

**Action Plan: National Program 107 – Human Nutrition
2009 – 2013**

Goal: National Program (NP) 107, *Human Nutrition*, aims to improve the nutrition and health of the American people by enhancing the quality of the American diet and improving related health behaviors through research. Distinctive aspects of NP107 research include an emphasis on a food-based approach to improving health; the core capability to sustain long-term research in areas deemed of high priority for the Nation’s health; the availability of state-of-the-science equipment and facilities for human research across the lifecycle; and the conduct of multidisciplinary research to improve the American food supply. Unique national resources that are part of NP 107 include the National Nutrient Databank laboratory, the “What We Eat in America” survey group, and a laboratory that develops and improves methods for food analysis.

The U.S. food supply provides high quality foods that allow people to meet their nutritional requirements at lower relative cost than in any setting in history. Because of the wide variety of inexpensive, convenient, and tasty foods available, it is easy for people to consume too many calories and insufficient essential nutrients unless they have access to and implement relevant knowledge. Improper nutrition, in combination with a sedentary lifestyle, contributes to obesity, type 2 diabetes, hypertension, cardiovascular disease, some types of cancer, gallbladder disease, and osteoarthritis. At least 7 in 10 Americans will be affected by one or more of these conditions.

NP 107 aims to identify nutritive and health-promoting components in foods, to evaluate the nutritional value of diets eaten by people in America, to determine how consumption of specific foods or food components in combination with appropriate physical activity can enhance the health of the population, and to develop strategies to improve food choices and modify related lifestyle factors (e.g., increase physical activity) to promote health in Americans. This knowledge provides valuable information to policy makers, farmers, food processors and manufacturers, and consumers.

NP 107 is not aimed at treating or curing disease but is focused on maintaining health and preventing disease through food-based recommendations. In the past, nutrition research addressed nutrient requirements to avoid deficiencies, which are now of less concern in the United States. Rather, over-consumption and caloric imbalance have become more significant issues for the average American. Further, individuals respond differently to dietary interventions, prompting the need for “personalized” nutrient requirements; to meet this need, ARS nutrition research has begun to incorporate genomic and metabolomic technologies. Researchers are also actively investigating non-nutrient components (i.e., those with no known human requirement) of foods, such as a variety of plant chemicals that have health-promoting activities. Partnerships with other federal, non-profit, and industry agencies/groups allow ARS to leverage funds and build upon common research goals. NP 107 addresses four over-arching components:

- Nutrition Monitoring and the Food Supply
- Scientific Basis for Dietary Guidance for Health Promotion and Disease Prevention
- Prevention of Obesity and Related Diseases
- Life Stage Nutrition and Metabolism

Relationship of This National Program to the ARS Strategic Plan: Outputs of NP 107 research support the “Actionable Strategies” associated with the performance measures shown below from the ARS Strategic Plan for 2006-2011, Objective 5.2: *Promote Healthier Eating Habits and Lifestyles*.

Performance Measure 5.2.1: Monitor food consumption/intake patterns of Americans, including those of different ages, ethnicity, regions, and income levels, and measure nutrients and other beneficial components in the food supply. Provide the information in databases to enable ARS customers to evaluate the healthfulness of the American food supply and the nutrient content of the American diet. **Target:** Databases on food composition and nutrient intake will be used by ARS customers to conduct human nutrition research; to establish Federal dietary policy guidelines, food assistance and feeding programs, and food labeling; and to develop nutrition education tools to improve the health of the American people.

Performance Measure 5.2.2: Define the role of nutrients, foods, and dietary patterns in growth, maintenance of health, and prevention of obesity and other chronic diseases. Assess bioavailability and health benefits of food components. Conduct research that forms the basis for and evaluates nutrition standards and Federal dietary recommendations. **Target:** ARS research results will be used in authoritative reports on national human nutrition standards and dietary guidance as well as to establish Federal nutrition policy and regulations to safeguard the health of the American people.

