIH, and the private sector. He added that research would be further facilitated if USDA truly embraced a much more balanced approach that recognizes food and nutrition in addition to agriculture and if NIH embraced a greater health-promotion agenda, rather than focusing on combating disease.

Nutrition Education for Physicians: One Approach

The typical student entering medical school has had very little exposure to agriculture, nutrition science, and many of the health-related struggles confronting their future patients. The burden on universities to fill those gaps in their education, said David Mallott, Associate Dean for Medical

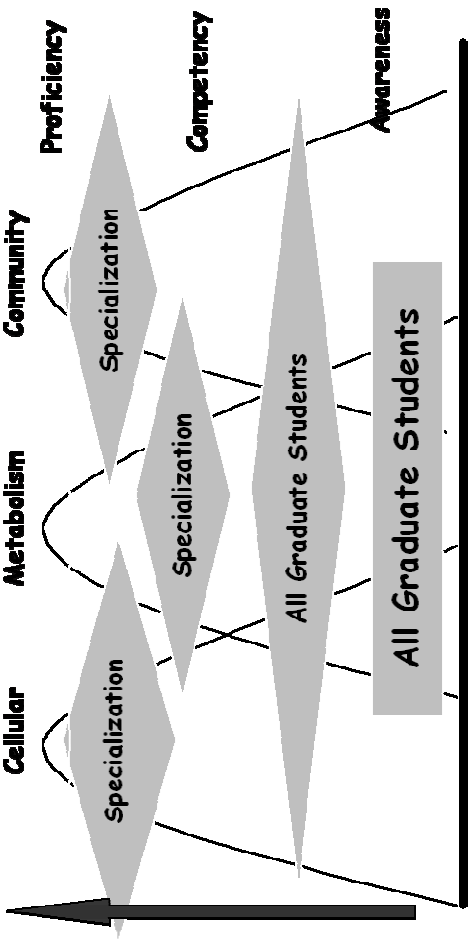


Figure 3-1. The Cornell Model of Integration and Application[25]

[25] Adapted from Figure 2, Allen, L.H., Bentley, M.E., Donovan, S.M., Ney, D.M., and P.J. Stover. 2002. Securing the future of nutritional sciences through integrative graduate education. Journal of

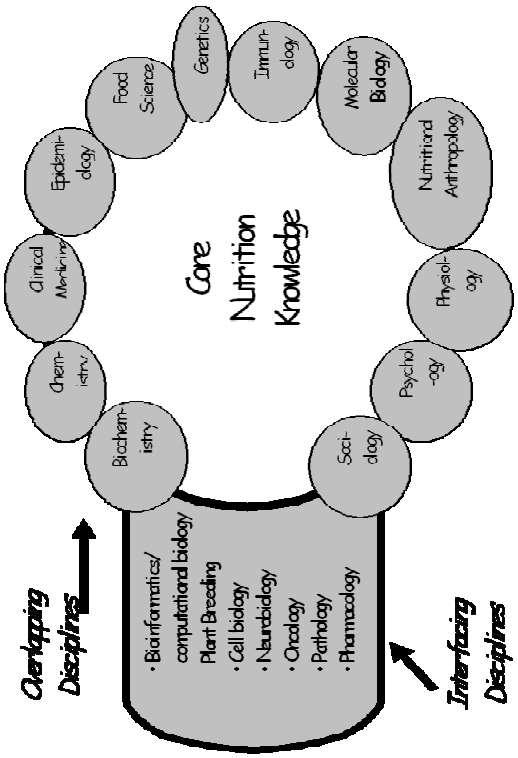


Figure 3-2. Overlapping and Interfacing Disciplines in Nutrition at Cornell University[26]

[26] Adapted from Figure 1, Allen, L.H., Bentley, M.E., Donovan, S.M., Ney, D.M., and P.J. Stover. 2002. Securing the future of nutritional sciences through integrative graduate education. Journal of Nutrition. 132(4):779-784

Education at the University of Maryland School of Medicine. Mallott gave several reasons for the gaps. Medical students, like much of American youth, are overwhelmingly suburban and have never been to a farm, except perhaps a pick-your-own facility. Starting in high school, many students gravitate to high-technology, subcellular scientific fields, such as genetics, with little appreciation of the larger ecologic picture into which one might put nutrition and nutrition science. This trend is compounded by the lack of nutrition in the undergraduate curriculum of the average premedical student. Medical students have little awareness of nutrition science, and medical schools begin teaching nutrition often too late to have a significant impact. Moreover, medical students and physicians are generally healthy and have access to good health care and health information, which can make it difficult for them to empathize with patients who do not, he said. It is essential to break down those barriers, Mallott stated.

The University of Maryland School of Medicine's approach to nutrition education starts in the first month. As part of the introduction to clinical practice, there are a series of life-cycle–based lectures, supplemented by a series of activities to engage the students, Mallott explained. The curriculum includes a practicum in the first year, in which where each student is given an imaginary budget and asked to go food-shopping for an impoverished inner-city mother and her children. Students later receive "heart-smart cooking classes" and an assignment to spend time at a rural health-education center, where they study the eating habits of patients and their families. The purpose is to get them to see why individual people eat what they do. Noting that the supreme commodity in medical education, and in the medical field itself, is time, Mallott asked the workshop participants to be mindful that whatever integrative function is needed has to be packaged for easy digestion by the medical world.

FOOD–HEALTH INTEGRATION IN A PRIVATE ENTERPRISE

Eric Gugger, Technical Manager of the Nutrition Science Group at the General Mills' Bell Institute of Health and Nutrition, provided an industry perspective on the types of nutrition-related research sponsored and funded by food companies, sometimes in partnership with universities and other entities. He also explained how consumer interest has led the food manufacturer to use health claims to help market its products.

General Mills, one of the largest U.S. food companies, with brands that include Cheerios, Pillsbury, Betty Crocker, and Yoplait, recently has been able to make health an economic driver. Gugger noted that the company uses product packaging to convey messages to consumers about products' potential health

benefits. The messages are most evident on boxes of cereals like Total and Cheerios, which tout benefits such as lower cholesterol, reduced risk of heart disease, and weight loss—benefits that are supported by decades of research and are well understood by consumers, he said. The company also uses press releases and commercials, which give it more flexibility to discuss the results of diet-related studies, as well as handouts, dispensed through dietitians and nurses, with information on how a cereal like Cheerios would fit into the American Heart Association guidelines (see Box 3-1).

General Mills marketing research has determined that consumers respond best to familiar foods or products that are identified as having a recognizable and familiar health benefit. They do not want to pay more for health benefits, however, and are not interested in products targeted specifically to health benefits or that contain additional ingredients that produce health benefits.

"Scientific research is the foundation of our health messages," Gugger said, noting that the company relies on published studies in addition to company-funded research. General Mills tends to fund product- or platform-specific research rather than basic research, which is funded when an issue or food product is of particular importance or has an advantage in the marketplace. It also funds clinical trials at universities and through contract research organizations, in-house dietary-intake research, and epidemiologic research,

Box 3-1. General Mills Healthy Eating Programs.[27]

The Bell Institute of Health and Nutrition was developed at General Mills to examine health and nutritional issues. The institute's mission is to drive the development of foods that help people to be healthy. Scientists in the institute have contributed to research on whole grains, micronutrients, and breakfast. Through its educational efforts and sound scientific research, the institute serves as a resource for health-professional organizations.

The Bell Institute has developed several kits for health professionals to use to educate their patients. One of the kits, "Destination Heart Healthy Eating," is designed to help patients reduce their risk of cardiovascular disease. The kit provides health professionals with information and resources to use to assist their patients in changing their dietary patterns and habits to reduce their risk for cardiovascular disease. The information that the institute provides in this packet is consistent with the 2000 American Heart Association dietary guidelines and the 2001 National Cholesterol Education Program cholesterol guidelines.

[27] The Bell Institute of Health and Nutrition. 2003. Available at http://www.bellinstitute.com/nutrition/index.htm [October 2003].

when related to product or platform. Gugger said General Mills is seeking more research on diet and diet patterns versus specific compounds, on whole foods, and on health outcomes for the consumer that can be conveyed in a positive manner.

A MODEL FOR INTEGRATING TWO DISCIPLINES

John Linehan, Vice President for Biomedical Engineering Programs at the Whitaker Foundation, described how the private, nonprofit foundation served as a catalyst for the development of a new interdisciplinary field of study—biomedical engineering—that has since become a major discipline in many colleges and universities and has led to important breakthroughs in the study of genetics. The foundation efforts to promote biomedical engineering served as a springboard for discussion of the integration of such fields as agriculture and public health, and some participants later cited the foundation's achievements and methods as a possible model.

The foundation decided in the late 1980s to close down, and therefore began to invest all its funds into the development of the newly emerging field of bioengineering, which incorporated physics, chemistry, mathematics, and biology. The foundation started in 1975 by awarding seed grants to young investigators for initial research to generate preliminary data to be used in developing more traditionally funded research programs through NSF and NIH. Although successful, it was slow in producing results, so the foundation later decided to offer larger competitive development and leadership awards to universities, which had to compete for the funds. Specifically, the universities were asked to propose programs to further biomedical-engineering education.

The funding program was set up with the following elements:

- The foundation required matching funds, but it placed no cap on how much it would invest.
- It was flexible—it avoided prescribing whether the funds had to go toward startup costs, new buildings, or hiring of new faculty.
- If a proposal included a new building, the foundation would not be the major investor, but would be willing to be the first investor.
- Universities were required form departments to qualify for some of the major awards. This policy was put in place with the recognition that formalized infrastructure was needed to ensure the sustainability of the initiative.

According to Linehan, universities viewed the program as a great opportunity, because "this was at the time of the molecular revolution and the computer

revolution. He imagined them saying, "if we are ever going to do something in an accelerated way, this is the opportunity to do it." Eighty programs applied for the grants, submitting very detailed plans; 15 were involved in extensive follow-up site visits by foundation staff.

Bioengineering education and interdisciplinary research and education have flourished as a result of the program, Linehan said. Departments were formed in colleges of engineering, as bridge departments between medical and engineering schools, or with faculty who had joint primary appointments or funding. One example is the 1998 creation of a new biomedical engineering department that bridges Georgia Institute of Technology's College of Engineering and Emory University's School of Medicine; it now has over 20 active faculty members.

Linehan emphasized the catalytic role of new technologies that are driving bioengineering, in such fields as cell signaling, functional genomics, and high-throughput phenotyping. He noted that "when the educational programs exist, the young men and women will come, and if they come in sufficient numbers and are of sufficient quality, then the field will be secure in the future."

