FROM NORTH CAROLINA TO THE WORLD:
SOLUTIONS TO
Global Challenges
RESEARCH REVIEW 2008-2012

NC RESEARCH CAMPUS SCIENTISTS RECEIVE
Bill & Melinda Gates Foundation
CHALLENGE GRANTS
Dear Friends of Science,

Solutions to the biggest problems facing our world need great minds in many disciplines. This is the realization that many years ago gave birth to my vision for the North Carolina Research Campus. Since then, some of the greatest minds in science have been willing to reach across the boundaries of intellectual isolation and institutional affiliation to join us in Kannapolis. They are working collaboratively bringing forth solutions to the greatest challenges facing mankind in health, nutrition and agriculture.

Without solutions to these challenges, there are few options that will guarantee the survival and well being of our planet. The scientific collaboration and discovery that is working at the NC Research Campus in Kannapolis is a model that sets a new standard for the collaborative creation of effective solutions for the prevention and treatment of disease, alleviation of hunger, the provision of food security and economic stimulus not only in North Carolina and the United States but around the world.

Our University of North Carolina researchers have received over $40 million in grants since opening four years ago. Duke University has brought another $1.8 million to the campus community in Cabarrus County for the Cabarrus Health Alliance to participate with them in a study to improve diabetes care. New products, groundbreaking studies and healthier varieties of fruits and vegetables are only the first results of the good work happening at the NC Research Campus in Kannapolis, North Carolina. A city just north of Charlotte that was once known worldwide for textiles, Kannapolis is rising from the loss of thousands of jobs a decade ago as a center of life-changing science and discovery.

I invite you to learn more by reading through this publication. As you do, realize that the NC Research Campus is a story of hope in a world desperately seeking answers to complex questions. While the pages that follow are informative, they cannot tell the entire story of the great purpose and work being accomplished. I invite you to come to Kannapolis and see for yourself the benefits of being part of the NC Research Campus.

Warmest Regards,
David H. Murdock

“To do the impossible, you must see the invisible.”
~ David H. Murdock
Solutions for Global Challenges

The statistics are dire regarding obesity, diabetes, heart disease, Alzheimer’s disease, cancer and other nutritionally-related and lifestyle-dependent diseases. But solutions are at hand.

One center of research that is producing solutions to the most dire global health challenges is the North Carolina Research Campus in Kannapolis. Just north of Charlotte, the scientists at the NC Research Campus are revolutionizing health by unlocking the genomic, metabolomic and proteomic markers of disease and enhancing the disease-preventing, nutritional benefits of fruits and vegetables. Healthier consumer products and varieties of produce are beginning to flow from the laboratories of the NC Research Campus to grocery store shelves and impoverished areas of the United States and other countries to fight malnutrition. Together, these scientific advances and their translation to the prevention and treatment of disease are precipitating a global shift in the understanding of how a healthier diet can prevent and treat disease, allowing people to live long, healthy and more prosperous lives.

As the science emanating from the NC Research Campus changes lives so does the economic impact. In 2005, when founder David H. Murdock and leaders of the state of North Carolina announced the construction of the campus, the city of Kannapolis was recovering from the 2003 loss of thousands of textile jobs after the closure of Pillowtex, which was once Cannon Mills, the largest producer of home textile products in the world. Since opening in 2008, the NC Research Campus has helped lay the foundation for Kannapolis to become a hub of scientific discovery by creating hundreds of jobs and attracting new business to the area. Through statewide partnerships with farmers, the partners of the NC Research Campus are also boosting the state’s agricultural industry by developing more marketable varieties of fruits and vegetables and new methods to preserve nutrients postharvest. With Rowan-Cabarrus Community College’s training center on campus, future researchers are receiving the training to fill the biotechnology jobs created at the NC Research Campus and throughout the state.

As Erskine Bowles, former president of the University of North Carolina system, predicted in 2006 the “remarkable science” of the NC Research Campus will build on the strengths of our state in agriculture, biotechnology, medicine and health to create new jobs. “But it is not,” he added, “just about jobs here in Kannapolis or Charlotte. It is about new discoveries that will make their way to the marketplace and create jobs for generations to come.”
WHY The NC RESEARCH CAMPUS?

The scientists of the NC Research Campus are producing revolutionary research and developing innovative products along the combined fronts of human health, nutrition and agriculture. By focusing research on how foods fight disease and understanding the links between genetics and nutrition, the North Carolina Research Campus is spurring new and diverse approaches to alleviate hunger, improve the nutritional value of food, provide more nutritious consumer products and lessen the impact of diseases like obesity, diabetes, cancer and Alzheimer’s.

“The NC Research Campus is a rarity among research centers combining the best minds from the public and private sectors with world class instrumentation,” commented Lynne Scott Safrit, president of Atlantic American Properties and the North American Commercial Division of Castle and Cooke, the developers of the NC Research Campus. “The combination is resulting in new and healthier plant varieties and new understandings of how the phytochemicals in plants prevent and can be used to treat disease. No doubt, the combined force of this research will lengthen and enrich lives all over the world.”

From research collaborations to hosting events to leasing space, the opportunities to join the NC Research Campus and work side-by-side with the campus’ scientists are ample. The 350-acre campus features over 800,000 square feet of wet lab and Class A office space in the David H. Murdock Core Laboratory Building, the NC State University Plants for Human Health Institute, the UNC Nutrition Research Institute, the Rowan-Cabarrus Biotechnology Training Center and the LabCorp Biorepository. The campus’ medical corridor is anchored by the 65,000 square foot Cabarrus Health Alliance building and will expand by another 60,000 square feet with the opening of the Carolinas Healthcare System building.

Wet lab and office space are available for lease. Build-to-suit opportunities are available on campus as well as in the neighboring downtown village where thousands of square feet of additional space can be customized to suit both research and corporate operations. The campus will continue to expand to include additional wet lab and Class A medical and office space, a wellness center, conference center, a retail corridor and residential housing adjacent to the campus.

“The most important advancement at the NC Research is the translation of research into product development,” said Clyde Higgs, vice president of business development. “New products like a powder that concentrates the benefits of fruits and vegetables and chia seed snacks that make fatty acids essential to metabolism more readily available are just two examples. They represent the beginning of how our collaborative environment is ushering in a new era of healthier food choices and healthier lifestyles.”

NC RESEARCH CAMPUS PARTNERS

Appalachian State University | Cabarrus Health Alliance | Carolinas Healthcare System
David H. Murdock Research Institute | Dole Nutrition Research Laboratory
Duke University MURDOCK Study | General Mills | LabCorp, Inc. | Monsanto
North Carolina Agricultural and Technical State University
North Carolina Central University | North Carolina State University
Rowan-Cabarrus Community College | Sensory Spectrum
University of North Carolina at Chapel Hill
University of North Carolina at Charlotte
University of North Carolina at Greensboro

www.NCResearchCampus.net
The quest of the NC Research Campus scientists to find solutions to alleviate hunger and malnutrition stretches from North Carolina to developing countries in Africa. NC Research Campus scientists Steven Zeisel, MD, PhD, Steven Maranz, PhD, and Mary Ann Lila, PhD, have each received a $100,000 Grand Challenges Explorations grant from the Bill and Melinda Gates Foundation.

