Subcommittee Report on Grand Challenge: Improving our Health

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Introduction

From recreation and weight control to designing fruits, vegetables and animal products better able to prevent chronic diseases to improving human health and production efficiencies in livestock and using the latest advancements in biotechnology to search for new drugs, the College of Agriculture and Life Sciences at Texas A&M University is dedicated to improving health of humans, animals and plants. Our students in the life sciences will be among the leading research scientists and technicians, registered dietitians/nutritionists, physicians, pharmacists, and biotechnology engineers of the future. We believe in taking a leadership role in improving health by providing students and researchers with state-of-the-art equipment and facilities to investigate such areas as genomics and structure-based drug design combined with computer bioinformatics to find the molecular basis of disease and the right intervention to target a specific disease. Other research is aimed at finding nontoxic “smart drugs” that can be carried by nanoparticles directly to disease sites in the body. Programs aimed at nutrition and metabolism enable health outcome optimization through personalized assessments and interventions. Importantly, programs in recreation and nutrition focus on optimizing health and preventing the most common and debilitating diseases currently facing Americans. Health promotion starts with healthy habits and our programs are proactive in improving learning and success in children. With obesity and diabetes reaching epidemic levels in the U.S. and globally, scientists are unraveling the mysteries of factors affecting the newborn as small babies are predestined to experience increased risks of metabolic syndrome including obesity, diabetes and cardiovascular diseases. Improving our Health through research that benefits humans, animals, plants and the environment is one of the critical Grand Challenges for strategic emphasis for years to come.

Focus Areas

Within this grand challenge area, the sub-committee members have identified five foci for this initiative: (1) One Health: A Systems Biology Approach, (2) Foods for Health and Prevention of Disease, (3) Ingestive Behavior and Metabolism, (4) Wellness through Parks and the Natural Environment and (5) Population Growth and Reproductive Rights. A brief description of each is provided below.

One Health: A Systems Biology Approach

One Health is an overarching theme recognizing the complex links between animal, human, and ecosystem health that are both beneficial and problematic and require investments in basic and
translational research, education and outreach for solutions. The guiding principles for success are those set forth in National Institutes of Health’s Roadmap (see https://commonfund.nih.gov/) based on a systems biology approach to integrate the scholarship of multiple disciplines in human and veterinary medicine, agriculture and life sciences, biomedical engineering, computational sciences, genomics and environmental scientists. This integration of scholarship will ensure a safe, abundant and affordable food supply, advance health care for all species and protect our ecosystem, as well as protect society and our environment from biological threats.

The “One Health” initiative at Texas A&M University must include research from individual genes to entire organs, systems and whole organisms. Interdisciplinary teamwork is essential to explore the broad array of intricate and interconnected pathways of communication among genes, molecules, and cells. The goal is to understand how these pathways are integrated in complex organisms, determine how disturbances in these pathways lead to disease and disease resistance, and desired phenotypes that enhance production agriculture, human and animal health, and health of the ecosystem. A central and fundamental principle is that biological processes are governed by expression of genes through transcription of messenger RNAs that translate to proteins to form the "proteome." To understand the proteome, researchers must collaborate to determine, in real time, which cells produce proteins and in what amounts and how interactions among large numbers of individual proteins affect biological functions. This enhances understanding of metabolic components and networks within cells, the "metabolome", that is assessed by technologies to measure local concentrations of carbohydrates, lipids, amino acids, and other metabolites within a single cell or even a specific part of a single cell. The goal is to define metabolic differences between normal and diseased cells or between energetically efficient and inefficient cells with respect to environment, disease, injury or infection. Notably metabolomics reflects the integrated outcome of an active genotype with the environment, a component that includes both diet and physical activity. Diet and the creation of environments conducive to healthy activities engage all aspects of the agricultural enterprise. The realization of expectations of the integration of scholarship from agriculture, physics, chemistry, and engineering to enable scientists to use computers and robotics to separate molecules in solution, read genetic information, visualize three-dimensional shapes of natural molecules such as proteins, macromolecules and image the brain activity in real time. Each of these techniques generates large amounts of data that biologists can appreciate only when it is evaluated using Bioinformatics and Computational Biology that underpin an "information superhighway" that advances biological sciences to solve mysteries associated with differences among individuals in their growth and development, reproductive potential, response to environmental factors and resistance to disease and parasites. Structural Biology is also a key to the development of proteins, peptides, phytotonutrients, and other macromolecules or fabricated nanostructures that enhance health and well-being when used as pharmaceuticals.