Box 3-2. Biomedical Engineering Educational Summit—The Whitaker Foundation.[28]

The Whitaker Foundation held a four-day Biomedical Engineering Educational Summit in December 2000 to help universities design and modify biomedical engineering educational programs for the future. This ambitious undertaking brought together a group of experts to hear various experiences and discuss new curricula to prepare students for future careers in bioengineering. Participants in the summit discussed and made recommendations in several areas of biomedical engineering education, including:

- Focus on the foundations of undergraduate education, such as basic science and engineering
- Include real-world experiences in the classroom and laboratories
- Incorporate advances in the curriculum and teaching methods and materials in various biomedical/bioengineering fields, including bioethics, biomechanics, bioinstrumentation, biosystems, cellular and molecular engineering, biomaterials, functional genomics, cell and tissue engineering, computational biology, biologic and biomedical imaging, and microengineering

The summit has led to a number of subsequent programs and meetings that have focused on educational issues in the bioengineering field.

[28] The Whitaker Foundation. 2003. Biomedical Engineering Educational Summit Meeting. Available at http://summit.whitaker.org [September 2003].

OPPORTUNITIES AND OBSTACLES

Responding to audience questions, the panelists discussed current and future trends in food and health research, as well as obstacles to progress. Recent breakthroughs in genomics are opening up a new avenue of diet–health research—one that is shifting the focus of health care from intervention to prevention. Muscoplat noted that changes are needed in food and health funding structures to clear the way for interdisciplinary studies and in agricultural policy to support a new paradigm based on benefits to citizens and consumers.

Genomics and the Diet-Health Nexus

The public-health focus on nutrition and health is expected to increase steadily in the next decades, Garza said. He attributes the likelihood of this increasing emphasis in large part to recent advances in genomics. Public health will move steadily from crisis-driven interventions to increasing emphasis on preventive medicine as scientists understand better how nutrition and other environmental factors affect human health and use that knowledge to target treatment to individuals and groups, Garza said. Preventive therapies that include nutrition strategies will be used increasingly as scientists gain further insight into single-nucleotide polymorphisms, haplotypes, and other epigenetic changes that will help us understand individual and population risks of diet-related diseases.

Agricultural Production Policies

Agricultural policies have inadvertently resulted in some adverse consequences for the United States, on public health, the ecosystem, world trade, and rural communities. Muscoplat said it is time for the United States to shift to a new agricultural paradigm—one based on what is both good for consumers and profitable for farmers. In the future, the "from farm to table" paradigm will be shifted to "from table to farm"—what we should eat to be healthy will drive what is produced, instead of production driving consumption.

Public Education

As a growing field, food and health knowledge is ever-changing, and it is a challenge to keep educators, clinicians, and the public up to date on the latest nutrition and health recommendations. Mallott suggested that educators need to focus more on the process of continuous learning, to understand better how to gather, incorporate, refine, and evaluate knowledge from formal and informal

sources. Without such knowledge, consumers will not drive the production and development of healthful foods, and physicians will not be able to advise their patients accurately on healthy choices.

Muscoplat pointed out that modifying human behavior with regard to diet and health has proved far more challenging than expected—taste, convenience, abundance, and price all complicate lifestyle choices. He reminded listeners that low-fat diet recommendations intended to reduce heart disease and other diet-related major diseases were put out 30 years ago, and that rates of obesity have since increased significantly. He questioned whether the cause of that trend is the practices and products of the current food-production system—whether science, the marketplace, consumer behavior, and agricultural policy interact to produce unintended, unhealthful consequences. He recommended a global, multidisciplinary, geopolitical perspective to solve this complicated problem.

Preventive Medicine

Edward P. Richards, Director of the Louisiana State University Law Center Program in Law, Science, and Public Health, reminded panelists of the impact of legal, economic, and insurance issues on American health and its health-care system. As examples, he specifically identified the short-term contractual nature of insurance policies as shaping short-sighted, responsive health-care practices, and the pharmaceutical industry's interest in genomics based on commercial uses rather than therapeutics. Panelists reiterated the importance of those concerns, which perpetuate a curative rather than preventive perspective, and monetize problems and outcomes that should be looked at in terms of sustainability and social benefit. Mallott, speaking as a psychiatrist, included nonrational dietary and lifestyle choices made on non-rational bases and the youth-oriented culture as also playing important roles in a disease-oriented rather than wellness-oriented system.

Food Safety

One participant felt that foodborne disease presented a key opportunity to focus on preventive measures. The food supply in the United States is one of the safest in the world, but the CDC estimates that each year 5,000 Americans die from foodborne illness, 76 million get sick, and more than 300,000 are hospitalized, some with long-term health consequences.[29] Some populations, such as children and the elderly, are especially vulnerable, and discussants felt

[29] For more information on food safety, see: http://www.cdc.gov/foodsafety/

that science has the ability to help lift the burden of food safety from the consumer to the elimination of hazards early in the food system.

Disease surveillance and other food-safety efforts have increased as a secondary result of counterterrorism efforts since the 2001 bioterrorism events, but there are still improvements to be made, Mallott felt, in that cases of foodborne disease were still going unrecognized and uncounted. The opportunity to take a broader view of the food system and its vulnerabilities and to strengthen the whole system should not be lost, Garza added.

Institutional Coordination

Panelists encouraged funding agencies to engage with each other and to designate specific grant opportunities for interdisciplinary research in food and health and suggested that grant review include evaluative criteria for determining the extent of crosscutting science. Cited as an example was the successful experience of the NIH Bioengineering Consortium (BECON),[30] which consists of senior-level representatives of all the NIH institutes, centers, and divisions plus representatives of other federal agencies concerned with biomedical research and development. Linehan directed attendees to a symposium on promoting team research that BECON recently organized.[31]

Some audience members and panelists suggested that the National Academies had the opportunity to set examples of better integration of agriculture and nutrition. The National Academies' newly launched partnership with the Keck Foundation to push the frontiers of science through a joint program of focused symposia and seed grants may be a useful platform for advancing interdisciplinary food and health research, some participants offered.

[30] For more information on BECON, see:http://www.becon.nih.gov/becon.htm

[31] The Symposium on Catalyzing Team Science was held on June 23-24, 2003 at the NIH Natcher Conference Center. Its goal was to examine the forces encouraging and discouraging team approaches to biomedical research and to explore how NIH, academe, and others can stimulate and reward team efforts. About 350 attendees participated in the plenary presentations, topical breakout sessions, and case studies of effective team science. A draft summary of the symposium is available at: http://www.becon.nih.gov/symposium2003.htm

4

Challenges Faced and Met in Research on Food and Health

A panel of five university researchers reported on a wide variety of research programs related to food and health, ranging from promising experiments to proven treatments and from foods with healing properties to those carrying pathogens. Panel members also addressed related issues, such as the importance of collaboration and funding structures in advancing their research and what they consider the most effective approaches for combating diet-related health problems. Some panelists shared personal perspectives on developing research programs that broke interdisciplinary barriers.

RESEARCH ENDEAVORS INVOLVING FOOD

Researchers described how some foods are being tested for their potential to treat disease and others are being modified or fortified to enhance health. Mushrooms, essential oils, and other foods are being used in studies to treat cancer and other chronic diseases, they said. Corn has been modified to increase its protein content, and eggs and milk have been fortified with omega-3 fatty acids.

Food as a Curative

Harry Preuss, Professor of Physiology, Medicine, and Pathology at Georgetown University Medical Center, began his career in internal medicine as a nephrologist. Initially, he worked on sugar-induced hypertension. When he found that chromium, as a nutritional supplement, circumvented that mechanism, he became committed to exploring the food and health connection, especially in preventive medicine and aging. Preuss pointed out that nutrition and health issues were often considered in the realm of "alternative medicine," a label that he questioned, saying, "Something works or it doesn't." He expressed concern that consumer information on healthy diets presented mixed and sometimes incorrect messages, and he felt that emphasis on counting calories and exercise would be beneficial.

Preuss described his current research on the impact of foods—such as mushrooms, bitter melon, and essential oils, and nutritional supplements on immune function, cancer, diabetes, and hypertension. He termed the findings "possibilities," saying that more research is needed to prove definitively their effectiveness. He noted that interest in the therapeutic effect of mushrooms in treating cancer and immunologic disorders is growing. As an example, Preuss offered preliminary results from one Asian study on the effect of maitake mushrooms on rats with cancerous tumors, which suggested potential shrinkage of the tumors, although he noted that the study was not a double-blind placebo-controlled study, so the result would be of limited value. He added that an extract of maitake and maitake powder have also been suggested by some to diminish the side effects of chemotherapy, but "whether this turns out to be something wonderful, we will have to see."

Preliminary results of tests with grislin (a fraction of maitake), bitter melon, and a combination of the two to treat insulin resistance and hypertension associated with diabetes were positive, Preuss said. He had found that the most sensitive index of insulin resistance is a rise in blood pressure, and with treatment, blood pressure went down in every case. Cinnamon, fiber, and chromium compounds also can be effective in increasing insulin sensitivity, he noted.

Preuss said he has found that some essential oils are effective as bactericides and fungicides. Two oils used in laboratory tests—monolaurin derived from coconut oil and the essential oil of oregano—killed *Staphylococcus*, *Helicobacter pylori*, and even anthrax. He suggested that oregano might also be effective in killing *Candida albicans* and *Escherichia coli*. "There are things that can be done with the foods that have little risk and can be helpful with chronic disorders," he concluded.

Food Altered to Increase Nutritive Value

Brian Larkins, Professor of Plant Sciences and Molecular and Cellular Biology at the University of Arizona, described recent efforts to enhance the protein quality of maize. He also discussed current laboratory work aimed at understanding the molecular processes underlying the changes.

Some 9 to 10 billion bushels of corn are produced in the United States each year, but this widely consumed cereal has relatively poor protein quality, he said. Corn is especially low in lysine, an essential amino acid for humans and some animals. Over the last few decades, researchers have been successful in altering the protein composition of corn and increasing its lysine content. Early attempts at protein enhancement resulted in corn with a soft, starchy texture that made it susceptible to insects and produced "lousy tortillas," Larkins noted. However, plant breeders, working with modifier genes, have created a mutant protein-enhanced corn called Quality Protein Maize (QPM) that is very similar to normal corn (see Box 4-1 for a more detailed perspective).

Larkins and his colleagues are studying the molecular processes and mechanisms behind the success of QPM, trying to understand how the modifiers work, how the mutation changes the lysine content, and the function of a process called endoreduplication, which amplifies the number of gene copies when the kernel is developing. They have determined that development of QPM is closely related to the structure of starch, he said.

Larkins' laboratory goes beyond traditional cereal chemistry by looking at the development of corn kernels, especially the synthesis of starch and storage proteins. It has determined that part of the cytoskeleton network that surrounds the endoplasmic reticulum can serve as an indicator of the lysine content, and allows it to be used in selecting for increased protein quality. Larkins has also linked the physical structure of starch grains in the endosperm to how high-quality protein genotypes are developed.