The Gates Foundation is dedicated to improving people’s health in order to alleviate hunger and poverty. The foundation’s Grand Challenges Explorations grants fund new and promising ideas to address global health issues. Malnutrition is a global health challenge that the World Bank estimates impacts over 925 million people worldwide. Africa is one of the hardest hit continents. In sub-Saharan Africa, United Nations statistics reveal that up to 20 percent of all children are underweight and nearly 50 percent have stunted growth. In Zambia alone, at least 50 percent of children are vitamin A and iron deficient and up to 13 percent are born with low birth weights indicating poor maternal nutrition. Zeisel, Maranz and Lila’s Gates-funded projects directly address each of these issues.
Improving Maternal Nutrition and Infant Development

STEVEN ZEISEL, MD, PhD, director of the University of North Carolina at Chapel Hill Nutrition Research Institute (NRI) and Kenan Distinguished University Professor in nutrition and pediatrics in the Gillings School of Global Public Health and the School of Medicine, is addressing malnutrition in the Republic of the Gambia by improving maternal dietary intake. Zeisel is credited with the discovery of choline’s role as an essential nutrient, particularly for fetal and infant development. His research indicates that women need to eat diets adequate in choline, which is found in foods such as soybeans, peanuts and potatoes, to assure optimal brain development in their infants. Zeisel is collaborating with Carol Cheatham, PhD, assistant professor of psychology in the UNC Chapel Hill College of Arts and Sciences and a researcher at the NRI, and Andrew Prentice, PhD, scientific director of the Medical Research Council’s Keneba field station in Gambia, Africa. Zeisel’s project will design a new diet intervention for use in Gambia. Methods will be developed in partnership with the NRI in Kannapolis, to test infant memory, study brainwaves with solar-powered instruments and to determine the single-nucleotide polymorphism (SNP), a DNA sequence variation, related to choline metabolism in Gambia.

A Cure for VITAMIN A Deficiency

STEVEN MARANZ, PhD, with the David H. Murdock Research Institute, is a two-time Gates Foundation Grand Challenges Exploration grant winner. While a postdoctoral fellow at Cornell University, he received a Grand Challenges Explorations grant to develop an anti-malarial beverage based on traditional treatments of parasites with plant flavonoids. In his most recent Grand Challenges grant, he is developing probiotic bacteria that can synthesize carotenoids as a new solution to reduce vitamin A deficiency. Dietary carotenoids are required by the human body in order to make Vitamin A. Vitamin A deficiency is a condition that causes blindness, reduces the ability to fight infections and, in developing countries, contributes to the death of almost one million children annually. Maranz’ research reflects his dedication to the production of nutraceuticals and biologics as a means to reach populations around the world that are trying to overcome disease and malnutrition but have little access to clinical medicine. While most people in the United States have adequate vitamin A levels, the use of probiotic bacteria to deliver compounds that improve human health could have far reaching impacts in overall wellness and in treating specific medical conditions.

“If you look at the global map of poverty, vitamin A deficiency overlaps it,” Maranz said. “In the United States, there are so many fortified foods that people have adequate vitamin A. There is potential to use the same principles with other dietary and medicinal compounds that could be delivered by probiotic bacteria. This is the real promise for the US and other wealthy countries where generally people have adequate nutrition but still have numerous medical problems.”

The use of food as medicine, otherwise known as nutraceuticals, is a rapidly evolving industry that in the US is valued at $86 billion per year. “I think we are at the beginning of an era where food is not something you eat just because it tastes good or because you are hungry. Our fundamental perception of health will involve eating things that deliver not only nutrients but pro-health compounds,” Maranz said.
MARY ANN LILA, PhD, who is the director of the North Carolina State University Plants for Human Health Institute (PHHI), is applying technology developed in partnership with Rutgers University that extracts phytochemicals from fruits and vegetables and concentrates them into flour. Phytochemicals are plant compounds known to boost the immune system and provide other health benefits. The flour can be mixed with foods to provide a continual supply of healthy nutrients. Many rural villages in Zambia do not have access to fruits and vegetables except on a seasonal basis. Lila is providing a free license for the use of the technology in Zambia. It is simple enough that local villagers are learning to use it, providing them with entrepreneurial opportunities. Lila’s project targets pregnant women, infants and young children and addresses two of the causes of malnourishment, limited availability and the high cost of fruits and vegetables.

Although the Gates Grants are specific to Africa, each can translate to solutions for underserved populations who are in need of greater access to the health benefits of fruits and vegetables. Lila’s “biofortification strategy makes simple, cost-effective, protein-rich flours infused with fruit nutrients that result in an end product that is a completely shelf-stable source of fruit goodness.” Because of the simple form of these protein-rich flours, she explained, they can deliver fruit bioactive compounds as a functional food to ‘food deserts’ in the USA, including places in North Carolina, where people do not have good access to fruits.

“If people don’t eat fruit, then they do not have access to the immunostimulatory properties that fruit bioactives can deliver to the human body, and they will be more susceptible to disease.” Lila said. “This technology captures the bioactive health protective principles from fruits without the sugars. This technology is a means to get fruit to underserved populations who for whatever reason do not have it in their diet right now.”
Health Benefits of Small Molecules

Zambia, Chile and Alaska are just three of the places that MARY ANN LILA, PhD, director of the NC State University Plants for Human Health Institute, has traveled to unlock the secrets of the bioactive compounds in plants. These bioactive compounds have beneficial impacts on chronic disease and human metabolism.

Bioactive compounds are not proteins, vitamins or minerals. They are a mixture of chemicals that plants produce in response to environmental stressors. “This profile of chemicals within a plant is what potentiates a response in the human being that ingests the plant,” Lila explained. “We are looking at how the bioactive compounds interact and create a biological effect.”

A major focus of Lila’s research is on crops such as cranberries and blueberries. Blueberries are an important crop in North Carolina. The state ranks sixth in the nation in blueberry production with an annual value exceeding $50 million. Lila is researching how the bioactive compounds or phytochemicals can be used to treat diseases such as Parkinson’s disease and diabetes. She focuses mainly on the pigments that contain anthocyanins and their interaction with other flavonoid compounds. She conducts similar research with sweet potatoes, another important agricultural crop to North Carolina. According to the North Carolina Agricultural Research Service, 40 percent of the national supply of sweet potatoes comes from the state. One of Lila’s goals is to promote the value of sweet potatoes by better defining its functional food properties. She is also studying plant compounds as a potential treatment for malaria, a mosquito-borne disease that kills as many as one million people worldwide annually.

Lila’s research is only one example of how researchers at the North Carolina Research Campus are capitalizing on bioactive compounds to find new ways to prevent and treat disease, breed nutritionally enhanced varieties of fruits and vegetables and preserve the benefits of bioactive compounds postharvest.
BLUEBERRIES for Better Health

One of the Plants for Human Health Institute's most recent achievements is the sequencing of the blueberry genome. ALLAN BROWN, PhD, a researcher with NC State's Plants for Human Health Institute, along with Lila and a multi-institutional consortium led the sequencing project.

The blueberry is recognized for its high levels of vitamin C, fiber, manganese and antioxidants that neutralize the free radicals in the human body that are linked to aging and the development of cancer, cardiovascular disease and other age-related illnesses. Understanding the blueberry genome allows for the development of new medical applications and improved blueberry varieties that could strengthen the state's blueberry industry. North Carolina ranks sixth in the United States in blueberry production.

The blueberry has a more complex genome than other fruits that have already been genetically sequenced. To complete the project required the suite of scientific equipment available at the David H. Murdock Research Institute (DHMRI), the NC Research Campus' core laboratory. As a non-profit contract research organization, the expertise of the DHMRI spans genomic, metabolomic and proteomic sciences using some of the most advanced instrumentation available in the world.

With the blueberry genome sequenced, Brown is working to interpret the functionality of specific genes in relation to the health benefits of the blueberry. By comparing the blueberry genomic sequence to other sequenced fruits, gene functionality and the health benefits of fruits can be even better understood and lead to more nutritious varieties and medicinal applications.