Performance Measure 5.2.3: Publish research findings not encompassed under the other performance measures for this objective likely to significantly advance the knowledge of human nutrition, extensively influence other researchers in the same or related field, or yield important new directions for research. **Target:** Research studies will be published in peer reviewed literature that will strongly influence the field of human nutrition and/or demonstrate impact through high citation rates.

Component 1: Nutrition Monitoring and the Food Supply

The food choices Americans make are dynamic and reflect an ever-changing U.S. food supply. Because foods and their health-promoting components are fundamental to maintaining optimal health and lowering risk for chronic disease, it is essential to have accurate and up-to-date information about the composition of foods and the nutrient intake of Americans. Furthermore, research to elevate health-promoting components in crops will help provide Americans with a more nutritious food supply.

Problem Statement 1A: Determine Food Consumption and Dietary Patterns of Americans.

“What We Eat in America, NHANES,” the only nationally representative dietary survey conducted in the United States is carried out in partnership with the Department of Health and Human Service’s National Center for Health Statistics. ARS will continue to collect, disseminate, and evaluate the food and nutrient intake data plus develop methods and systems for dietary data collection, processing, and quality control to support the survey. This dietary survey information has broad research and policy applications, e.g., monitoring the nutritional adequacy of American diets, measuring the impact of food fortification on health, developing dietary

policy such as the *Dietary Guidelines for Americans*, estimating exposure of population groups to food contaminants, evaluating the nutritional impact of USDA food assistance programs, and assessing demand for agricultural products.

Research Needs:

The survey's significant public policy and health assessment applications mandate the collection, analysis, and release of accurate and high quality data on a timely basis. Thus, the dietary intake of the national population must be sampled representatively and the data collected each year; new technological innovations utilized for dissemination; improved dietary collection methods developed and validated with objective biomarkers of dietary intake; and dietary data analyses on the nutritional health of the American population released in a timely manner.

Anticipated Products:

- Biennial release of nationally representative data on the food and nutrient intake of Americans.
- New information on enhanced dietary assessment methods to improve the study of diet and health relationships.
- Knowledge of the food intake, dietary patterns, and nutritional adequacy of Americans, including population subgroups of varying ages, ethnicities, and income levels; and interpretation of the data relative to food and nutrition policy and programs.

Potential Benefits:

- Monitoring the diets of Americans on a continuing basis will inform future research needs, guide food and nutrition interventions, and help create policies to support health and minimize disease in the United States.

Problem Statement 1B: Determine Food Consumption and Dietary Patterns of “At-Risk” Populations in the United States.

The prevalence of many nutrition related health problems is greater for minority, rural, low socio-economic, and some ethnic groups, which has led to the designation of “at-risk” populations. Some pockets of at-risk populations are not sampled in national surveys. Rather, populations with similar demographic characteristics are used to represent these at-risk groups with the role of culture, ethnicity, attitudes, beliefs toward food, and food availability concerns not taken into account. Small regional surveys as well as longitudinal and epidemiological studies are needed to better understand the role of food, physical activity, and related behaviors contributing to the health disparities of these populations.

Research Needs:

ARS scientists will collect and evaluate data on food consumption, dietary patterns, food choices, physical activity, and related behaviors and health disorders in at-risk communities and populations not usually sampled in the national survey. This could include minority (African Americans, Hispanic, and Native American populations), rural, low socio-economic, and vulnerable age groups, such as children and the elderly. This information will provide reference data from which appropriate nutrition and health interventions can be developed and best practices determined to reduce the health

disparities within these populations. Culturally and linguistically appropriate methods and instruments will be specifically designed/adapted and validated for these sub-groups.

Anticipated Products:

- Knowledge of food choices, food and nutrient intake, dietary patterns, and physical activity of at-risk population sub-groups not sampled in the national survey.
- New culturally appropriate and validated methods for measuring dietary intake, physical activity, and related behaviors for these population sub-groups.
- New information on food availability and accessibility of these at-risk populations to inform policy decisions at the state and national level.