Foods for Health

Foods for Health (FFH) research examines the complex systemic processes, from consumer choice to biochemical mechanisms that underlie functions of nutrients in plant-and animal based foods that enhance human health and disease prevention. For example, FFH research includes isolation and characterization of naturally occurring compounds to determine their potential human and animal
health benefits. Establishing the health benefits of such compounds in vitro and in vivo requires research at the cellular level, as well as studies involving animal models, and human intervention studies to unravel mechanisms of action. All of this requires multidisciplinary expertise. Therefore, the success of this research and education plan must integrate broad expertise in horticulture, food science and engineering, nutrition, chemistry, medicine, veterinary medicine, poultry and animal sciences, toxicology, microbiology, biochemistry and economics.

There is growing recognition that bioactive compounds in food play critically important roles in disease prevention in humans. Therefore, the options consumers have and the choices they make determine the nutritional status of the nation. These options and choices are critical to national health goals because healthy diets are strongly linked to longevity and to the prevention of disability, major chronic diseases, and death in the United States.

Producing healthful options and guiding healthful consumer choices depends on a “consumer to farm” rather than a “farm to consumer” approach of which a key component is creation of an informed consumer through effective outreach and K through 12 educational programs. Therefore, a systems-wide approach encompassing multidisciplinary FFH research ranging from pre- and post-harvest production methods to understanding the roles of individual bioactive compounds and whole foods in prevention of disease will be critical to improving our health.

Ingestive Behavior and Metabolism

Food and feed consumption is the fundamental process whereby nourishment is taken into the body. This activity is influenced by a disparate group of variables that include hedonic, social, economic, cultural, psychological, health status and food availability. Comestible items must then be reduced to their metabolically useable forms by physical and chemical processes that can be transported beyond the gut and utilized by the body. Metabolism can be normal, dysfunctional or optimal, with criteria for these designations varying with genetics, gender, ethnicity, physiological age and pre-existing health conditions. Because metabolism occurs in cells across multiple tissues and utilizes gene products and essential nutrients, its regulation requires multiple levels of control including those at the transcriptional, translational, hormonal and neuroendocrine levels. The regulatory processes use multiple interrelated signaling systems integrated at the level of the brain. Characterization of metabolism properly includes evaluation at the transcriptional/translational level, chemical level via metabolomics and proteomics (substrate/product relationships as well as protein “machine” amounts and status), clinical (acute integrated responses) and long-term health outcome level. The emerging field of epigenomics is the study of how environmental factors, nutrition, stress and gender modify structure and expression of genes without affecting the make-up of the genome directly. Epigenetic modifications of the genome adversely impact fetal growth and development and metabolic activity (metabolome) that predisposes one to adult onset of metabolic and inflammatory diseases (e.g., obesity, diabetes, and cardiovascular diseases). The genome can be thought of as a hard drive on a computer and the epigenome is the software that regulates the expression of genes within the genome. For most chronic disease, the long-term health outcomes arise through the integrated and summative effects of daily ingestive choices and their effects on
the epigenome as reflected in the metabolome, a currently underutilized diagnostic for personalized health solutions.

Wellness through Parks and the Natural Environment

Research on wellness through parks and the natural environment examines how public parks, gardens, greenways, and other natural areas contribute to individual and community health. An important direct benefit is in the form of restoration of healthy minds and bodies. The natural environment impacts people’s well-being, ability to concentrate, outlook on life, and stress levels. These impacts are well documented through research based on Biophilic Design and attention restoration theory. Findings from this research have led directly to the redesign of hospitals around the world where natural elements have been shown to accelerate the healing process. Likewise, in his recent book, The Nature Principle, Richard Louv documented that health professionals are beginning to actually prescribe time in parks and natural areas as a supplement to traditional drugs and counseling methods.