The blueberry is recognized for numerous health benefits. Brown's work sequencing the blueberry genome has the potential to make those benefits more widely available in enhanced blueberry varieties and through new medical applications. Brown also researches cruciferous vegetables like broccoli and cabbage that have health benefits including dietary fiber, calcium, iron and vitamins A and C. Cruciferous vegetables also contain sulforaphane and indoles that are proven to protect against cancers. As early as 1982, a study by the National Research Council entitled Diet, Nutrition, and Cancer found “there is sufficient epidemiological evidence to suggest that consumption of cruciferous vegetables is associated with a reduction in cancer.” Over the years, the evidence continues to mount that cruciferous vegetables and their chemopreventative phytochemicals reduce the risk of many types of cancer when consumed regularly. Brown's research is focused on developing varieties of broccoli and cabbage with enhanced cancer-fighting bioactive compounds.
Tangy, spicy and aromatic, ginger is a spice used to flavor meats, vegetables and even baked goods. More than a culinary delight, ginger has been valued for thousands of years for its numerous health benefits.

Ginger, which is the rhizome or underground stem of the plant Zingiber officinale, is recognized as more than a culinary delight. For thousands of years, the spice has been used as a natural solution for digestive upsets like nausea, diarrhea and cramping. Recent studies have found that bioactive components in ginger have strong anti-oxidative, anti-inflammatory and anti-diabetes activities.

ShengMin Sang, PhD, an expert in natural product research and lead scientist for functional foods with NC A&T State University’s Center for Excellence in Post-Harvest Technologies, has found that ginger also has anti-cancer effects. Sang is studying ginger as a lung cancer and a colon cancer preventative agent. Most recently in a collaborative research study with Tinchung Leung, PhD, of NC Central University’s Nutrition Research Program, the two discovered that ginger is a potential treatment for anemia commonly caused by chemotherapy or renal disease.

Leung has extensive experience using zebrafish to study disease and its pathways, specifically small molecules that may be drug candidates for the treatment of cardiovascular disease and cancer. He is particularly interested in how zebrafish can serve as a high-throughput tool for natural products and nutritional studies.

Treatments for anemia caused by chemotherapy or renal disease are limited, injectable and come with serious side effects including blood clots and accelerated tumor growth in cancer patients. Sang and Leung envision their research leading to a new, oral treatment for anemia, possibly one of the first based on a natural product.
TINCHUNG LEUNG, PhD, employs a zebrafish vertebrate model to understand the molecular mechanisms of cardiovascular diseases and to validate their therapeutic compounds including drug-like small molecules and natural products. Using zebrafish, he studies small molecules that may be drug candidates for the treatment of cardiovascular disease and cancer. He is particularly interested in using zebrafish as a high-throughput tool for natural products and nutritional studies.

“With the zebrafish,” Leung said, “there is a developmental advantage. As a high-throughput, whole animal model, it is very important as a pre-clinical model to test drugs early and see the bioavailability to tissues (and) if there are high efficacies or toxicities. You can test for pharmacokinetics as well.”

Also part of the Nutrition Research Program, XIAOHE YANG, MD PhD, studies molecular and cellular cancer biology, specifically breast cancer etiology and prevention. Approximately 30 percent of all breast cancers are associated with the over-expression of the HER-2 protein that causes cancerous cells to reproduce rapidly. The drug Herceptin is one of the major treatments for HER-2+ breast cancers, either alone or in combination with chemotherapy. Herceptin, in combination with chemotherapy, is also approved for the treatment of HER2+ metastatic cancer of the stomach or of the gastroesophageal junction. His research involves understanding and finding a solution to Herceptin resistance. His studies further explore dietary and environmental factors that influence the development of Her-2+ cancers.
The University of North Carolina at Greensboro’s Center for Translational Biomedical Research is researching the influence of bioactive components in the role of diet in order to help people live longer, healthier lives. The Center uses metabolomics as the basis from which to identify and evaluate bioactive ingredients from food, plants and traditional Chinese medicines for the prevention and treatment of metabolic disorders such as diabetes, obesity and cancer. Other research examines cellular and molecular mechanisms of bioactive components in order to address fundamental research questions that enhance the basic understanding of the contribution of bioactive components to human health and wellness, healthy aging and disease prevention.

WEI JIA, PhD, professor of Nutrition at UNC of Greensboro and co-director of the Center for Translational Biomedical Research, is an expert on traditional Chinese medicine. He is specifically looking at how compounds in herbal and traditional medicines induce changes in human health at the metabolic level. He is focusing on drug discovery and drug development based on herbal compounds. He and his research team have developed herbal-based dietary supplements and treatments for bone cancer and a disease similar to diabetes called Xiao-ke. Jia also demonstrated that plant components from traditional Chinese herbs can lower cholesterol and help with weight loss. He and his research team continue to identify and characterize the herbs in plant compounds developing dietary supplements and other drugs and treatments. Co-director with Jia is ZHANXIANG ZHOU, PhD. Zhou researches alcoholic and non-alcoholic liver disease studying organ-organ interactions in the pathogenesis of liver disease and the effect of bioactive phytochemicals in prevention and treatment of liver disease.

The North Carolina Strawberry Association’s most recent report places the state as third in the United States in strawberry production. Annually, 19.5 million pounds of the berries are produced on approximately 1,600 acres bringing an economic return of $24 million in farm income. JEREMY PATTISON, PhD, and a multidisciplinary research team are improving the viability of the state’s strawberry industry. They are developing a new variety of strawberry by addressing the genetic improvement of fruit quality, health-promoting potentials, productivity, season extension and resistance to insects, pests and pathogens. With enhanced nutritional benefits, a longer growing season and more marketable qualities, consumers and growers will both benefit.
Despite how filled fruits and vegetables are with health-promoting and disease-fighting nutrients, they have to make it to market with their nutritional value intact, and looking, smelling and tasting great. This is the challenge of postharvest physiologists like Penelope Perkins-Veazie, PhD, NC State University professor in the Department of Horticultural Science who works at the Plants for Human Health Institute.

Her research centers on extending the shelf life of fruits and vegetables while maintaining the phytonutrient content and overall quality. Veazie studies a variety of fruits and vegetables including strawberries, raspberries, watermelon, mangoes, lettuce, sweet potato, cucumber and tomatoes. Her research involves evaluating breeding materials, storage strategies and packaging to develop more efficient postharvest methods and materials. She also evaluates food safety, quality and characteristics appealing to consumers such as flavor, color, antioxidants and texture to make sure growers will have better quality fruits and vegetables to send to market. Perkins-Veazie has experience with product development researching fresh-cut products and the application of the lycopene in watermelon to prevent skin damage, which adds value for farmers and consumers.

Postharvest physiology extends to keeping food free of contamination. This is the focus of Leonard L. Williams, PhD, lead scientist of NC A&T’s Center for Excellence in Post-Harvest Technologies. Williams knows that no one wants to dine with Listeria monocytogenes, Salmonella, Staphylococcus aureus, E. coli O157:H7 or any of the 31 known microorganisms that cause foodborne illnesses. The Centers for Disease Control and Prevention (CDC) reports that annually these types of pathogens cause over 48 million illnesses, 128,000 hospitalizations and over 3,000 deaths, mostly in people who are young, elderly, pregnant or immunocompromised.

Williams’ priority is to find natural alternatives such as phytonutrients from plants that are known to have antimicrobial properties. Sorrel (Hibiscus sabdariffa), a perennial herb, is an example of a plant that Williams’ research has proved has antimicrobial activity that can inhibit E. coli O157:H7. Williams is part of studies that track the source of pathogens like MRSA (methicillin-resistant Staphylococcus aureus), Verotoxin-producing E. coli (VTEC), Salmonella, Listeria monocytogenes and Staphylococcus aureus on produce like lettuce, green onions, sprouts and spinach in North Carolina, California, the US Midwest and Mexico. Another common pathogen that is responsible for millions of illnesses a year is norovirus. Williams is one of six co-leads on a multi-year, $25 million US Department of Agriculture grant that involves 19 universities and organizations all aiming to reduce the effects of norovirus.