Potential Benefits:

- The research will provide new knowledge to inform nutrition and food policy and food assistance programs with the aim of lessening health disparities for at-risk populations.

Problem Statement 1C: Provide U.S. Food Composition Data

ARS provides nationally representative food and dietary supplement composition data that are critical to the support of nutrition monitoring, nutrition research, food regulation, labeling, and trade, and to the development of dietary guidance and education. This task is challenging because of a rapidly changing U.S. food supply, evolving consumer food choices, and growing demand for data on newly discovered, potentially health-promoting food components. Partnerships are critical to accomplishing this work. ARS and the Department of Health and Human Services are partnering on the National Food and Nutrient Analysis Program (NFNAP) that enables nutrient analyses of foods that are major contributors of nutrients and other health promoting food constituents in the U.S. food supply. The Dietary Supplement Ingredient Database is also being created through this program partnership. The National Institutes of Health's National Cancer Institute and Office of Dietary Supplements are lead DHHS agencies for NFNAP.

Research Needs:

There is a need for food composition data for essential nutrients as well as new, potentially health-promoting compounds. Accurate and current food and dietary supplement composition databases must be compiled and maintained utilizing appropriate and standardized approaches for data acquisition, evaluation, compilation, and dissemination. To support these objectives, research is needed on methods of statistical sampling, composition analyses, and quality control, and must include the development of state-of-the-art analytical methods for food and dietary supplement composition analyses.

Anticipated Products:

- Current and accurate food and dietary supplement databases for essential nutrients and health-promoting components.
- New and improved analytical methods for food constituents and libraries of essential nutrient and health-promoting compound profiles.

Potential Benefits:

- Accurate, up-to-date, nationally representative food and dietary supplement composition information will improve nutrient intake data and create a better understanding of the relationship between diet and health for the American population.

Problem Statement 1D: Enhance the Health-Promoting Quality of the Food Supply

Plant and animal food products provide a broad range of nutrients and health-promoting non-nutrient components that help reduce the risk of diet-related chronic diseases and promote healthier lives for all. Knowledge of how these components of the food production continuum influence the quality of the final food product is critical to assuring the availability of a nutritious food supply. However, the density of these components varies from food to food, due to both genetic attributes as well as environmental factors. These influences include crop production practices, traditional breeding or genetic modification of food crops, environmental variables such as water, temperature, or atmospheric carbon dioxide, and post-harvest processing methods, all which can lead to changes in the nutritional quality and health-promoting composition of foods. This knowledge is essential to devising and executing new strategies that will further enhance the health-promoting qualities of foods.

Research Needs:

There is a need for data on the influence of different production practices and associated environmental factors on the nutritional and health-promoting quality of foods. Expression and functional analyses of the genes and gene products that regulate the uptake, movement, and deposition of essential mineral elements in food organisms are required to identify gene candidates for molecular breeding. Similarly, methods to identify and functionally analyze the genes responsible for the synthesis of health-promoting constituents or for the synthesis of non-nutritive food components that enhance or inhibit the bioavailability of dietary nutrients are also needed. Research involving proof-of-concept conventional or transgenic breeding strategies will be pursued to assess nutritional benefits.

Anticipated Products:

- New information about the effects of production practices and environmental conditions on the nutritional quality of the U.S. food supply in terms of nutrient content and bioavailability.
- Knowledge of individual genes that control the accumulation of essential nutrients or the synthesis of health-promoting components in foods.

Potential Benefits:

- This research will lead to the development of agricultural products and new plant cultivars with higher nutritional and health-promoting value.