Bruce Watkins, Director of the Center for Enhancing Foods to Protect Health and Professor at Purdue University, and Adjunct Professor of Anatomy at the Indiana School of Medicine, described various ways in which foods are being altered to enhance their nutritional content and quality. He also described current research in the use of nutraceuticals and phytochemicals to prevent or correct medical conditions, such as osteoporosis and obesity.

Box 4-1. Quality Protein Maize (QPM).[32]

In 1963, three scientists at Purdue University discovered opaque-2 maize, a mutant maize that was nearly twice as nutritious as normal maize and which contained proteins. The discovery of the opaque-2 gene led many scientists to believe that the protein deficiency that afflicts millions of people who depend on maize as a stable food supply could be improved by adding the opaque-2 gene to the world maize crop. However, the opaque-2 gene gives the kernel a soft, starchy texture that caused the maize to be more susceptible to insects and to break easily, and it could not be used to produce the same quality of food as normal maize.

A team of maize scientists at the International Maize and Wheat Improvement Center (CIMMT) in Mexico were able to develop what is now called Quality Protein Maize (QPM), which has a greatly enhanced nutritive value, high yields, normal moisture content, and good endosperm hardiness. In 2000, Surinder K. Vasal, a maize breeder, and Evangelina Vilegas, a cereal chemist, shared the World Food Prize for their efforts in developing QPM in the 1970s and 1980s. Since 1996, CIMMT and other organizations have been able to strengthen QPM breeding and promotion programs and have targeted developing countries that use maize as a food staple. Norman E. Borlaug, Nobel Peace laureate and president of the Sasakawa Africa Association, has strongly endorsed QPM research and use through Sasakawa Global 2000, a program that has successfully promoted QPM in Ghana and several other African nations.[33]

The Center for Enhancing Foods to Protect Health is a faculty-led organization with a focus on advancing knowledge about food and how it affects health. It has four research aims: discovery and methods development for health protectants, such as phytochemicals and nutraceuticals; testing and validation of health benefits, using primarily cell-culture and animal models; precommercialization of functional food components introduced into traditional food products; and molecular biology and food functional genomics. The center is a collaborative effort involving faculty in the Schools of Agriculture, Consumer and Family Sciences, and Veterinary Medicine at Purdue University, and the School of Medicine, at Indiana University-Purdue University Indianapolis (IUPUI), as well as scientists at other institutions. For example, food scientists at the center are studying the feasibility of adding functional food ingredients to bread formulation while making sure that it is visually appealing

[32] International Maize Testing Unit: QPM Background. 2003. Available online at http://148.223.253.105/qpmbackground.htm [October 2003].
[33] For more information, see the National Research Council report, Quality Protein Maize. 1988. Washington, D.C.: National Academy Press.

and maintains the usual qualities of white bread. The center, in cooperation with other institutions and industry, has produced eggs fortified with omega-3 fatty acids and conjugated linoleic acids, Watkins said. Researchers at the Center are also exploring how diet can correct atrophy in muscle and bone tissue that results from disuse, fractures, and space travel, and how nutraceuticals and phytochemicals affect the differentiation of osteogenic stem cells.

The center has an educational component, with a special focus on middle school through college, covering the origin of foods, how foods are processed, food chemistry, and how nutrition affects health. Adult-education efforts include the Phytochemical Learning Resource, which is available on the Internet and on CD, to help nutrition educators and dieticians.

Watkins' research career exemplifies the kind of integration that is being promoted for food and health research. He began his research career in animal production and animal nutrition, investigating the role of probiotic bacteria in gnotobiotic chicks to reduce enteric pathogens. He then moved on to biotin metabolism and sudden death syndrome, characterization of abnormal bone growth in nutrient deficiency, food lipids and the chemistry of functional food ingredients, molecular and physiologic actions of phytochemicals on cell function and bone biology, and nonembryonic stem-cell research in bone health.

Food as Potential Pathogen

Two panel members discussed the other side of food and nutrition: its potential to harm rather than nourish or heal. Linda Saif, a Professor at the Ohio Agricultural Research and Development Center of the Ohio State University, discussed her research on enteric calciviruses that affect animals and humans, including the Norwalk virus that has caused outbreaks of stomach illnesses on cruise ships and in other settings. Susan Sumner, head of the Department of Food Science and Technology at Virginia Polytechnic Institute and State University, addressed the impact of globalization of the food supply, the use of food as medicine, and the potential of food as an agent of bioterrorism.

Saif reported that foodborne infections in the United States cause about 76 million illnesses each year, account for about 325,000 hospitalizations and 5,000 deaths each year[34], and have an estimated annual cost of $23 billion.[35]

[34] Mead, P.S., Slutsker, L., Dietz, V., McCaig, L.F., Bresee, J.S., Shapiro, C., Griffin, P.M., and R.V. Tauxe. 1999. Food-related illness and death in the United States. Emerging Infectious Diseases. 5:607-625.

[35] Hedberg, C. 1994. Changing epidemiology of food-borne disease: A Minnesota perspective. Clinical Infectious Diseases. 18:671-682.

Noroviruses (caliciviruses) cause an estimated 67 per cent of the known cases if foodborne illness. Outbreaks associated with those viruses have occurred on cruise and military ships and in other institutionalized settings, such as schools and nursing homes. About 40 percent of the outbreaks are thought to be the result of foodborne infections, but the infections can also be waterborne.

Saif and her colleagues have tried to address some of the impediments to working with noroviruses. They adapted a porcine enteric calicivirus to grow in cell culture by using novel methods and they are now using it as a model to try to grow human enteric caliciviruses (noroviruses and sapoviruses). The researchers also used primers originally developed to detect human caliciviruses to detect animal caliciviruses; with sequence analysis, they discovered that the two groups of viruses are genetically similar. Recently they developed an infectious clone of a porcine enteric calicivirus that they hope to use in studying the molecular basis of the virus's virulence and cell adaptation. Current research at the university focuses on determining how the viruses cause diarrhea in host species and how the infections can be prevented by using pigs and claves as animal models for sapoviruses and noroviruses similar to those that infect humans. Researchers, including those in Saif's laboratory, are using bioengineering to develop noninfectious calicivirus-like particles for use in vaccines and are trying to determine the origin of strains of the virus that affect humans—particularly to see whether they are zoonotic. Enteric caliciviruses and coronaviruses are among a large number of emerging pathogens that are believed to be zoonotic. Saif singled out the SARS coronavirus as one example of the harm that such pathogens can cause.

As a food microbiologist, Sumner identified food safety, food bioterrorism, a global food supply, and the use of foods as medicine as issues of importance. She discussed several unanswered questions that should be investigated further, regarding the risk that the United States faces from a food-related bioterrorist attack: How great is the risk? What types of foods are the most likely targets? What segments of the population are at greatest risk? Sumner was also concerned about the preparedness of the food producers and processors to deal with the intentional introduction of pathogens and toxins that would normally not be found in foods and that cannot be controlled with the usual food-safety practices.

Consumers expect food to be processed the same, to have the same high nutritional quality, and to be equally fresh and safe, regardless of where it is produced, Sumner explained. However, globalization raises serious concerns about food safety, she continued, citing as one example fears about mad cow disease associated with beef products from the United Kingdom and, more recently, Canada. New food-processing techniques are being developed and

used, but how they affect the safety and nutritive value of foods has yet to be determined, she said. Questions remain about the tradeoffs between fresh and processed foods—which is better from a nutrition standpoint versus a safety standpoint, and what are the best ways to strike a balance between fresh and processed foods. As with the baby-food and pet-food industries, food products are going to be targeted for development for specific health-related features, both in terms of food safety and of chronic disease.

Collaboration

Several panel members stressed the importance of collaboration across disciplines, agencies, and institutions to foster better research and education in food and health. They also stressed that funding agencies should establish or increase funds aimed specifically at cross-sectional research and that institutions should change their reward structures to support collaboration.

Using calicivirus research as a model, Saif identified four essential components for integrated research programs: funding, collaboration, infrastructure, and graduate students and postdoctoral fellows. Establishing a broad funding foundation by breaking out veterinary, food-safety, and human-health components of her research program has allowed her to obtain funding from USDA, EPA, and NIH. Saif added that timely availability of visas for top international students and postdoctoral fellows is also essential: severe visa restrictions may jeopardize our globally competitive scientific research programs and may limit participation by international scientists in U.S. scientific meetings, thereby weakening both U.S. and global scientific research.

Saif stressed the importance of collaboration among veterinary, agricultural, and biomedical scientists in studying foodborne pathogens and other disease agents suspected of originating in animals. This reminded listeners that, of 156 emerging diseases, almost three-fourths are zoonotic,[36] and more information is needed about them in the natural hosts. For example, biomedical researchers only recently recognized that coronaviruses, which cause colds and other respiratory illnesses in humans and were responsible for the recent outbreak of SARS, have caused respiratory and enteric diseases in animals for many years, she said. Closer ties between animal and medical scientists could facilitate research into how those diseases are spread, but more support is needed to encourage such collaboration. She suggested that although USDA and NIH grants support basic research, sometimes bridging or targeted competitive

[36]Levy, Stuart B. 1996. Microbial threats and the Global Society. Emerging Infectious Diseases. 2(1): 62-63. Available on-line at http://ftp.cdc.gov/pub/EID/vol2no1/adobe/vol2no1.pdf [January 2004].

grants, especially in comparative medicine, are needed to develop specific diagnostics and vaccines for emerging animal diseases and animal reservoirs of human diseases and or to assess and control food-borne pathogens.

Both the administrative and investigative components of research infrastructure are being taxed as many universities are changing from state-supported to state-assisted, Saif said. Grants-management offices and long-term technical support from universities are important for developing successful integrative research programs, as are facilities to study infectious animal, plant, and human pathogens, including bioterrorism agents. Without highly qualified national and international graduate students and postdoctoral fellows to carry out and carry on research, these programs would not succeed, Saif added.

Nancy Lewis, Associate Professor of Nutritional Sciences and Dietetics and Chair of the Interdepartmental Nutrition Graduate Program at the University of Nebraska, described her career as a microexample of integration—in this case, of nutritional biochemistry with nutrition behavior.

The Interdepartmental Nutrition Program is the University of Nebraska's primary doctorate program in human nutrition, includes faculty in food science and technology, in animal science, and in the Department of Nutritional Science and Dietetics. To incorporate health behavior, a faculty member of the Psychology Department who is interested in health behavior change has recently been recruited, Lewis reported. With the added expertise, the program is better able to serve the needs of students interested in nutrition behavior. A continuing challenge for the program is meeting the graduate education and research needs of practicing dieticians, who provide the university with invaluable connections to the health-care environment. As practitioners working full-time in nutrition therapy, they are interested in enhancing their clinical skills, their understanding of science, and their level of practice. One creative solution has been to develop courses for distance delivery, so that students do not have to be on campus to meet all their educational needs. That solution will not, however, solve problems of residency requirements or of availability of research facilities. The agriculture and food and health connection can be strengthened by working with clinicians, determining and meeting their needs, Lewis said. As several panel members pointed out, collaboration is often closely aligned with funding, making it very difficult for one to occur without the other.