At NC A&T, postharvest research includes the stabilization and packaging of phytochemical-enriched products so that they withstand processing, transportation and storage. Guibing Chen, PhD, operates NC A&T’s Food Engineering, Processing and Packaging Laboratory. He is taking advantage of techniques like microfluidization to enrich foods with fiber and activate higher levels of antioxidants more safely and effectively. He is also working with food chemists to develop new high fiber products.
NC A&T State University's Center for Excellence in Post-Harvest Technologies conducts cutting-edge research in postharvest technologies and food science. The Center's goal is the development of multidisciplinary programs focused on postharvest technologies including research pertaining to processing, preservation, recovery of health promoting food components, food safety issues, storage stability and quality and value-added product development for food and non-food uses.

Lead scientist LEONARD WILLIAMS, PhD, specifically addresses the application of bioactive compounds as prevention of foodborne illnesses. Williams also leads research tracking the microbes that cause foodborne illnesses like Listeria monocytogenes, Salmonella, Staphylococcus aureus, E. coli 0157:H7 through the food chain from farmers' fields to consumers' tables. The Centers for Disease Control (CDC) track the prevalence of the 31 known microbes responsible for foodborne illnesses. In the United States, foodborne illnesses cause 47.8 million gastroenteritis illnesses, 127,839 hospitalizations and 3,038 deaths per year.

GUIBING CHEN, PhD, operates the Food Engineering, Processing and Packaging Laboratory where he is experimenting with the use of many tools to find new ways to stabilize phytochemically-enriched products during the packaging process so that the nutrient value and resulting health benefits endure processing, transportation and storage. Microfluidization is one technique that Chen is researching that safely and effectively enriches foods with fiber. Microencapsulation is a technology Chen is developing to stabilize bioactive ingredients in foods. Collaborating with Williams, Chen is researching how microencapsulation can be used to house compounds that can delay or kill the microorganisms that cause foodborne illnesses. He is researching other food packaging techniques including sterilization, ultrasound processing, freeze drying and extrusion processing, all to ensure foods maintain nutrient content through packaging and distribution.

“Pathogens cause a lot of deaths, sickness and hospitalization, which result in a tremendous economic burden with loss of work, doctor visits, and, on the food industry, with recalls and lawsuits. It exponentially compounds itself to where foodborne illness is probably one of the most costly to treat. It is something we hope to help find a remedy for through research in this center.”
Statistics from the Alzheimer's Association reveal that 5.4 million Americans are living with Alzheimer's disease. By 2050, that number is estimated to reach 16 million. Alzheimer’s is the sixth leading cause of death in the country and the fifth among people over the age of 65. Just as feared are other memory disorders like mild cognitive impairment (MCI) and dementia, which are many times precursors to Alzheimer’s disease.

Scientists with the UNC Chapel Hill Nutrition Research Institute and the MURDOCK Study are taking the lead at the NC Research Campus to understand the development of memory disorders and determine preventative strategies.

**Nutrition Research Institute B.E.R.R.Y Study**

**CAROL CHEATHAM, PhD**, assistant professor of Psychology at UNC Chapel Hill and a lead scientist with the Nutrition Research Institute, is leading The B.E.R.R.Y Study, which stands for Blueberries: Exciting Research Relevant to You. Cheatham specializes in behavioral and electrophysiological approaches to researching the brain development of infants, toddlers and young children. She specifically studies the role of fatty acids and nutrients like choline, iron and zinc. The B.E.R.R.Y Study expands her research to include older adults.

Blueberries are being studied as a dietary supplement in relation to cognitive abilities because they are high in anthocyanins, which is the phytochemical responsible for their blue color. Anthocyanins are antioxidants and associated with improved memory function as well as with the prevention of some cancers and other diseases. Cheatham’s study aims to further define the link between anthocyanins and human cognition as well as identify biomarkers, which are proteins in the blood, and any genetic links that can be researched further in future studies.

**MURDOCK Study Memory Health Screening**

A Memory Health Screening is being conducted by Duke University’s Joseph and Kathleen Bryan Alzheimer’s Disease Research Center (Bryan ADRC) in Durham, NC in partnership with the MURDOCK Study (the Measurement to Understand the Reclassification of Disease of Cabarrus/Kannapolis), which is based at the NC Research Campus. The purpose of the study is to advance the understanding of linkages between Alzheimer’s disease, genetics and exposure to environmental factors. The study aims to clarify the factors that accelerate or postpone Alzheimer’s disease and gather biological data to discover biomarkers that may indicate Alzheimer’s disease. This research will continue to increase the understanding of the underlying causes of the disease and the associated risk factors like hypertension and diabetes that together establish a clinical signature of the disease that is critical to early diagnosis. This data from the Memory Health Screening may lay the foundation for a long-term prevention study that could lead to clinical trials for a new Alzheimer’s treatment.
The UNC Chapel Hill Nutrition Research Institute (NRI) is pioneering the field of individualized nutrition. Directed by STEVEN ZEISEL, MD, PhD, a renowned scientist recognized for his discovery of choline as an essential nutrient for brain and cognitive development, the NRI is dedicated to understanding why there are individual differences in metabolism and nutrient requirements. Zeisel leads a team of scientists who are applying advances in the sciences of nutrigenomics, metabolomics and epigenetics to find ways to use individually targeted nutrition to enhance brain development and to prevent or treat obesity, diabetes and cancer.

The NRI team includes ANDREW G. SWICK, PhD, Director of Obesity and Eating Disorders Research. Swick’s research responds to the growing global epidemic of obesity. His team analyzes how the gut senses food and sends signals to control appetite and metabolism and is providing solutions that can help curb the epidemic. Swick is specifically researching how the hormonal response to the digestion of fats in the intestine can be manipulated to increase satiety and prevent hunger inducing weight loss. He is also investigating the variability of energy expenditure in humans and the effects of diet, exercise, phytochemicals, nutriceuticals and pharmaceuticals on energy metabolism and body weight. Swick's research has increased the understanding of the relationships between diet, gut metabolism and body weight.

BRIAN BENNETT, PhD, focuses on genetic components of chronic metabolic diseases, such as cardiovascular disease and obesity. Using integrative genetic studies or systems genetics, he examines the relationship among factors such as genetic variants, gene expression levels, metabolite levels and their interactions to determine increased susceptibility to cardiovascular disease. Bennett uses these methods to investigate the effects of specific dietary components on metabolic diseases in order to establish how diet affects gene expression. He specifically studies the role of the metabolite TMAO, which appears to change with diet and is predictive of cardiovascular disease. He is working to identify the interaction of biologic networks regulating TMAO levels.

MIHAI NICULESCU, MD, PhD, specializes in the study of epigenetics and nutrition. Epigenetics is the study of how gene expression changes without DNA changing. He is recognized as a global leader in the field and is co-editor of the book Nutrition in Epigenetics. His current research is demonstrating the importance of a mother’s diet to fetal brain development. He is specifically studying the relationship between maternal obesity, the ingestion of omega-3 fatty acids and postnatal brain development.

PHILIP A. MAY, PhD, recently won an $8.9 million grant from the National Institutes of Health’s National Institute on Alcohol Abuse and Alcoholism to study Fetal Alcohol Spectrum Disorders (FASD). The grant funds May’s research into the prevalence and characteristics of FASD in the United States, which compliments his existing research into the individual nutrient risk factors related to alcoholism during pregnancy. Because the symptoms of FASD are typically evident late in childhood, they are difficult to diagnosis early and to track. The grant will allow May to work with first graders across the United States including North Carolina to develop new methods for diagnoses and tracking.