Component 2. Scientific Basis for Dietary Guidance for Health Promotion and Disease Prevention

Dietary guidance focuses on identification of dietary (foods, nutrients, and health-promoting components), physical activity, and other lifestyle practices linked to maintaining health and preventing specific diseases. Such guidance is used as the basis for federal food and nutrition policy, which, in turn, has significant economic and societal impacts. To be of greatest use, dietary guidance should be based on appropriate scientific evidence. The process of developing this guidance involves not only identifying potential factors of interest and their molecular and cellular mechanisms of action, but also substantiating such effects in controlled intervention trials. Enhanced understanding of the needs of individuals within the U.S. population, particularly with respect to genetic differences and lifecycle stage, will improve the usefulness of this information for eventual development of individualized dietary guidance. Research is also needed to determine how best to communicate this scientific information to the public.

Problem Statement 2A: Identify Roles of Food, Nutrients, Food Components, and Physical Activity in Promoting Health and Preventing Disease

Diet-related diseases are a major public health concern in the United States. Population-based research has linked dietary patterns and the intakes of specific nutrients or other food components with health maintenance and decreased risk of disease. At the same time, advances in laboratory sciences have created new tools and opportunities that have deepened the understanding of how foods, nutrients, and other food components, along with physical activity, can promote health and prevent disease. ARS research will elucidate the roles of food components in minimizing the risk of diseases such as cardiovascular disease and cancer as well as in maintaining physiological functions necessary for optimal health and well-being, including sensory systems (such as vision), immune competence, brain function, reproductive systems, gastrointestinal health, bone health, and muscular function.

Research Needs:

Researchers will work to generate knowledge of how foods, nutrients, health-promoting food components, and physical activity affect metabolic and physiologic factors related to risks of disease/dysfunction. This work will include improving knowledge of biologically active food components, i.e., their bioavailability, metabolic mechanisms of action, and effects on receptive/sensitive population sub-groups and/or phenotypes. Also, new tools are needed to assess exposures and impacts on molecular/cellular mechanisms of nutrients and other food components in optimizing healthy physiologic and cognitive functions at all stages of the lifecycle. Research will focus on nutrients and other health-promoting food components of high public health significance.

Anticipated Products:

- Improved knowledge of mechanisms whereby foods and biologically active food components, as well as physical activity and lifestyle factors alter physiological functions.
- Measurement of bioavailability of nutrients and food components and factors that modulate their levels in the body.
- Demonstration in cell and animal model systems that these factors reduce the risk of disease/dysfunction.

- Evidence that specific foods, nutrients, food components, and physical activity improve health in human studies.

Potential Benefits:

- An improved understanding of how health-promoting food components support health and reduce risk of disease will enable the design of better research studies to increase knowledge on the linkage of diet to health.
- More accurate data on the relationship between nutrition, physical activity, and health will lead to better estimates of requirements, metabolic consequences, and recommendations for optimal intake levels.

Problem Statement 2B: Improve the Scientific Basis for Updating National Dietary Standards and Guidelines

There is an ongoing need to improve the scientific basis for the types and amounts of nutrients and other health-promoting food factors required to maintain health and prevent disease, and this need evolves with the development of new information and application of new methods to examine specific physiologic functions. At present, few nutrient standards and dietary guidelines can be individualized and little is known about the variability in nutrient needs among different life stage groups, particularly in children and older adults. ARS research will focus on increasing the certainty and specificity of information about the health impacts of foods, nutrients, and other food components, as well as physical activity. This will allow the development of national nutrient recommendations and dietary guidelines based on a firmer scientific foundation and enhance the usefulness of such guidance in programs that rely upon them. Research will focus on nutrients and other health-promoting food components of high public health interest.

Research Needs:

Researchers will evaluate the quantitative needs for nutrients, as well as the inter-individual variability in those needs, effects of excess intakes, and interactions of nutrients and other health-promoting food components in specific at-risk populations. ARS research will develop methods to assess adequacy and excess of nutrients and other food factors, and efforts will include validation of biomarkers of exposure and impact. Researchers will also examine the individual variation of requirements due to effects of genetics, epigenetics, lifestyle, and physical environment, and they will seek to develop effective methods to communicate dietary guidance to consumers, policymakers, and researchers.