Lewis also discussed the multistate research committee on omega-3 fatty acids called NC-1167 (Committee on N-3 Polyunsaturated Fatty Acids and Human Health and Disease) as an example of improving interdisciplinary research. Initially, the committee members had a nutritional-biochemistry perspective. By recruiting additional committee members who shared her interest in nutrition

behavior, she was able to incorporate this perspective into the committee's discussions and research planning. It has been successful in working with the Nebraska Heart Institute on behavioral interventions, and Lewis suggested that grant proposals requiring such integration as she has experienced, including biochemical, behavioral, and outreach or continuing-education components, would be very valuable.

Larkins addressed factors that he believed contributed to his success in obtaining support. His research has been supported by several federal agencies, including the USDA's National Research Initiative (NRI), the Department of Energy's Energy Biosciences Program, and NSF, as well by industry sponsors. He concluded that his work had appeal to both the public and private sectors because some aspects have practical applications and others involve fundamental molecular genetics, molecular biology, and cell biology. His multidisciplinary approach was also attractive to students from a variety of backgrounds. He qualified his success by adding that if he had tried to support his research on the basis of nutrition, he probably would not have gotten any funding, and his diverse funding sources demonstrated that food and health research is not the primary interest or responsibility of any one agency.

Larkins pointed out that the structure of research funding presented challenges to traditional food and health research: the average funding from USDA's NRI is about $60,000 per year for two years. That requires that the grant-renewal process begin in the second year of the initial grant. He contrasted that with NIH's average level of research funding: $250,000 per year for four years, not including indirect costs. He noted that agencies are more willing to fund research on organisms that can be raised in laboratories or growth chambers, such as yeast or *Arabidopsis*, which is relatively inexpensive and more easily justified, and less likely to fund research on crop plants, such as corn, wheat, or soybeans, which is more labor-intensive. He also noted that there has been a substantial reduction in institutional support, especially in Colleges of Agriculture, for research infrastructure.

SOLUTIONS TO FOOD-RELATED HEALTH PROBLEMS

Responding to a question about which technologic solutions or approaches are likely to have the most immediate effect on food-related health issues, Watkins zoned in on approaches that increase dietary intake of good fats and reduce harmful fats; this is an opportunity for developing new and better food-delivery systems. He mentioned that omega-3 fatty acids are a crucial nutrient for avoiding deficiencies and optimizing health. NIH studies indicate that omega-3 fatty acids can have dramatic effects on health, possibly even on psychiatric

disorders, he said. However, most consumers are not getting the recommended amounts of omega-3 fatty acids in their diets, because they do not eat sufficient quantities of fish and edible oils high in this nutrient, Watkins cautioned. This underlines the importance of making the nutrient available in a broader array of foods, he said, noting that just last year FDA approved the use of DHA, an omega-3 fatty acid, in infant formulas. Technologies that reduce harmful fats in the diet are also crucial for better health, he added. They include changing how vegetable oils are processed, modifying plants that produce edible oils, and reducing the content of animal products.

Looking to the future, Watkins envisioned a directed approach to food development: products would be targeted to a person's age, gender, and genetic makeup. He highlighted the opportunities presented by the Human Genome Project: new food products could be developed that lower risk of chronic disease through an understanding of how those components in foods modulate genes and protein expression. Other opportunities are the development of food components that work with drugs as drug synergists to address issues of cardiovascular disease or decreasing inflammatory response; bioactive ingredients, nutraceuticals and phytochemicals; and proteins, such as antibodies that are produced from plants. As the food supply evolves, Watkins predicted lower health-care costs, better nutrition, new medical and functional foods, delayed onset of disease, and improved quality of life.

Sumner took a broad view of the role of food in health, with the convergence of such issues as food science, nutrition, food safety, diet, chronic disease, and medicine. She envisioned an integrated, multilevel approach, targeting specific populations. Sumner applauded the rich tradition of collaboration between agriculture and life sciences, but she pushed for increased collaboration with medical and veterinary colleagues.

Sumner cited the example of the Virginia Tech food and health initiative, involving the Department of Food Science and Technology, the Department of Human Nutrition, Foods and Exercise, and the Center for Food and Nutrition Policy. She challenged scientists to consider how a specific research objective can fit into a bigger picture that may open up new opportunities and questions in food and health. She also called for better communication with consumers and regulators, who may be looking for a quick solution to a health problem that has taken years to develop.

5

Breakout Group Discussions

In the final session of the workshop, participants were divided into eight discussion groups and asked to discuss five questions related to food and health integration. The discussion format provided an opportunity for every participant to respond to earlier presentations and to offer their own ideas and recommendations on the subject. A rapporteur in each group took notes and presented a summary of the group's discussion to the entire gathering. The groups' ideas and recommendations reflected many of the themes discussed earlier in the workshop, but also included fresh perspectives and suggestions.

Question One: Are food and health research and education currently conducted and managed to maximize scientific progress, incentives for collaboration, and benefits to the public health?

Rapporteurs for all the breakout groups reported that discussants felt that better integration, coordination, and collaboration among all the entities involved in food and health were needed. Building on this general feeling and in response to Question Two, discussants identified a number of particular issues that contribute to the problem, as well as examples of successful attempts to overcome it.

Question Two: What activities, programs, or initiatives currently exist in your institution, organization, or agency to address the challenges of improved integration of agriculture and health sciences? What gaps remain?

INSTITUTIONAL INFRASTRUCTURE

Many participants were positive about a number of new collaborative entities springing up, including research teams, centers, institutes, and various coordinating groups, mostly in the academic realm. It was discussed that there is a need to motivate the various government agencies to collaborate as much as the researchers and educators. Even so, researchers were believed to be often ahead of the universities, agencies, and corporations that employ them, and integration was often ad hoc and based on individual relationships rather than strategically planned integrated programs. Because public educational institutions are often resource-driven, faculty members are required to become entrepreneurial, responding to the opportunities presented to them.

Agency interaction is often hindered by current structures to provide joint resources, some participants thought. Historically, funding institutions support particular types or topics in research, with the larger grants often going to the more traditional research models. Some institutions, such as NIH, offer large grants that provide the level of overhead support that universities require. Others agencies, such as USDA, and private associations, such as the American Heart Association, have limitations on how much of their funding can be used for overhead (sometimes no more than 10 per cent). Potentially integrative proposals presented by one agency to another, in which the originating agency would like to marry pools of funds, may be looked at by the recipient agency (often with a much larger portfolio) with suspicion. It was suggested instead that institutions try to focus on common interests.

Some participants identified a need for more and better collaboration across sometimes insular agencies and institutions to overcome the "silo effect." This applies to both government agencies and the various colleges at universities that deal with these issues. As on participant stated "[Institutional] silos are real. They are as prevalent as the silos you see on the rural landscape around America." In many cases, schools of agriculture, nutrition, or family and consumer sciences and medical and public health schools are on separate campuses, some distance apart in many cases, and some participants felt that this creates a substantial barrier to communication.

There was a perception on the part of some discussants that funding from one agency is "better than funding from another agency," and that raises some problems in getting interagency cooperation. It may be a result of differences in facilities and administration costs among agencies. It may also result from differences in probability of funding or of getting a proposal funded by different agencies, which is related to the overall amount of funds available from different agencies. There was also some concern that training programs emphasized individual investigations and reductionist methods, and not team research, which they felt is needed to address the kinds of questions that were posed during the workshop.

There was a feeling among some participants that there were differences in funding-agency perspectives, among review panels, and among program leaders, who in different agencies might have more or less narrow views of their responsibilities. There was also a feeling that there were no programs to integrate across all needs and that research was looked at on a project level, rather than on a program level in terms of priorities. Some participants pointed out that it is important to look beyond food-related diseases, especially obesity, and to consider the relationship between food and wellness.

Some discussants felt that promoting interdisciplinary research or bridging the gaps in different institutions was not currently a priority. One participant noted that even when institutions encourage interdisciplinary activities generally, young investigators are cautioned to be careful about getting too involved in team research, because that may not be the way to get promoted.

INCENTIVES

To break down the silos, some participants felt that a policy review at the federal level could play a valuable role in promoting progress. Some thought that what is needed is a single agency to volunteer to take the lead in promoting research and education in food and health: "Until the big guys fund and frame the research in the interdisciplinary area, identify funding for it and specify that is what it is for, we are not going to get very far in getting it done." Some participants suggested that the White House Office of Science and Technology Policy could play a leading role, declaring interdisciplinary food and health research to be a priority and developing cross-agency budgets. Another suggestion was the creation of a group within the federal agencies that would broker grants, allowing researchers to get advice on where to submit collaborative, integrative research programs for the greatest probability of success.

In the academic realm, some participants identified the lack of incentives to encourage university faculties to be more interdisciplinary, particularly with respect to promotion and tenure, as a problem. Modification of the reward structure is needed, so that collaboration between different fields of research and between research and education is more straightforward. New institutional tools could be made available by institutions to foster better collaboration, such as matching funding, fellowships, and other special incentives.

For investigators actively interested in crossing the divide between food and health research, low funding levels are a disincentive. That is especially true for food and agricultural scientists, given that health research has more funds available than other general research. Indirect costs were also identified as an obstacle to developing new and integrative research programs. It was suggested that it is important to look beyond single institutions and to enhance both current and new regional research efforts

PRODUCER AND PUBLIC INVOLVEMENT

Some participants noted that most of the health concerns revolving around food, nutrition, and health were "life-choice diseases." It was pointed out that as a nation we are not successfully educating the public to bring about substantial behavioral change for improved health—even people who have a need and now get the information, do not use it properly. An improved message with regard to food and health is needed, as is improvement in how that message is used by those who receive it. One suggestion was for USDA to use its extension network to get the message out and to bring food and health research together, which might require additional funding. One group of discussants thought that an effort could be made to increase the focus on making this link in the early grades, rather than waiting to work with an adult audience, and attract new partners, such as the Howard Hughes Medical Institute and the National Science Foundation, which have innovative programs to bring science to the lower grades. Agricultural producers and food processors were also identified as important partners in improving knowledge of the relationship of food and health.

EXAMPLES

- **Fight BAC!** is a public-education campaign focused on safe food handling, whose goal is to educate consumers on steps that they can take to fight foodborne bacteria and reduce their risk of foodborne illness. Initiated in 1996, the campaign is now supported by public and

private organizations from all aspects of the food and consumer industry, including meat and produce marketers, allied trade groups, consumers, public-health organizations, and government agencies. For more information see www.fightbac.org.