MARTIN KOHLMIEIER, MD, specializes in the development of novel biochemical methods for the assessment of dietary intake, nutrient adequacy, the inherited handling of foods and associated cancer risks. His research has a practical side helping people safely navigate daily food choices with innovative online applications. Kohlmeier is the lead author of numerous online nutrition courses for healthcare professionals. He has authored Nutrient Metabolism, a textbook describing how the body handles about one hundred important compounds in food. His newest book is Nutrigenetics: Applying the Science of Personal Nutrition, the first comprehensive textbook on the subject.
The MURDOCK Study - Measurement to Understand the Reclassification of Disease Of Cabarrus/ Kannapolis - is a multi-tiered, longitudinal health study locally based in Kannapolis at the NC Research Campus. The study falls under the Duke Translational Medicine Institute (DTMI) and is funded by an initial gift of $35 million from David H. Murdock, founder of the NC Research Campus, chairman of Dole Foods, Inc. and owner of Castle and Cooke, Inc.

The MURDOCK Study is building a community registry of the local residents age 18 and older of Kannapolis and Cabarrus County and the surrounding region. The registry has already exceeded 8,000 participants.

Enrolling in the MURDOCK Study’s community registry involves donating biological samples of blood and urine for storage in the LabCorp-Kannapolis Biorepository. The samples are cross-referenced with participants’ medical history, demographics and other data. The samples, when approved by the MURDOCK Leadership Committee, are used by Duke researchers and partners to identify novel biomarkers. By tapping into such valuable assets, Duke investigators and physician-scientists are working to characterize disease risk factors and change the understanding of diseases and treatments. Specific research findings generated from the MURDOCK Study include:

**Hepatitis C:** A protein biosignature of response was identified for individuals receiving Interferon treatment for hepatitis C. In addition, this group reported on the relationship between a genetic variant near the interleukin-28b gene and hepatitis C viral clearance with interferon treatment, leading to the development of a commercially available test.

**Cardiovascular Disease:** Efforts were completed to validate the association between future cardiovascular events (death and heart attack) and metabolomics factors that contribute incrementally to information from identified clinical predictors of risk. Protein signatures and gene expression data are also being evaluated.

**Obesity:** A branched chain amino acid-related metabolic signature was determined to differentiate obese and lean individuals and to be associated with insulin resistance.

**Osteoarthritis:** Research undertaken by this team has demonstrated that bone trabecular integrity by fractal signature analysis can predict progression of knee osteoarthritis based on X-ray and MRI measures. The team also used proteomic analysis of joint fluid to identify potential new biomarkers for osteoarthritis progression that are now being evaluated in ongoing studies.

The MURDOCK Study also hosts additional studies in partnership with Duke researchers that include Memory Health, Physical Performance, Centenarian, Severe Acne and Multiple Sclerosis.
Changing the Course of DIABETES TREATMENT

Type 2 diabetes is considered an epidemic. In the southern United States, rates of diabetes are some of the highest. Cabarrus Health Alliance (CHA), the public health department of Cabarrus County where the NC Research Campus is located, is part of a three-year Duke University program with the goals of improving Type 2 diabetes care and management and health outcomes and reducing healthcare costs related to diabetes in the Southern United States. The program is funded by a $9.7 million award from the Centers for Medicare and Medicaid.

Under the leadership of Dr. Robert M. Califf, vice chancellor for Clinical and Translational Research of Duke Medicine, director of the Duke Translational Medicine Institute and lead investigator for the MURDOCK Study, the study, From Clinic to Community: Achieving Health Equity in the Southern United States, involves four counties where teams of trained healthcare workers will utilize new technologies to educate and deliver diabetes care and information along with an informatics infrastructure that will allow care teams to understand the changing diabetes landscape across the nation. Cabarrus Health Alliance will receive $1.8 million as part of the study. The funds will create seven new jobs, including community health workers, information officers and health integrators.

For over 100 years, Cabarrus Health Alliance (CHA) has provided Cabarrus County with public health services ranging from medical clinics to restaurant inspections. The agency is considered a 21st Century Model Public Health Agency that promotes healthy individuals, healthy living and healthy communities through services, classes, research and outreach that go beyond the bounds of a traditional public health department.

CHA’s new location, a 65,000 square-foot, modern building, anchors the NC Research Campus’ medical corridor. All of the agency’s services are available including vaccinations, the outpatient medical clinic, dental clinic, environmental health services and child care. As a model agency and partner in the diabetes study with Duke, CHA’s expanded services such as a fitness center, a wellness kitchen and a training and education center will help encourage healthy lifestyle choices and provide new options for diabetic patients to receive treatment and medical care.

The Cabarrus Health Alliance is led by William F. Pilkington, DPA. Participating in the Duke-led program to develop new standards of care and treatment for people with diabetes allows Pilkington and his staff to contribute solutions to help end the current diabetes epidemic not only in Cabarrus County but globally. Diabetes is a serious disease with complications that include heart disease, stroke, high blood pressure, blindness, kidney disease and neuropathy. In the United States, 25.8 million children and adults or 8.3 percent of the population are diagnosed with diabetes. The American Diabetes Association estimates that 79 million people are pre-diabetic and another 7 million people have diabetes but are undiagnosed. The International Diabetes Federation (IDF) statistics reveal that diabetes is just as much an international crisis with 366 million people with diabetes, 4.6 million deaths due to diabetes and $465 billion spent on care for diabetes.
Carolinas HealthCare System (CHS) is one of the largest public, not-for-profit systems in the nation with over 30 affiliated hospitals, 6,200 licensed beds, over 1,900 physicians and over 48,000 people employed in the Carolinas. Patients find the care they need from childbirth to geriatrics at physician locations, freestanding emergency departments, outpatient surgery centers, pharmacies, laboratories and imaging centers. CHS also has a legacy of groundbreaking research. The James G. Cannon Research Center located on the main campus of Carolinas Medical Center in Charlotte specializes in research in areas such as emergency medicine, family medicine, general surgery, liver, digestive and metabolic disorders, Muscular Dystrophy, neuromuscular/ALS, OB/GYN, orthopedic engineering and proteomics.

In the Kannapolis/Concord community, CHS has provided healthcare for 75 years. To celebrate, a new 60,000 square-foot building is under construction along the medical corridor of the NC Research Campus. CHS will be the main tenant, leasing half of the Class A medical office space. The new building reflects CHS’ tradition of state-of-the-art facilities, equipment, diagnostic capabilities and research. It will house high tech imaging and multi-disciplinary fields of medicine spanning internal medicine, pediatrics, geriatrics, general surgery and general practice. Patients will not only have access to innovative healthcare, they will be able to participate in clinical research studies and educational programs provided by the campus’ university and corporate partners.
Peaking Human Performance Through Healthier Consumer Products

The work of the scientists at the NC Research Campus starts with identifying phytochemicals in fruits and vegetables and finding new agricultural and medicinal applications to prevent and treat numerous diseases like malnutrition, cancer, diabetes and obesity. Researchers are also directing their efforts to product development. They are revolutionizing health along with the marketplace by providing consumers products that are scientifically proven to have real health benefits.

Bridging academia, industry and the marketplace is the Appalachian State University (ASU) Human Performance Laboratory. Depending on treadmills, stationary bicycles, swimming pools, metabolic chambers and bod pods as their tools of scientific inquiry, DAVID NIEMAN, DrPH, FACSM, director of the Human Performance Laboratory and ASU professor of health and exercise science, and his research team seek to provide “practical answers” to the questions surrounding health, exercise and nutrition that help peak human performance.