Anticipated Products:

- Enhanced scientific basis for improved estimates for requirements and safe intake ranges of nutrients and other food components.
- Better estimates of inter-individual variation in nutrient requirements, including genetic bases for such variation.
- More complete data on nutrient adequacy in specific vulnerable population groups.
- Validated biomarkers for dietary exposure and health.
- Strategies and interventions capable of motivating consumers to use dietary guidance.

Potential Benefits:

- Enhanced scientific knowledge will lead to more precise recommended intakes for specific nutrients and health-promoting food components with regard to preventing particular conditions of public health importance. This information will inform the National Academy of Sciences' *Dietary Reference Intakes*, the nutritional standards for children and adults in the United States, and the *Dietary Guidelines for Americans*.
- With the development of information that more accurately approximates the nutrient needs, activity patterns, and consumer behavior for specific population groups and individuals, nutrition policymakers will be able to develop improved food and nutrition policies and programs, such as *Dietary Guidelines for Americans*, MyPyramid, WIC, Food Stamps, and child nutrition programs.

Component 3. Prevention of Obesity and Related Diseases

The prevalence of obesity and overweight continues to increase; currently, an estimated 66% of adult Americans fit within these categories (body mass index $> 25\text{kg/m}^2$). Among children and adolescents aged 2-19 years, the prevalence of overweight increased from 14% to 17% between 1999 and 2004 alone. These trends are unprecedented in U.S. history and are an important underlying cause of many related disorders, including cardiovascular disease, Type 2 diabetes and several cancers, as well as escalating health care costs. Reduction of excess weight is difficult to achieve and even harder to sustain, and experts are becoming increasingly aware of the critical need for effective, proven methods for the primary prevention of weight gain.

Problem Statement 3A: Understand the Causes and Consequences of Obesity and Related Disorders

Obesity is a complex condition with multiple etiologies. To understand this problem, it is important to explore dietary, biological, behavioral, and environmental factors influencing the development and consequences of obesity and related disorders across the lifespan.

Research Needs:

New information on genetic, epigenetic, neuroendocrine, and other biological mechanisms as well as behavioral and environmental factors underlying the development of obesity and related disorders is needed to understanding susceptibility and for devising strategies to promote and/or maintain healthy weight and body composition. Research will utilize molecular, cell, animal, and human models to unravel the complex problem of obesity, using innovations in biomarkers, statistical tools, complex modeling, bioinformatics, and instrumentation.

Anticipated Products:

- A more comprehensive knowledge of the biology underlying the development and consequences of obesity and related disorders, including the role of food and food components, gene-diet interactions, neuroendocrine and metabolic pathways, inflammation, and gut environment.
- Improved understanding of the interplay between biology and behavior and the contribution of behavioral and environmental factors to the development of obesity and related disorders in the diverse American population.

- Tools such as biomarkers (including gene expression and “omics” tools), statistical tools, complex modeling, bioinformatics, and instrumentation for the measurement of diet, physical activity, and health status.

Potential Benefits:

- New integrative knowledge and tools will inform research, public policy, and public health efforts to prevent obesity and its related disorders in the United States.

Problem Statement 3B: Develop and Evaluate Strategies to Prevent Obesity and Related Diseases

It is critically important to help people maintain a healthy weight and prevent obesity with its consequences. To date, interventions have generally not been effective. Researchers must develop a better understanding of how to help people adopt and sustain healthful food choices and physical activity patterns (lifestyles). Research is needed on food choices and physical activity behaviors, what influences them, as well as development and evaluation of innovative measurement and intervention strategies that will promote healthy weights at the individual, family, and community levels.