- The Center for Science in the Public Interest has established **Eating Green**, a campaign to improve the public's health and the environment by advocating for a more plant-based diet through policy change and public education.
- The **Food and Society Initiative** (FAS) is a Food Systems and Rural Development program of the W. K. Kellogg Foundation. The FAS Initiative is based on a vision of a future food system that provides, for all segments of society, a safe and nutritious food supply grown in a manner that protects health and the environment and adds economic and social value to rural and urban communities. The purpose of the FAS Initiative is to support the creation and expansion of community-based food systems that are locally owned and controlled, environmentally sound, and health-promoting. For more information see www.wkkf.org/Programming/Overview.aspx?CID=19.
- USDA's **National Research Initiative Competitive Grants Program** (NRI) is the office in the Cooperative State Research, Education, and Extension Service that is charged with funding research on key problems of national and regional importance in biologic, environmental, physical, and social sciences relevant to agriculture, food, and the environment on a peer-reviewed, competitive basis. The goals of the NRI are to increase the competitiveness of U.S. agriculture; to improve human health and well-being through an abundant, safe, and high-quality food supply; and to sustain the quality and productivity of the natural resources upon which agriculture depends. For more information see http://www.reeusda.gov/nri/.
- NIH's **Community Based Participatory Research Program** was started by the National Institute of Environmental Health Sciences in 1995. The purpose of awards in this program is to develop community-based public-health research approaches to diseases and health conditions that have an environmentally related etiology and to determine the value of the methods. Awards are intended to stimulate further advances in the design and implementation of prevention and intervention methods that are appropriately applied to environmental health; to accumulate and evaluate data, making assignments of environmental etiologies of diseases more plausible; and to develop, implement, and evaluate community-based exposure-assessment protocols. For more information see http://www.niehs.nih.gov/translat/cbpr/cbpr.htm.

- The mission of the Illinois **Council on Food and Agricultural Research** (C-FAR) is to secure additional resources to fund relevant, high-quality research, and related outreach programs that lead to profitable, consumer-sensitive, and environmentally sound food and agricultural systems in Illinois and the nation. C-FAR will foster public confidence in food and agricultural research through public participation in the planning and evaluation of the process and impact of research activities. For more information see http://www.ilcfar.org/.

Question three: What potential national initiatives could be implemented to address the challenges of improved integration of agriculture and health sciences?

An interdisciplinary, multi-institutional initiative was repeatedly put forward by the discussion groups as a mechanism to promote the integration of food, food-system, and health research and education. To accomplish this, some participants envisioned the federal and state governments working as a unit to create a funding program with that focus. To encourage an integrative research approach, the initiative could support programming that carried mechanistic work through public-health outcomes, requiring scientists to demonstrate from the onset of their research program how their work could be translated to other food, agriculture, and health fields. Research programs could also be combined with education and outreach. Substantial up-front funding for existing programs that demonstrated those linkages was believed to be useful, rewarding those who were creating new intellectual and organizational relationships. Some discussants suggested more diverse grant-review panels that represented a broader range of backgrounds and expertise. Academic institutions could promote integrative programming by allowing cluster hires, cross appointments, and reorganization of colleges and departments, including agriculture and medical schools, extension programs, and state health departments. The systematic evaluation of research programs at the termination of a grant to assess the success of a program in making linkages is also important, as is a planned terminal evaluation of the initiative itself.

Some participants reiterated the need for more coordination and a body responsible for it, which was envisioned by different participants as either an individual, center, institute, or agency willing to take the lead and serve as champion, or as an interagency working group to provide program direction. Some participants believed that it would be useful for Congress to consider a farm bill that would be more responsive to nutrition and health needs, rather than commodity- and support-focused, to provide the push needed to develop this leadership, and that it was important to convey this message to legislators. The 2002 Farm Bill has already created a taskforce to evaluate the merits of

establishing one or more national institutes focused on disciplines important to the progress of food and agricultural science. Many participants also emphasized the need for diverse membership of the guiding bodies, including the Centers for Disease Control and the Department of Defense. Other entities that might be included in the initiative in some fashion are schools of public health, economists, private health insurers , the private sector, and, of course, the consumer.

In terms of targeting a specific food and health issue, a number of participants felt that we should focus on childhood nutrition, including expanded elementary education programs. Alternative suggestions included obesity, diabetes, or other chronic diseases; food safety; and food security. Others felt that a consumer-behavior approach was needed to look at overall eating patterns rather than specific issues, such as the role of functional foods. Some felt that an initiative that would enhance the public's understanding of the agricultural system and its impact on public health was needed.

The NSF's National Nanotechnology Initiative (NNI) was cited as a good model to follow. Initially funded in FY 2001, the NNI is an effort to strengthen critical scientific disciplines and encourage interdisciplinary research and education to develop a long-term vision, establish federal priorities, and coordinate the national program.

President Bush's HealthierUS Initiative is based on the premise that increasing personal fitness and becoming healthier is critical to achieving a better and longer life. Extensive research has shown that making small adjustments and improvements in the activities of daily life can improve overall health and prevent disease and premature death. The HealthierUS Initiative uses the resources of the federal government to alert Americans to the vital health benefits of simple and modest improvements in physical activity, nutrition, and behavior. The initiative will encourage all Americans to be physically active every day, eat a nutritious diet, get preventive screenings, and make healthy choices to prevent diseases associated with obesity, such as heart disease, cancer, stroke, chronic obstructive pulmonary disease (for example., bronchitis, emphysema, and asthma), and diabetes.

Question four: How can education and outreach contribute to improved research integration?

Building on the suggestion to require demonstration of a broader scientific perspective in research proposals, discussants felt that education and outreach components also needed to be built into research programs from their initiation. In addition, there was a feeling that the effectiveness of tools for education and

outreach needed to be the subject of research. The Food Guide Pyramid was cited as an example of a well-known public-outreach program, which is not useful if no one follows it. New technology could also be investigated to improve outreach. Discussants identified the need for greater integration and greater breadth in the primary and continuing-education programs for food and health professionals, including animal health. Professional societies and associations might be called upon to help develop more integrated and collaborative approaches.

The public needs to become a partner in the effort to bring agriculture, food, and health sciences together, some discussants felt. Communities have a role in disseminating information, as well as receiving it. With the public's increased awareness and support, there would be an additional driver for better integration at the government and academic levels. The proposed expansion of the federal food and nutrition program could be used to focus integrated research and extension by reaching out to those who need information and technical assistance immediately to improve their life choices. An additional issue identified by discussants was that the consuming public does not know what is factual in food and health claims. There is no good means of identifying what is scientifically sound, so some mechanism of establishing a seal of approval for accuracy was suggested.

Increased targeting of educational efforts was identified as an issue of growing importance. Extension and other outreach programs could focus on low-income audiences, because they are often at greater food and health risk. One participant identified the individualized client plan model that is being used at Alcorn State University, where outreach workers try to solve the problems of the family in totality—not only economic problems, but health, education, and any other problems with which a family is afflicted

At the same time, it is important to educate schoolchildren, who can take the message home to their parents, so that entire families can embrace healthy changes. Students need to have early exposure to the need for research and to what is involved. Some felt that there should be incorporation of more discussion into the whys of food choices and the hows of food production, rather than just saying that one should eat this or that food. Most young people do not see the direct connection among foods, the school lunch program, and the research associated with foods and the good outcomes associated with eating particular ways (nor do their parents with the food-stamp program). To accomplish these goals, some participants felt that state governments needed to ensure that teachers and administrators had the necessary resources.

Question five: Which technical research fields would be most amenable or of high importance to initial integration efforts?

Discussants responded to this question in two ways: Some suggested a paradigm shift in food and agriculture research programming: first determine the health benefit desired or the population most susceptible to a health condition, and then work backward from there to the development of a product that is acceptable to the public. Other discussants offered up a variety of suggestions for priority topics:

- Behavioral psychology of food choice and health
- Bioactive components of foods
- Comparative medicine
- Diabetes
- Economics of preventing long-term chronic illness related to diet and nutrition
- Emerging diseases
- Environmental health
- Evaluation of research
- Food engineering
- Genomics (toxicogenomics, nutritionomics)
- Geography
- Intellectual-property rights
- Marketing, education, and behavior
- Nutraceuticals
- Obesity
- Physical exercise and physical activity
- Probiotics
- Satiety
- Sustainable agriculture
- Toxicology

6

Summary

Speakers and participants addressed a wide array of issues related to food and health. They cited obesity, hunger, malnutrition, and diabetes as some of the major food-related health concerns. They described research pertaining to the use of various foods to treat or prevent chronic diseases, the role of foodborne pathogens in causing intestinal illnesses, and the need for improvements in biosecurity. Diet and food-related health concerns were seen as a driver for the movement toward a preventive health-care system.

Participants also discussed a variety of mechanisms for bringing together the nation's agriculture and health-care infrastructures with the goal of improving public nutrition and health. They pointed to models of successful integration in education, government, and the private sector, but they also cited many shortcomings, especially in institutional support of multidisciplinary research. Multidisciplinary teams made up of professionals in such fields as nutrition, medicine, public health, agricultural production, food technology, behavior, economics, and marketing are the key to defining and refining the underlying research that is necessary. Evaluation of the performance of those mechanisms was identified as a necessary component of a successful program.

The theme of consumer education and information emerged throughout the symposium. Many participants agreed that better education in diet and health

was needed at all levels and for all sectors of society, starting in early childhood. Participants expressed a wide range of opinions on whether consumers receive consistent and clear information about diet and health from the media and other sources. However, there was close agreement on the need for more research in the behavioral and social sciences to determine the factors behind consumers' dietary and lifestyle choices and the need to find ways to overcome resistance to healthier options.

Specifically, meeting attendees made the following suggestions:

- ***Form Interdisciplinary Bridges*** All too often, the food and health components of institutions, such as various colleges that belong to the same university, are cut off from each other and fail to work together to achieve common goals. Whether they are due to physical, conceptual, or historical barriers, these counterproductive arrangements need to be replaced to allow more synergy.

- ***Reevaluate Reward Structures*** Investigators are often trained and rewarded for individual work rather than teamwork, and a shift to multidisciplinary research requires a modification of reward structures. "Glue investigators," who would act as liaisons between individuals and teams, could help to resolve the issue.

- ***Revise Support Infrastructure*** Many issues are related to support—difficulties in obtaining adequate funds for nutrition-related research, funding inequities among federal agencies in amount and duration, and the need for more funding specifically earmarked for food–health research and training. A new institution that bridges agriculture and health may be needed.

- ***Identify a Champion*** A person or a body with high visibility and integrity is needed for a sustained campaign to promote awareness of the interdependence of food and health, and awareness of the need for increased research on this topic.