In more technical terms, the goals of the Human Performance Laboratory are to research the affects of exercise and nutrition on human health by understanding the effects of plant molecules on age-related loss of muscle mass, muscle mitochondrial biogenesis and exercise-induced changes in immune function, oxidative stress and inflammation. The research focus and established relationships with beverage, food, nutritional supplement and pharmaceutical companies have made the Human Performance Laboratory a resource for product testing. Dole Foods, the largest marketer and seller of fruits and vegetables, is one of the corporations that engage the Human Performance Laboratory to conduct studies.

A recent Dole and ASU study published in the Journal of Alternative and Complementary Medicine found that milled chia seeds versus whole seeds supply higher levels of alpha-linolenic acid (ALA). ALA is an omega-3 fatty acid essential to human metabolism that can only be obtained through consuming fish or plants. Partnering on chia studies with ASU has contributed to a better understanding of the seeds’ nutritional benefits and the development of a Dole line of chia-based products.

Dole is taking a similar approach to better defining the health benefits of bananas. A Dole/ASU study published in the online peer-reviewed journal PLoS ONE showed that bananas provide an energy boost similar to that of sports drinks as well as greater nutrition including antioxidants, fiber, potassium and vitamin B6. In addition, bananas are a natural source of sugars.

“We compared bananas as an energy source to a carbohydrate drink that is commercially available,” said NICK GILLITT, PhD, director of the Dole Nutrition Research Laboratory at the NC Research Camps. “It is interesting that the particular energy drink that we used had millions of dollars spent on development, and it turns out that a natural banana does the same thing.”

ASU and Dole are planning future studies with Olympic-level swimmers to test concentrated, freeze dried powders made from fruits and vegetables that can provide nutritional benefits in conveniently packaged portions. They are also planning studies involving a powder with concentrated fruit and vegetable polyphenols and antioxidants developed by Mary Ann Lila, PhD, director of the NC State University Plants for Human Health Institute at the NC Research Campus, and Rutgers University.

“Everybody should eat more fruits and vegetables and should be buying them,” Gillitt said, “but in this fast-paced world, it is often impractical to take the time to blend all these fruits and vegetables into our diets. Thus, if we can supply convenient packaged products that provide all of the health benefits of fresh produce, we can solve that problem.”
The American Heart Association 2012 statistics reveal that 33 percent of adults, 29 percent of adolescent girls and 17 percent of boys are not engaging in regular physical activity. The result is an increase in obesity, diabetes, cancers and other diseases related to nutritional and lifestyle choices. A national leader in the area of nutrition and exercise immunology, the ASU Human Performance Laboratory is part of the solution.

The laboratory is led by David Nieman, DrPH, FACSM, a recognized authority in the areas of exercise immunology and sports nutrition, obesity, aging and nutritional assessment. His research team includes Andy Shanely, PhD, and Amy Knab, PhD, both of whom are ASU assistant professors of exercise science, and Research Scientist Lynn Cialdella Kam, MBA, MA, PhD, who manages the biochemistry laboratory. Research Manager Pamela Krasen, MS, and Research Associate Dustin Dew manage the laboratory’s research studies.

Working closely with trained and amateur athletes, corporate collaborators and sponsors as well as community participants, the Human Performance Laboratory investigates the influence of plant molecules called flavonoids on age-related loss of muscle mass (sarcopenia), muscle mitochondrial biogenesis and exercise-induced changes in immune function, oxidative stress and inflammation. Their research is adding to the scientific understanding of the positive effects of exercise on the body and how nutrition affects human performance during exercise. They also work with food companies to better understand the health benefits of their existing products and to develop healthier consumer products.
Fruits and vegetables are an extremely healthy, low-fat source of vitamins, minerals and dietary fiber. People who consume fruits and vegetables on a regular basis are more likely to enjoy a lower risk for developing numerous diseases including cardiovascular disease, diabetes, obesity and many types of cancer. From apples to zucchini, phytochemicals, which are the bioactive compounds found in plants, are getting the credit for keeping people healthy and aiding in the prevention and treatment of such diseases.

These so called phytochemicals, often referred to as antioxidants, flavonoids or polyphenols, are now at the cutting edge of nutrition research. According to the American Cancer Society, scientists have identified thousands of phytochemicals but only a small proportion have been studied closely. Dole Food Company, Inc., the world’s largest producer and seller of fruits and vegetables, intends to substantially enlarge the understanding of the role of phytochemicals in human health.

The Dole Nutrition Research Laboratory located at the NC Research Campus is identifying and quantifying the myriad of phytochemicals found in the company’s fruits and vegetables. A portfolio of produce that includes over 200 products such as commodity fresh fruits and vegetables, packaged salads and a large line of canned, frozen fruit and value-added products. Dole’s goal at the NC Research Campus is two-fold. First, supporting the nutrition research requests of the company’s divisions especially in new product development, and, secondly, conducting collaborative studies with NC Research Campus partners to contribute to the knowledge base on the healthful nature of fruits and vegetables in the human diet. These two accomplishments will allow Dole to strengthen its consumer platform from which it advocates healthier dietary choices.

At the NC Research Campus, which is home to 16 academic, corporate and non-profit partners, Dole to-date leads the collaborative research effort with other campus partners including Appalachian State University’s Human Performance Laboratory, the David H. Murdock Research Institute, NC State University’s Plants for Human Health Institute and NC A&T State University. Studies have involved the use of bananas as an energy source for athletic performance, chia seed consumption and omega 3 bio availability, the effects of fruit and vegetable juice on inflammation and oxidative stress, the health benefits of vitamin D from portabella mushroom powder and the identification of bacterial metabolites from black tea polyphenols.

Dole’s research at the NC Research Campus has contributed directly to the development of a number of Dole products including a chia seed cluster snack and a vitamin D mushroom powder. Research results are being published in peer-reviewed scientific journals broadening the global scientific knowledge regarding food, health and nutrition available to other companies and academic researchers worldwide.
Feeding the World with Knowledge

Dole Foods is not only a leader in producing and selling fruits and vegetables, they are also a leader in nutrition education. Spearheaded by David H. Murdock, chairman of Dole Foods and the visionary behind the NC Research Campus, and his personal commitment to a plant-based diet, the Dole Nutrition Institute (DNI) was born over 20 years ago to “feed the world with knowledge.” The latest research findings, recipes and health tips are made available through the Institute’s website, a free online monthly newsletter, videos, brochures, cookbooks and educational materials, all of which has propelled the DNI into a global leader in nutrition education.

At the NC Research Campus, the Dole Nutrition Research Laboratory is identifying the phytochemicals present in the company’s fruits and vegetables, enhancing the nutritional value of the company’s products and expanding the scientific knowledge around the role of the benefits of phytochemicals in keeping people healthy.

“For 160 years, Dole has been a leader in delivering fresh fruits and vegetables to the world. For over 20 years, we’ve been a leader in nutrition education and advocating for the health benefits of a plant-based diet,” said Nick Gillitt, PhD, director of Nutrition Research. “Now through our Nutrition Research Laboratory at the NC Research Campus, we are going the next step to understand the science behind what makes our products healthy. We’re sharing our findings not only with our consumers but with the food industry and scientists worldwide through peer-reviewed publication.”
From the consumer point of view, deciphering health benefits amidst a sea of brands, colors, styles, types, flavors, health claims and price points is difficult. **Sensory Spectrum** provides companies and the NC Research Campus partners the opportunity to introduce sensory analysis into product development.