Research Needs:

To identify methods of promoting change in diverse populations, researchers must develop knowledge of how socio-demographic, environmental (cultural, community, neighborhood, institutional, social), economic, psychological, and biological factors influence food choices and physical activity practices of children, adolescents, and adults. Better measures of food choices, dietary intake, physical activity, and related variables can improve the quality of the research. There is a need for research on single or multi-component interventions in order to identify effective change methods for healthier lifestyles, as well as for new technologies to obtain better measures and behavior change in groups using them.

Anticipated Products:

- Knowledge of the relationships among demographic, social, environmental, economic, psychological, biological, and behavioral variables leading to unhealthy weight gain and obesity.
- Innovative, valid, reliable, and feasible methods for better measures of food choices and intake, physical activity, and related variables.
- Proven effective procedures (including intervention mapping, protocols, and curricula) for promoting change in social, community, psychological, biological, and behavioral variables at all points in the pathways to the development of obesity in different types of individuals, families, and communities.

Potential Benefits:

- With innovative measures and models for understanding the influences on behaviors impacting energy imbalance and procedures for promoting changes in these variables, national, regional, state, and local policy makers will be better able to prioritize how best to use resources to address the obesity epidemic in diverse groups in the United States.

- New technological methods developed will provide innovative ways for business and industry to help prevent obesity through the development of new products that promote healthier food choices, food consumption patterns, and physical activity habits.
- Successful intervention strategies will enable individuals, families, and communities to sustain healthy weights, prevent obesity in diverse groups, and reduce health care costs in the United States.

Problem Statement 3C: Evaluate the Role of the *Dietary Guidelines for Americans* in Preventing Obesity

The *Dietary Guidelines for Americans* (DGA) are a central component of U.S. food and nutrition policy and provide authoritative recommendations on dietary intake and physical activity for long-term health. The DGA provide advice on food choices and appropriate levels of physical activity for maintenance of healthy weight, and thus are anticipated to be an effective tool for prevention of weight gain in the United States. However, because few Americans currently follow the DGA and because the DGA have never been tested as a complete package for their acceptability and efficacy for preventing weight gain, research studies are needed to address the general question of adherence to the DGA and whether high levels of adherence to both the food and physical activity recommendations prevent the development of obesity in children and adults.

Research Needs: The 2005 DGA Advisory Committee identified a number of key overarching research topics that should be addressed and the results made available for future DGA deliberations. Two specific topics were to “determine the barriers for complying with the DGA among children, low-income populations, and various ethnic groups,” and “to identify various mechanisms to motivate individuals to change their eating behaviors and habits.” There is also a need to study the impact of the DGA dietary and physical activity recommendations, when optimally implemented, on body weight, body composition, and expected health outcomes

Anticipated Products:

- Enhanced knowledge of barriers and facilitators to DGA adherence that will promote greater acceptance and adoption of healthy dietary and activity patterns in the general U.S. population.
- Improved understanding of the efficacy of the DGA’s recommended dietary and physical activity patterns in the primary prevention of unhealthy weight gain.
- Necessary data to revise the DGA, if needed, and justification for no revisions if the data support this.

Potential Benefits:

- This research could result in wider acceptance and use of the DGA recommendations by the American population, leading to reduced prevalence of overweight and obesity and parallel reductions in the prevalence of chronic diseases and health care costs in the U.S. The research could also lead to new scientifically tested practical interventions that promote adherence to the DGA.

Component 4. Life Stage Nutrition and Metabolism

The metabolism, nutrient requirements, and health effects of food components in humans vary across stages of the life span. Dietary intake early in life, including intake of the mother before and during pregnancy, has major effects on development, child health, and disease prevention later in life. At later stages of the life span, diet affects the processes of maturation, aging, and cognitive and physical functioning. For example, the increased prevalence of chronic disease and disability among the elderly population may be modified by improved nutrition. Mammalian development is intimately reliant upon nutrients and other food components, which serve as building blocks, signaling molecules, and enzyme cofactors. Furthermore, “nutritional programming” occurs during certain critical periods when nutrition affects developmental processes, resulting in permanent or long term changes in structure, function, gene expression, and consequently, disease susceptibility. Overall, these processes remain poorly understood.