- ***Integrate Food–Health Research with Behavioral Studies*** There is awareness that behavioral and social factors influence food and lifestyle choices, but there is a dearth of specific knowledge about the issue, and it is crucial for further research.

- ***Begin Nutrition Education in Early Childhood*** Early education will reinforce healthful eating habits, which also could be conveyed from child to parent.

- ***Involve Leaders in Government and the Public*** Changes in agricultural policies, such as farm subsidies, and in production practices may be needed to provide consumers with healthier food choices. Participants suggested a number of avenues for change, including legislation.

At the close of the meeting, participants were left with the words of William Kirwan, Chancellor of the University System of Maryland, who expressed the hope of many of the participants that the workshop will be the catalyst for a new paradigm for research and education in food and health.

Appendix A

Agenda

A National Academies Workshop
EXPLORING A VISION:
INTEGRATING KNOWLEDGE FOR FOOD AND HEALTH

The National Academies Lecture Room
2101 Constitution Avenue NW
Washington, DC 20418
June 9, 2003
8:00 am to 5:30 pm

8:00 am **Welcome and Overview of Workshop**
Dr. Barbara P. Glenn, National Academies' Board on Agriculture and Natural Resources

8:30 am **Keynote Address:** *Meeting the Nation's Food and Health Challenges*
Dr. John H. Marburger, Director, White House Office of Science and Technology Policy

9:00 am **Panel Dialogue:** *Integrative Research Infrastructure for Food, Agriculture, and Health*

Dr. Charles C. Muscoplat, Vice President for Agricultural Policy and Dean of the College of Agricultural Food and Environmental Sciences, University of Minnesota
Dr. David B. Mallott, Associate Dean for Medical Education, University of Maryland School of Medicine
Dr. Cutberto Garza, Vice-Provost, Cornell University; Professor, Division of Nutritional Sciences, Cornell University, Cornell University
Dr. Eric Gugger, General Mills, Inc.
Dr. John H. Linehan, Vice President, Whitaker Foundation

10:30 am ***BREAK***

10:45 am **Panel Dialogue:** *Challenges Faced and Met in Research on Food and Health*
Dr. Harry G. Preuss**,** Professor of Medicine and Pathology, Georgetown University
Dr. Brian A. Larkins, Professor of Plant Sciences and Molecular & Cellular Biology, University of Arizona
Dr. Bruce A. Watkins, Professor and University Faculty Scholar, Director, Center for Enhancing Foods to Protect Health, Purdue University
Dr. Susan Sumner, Professor and Department Head, Department of Food Science and Technology, Virginia Tech University
Dr. Nancy M. Lewis**,** Associate Professor of Nutritional Science and Dietetics, Chair, Interdepartmental Nutrition Program, University of Nebraska
Dr. Linda J. Saif, Professor, Food Animal Health Research Program, Ohio State University

12:00 pm **Lunch**

1:00 pm **Luncheon Address:** *The Changing Landscape of the Food and Fiber System: Responses to the Public Health Challenge*
Under Secretary Joseph J. Jen, U.S. Department of Agriculture

1:30 pm **Setting the Stage:** *Incentives for Multidisciplinary Science*
Dr. Van S. Hubbard**,** Director, NIH Division of Nutrition Research Coordination; Chief, Nutritional Sciences Branch, National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health

1:45 pm **Charge to Breakout Groups**

Moderator: ***Dr. Daryl B. Lund,*** Professor, Department of Food Science; Executive Director, NCRA of State Agricultural Experiment Station Directors, University of Wisconsin

Question 1: Are food and health research and education currently conducted and managed to maximize scientific progress, incentives for collaboration, and benefits to the public health?
Question 2: What activities, programs, or initiatives currently exist in your institution, organization, or agency to address the challenges of improved integration of agriculture and health sciences? What gaps remain?
Question 3: What potential national initiatives could be implemented to address the challenges of improved integration of agriculture and health sciences?
Question 4: How can education and outreach contribute to improved research integration?
Question 5: Which technical research fields would be most amenable or of high importance to initial integration efforts?

2:00 pm **Breakout Groups**

3:30 pm ***BREAK***

3:45 pm **Report of Discussions**
Moderator: ***Dr. Daryl B. Lund***, University of Wisconsin

4:45 pm **Summary of the Workshop**
Dr. William E. Kirwan, Chancellor of the University System of Maryland

5:15 pm **Final Thoughts**
Dr. Barbara P. Glenn, National Academies' Board on Agriculture and Natural Resources

5:30 pm **Reception**
Closing Remarks: *Science to Improve Public Health and the Food System: Bridging the Divide*
Secretary Tommy G. Thompson, U.S. Department of Health and Human Services

Appendix B

Speaker Biographies

Dr. Cutberto Garza
Professor and Director, Division of Nutritional Sciences, Cornell University
Director, United Nations University's Food and Nutrition Program

Cutberto Garza is an internationally recognized expert on infant and maternal nutrition. He served as Director of the Division of Nutritional Sciences at Cornell University from 1988 to 1998 and as vice provost of Cornell University from 1998 to 2000. He was reappointed to the office of Director of the Division of Nutritional Sciences in 2003. He currently serves as a member of the Faculty of the Division of Nutritional Sciences at Cornell University and as the Director of the United Nations University's Food and Nutrition Program. Before moving to Cornell, he held the rank of Professor of Pediatrics at Baylor College of Medicine and served as associate director for the USDA/Baylor Children's Nutrition Research Center. He has served on numerous advisory groups for the United States government, National Academies of Science, World Health Organization, World Food Program, and other local and international agencies. Among these appointments are chair of the 1999 U.S. Dietary Guidelines Advisory Committee appointed by the Secretaries of Agriculture and Health and Human Services, co-chair of the U.S.-E.U. Biotechnology Forum, and member of the WHO Expert Consultative Group on the Optimal Duration of Exclusive Breastfeeding. He served as chair of the Food and Nutrition Board of the Institute of Medicine from 1996 to 2002. He currently chairs the World Health

Organization's Multicenter Growth Reference Study, a six-country effort designed to develop new international growth references for infants and young children. Among his past duties at Cornell University was oversight for the university-wide genomics initiative that includes efforts in plant, mammalian, microbial, and computational genomics, and genomic-related innovative technology development. He was the recipient of the 1996 Feinstein World Hunger Prize for Research and Education awarded by Brown University. He is a member of the Institute of Medicine of the National Academies of Sciences, and was named to the inaugural class of National Associates of the National Academies of Sciences last year, in recognition of his contributions to the work of the academies. Dr. Garza received his B.S. from Baylor University in 1969, an M.D. from Baylor College of Medicine in 1973, and his Ph.D. from the Massachusetts Institute of Technology in 1976.

Dr. Barbara P. Glenn
National Academies' Board on Agriculture and Natural Resources
Executive Vice President – Scientific Liaison, Federation of Animal Science Societies

Barbara P. Glenn is Executive Vice President and Scientific Liaison for the Federation of Animal Science Societies. She was previously a research scientist (dairy and animal) with the Agricultural Research Service, USDA, and has done extensive research in nutrient use by the lactating dairy cow for milk production, including effects of processing corn sources and forages on energy and protein digestion and excretion, and impact on environmental quality. Dr. Glenn is a past member of the FDA center for Veterinary medicine advisory Committee and past Chair of the Coalition on Funding Agricultural Research Missions (CoFARM). She is a fellow with the American Association for the Advancement of Science. She has served on numerous associations, boards and committees including President of the American Society of Animal Science, Board Member of the Federation of Animal Science Societies, and the American Dairy Science Association. Dr. Glenn earned both her B. S. (1975) and Ph.D. (1980) from University of Kentucky.

Dr. Eric Gugger
Technical Manager, Nutrition Science Group
Bell Institute of Health and Nutrition
General Mills Company

Eric Gugger and his group lead the process of creating meaningful health information for the General Mills businesses and brands by applying clinical trials, dietary intake research, and existing nutrition research. His primary area of responsibility is diet and heart disease. Prior to joining General Mills, Dr. Gugger worked for the Archer Daniels Midland Company as a Senior Nutrition Scientist, and therefore has had the opportunity to view nutrition and health

research from the perspective of an agro-processor/ingredient supplier, as well as from that of a consumer foods company. He is a graduate of the University of Illinois at Urbana Champaign, with a B.S. in Chemistry and a Ph.D. in Food Science.

Dr. Van S. Hubbard
Director, National Institutes of Health Division of Nutrition Research Coordination
Chief, Nutritional Sciences Branch, National Institute of Diabetes and Digestive and Kidney Diseases
National Institutes of Health

He is responsible for development of research initiatives and management of research programs related to the nutritional sciences and obesity. Dr. Hubbard has been at NIH since 1976 in various positions and is a Captain within the US Commissioned Corps of the Public Health Service. He currently is chair of the NIH Nutrition Coordinating Committee and is the Department of Health and Human Services liaison for the Interagency Committee on Human Nutrition Research. Dr. Hubbard serves as the NIH representative on numerous committees and work groups including various Healthy People 2010 work groups and is co-lead for the Nutrition and Overweight Focus Area and the development of the Surgeon General's Initiative to address overweight and obesity. Additionally, he serves on several non-federal committees such as the Committee on Nutrition of the American Academy of Pediatrics and the International Advisory Board of the Medical Nutrition Education Project at University of North Carolina at Chapel Hill. Other professional activities include serving as Professor of Pediatrics at the Uniformed Services University of the Health Sciences and as a member of the editorial boards of the Journal of Nutritional Biochemistry and the Journal of Parenteral and Enteral Nutrition. As a collateral duty, he has been the Commanding Officer of the Public Health Service Disaster Medical Assistance Team. Dr. Hubbard has received many honors from the US government, such as the Certificates of Appreciation from agencies within the Department of Health and Human Services, the Federal Emergency Management Agency, and US Department of Agriculture. He also has been awarded two HHS Secretary's Awards for Distinguished Service, the USPHS Outstanding Service Medal, and two Meritorious Service Medals. Dr. Hubbard is a Diplomate of the National Board of Medical Examiners and Fellow of the American Academy of Pediatrics. In 2000, he was made an Honorary Member of the American Dietetic Association. In 2002, he received the George Bray Founders Award from the North American Association for the Study of Obesity. He received his Ph.D. in biochemistry and his M.D. degree from the Medical College of Virginia, Virginia Commonwealth University. Prior to coming to NIH, he completed an internship and his residency in the Department of Pediatrics at the University of Minnesota Hospitals. His major research

interests are clinical nutrition, obesity, cystic fibrosis, essential fatty acid metabolism, and nutritional modulation of disease risk.