Headquartered in New Providence, New Jersey, Spectrum’s 14,000-square-foot North Carolina Spectrum Discovery Center opened in 2009. It employs sensory scientists, administrators and panelists. The Center is home to numerous trained panels and a database of thousands of individuals from the Charlotte-area who participate in sophisticated consumer research studies. The consumer studies gauge response to products that are being created for market introduction as well as provide feedback on product usage and concept acceptance.

Sensory Spectrum develops unique panels to meet the business needs of the industry. A panel like the Spectrum Community Narrative (SCAN) is trained in creative techniques and evaluates products using the consumer point of view by assisting in translating technical sensory language into consumer terms. Other panels require individuals to be trained in the appearance, flavor, texture or feel of the products to become experts in multiple product categories whether it is a personal care product such as a lotion or a food item such as a baked good. The Spectrum Descriptive Analysis method, developed by Sensory Spectrum President and Founder Gail Vance Civille, is utilized extensively in the training and evaluation of products. Knowledge from these panels allows products to be distinguished from the competition in the marketplace. Sensory has tested everything from food to furniture including beverages, home care products, appliances, fruits and vegetables.

At NC Research Campus, Sensory participated in the NC Strawberry Project, a partnership of NC State University (NCSU) Plants for Human Health Institute (PHHI), NC MarketReady and Johnson and Whales University. Sensory Spectrum conducted sensory analysis on 16 strawberry breeding lines and cultivars by looking at and scoring traits such as appearance, shape, color, flesh texture, firmness and flavor using panels of consumers, chefs and farmers.

The feedback from the panels provided precise and detailed data that Jeremy Pattison, PhD, strawberry breeder with PHHI and an assistant professor in the NCSU department of horticultural science, is using to breed a better North Carolina strawberry, increase the strawberry growing season and grow strawberries in more regions, increasing the economic impact of the industry in the state.

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**Translating Sensory Data into Consumer Products**

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**GAIL VANCE CIVILLE**
President
Sensory Spectrum, Inc.

**JUDY HEYLMUN**
Vice President Business Development
Director Spectrum Discovery Center
North Carolina

*Sensory Spectrum adds a unique scientific capability to the NC Research Campus — one that translates sensory data into products acceptable to consumers. Sensory Spectrum President Gail Vance Civille is a pioneer of sensory evaluation techniques used by industry, academia and government. She developed Spectrum Descriptive Analysis™, a groundbreaking system of sensory analysis that scientifically rates the flavor, texture, fragrance, skinfeel and fabricfeel of products. Led by Judy Heylmun, vice president of business development and director of the NC Discovery Center at the NC Research Campus, Sensory sponsors trained panels that evaluate products in analytical, consumer language that gauges product knowledge and distinguishes consumer preferences, which gives Sensory’s clients data that allows them to differentiate their products in the marketplace. At a time when consumers are deluged with product choices, understanding the packaging, wording, tastes, textures and colors that motivate their choices is a step to encouraging healthier food choices and healthier lifestyles.*
Giving Consumers New Reasons to Choose Fruits and Vegetables

Imagine foods with bright colors, pleasant aromas, great taste and a proven ability to help manage weight and prevent disease.

Actually, no imagination is needed. Just walk into a farmers market or go to the produce department of a local grocery store. The fruits and vegetables lining the shelves are full of vitamins, minerals and bioactive compounds that are linked to the prevention of obesity, diabetes, some cancers and cardiovascular disease. Even with all of their benefits, the majority of people worldwide are not eating enough fruits and vegetables on a daily basis.

MONSANTO, a multinational agricultural biotechnology company, is on a mission to change that trend by making fruits and vegetables more appealing to consumers while providing farmers with better and more marketable crops. At the forefront of the company’s research and development of new fruit and vegetable varieties are the scientists at the NC Research Campus.

As a part of the company’s fruit and vegetable seeds division, Monsanto scientists at the NC Research Campus are focused on investigating specific traits of peppers and melons. Monsanto works closely with the Nuclear Magnetic Resonance (NMR) laboratories and the Analytical Sciences groups to take advantage of the David H. Murdock Research Institute’s (DHMRI) advanced scientific platforms in the fields of genomics, proteomics and metabolomics.

As Monsanto’s laboratory expands its research to other fruits and vegetables like tomatoes, the access to this type of instrumentation is critical. Monsanto is also looking at taking advantage of the DHMRI’s instrumentation for research involving row crops like corn, soybeans, cotton, alfalfa and canola. But for now, Monsanto’s focus remains on giving consumers new reasons to choose fruits and vegetables.

Monsanto, a multinational agricultural biotechnology company, is on a mission to make fruits and vegetables more appealing to consumers while providing farmers with better and more marketable crops.

“There are a lot of reasons why consumers don’t eat enough fruits and vegetables. Some of it has to do with convenience. Some of it has to do with the way things taste,” said Susan MacIsaac, Monsanto’s site lead at the NC Research Campus. “So by being able to enhance characteristics in fruits and vegetables, our hope is that they’ll be more attractive to consumers. They’ll want to eat more and, as a result, they’ll be healthier. That’s absolutely a driving force behind what we do.”
Taking Oats to the Next Level

Make a list of healthy foods, and oats will be on it. Why? Because of the beta-glucan the grain contains.

Beta-glucan is a soluble fiber that is clinically proven to reduce cholesterol. Lowering cholesterol, according to the American Heart Association, is known to lessen the risk of stroke and heart disease.

Even with proven heart-healthy benefits, food manufacturer GENERAL MILLS is working to make oats even better. As the producer of Cheerios and one of the largest users and handlers of oats in North America, the company has invested in research to yield, solely through natural and traditional breeding methods, an oat with higher and more consistent levels of beta-glucan.

To achieve their goal of healthier oats, General Mills funded through the United States Department of Agriculture the creation of a “genome map” to be shared through a publicly accessible database for oat breeders around the world. General Mills’ initial investment spurred the formation of a research fund of more than $1.7 million and a global research partnership of more than 30 scientists.

In 2010, General Mills joined the NC Research Campus where the collaborative research has advanced the understanding of the oat genome to the point that it equals that of other grains such as wheat and barley. General Mills collaborates with the David H. Murdock Research Institute (DHMRI) and the University of North Carolina at Charlotte’s Bioinformatics Services Division, both on the campus, on next generation sequencing of oats. The DHMRI contains one of the largest collections of scientific equipment for the study of proteomics, genomics and metabolomics. Of use to General Mills is also the DHMRI’s microscopy suite and NMR facility, which contains 950 MHz and 700 MHz Bruker spectrometers. The 950 MHz is the largest in the western hemisphere.

“While General Mills has more than 1,200 research and development employees with a variety of deep technical expertise, we don’t have any employees who specialize in this specific type of research,” said ERIC JACKSON, General Mills research scientist and NC Research Campus site lead. “We can now co-develop and brainstorm solutions and research ideas ahead of time with the people who can also execute and plan the research.”

General Mills is a leading global food company. With brands as familiar as Betty Crocker, Green Giant and Cheerios, General Mills has been “nourishing lives” since the 1860s. At the NC Research Campus, the company is focused on mapping the oat genome to create, solely through natural and traditional breeding methods, an oat with higher and more consistent levels of beta-glucan as well as a greater resistance to pests and disease. Beta glucan is the soluble fiber clinically proven to reduce cholesterol. Lowering cholesterol, according to the American Heart Association, is known to lessen the risk of stroke and heart disease.
Emerging in the early 1980s, bioinformatics has evolved alongside advances in computational capabilities, the Internet and gene sequencing into a required tool box of methodologies to analyze data produced by gene sequencing and high-throughput screening technologies.