Problem Statement 4A: Understand Mechanisms by which Nutrition Promotes Healthy Development and Function from Conception to Old Age

There is a need for increased knowledge of relevant basic and fundamental processes of development and aging, how these processes are influenced by diet, nutrition, and other factors (e.g., physical activity, gut microflora, co-morbid conditions) in order to identify nutrient requirements and appropriate dietary composition and patterns; research is also needed to identify other lifestyle strategies to improve metabolic, physiologic, and cognitive function and health at each stage of the life span.

Research Needs:

Knowledge will be generated on the fundamental mechanisms by which food components and physical activity influence growth, development, and aging as well as the means by which these biological stages themselves affect nutrient requirements. Effective strategies will be developed to improve physiologic and cognitive functioning through diet, nutrition, and physical activity interventions.

Anticipated Products:

- Increased knowledge of basic physiological processes related to age-specific alterations in cell, tissue, and organ metabolism throughout the lifespan and the impact of these developmental changes on nutrition and health.
- Increased data on how the biologically relevant effects of diet, nutrition, and physical activity on cellular function influence physiology, behavior, and health of individuals at different life stages.
- Further development of appropriate tools and models to investigate changes in metabolic status at all stages of the lifespan, including growth, development, and aging, and how these affect nutrient requirements.

Potential Benefits:

- The results of this research will provide the understanding required to optimize dietary recommendations for individuals at all ages, so that they can better adapt to the metabolic and physiologic changes that occur throughout the lifespan and enjoy improved health.

Problem Statement 4B: Define the Nutritional Bases for, and Consequences of, Nutritional Programming

Mammalian development proceeds via a specific series of irreversible steps that progressively increase the complexity of body structures, functions, and gene expression patterns. The irreversible nature of biological development involves diverse “critical windows,” developmental periods during which specific milestones must be achieved to lay the groundwork for subsequent steps. Research in nutritional programming will lead to nutritional recommendations during critical periods of development in order to optimize long-term as well as short-term health. This will be achieved through in vitro, animal, and human studies.

Research Needs:

Improved knowledge of mammalian development and the specific mechanisms by which nutrients affect these processes is necessary to develop nutritional interventions and strategies to enhance health over the life course. Potential mechanisms to be investigated include alterations in cell number, tissue remodeling, and epigenetic changes.

Researchers also need to identify the critical windows during which nutritional status can induce long term or permanent changes in mammalian structure, function, and gene expression, as well as the specific nutrients and food components that affect developmental outcomes. There is also a need to elucidate the complex relationship between maternal nutrition and nutrition of the embryo, fetus, and infant. Human studies of nutritional programming will also benefit from the identification of biomarkers to serve as indicators of nutritional exposures during critical developmental periods.

Anticipated Products:

- More accurate information about the fundamental mechanisms responsible for long-term development and molecular regulation of organ structure, function, and metabolism, and an improved understanding of how specific nutrients and other food components induce permanent changes in these processes.
- More thorough knowledge of the critical periods of development during which targeted nutritional and physical activity interventions are most likely to have long-term health benefits.
- Improved ability to relate the results of studies in animal models of nutritional programming to the human situation.

Potential Benefits:

- Understanding the specific mechanisms, critical developmental periods, nutrients, and food components important to nutritional programming will enable the development of nutritional interventions and strategies that, although targeted to a short period in an individual’s life, promote health throughout his or her lifespan.
- Research in nutritional programming will yield new insights into dietary strategies for prevention of diseases including obesity, cardiovascular disease, type 2 diabetes, cancer, and autoimmune and infectious diseases.
- With an improved understanding of the role that nutrition plays in promoting optimal brain and eye development, scientists will be better equipped to develop nutritional interventions and strategies to induce lifelong improvement in cognitive function and vision.