Parks and other natural areas contribute to health by providing inviting places for people to engage in physical activity, including gardening, walking, and bicycling. Research shows that proximity and availability of parks and natural areas is linked to higher rates of physical activity and lower rates of obesity, diabetes, and hypertension. Stated differently, improved health is linked to physical activity which is linked to opportunities in the physical environment. Public parks and trails provide affordable, accessible, safe places and amenities to support active and enjoyable lifestyles for all age groups.

There are also many positive social benefits associated with parks that build family and friendship networks. Some of these social benefits are often realized through programs in parks and other recreational areas. Other social benefits accrue more directly simply because parks and other natural areas are attractive places to visit. Parks contribute to people’s well-being by promoting interaction and community, which nurture social support. It also keeps the community engaged in maintaining a healthy environment.

Parks and natural areas contribute to community health by helping to protect drinking water and other aspects of ecosystems on which people rely. There are clear linkages, for example, between the quality of water coming out of catchment areas and the amount of parklands and forest areas. Austin has multiple Edwards Aquifer Recharge Zones designated as a part of their larger system of green infrastructure. These zones are strictly guarded from development as they serve to help filter and purify rainwater as it enters the aquifer. This has direct implications for the health of people in San Antonio who drink this water daily. Rural areas with larger parks and protected areas are particularly critical in sustaining critical ecosystems.

Population Growth and Reproductive Rights

A driving assumption underlying our Grand Challenge charge is that the world’s population will grow to 9 billion by 2050. This assumption is likely true is population growth is left unattended. The issue
of population growth centers around family size and reproductive rights which requires a strategy to educate women, both globally and locally, regarding reproductive health, nutrition, quality of life issues for families, ownership and management of land, and management of farms. With improved education of women it has been demonstrated that birth rates decrease which reduces pressure on available resources including food sources and the environment. Importantly, the projected increases in the human population on our planet will stabilize and perhaps decrease in response to improved education and decision making by women of the world. We need a mechanism to recruit and educate more women from developing countries who can become leaders in dealing with these issues within their respective cultures. Replicating the land-grant university system in developing countries will provide an opportunity for promulgating the concept of teaching, research and service to enhance educational experiences in general and to build strengths in agriculture and life sciences and engineering critical to building a strong infrastructure for countries to ensure a safe, abundant and affordable food supply that underpins economic and political stability.

**Integration through Translation and Application**

The system approach required for solving complex problems is evident, not only in the focus areas, but through the translation and dissemination of new knowledge. By strategically and collaboratively working across disciplines, we are able to determine appropriate direction in curricular revision and assessment measures. Formal and informal education, degree programs, certificates, and continuing education efforts will provide broader impacts and implications for the public. Plant and animal biotechnology will be enhanced by new discoveries and practices to drive enterprises and economic growth. Changes in food selection and healthy lifestyles can reduce the cost of healthcare. These interrelationships would promote strategic initiatives within the college, university, and external stakeholders.

In order to realize the potential to impact the “Grand Challenge To Improve Our Health” it is essential that we capitalize on expertise from many disciplines. There are many centers and institutes at Texas A&M University that address issues critical to the overall goals of faculties who can contribute to this Grand Challenge. These include the Institute for Plant Genomics and Biotechnology, the Center for Animal Biotechnology and Genomics, the Vegetable and Fruit Improvement Center, the Institute for Obesity Research and Program Evaluation, and the Agrilife Extension Service; however, there has been and is a more important challenge for success on the College Station campus. The challenge is to break down barriers that allow creation and maintenance of outstanding core facilities that serve the research needs of all faculties across our Texas A&M University campus through support from all academic units. Researchers at Texas A&M University often require access to resources, technical expertise or pieces of equipment that no individual investigator can acquire. This is due to the rapid evolution of knowledge, techniques and associated equipment to address key aspects of scientific research. The solution is a mechanism to provide access to outstanding Core Facilities that allow individuals or teams of scientists to keep abreast of both technical and intellectual advances in their science and to capitalize on synergies created through inter-disciplinary and multi-disciplinary research. There is a clear need to have discussion across the various grand challenge groups to capture and focus on the many common issues of concern in meeting the grand challenges.
Outcomes/Goals

1. COALS/TAMU as the key player in development and implementation of plans to improve people’s health – based on reputation, visibility, demonstrated impacts in this area.