Dr. Joseph J. Jen
Under Secretary for Research, Education, and Economics
U.S. Department of Agriculture

Joseph J. Jen was sworn in as the under secretary for research, education, and economics by Agriculture Secretary Ann. M. Veneman on July 17, 2001. He oversees four agencies of the U.S. Department of Agriculture: the Agricultural Research Service; the Cooperative State Research, Education, and Extension Service; the Economic Research Service; and the National Agricultural Statistics Service. Dr. Jen is a widely recognized agricultural scientist and educator, with experience in both the public and private sectors. Since 1992, Dr. Jen has served as the dean of the College of Agriculture at California Polytechnic State University in San Luis Obispo. In this capacity, Dr. Jen oversaw eleven departments with 3,500 students, 250 faculty and staff, and a budget in excess of $30 million. From 1986 to 1992, Dr. Jen was division chairman of the University of Georgia's Division of Food Science and Technology in Athens, Georgia. He served as director of research at the Campbell Institute of Research and Technology for the Campbell Soup Company from 1980 to 1986. He was an associate professor at the Department of Food Science and Human Nutrition at Michigan State University in 1979. Dr. Jen was a food science and biochemistry professor at Clemson University from 1969 to 1979. From 1975 to 1976, he served as a research food technologist at the Horticultural Research Institute for the U.S. Department of Agriculture's Agricultural Research Service in Beltsville, Maryland. Dr. Jen was elected as a Fellow of the Institute of Food Technologists in 1992, and received the Distinguished Educator Award from the National Association of Colleges and Teachers of Agriculture in 1999. In 2002, he was honored by Washington State University with the Graduate Alumni Achievement Award. Dr. Jen received his B.S. degree in agricultural chemistry from National Taiwan University in 1960. He earned a M.S. degree in food science from Washington State University in 1964 and a Ph.D. degree in comparative biochemistry from the University of California at Berkeley in 1969. He also received an M.B.A. from Southern Illinois University in 1986.

Dr. William E. Kirwan
Chancellor of the University System of Maryland

William English Kirwan became the third chancellor of the University System of Maryland in 2002. Dr. Kirwan was appointed to this position after serving as President of Ohio State University for four years, and as President of the University of Maryland, College Park for nine years. Prior to his presidency, he was a member of the University of Maryland faculty for 34 years. Dr. Kirwan received his bachelor's degree in mathematics from the University of Kentucky

and his master's and doctoral degrees in mathematics from Rutgers, The State University of New Jersey, in 1962 and 1964, respectively. He is a member of several honorary and professional societies, including Phi Beta Kappa, Phi Kappa Phi, the American Mathematical Society, and the Mathematical Association of America. He is co-editor of the book Advances in Complex Analysis and has published many articles on mathematical research. As Chancellor, Dr. Kirwan has launched numerous initiatives both to enable the University System of Maryland to make progress toward its legislative mandate of national eminence, and to focus on the importance of access and affordability. An internal review of the USM Strategic Plan will add a focused Vision Statement and Values Component to go along with the goals. The work of the Tuition Task Force will produce a straight-forward, easily understandable, more market-driven approach to tuition rates. The Efficiency and Effectiveness workgroup will continue its efforts to identify innovative ways to achieve the USM objectives in a cost-effective manner. Dr. Kirwan is Chair-elect of both the American Council on Education (ACE) and the National Association of State Universities and Land-Grant Colleges (NASULGC). He also serves on the board of directors of the Business-Higher Education Forum, the National Visiting Committee for the National Science Digital Library, and was a member of the Blue Ribbon Panel of the National Dialogue on Student Financial Aid. As a member and past-Chair of the NCAA Division I Board of Directors, Dr. Kirwan worked to enhance the Association's rules for initial eligibility of student-athletes and to strengthen "progress toward degree" requirements for student-athletes. His other leadership roles have included service as chair of NASULGC's Commission on International Affairs, chair of its Council of Presidents, and of its Commission on Human Resources and Social Change. He also chaired the National Research Council's Commission on the Mathematical Sciences in the Year 2000, which produced the report, Moving Beyond Myths: Revitalizing Undergraduate Mathematics. Dr. Kirwan was appointed by President Clinton to serve as a member of the National Commission on Mathematics and Science Teaching for the 21st Century and by President Bush to the Board of Advisors for Historically Black Colleges and Universities. Dr. Kirwan was elected to the 2002 class of the Fellows of the American Academy of Arts and Sciences.

Dr. Brian A. Larkins
Professor of Plant Sciences and Molecular and Cellular Biology
University of Arizona

Brian A. Larkins is a Professor of Plant Sciences and Molecular and Cellular Biology at the University of Arizona. His research has focused on the regulation of seed development and the synthesis of seed storage proteins, using a molecular genetic approach to investigate the biology of seed storage protein synthesis to increase the levels of these essential amino acids. These studies

have attempted to define the structure of storage proteins, the mechanisms by which they are synthesized and deposited in seed tissues, and the genes that regulate these processes. In his postdoctoral work at Purdue University, Dr. Larkins focused on characterizing the mechanism by which maize storage proteins (zeins) are synthesized and determining the mechanism by which their synthesis is altered in various endosperm mutants. He developed methods for isolating polysomes containing zein mRNAs and synthesizing zeins in vitro. This work was followed the isolation of zein mRNAs, and the genes encoding them were then cloned and characterized. Current work focuses on trying to understand the mechanisms by which these proteins assemble into protein bodies and influence the texture (hardness) of the endosperm. Dr. Larkins received his undergraduate degree in biology in 1969 from the University of Nebraska, after which he spent a year teaching high school biology. He then returned to the University of Nebraska, where he earned a Ph.D. in botany.

Dr. Nancy Lewis
Professor of Nutritional Science and Dietetics
University of Nebraska

Nancy Lewis is an Associate Professor of Nutritional Science and Dietetics in the College of Human Resources and Family Sciences at the University of Nebraska. Her research interests focus on diet and health relationships, disease prevention, omega-3 fatty acids, outcomes research, and prenatal nutrition intervention. Specifically, Dr. Lewis explores nutrition interventions that reduce chronic disease risk and effectiveness or outcomes research in nutrition care settings, identifying effective nutrition education and counseling interventions that will result in more healthy eating behaviors. This includes the design of research studies to document the most effective nutrition care services across different health care settings. Results of effectiveness or outcomes research can be used to guide practitioners in developing "best practice" models. Dr. Lewis also participates in a regional research project on omega-3 fatty acids and health maintenance, and has conducted human studies showing that the omega-3 fatty acid enriched egg is a healthy and viable source of the omega-3 fatty acids in Midwestern diets. Additional research has included prenatal nutrition intervention studies to document a defined protocol for in-home nutrition education and counseling in both Caucasian and African American women, and these studies have documented a reduction in the incidence of low birth weight among African American women using the defined nutrition intervention protocol. Dr. Lewis's career has included work with governmental health agencies; the American Dietetic Association, the American Association of Family and Consumer Sciences, the American Society of Nutritional Sciences, and the American Society of Clinical Nutrition. In 1968, Dr. Lewis received her Bachelor of Science in dietetics from New Mexico State University, her M.S. in

nutrition in 1973 from Iowa State University, and her Ph.D. in nutrition from the University of Nebraska in 1985.

Dr. John H. Linehan
Whitaker Foundation
Dr. Linehan was appointed Vice President of The Whitaker Foundation January 1, 2001. He had been Vice President, Biomedical Engineering Programs, since August 1, 1998. Prior to joining the foundation, he was the Bagozzi professor of biomedical engineering and the founding chairman of the department of biomedical engineering at Marquette University. He also was adjunct professor of physiology and medicine (pulmonary and critical care) at the Medical College of Wisconsin. Dr. Linehan was President (1999-2000) and a Founding Fellow (1993) of the American Institute for Medical and Biological Engineering. He was President of the Biomedical Engineering Society (1992-93) and named a Fellow of the American Society of Mechanical Engineering (1991). His interests in educational issues include leadership, curriculum development, teaching materials, and continuing education. He has published over 300 research articles, chapters, and abstracts and served as major professor for 36 graduate students.

Dr. Daryl B. Lund
U.S. Department of Agriculture's Executive Director of the North Central Agricultural Experiment Station Directors
University of Wisconsin
Daryl B. Lund earned a B.S. degree in mathematics at the University of Wisconsin-Madison, and a Ph.D. in food science with a minor in chemical engineering, also from the University of Wisconsin. During twenty-one years at the University of Wisconsin, he was a Professor of food engineering in the Food Science Department, served his last three years at University of Wisconsin as chair of the department and contributed over 150 scientific papers, edited five books, and co-authored a major text book in the area of simultaneous heat and mass transfers in foods, kinetics of reactions in foods, and food processing. In 1988, he continued his administrative responsibilities by chairing the Department of Food Science at Rutgers University, and from December, 1989 through July, 1995, served as the Executive Dean of Agriculture and Natural Resources with responsibilities for teaching, research, and extension at Rutgers University. From 1995 through 2000, he served as dean of Cornell University's College of Agriculture and Life Sciences. He is currently located at the University of Wisconsin, Madison, and serves as the Executive Director of the North Central Agricultural Experiment Station Directors.

Dr. David B. Mallott
Associate Dean for Medical Education
University of Maryland

David B. Mallott currently serves as the Associate Dean for Medical Education and the Director of the Office of Medical Education at the University of Maryland School of Medicine. Prior to becoming Associate Dean, Dr. Mallott was a Professor of Psychiatry and Adjunct Professor in the Department of Internal Medicine at the University of Maryland School of Medicine. He has also held numerous clinical positions, including as a Psychiatrist at the Baltimore Veteran's Administration Hospital and as Clinical Director of the Walter P. Carter Center in Baltimore, Maryland. Dr. Mallott earned a B.S. degree in biology from Swarthmore College, and an M.D. from the University of Pittsburgh School of Medicine. He is currently a member of the American Psychiatric Association, the American College of Psychiatrists, and the.Association of Medical Colleges' Group on Educational Affairs and Group on Information Resources. Dr. Mallott is also a visiting faculty member and science advisor for The Genetics Adjudication Resource Project at The Einstein Institute for Science, Health and the Courts.