At the NC Research Campus, the contributions of the UNC Charlotte Bioinformatics Research Services Division range from mapping the blueberry genome, to identifying new health benefits of bananas to better understanding the links between metabolism and obesity. While they partner with campus colleagues such as NC State University Plants for Human Health Institute, Dole Foods Nutrition Research Laboratory, the Appalachian State University Human Performance Laboratory and UNC Chapel Nutrition Research Institute’s Obesity and Eating Disorders Research Center, they also manage industry contracts that range from statistical analysis of health surveys to sequencing breast cancer samples for specified abnormalities.

UNC Charlotte’s bioinformatics services are powered by a 432-core processor Linux cluster with 8 GB RAM per core (3.4 TB total RAM). This increased memory is ideally suited for the high memory demands of biological data. Also part of the cluster are four high memory servers, one with 512 GB and 32 cores and three with 1TB of RAM and 24 cores. The system is expanded annually with additional computational nodes, disk space and memory to ensure that they are able to provide the bioinformatics support to any research partner, on or off campus.

To further enhance their capacity as a collaborative partner, they have access to the resources of the Department of Bioinformatics and Genomics at UNC Charlotte’s main campus, less than 20 miles south of Kannapolis, and support research efforts there. This connection has led to several collaborations between NC Research Campus researchers and those at the UNC Charlotte main campus.

Technologies like gene sequencing and high-throughput screening have exponentially increased the amount of data available to scientists. Bioinformatics, a field that combines areas such as molecular biology, computer science and data analysis algorithms, has become the required toolbox of methodologies available to scientists to analyze all of this data.

“Bioinformatics is a very broad field involving anything from searching and matching up DNA sequences all the way to looking at (cellular) networks and pathways and developing mathematical models of those pathways,” explained Cory Brouwer, PhD, director of the UNC Charlotte Bioinformatics Services Division and associate professor of Bioinformatics and Genomics at UNC Charlotte. “Bioinformatics is a necessary tool to get the best use of the latest research and genomics techniques.”

The National Center for Biotechnology Information adds that the “rapidly emerging field of bioinformatics promises to lead to advances in understanding basic biological processes and, in turn, advances in the diagnosis, treatment, and prevention of many genetic diseases. The implications . . . for both science and medicine are staggering.”
Improving Human Life Through Expertise and Instrumentation

Partnering with General Mills, DHMRI is essential to the mapping of the oat genome. Working with NC State University and its partners, DHMRI bioinformatics and genomics expertise contributed to the mapping of the blueberry genome. Working in partnership with companies, academic institutions and non-profit scientific organizations, the DHMRI, a non-profit, contract research organization, is driving research innovation and advancing the translation of discoveries from research laboratories to commercial markets in areas such as diabetes, breast cancer, liver disease, anorexia, ADHD, brain development, neurologic and psychiatric diseases, obesity and other metabolic syndromes.

Research Capabilities

DHMRI leverages capabilities and expertise across a wide spectrum of scientific disciplines that include immunology, cell and in-vivo biology as well as several scientific platforms consisting of genomics, metabolomics, proteomics, chemistry and bioinformatics. The In-Vitro Sciences Laboratory involves integrated cellular profiling, biochemistry and gene expression analysis for preclinical and clinical studies. The Genomic Sciences Laboratory provides critical support of studies involving genotyping, expression analysis, epigenetics and de novo genome sequencing and resequencing applications for a wide range of projects involving plants, animals and humans. The Analytical Sciences Laboratory supports studies ranging from biomarker sciences to compound analyses including discovery, quantitation and characterization using proteomics, metabolomics, analytical chemistry techniques and protein structure-based solutions using Nuclear Magnetic Resonance (NMR) spectroscopy as key platforms.

Key Instrumentation

DHMRI is home to a host of progressive instrumentation and equally matched expertise with opportunities for collaboration with other researchers, mobile laboratory stations for easy expansion and the potential for walk-up access to a number of laboratories. Laboratory instrumentation includes: a suite of Bruker NMR spectrometers, including 400, 600, 700, and 950 MHz NMR instrumentation, a comprehensive set of Carl Zeiss MicroImaging light and confocal microscopes and a wide assortment of genomic technology, including next generation sequencing platforms and state-of-the-art capabilities in metabolomic, proteomic, in-vitro and in-vivo sciences.
DHMRI provides the flexibility and adaptability to create client-oriented solutions to complex biological problems in the areas of:

**Food and agriculture**
Efforts focus on improving the discovery of critical traits that will help improve the predictability of plant breeding by providing access to multi-platform molecular profiling of a variety of species. Related applications include natural products and bioactive nutraceuticals.

**Nutrition and health**
Research focuses on monitoring the physiological and molecular responses to exercise and nutrition. Information from such studies is used to better understand the impact of genetics and the environment at an individual level. This includes how nutrition impacts each stage of development, from prenatal to adulthood.

**Therapeutics and diagnostics**
As medicine becomes more personalized, DHMRI supports the translational research path that leads from bench to bedside by offering the expertise and capabilities to support studies ranging from biomarker discovery to detailed characterization at the in-vitro, in-vivo, as well as clinical levels, to support biopharmaceutical and diagnostic R&D efforts.

**Customized analytical solutions**
DHMRI is able to apply a range of expertise and analytical systems to identify creative solutions; thereby taking a multifaceted approach to answer complex problems.

“To improve human nutrition and address human conditions through nutrition, demands ‘big science’ that requires the integration of plant biology, molecular biology, population genetics, clinical trials and computational sciences. Through the philanthropy of the visionary David H. Murdock, the DHMRI, the NC Research Campus and its partners, we are achieving this goal.”

- Steven Lommel, PhD, David H. Murdock Research Institute Board of Directors and Interim President
LabCorp’s biorepository is a purpose-built biological storage facility located near the NC Research Campus. Biorepositories are “libraries” in which biospecimens are stored for clinical or research purposes. When annotated with patient demographic or clinical data information, the specimens provide a snapshot in time that is especially useful in biomarker research.

Clients can also use LabCorp’s biorepository to store samples from clinical trials. They are working with various patient safety registries to house consented samples at the biorepository for future research efforts. Redundant back-up systems, validated state-of-the-art informatics and capabilities for on-site nucleic acid extraction make the LabCorp biorepository the facility of choice for biopharmaceutical and academic research specimen storage.

In LabCorp’s newest venture, assays developed at the David H. Murdock Research Institute (DHMRI) for contracted research will be transferred to LabCorp Clinical Trials laboratories worldwide to support global clinical studies. The agreement also provides a way to commercialize companion diagnostics and other biomarker assays once clinical validation has been established. The services available to clients through the DHMRI provide LabCorp with the opportunity to offer its clinical trials clients the most complete suite of biomarker development tools in the industry.

Rowan-Cabarrus Community College provides education and workforce training on the grounds of the NC Research Campus (NCRC). The Rowan-Cabarrus NCRC facility, a three-floor, 62,000 square-foot facility provides a “hands-on realistic training environment” for a region of North Carolina transforming itself from textiles to technology. This STEM-focused training center hosts ten classrooms, ten laboratories, faculty and staff offices, a community event room, library, multiple conference rooms and video conferencing capabilities plus a student center. Approximately 300 students take classes to earn an associate degree in biotechnology that prepares them for jobs as laboratory technicians, research assistants or quality control associates. The Rowan-Cabarrus NCRC facility is also home to the college’s nursing programs, developing the healthcare leaders of tomorrow. Approximately 100 students work toward earning degrees in nursing, preparing them for careers in hospitals, long-term care facilities and doctor’s offices.

Also in the Rowan-Cabarrus NCRC facility is the college’s Small Business Center, providing support to entrepreneurs and growing businesses. Rowan-Cabarrus offers associate degree programs in a wide variety of fields with diploma and certificate programs focusing on workforce training and continuing education.
Acknowledgements

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