2. COALS/TAMU as the principal partner in preparation and submission of multimillion dollar grants to address key issues related to food consumption habits, environment, exercise, and health, etc... Capitalize on all funding streams – NIH, NSF, DOE, USDA, private sources, excellence fund (student fees) and so forth to support excellence in teaching, research and service.

3. Expanded expertise in critical areas relevant to improving health with cross disciplinary degrees and research foci.

4. Support current highly productive faculty to enhance their programs and retain productive faculties and their programs.

Strategic Needs to Accomplish Outcomes and Goals

1. Core facilities accessible to COALS and TAMU researchers are needed. This requires planning for the appropriate Core Facilities and identification of required research space, personnel to interface with users and the acquisition of instrumentation for the core facilities, as well as clinical laboratory space. We have impoverished resources and facilities in general. We are not competitive because we lack equipment and computational/bioinformatics for data analysis. The state and university needs a long term commitment to building a strong infrastructure for research that supports excellence from within and attracts new talents. We suggest creation of a task force comprised of individuals from each college of the College Station campus to study and prioritize our needs.

2. Mechanisms for collaborations across colleges and universities should be examined. We have the potential to lead an interdisciplinary effort regarding wellness/nature principles, providing science-based demonstration of value. We must include economics, education, marketing, and behavioral change to understand the decision making process. Collaboration with the Center for Health Systems & Design in the Colleges of Architecture and Medicine could be a starting place. This Center is interdisciplinary and its programs focuses on health facility planning and design with research interests ranging from effects of stress on patients' health and wellbeing, to the design of healing environments for neonatal patients, children, the elderly, people living in the Texas Colonias, and AIDS patients.

3. COALS needs not only to attract new talent, but a strong effort must be made to invest in the development and empowerment of existing personnel through seed monies and internally funded proposals to enhance collaborations and innovations. Professional development and mentoring are key components to faculty retention and competitiveness in extramural funding.
4. Engagement at various levels of the college should be enhanced. Hiring of technicians, extension faculty, post-doctoral fellows, graduate students, and undergraduate students is essential for continuing and expanding successful research, teaching, and outreach programs in this area. This should include funding to support undergraduate student placement in labs as “work study” to create a community of engagement and skill development as a pipeline for graduate school and job placement for underrepresented populations. Interdisciplinary courses, seminars, and mentoring programs can engage students in solving complex problems related to our grand challenges.

5. A systematic process for evaluation of administrative functions is needed to assist with identification of opportunities for collaborations and efficiencies in project development and implementation. We must capture synergy administratively and learn from successful programs in the US (e.g., North Carolina State University, University of Florida, University of Missouri, MIT, Scripts Research Institute and the University of California). Grant support to develop interdisciplinary teams to work on the complex problems associated with health issues should be a priority.

6. Emphasis on the individual scientists and their creativity is a prerequisite for strong interdisciplinary teams. This can be accomplished by providing support, e.g., endowed chairs and professorships for excellent scientists who are now at Texas A&M University. We need a community of scholars in the “Improve Our Health” area. COALS communications could develop video clips linked to the grand challenge areas with faculty expertise highlighted. Investigators could talk about their research programs, research questions, and how their research fits into these challenges. Strong research teams evolve in response to interactions among productive individual faculties that recognize and capitalize on synergies created through collaborations. The productive individual faculty member is the one who will be welcomed into such teams. Monthly brown bag sessions or seminars could enhance further communication and collaborations.