Dr. John Marburger
Director
White House Office of Science and Technology Policy

John H. Marburger, III, is the President's Science Advisor and Director of the Office of Science and Technology. Dr. Marburger is the former Director of the U.S. Department of Energy's Brookhaven National Laboratory and President of Brookhaven Science Associates. He is presently on a leave of absence from the State University of New York at Stony Brook, where he served as President and Professor from 1980 to 1994 and as a University Professor of Physics and Electrical Engineering from 1994 to 1997. Dr. Marburger served as the Dean of the College of Letters, Arts, and Sciences at the University of Southern California from 1976 to 1980. He has been a member of numerous professional, civic, and philanthropic organizations including the Universities Research Association, the Advisory Committee to the New York State Senate Committee on Higher Education and the Board of Directors of the Museums at Stony Brook. He is a graduate of Princeton University and received a Ph.D. in Applied Physics from Stanford University

Dr. Charles C. Muscoplat
Vice President for Agricultural Policy
Dean of the College of Agricultural Food and Environmental Sciences
Director of the Minnesota Agricultural Experiment Station
University of Minnesota

Charles C. Muscoplat is Vice President for Agricultural Policy; Dean of the College of Agricultural Food and Environmental Sciences, and Director of the Minnesota Agricultural Experiment Station. Dr. Muscoplat also holds positions as Professor of Medicine and Microbiology in the Medical School and Professor of Animal Science in the College of Agricultural Food and Environmental Sciences. From 1981 until 1999, Dr. Muscoplat was Vice President for Medical Affairs at MGI PHARMA, Inc., as well as holding other senior management positions. Dr. Muscoplat was instrumental in bringing several biotechnology and biopharmaceutical products to the market between 1983 and 1999. These products include the countries first agricultural biotechnology developed corn plant and disease preventing monoclonal antibody for livestock. In addition, Dr. Muscoplat developed new drug therapies for cancer patients undergoing radiation therapy for head and neck cancer and also for patients with the autoimmune disease, Sjogrens Syndrome. From 1976 until 1981, Dr. Muscoplat was a faculty member at the University of Minnesota, College of Veterinary Medicine. Additionally, Dr. Muscoplat has served as a member of several national Advisory Committees including the National Academy of Sciences, National Research Council's Board on Agriculture, Board on Science and Technology for International Development, Research Advisory Committee of the U.S. State Department and Agency for International Development, and the Committee for Applied Science and Technology, a program to foster greater collaboration between scientists of the United States and Russia and the Newly Independent States of the Former Soviet Union. Dr. Muscoplat received his bachelor's degree in Chemistry in 1970 with a minor in Mathematics, and a Ph.D. in Veterinary Microbiology in 1975 from the University of Minnesota.

Dr. Harry G. Preuss
Professor of Physiology, Medicine, and Pathology
Georgetown University Medical Center

Harry G. Preuss received his B.A. and M.D. from Cornell University, trained for three years in Internal Medicine at Vanderbilt University Medical Center, studied for two years as a fellow in renal physiology at Cornell University Medical Center, and two more years in clinical and research training in Nephrology at Georgetown University Medical Center. He then worked as an Assistant and Associate Professor of Medicine at the University of Pittsburgh Medical Center for five years. He returned to Georgetown and is now a Professor of Physiology, Medicine, and Pathology. Recently, he performed a six months sabbatical in molecular biology at the National Institutes of Health

(NIH). His bibliography includes over 300 medical papers more than 200 abstracts. Dr. Preuss has edited or co-edited six books and three symposia. He is the co-author of two books written for the lay public: "The Prostate Cure" and "Maitake Magic." He was a special research fellow of the NIH in 1966, and an Established Investigator of the American Heart Association between 1967 and 1972. In 1976, Dr. Preuss was elected to membership in the American Society of Clinical Investigations. He is currently an advisory editor for six journals. His previous government appointments include the Advisory Council for the National Institute on Aging, the Advisory Council of the director of the NIH, and the Advisory Council for the Office of Alternative Medicine of the NIH. He has been a member of many other peer research review committees for the NIH and American Heart Association, and was recently appointed to membership on the National Cholesterol Education Program of the National Heart, Lung, and Blood Institute. Dr. Preuss has been invited as a feature speaker at many meetings and has participated in discussions concerning nutrition on audio and visual tapes, as well as live television. Dr Preuss was recently elected the ninth Master of the American College of Nutrition (ACN). He is a former chairman of the Hypertension Council of the ACN and the Council on Dietary Supplements, Nutraceuticals, and Functional Foods. Dr. Preuss has also served as Secretary-Treasurer, Vice President, President-Elect, and President. He was elected president of the Certification Board for Nutrition Specialists, and is now co-chair of the Institutional Review Board, which reviews all clinical protocols at Georgetown University Medical Center.

Dr. Linda Saif
Ohio Agricultural Research and Development Center
Ohio State University

Linda Saif is a professor and researcher with Ohio State University's Ohio Agricultural Research and Development Center (OARDC), working on the mechanisms of immunity against intestinal infections. Dr. Saif's research focuses on enteric and respiratory viruses, including rotaviruses, caliciviruses and corona viruses, which cause mortality and morbidity in both food-producing animals and humans. During the past 30 years, she has identified new intestinal viruses and developed diagnostic tests and research methods for working with them in the laboratory. Furthermore, she discovered viruses that cause intestinal diseases in livestock and developed methods for their control including passive immunization strategies to prevent viral diarrheas in neonatal animals. She is also credited with discovering the potential of enteric viral infections in animals to infect human populations. Her contributions to mucosal immunology and intestinal virology have had major impacts on animal and human health research and vaccine development. One example is Dr. Saif's ongoing effort to develop safe and effective vaccines for rotavirus diarrhea, which kills nearly half a million children annually. Dr. Saif earned her bachelor's degree from the

College of Wooster in 1969, and received her master's degree (1971) and doctorate (1976) in microbiology/immunology from Ohio State. She has been an OARDC faculty member since 1979, garnering more than $14 million in research grants and publishing numerous articles in books and professional journals. In 2002, Dr. Saif became the first Ohio State researcher not based on the Columbus campus to be recognized as a Distinguished University Professor, and was awarded an honorary doctorate by Belgium's Ghent University. She is an elected member of the National Academy of Sciences.

Dr. Susan Sumner
Professor and Department Head
Department of Food Science and Technology
Virginia Polytechnic Institute and State University
Susan Sumner received her B.S. in Food Science from North Carolina State University and her M.S. and Ph.D. in Food Science/Food Safety from the University of Wisconsin. Dr Sumner then joined the microbiology staff of the National Food Processors Association in 1987 as a project microbiologist. In 1990, she joined the Food Science and Technology faculty at the University of Nebraska-Lincoln as an Assistant Professor, and was subsequently appointed as Associate Professor. In August 1996, she joined the Food Science faculty at Virginia Tech as an Associate Professor and Extension Microbiologist. She is now Professor and Head of the Department. Since joining the Food Science and Technology Department at Virginia Tech, Dr. Sumner has continued her research interests into edible films as microbial barriers and decontamination of pathogenic microorganisms on fresh produce and poultry. Dr. Sumner's extension focus is food safety education for the food industry. Each year, she conducts food safety workshops for the food industry. The workshops include "Implementing a HACCP Program," "Verification, Validation, and Recalls," and "Basic Food Microbiology." An acidified food school is also offered for small processors and regulators. Dr. Sumner teaches Food Microbiology, which covers food borne disease organisms, natural toxins, control measures, thermal death time, and bio processing. Dr. Sumner has also taught Concepts of Food Product Development, which provides information on ingredient functionality as well as teamwork skills that students will need in the food industry.

The Honorable Tommy G. Thompson
Secretary
U.S. Department of Health and Human Services
Health and Human Services Secretary Tommy G. Thompson is the nation's leading advocate for the health and welfare of all Americans. He is the 19th individual to serve as Secretary of the department, which employs more than 60,000 personnel and has a fiscal year 2003 budget of nearly $503 billion. Since becoming Secretary of Health and Human Services, Secretary Thompson has

launched major initiatives to respond to strengthen the nation's preparedness for a bioterrorism attack; substantially increase funding for the National Institutes of Health; reorganize the Centers for Medicare and Medicaid Services to encourage greater responsiveness and efficiency; clear the backlog of waivers and state plan amendments, approving 1,400, and thereby provide health insurance to 1.8 million lower-income Americans throughout the nation; urge all Americans to prevent disease by focusing on critical health areas, such as obesity, diabetes and health disparities; and take the next bold step to continue making welfare a path to employment and opportunity. Secretary Thompson has dedicated his professional life to public service, most recently serving as governor of Wisconsin since 1987 to 2001. Secretary Thompson made state history when he was re-elected to office for a third term in 1994 and a fourth term in 1998. During his 14 years as governor, Secretary Thompson focused on revitalizing Wisconsin's economy. He also gained national attention for his leadership on welfare reform, expanded access to health care for low-income people, and education. Secretary Thompson began his career in public service in 1966 as a representative in Wisconsin's state Assembly. He was elected assistant Assembly minority leader in 1973 and Assembly minority leader in 1981. Secretary Thompson has received numerous awards for his public service, including the Anti-Defamation League's Distinguished Public Service Award. In 1997, the Secretary received Governing Magazine's Public Official of the Year Award, and the Horatio Alger Award in 1998. The Secretary has also served as chairman of the National Governors' Association, the Education Commission of the States, and the Midwestern Governors' Conference. Secretary Thompson also served in the Wisconsin National Guard and the Army Reserve.

Dr. Bruce Watkins
Professor and University Faculty Scholar of Food Science, Purdue University
Adjunct Professor of Anatomy, Department of Anatomy and Cell Biology, School of Medicine, Indiana University Purdue University Indianapolis

Dr. Bruce Watkins is Professor and University Faculty Scholar of Food Science, Purdue University, and Adjunct Professor of Anatomy, Department of Anatomy and Cell Biology, School of Medicine, Indiana University Indianapolis. Bruce is the director of the Center for Enhancing Foods to Protect Health (EFPH) at Purdue University. The Center's mission is to conduct research on and provide education for designed/functional foods and nutraceuticals to reduce disease risk and improve health in humans and companion animals and optimize the delivery of these functional components. The Center for EFPH is the first multidisciplinary and multi-institutional effort with a mission to develop analytical methods for phytochemicals, optimize the health protectant capacity of food, and create delivery systems for functional foods to reduce disease risk

and improve health. The center has faculty participants from the Schools of Agriculture, Veterinary Medicine, Consumer and Family Sciences, Pharmacy and Pharmaceutical Sciences, Liberal Arts, and the Indiana University School of Medicine. Dr. Watkins' research interests include food lipids, lipid biochemistry, eicosanoid and growth factor regulation of bone modeling, antioxidant nutrient interactions in chronic disease, plant phytochemicals, and nutrient-gene regulation. His research on functional foods with the poultry industry led to the development of designer eggs that are marketed in the United States. Dr. Watkins is an author for more than 100 publications. He has given 50 national and international invited talks since 1993. In addition, he serves on five editorial boards for nutrition and food science related journals. He teaches courses on lipid chemistry, nutritional sciences, and functional foods. Dr. Watkins received the PSA national research award for his investigations on biotin metabolism in 1990, and in 1994 was presented the BioServ Award from the American Society of Nutritional Sciences for his research on the biochemistry of fatty acids in bone. He was the recipient of the 1999 Research and Development Award from the Institute of Food Technologists for his work on lipids and growth factors in bone metabolism. Dr. Watkins obtained his B.S. and M.S. degrees in Nutrition from Colorado State University and the Ph.D. degree in Nutrition and Physiological Chemistry from the University of California, Davis in 1985.

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