

RESEARCH

HUMAN HEALTH | NUTRITION | AGRICULTURE





THE NC RESEARCH CAMPUS

The North Carolina Research Campus (NCRC) in Kannapolis, just north of Charlotte, is a public-private partnership made possible by the \$700 million investment of David H. Murdock, owner of Dole Food Company, Inc., and Castle & Cooke, Inc., and the North Carolina General Assembly.

The NCRC's collaborative and multi-disciplinary approach to science spans the identification of health-promoting phytochemicals in fruits, vegetables, grains and herbs; exercise physiology; post-harvest physiology; population-based, genetic studies; and personalized nutrition. The growing base of scientific knowledge combines new understandings of how nutrients, the environment and lifestyle choices impact brain and fetal development, cancer, diabetes, obesity, heart disease, fatty liver and other metabolic disorders, all to find new ways to prevent and treat disease and improve the prognosis for human health.

For the people of North Carolina, the NCRC transformed a 350-acre site from a shuttered textile mill into a thriving life science research center that is home to corporate, academic, healthcare and technology partners that jointly share a mission to improve human health, nutrition and agriculture.

EMPLOYMENT

The seven UNC schools at the NCRC—UNC Chapel Hill, NC State, UNC Charlotte, NCA&T, NC Central, UNC Greensboro and Appalachian State University- have created 250 new local jobs encompassing fulltime and part-time positions as well as high school through graduate level interns. The UNC schools have also collectively brought in more than \$60 million in grant funding through the end of FY13. The combined employment associated with the campus is just over 1,000. Fifty percent of these employees were locally hired while the rest have relocated from other states and countries.

ON CAMPUS

Since 2006, over one million square feet of wet lab and Class A office space have been built on the NCRC including the:

- David H. Murdock Core Laboratory Building
- NC State University Plants for Human Health Institute
- UNC Chapel Hill Nutrition Research Institute
- Rowan-Cabarrus Biotechnology Training Center
- LabCorp Biorepository
- Cabarrus Health Alliance
- NCRC Medical Plaza
- Plants for Human Health Institute Greenhouse Complex

The 50,000-square-foot DataChambers data center and the 110,000-square-foot city of Kannapolis municipal center and police headquarters are now under construction and should be occupied in 2015.





DAVID H. MURDOCK CORE LABORATORY BUILDING

The 311,000-square-foot David H. Murdock Core Laboratory is the centerpiece of the NCRC. The core laboratory is home to the David H. Murdock Research Institute (DHMRI), UNC Charlotte Bioinformatics Services Division, General Mills, Monsanto, NCA&T core lab facility and JC Med, LLC, a biotech spin-out of the UNC Nutrition Research Institute that develops and manufactures products to reduce insulin resistance.

DAVID H. MURDOCK RESEARCH INSTITUTE

The David H. Murdock Research Institute (DHMRI) is a non-profit research organization established by David H. Murdock. In September 2014, Mr. Murdock announced a \$15 million annual endowment given in perpetuity to DHMRI. Previously, he invested over \$140.5 million to support the institute's development and growth. DHMRI works with the scientists on the NCRC and collaborates with large and small pharmaceutical, biotech and agricultural companies as well as academic, non-profit and government organizations. DHMRI houses unparalleled scientific expertise and advanced instrumentation in genomics, proteomics, metabolomics, nuclear magnetic resonance (NMR) spectroscopy, microscopy, analytical sciences and bioinformatics.

For more information, visit www.dhmri.org

DUKE UNIVERSITY MURDOCK STUDY

The MURDOCK Study (Measurement to Understand the Reclassification of Disease of Cabarrus/Kannapolis) is a multi-tiered, long-term, community-based genomic study funded by a \$35 million grant from David H. Murdock. The MURDOCK Study, which is a part of Duke University's Translational Medicine Institute, stores the biological samples of its participants from specific zip codes in Kannapolis, Cabarrus, Rowan, Stanly and Mecklenburg counties at the LabCorp BioRepository, located in Kannapolis about a mile from the NCRC. Using advanced technologies such as the study of genes, proteins, and other biomarkers, scientists use the MURDOCK Study samples to uncover at the genetic and molecular level how diseases begin, progress and can be better treated. Already, the MURDOCK Study is breaking new ground in the understanding of and potential treatments for hepatitis C, osteoarthritis, coronary heart disease, multiple sclerosis and other chronic diseases. For more information, visit www.murdock-study.org.





TRAINING

The NCRC is also a training center for the next generation of scientists and medical professionals. Rowan-Cabarrus Community College offers two-year degrees in biotechnology and nursing in their training center that is walking distance from all of the campus' research centers. The Plant Pathways Elucidation Project (P2EP) is a one-of-a-kind, collaborative program that combines the expertise of leading scientists with the campus' university and corporate partners to train undergraduate, masters and doctoral-level students in fields like plant genetics and bioinformatics.

CAMPUS RESEARCH CENTERS AND PARTNERS

- Appalachian State University Human Performance Laboratory
- Cabarrus Health Alliance
- Carolinas Healthcare System
- City of Kannapolis
- Crown Biosciences
- DataChambers
- David H. Murdock Research Institute
- Dole Nutrition Research Laboratory
- Duke University/MURDOCK Study
- General Mills
- JC Med, LLC
- LabCorp Biorepository
- Monsanto
- NCA&T State University Center for Excellence in Post-Harvest Technologies
- NC Central University Nutrition Research Program
- NC State University Plants for Human Health Institute
- Rowan-Cabarrus Community College Biotechnology Training Center
- Sensory Discovery Center
- UNC Chapel Hill Nutrition Research Institute
- UNC Charlotte Bioinformatics Services Division
- UNC Greensboro Center for Translational Biomedical Research



APPALACHIAN STATE UNIVERSITY HUMAN PERFORMANCE LABORATORY

The Appalachian State University (App State) Human Performance Laboratory located at the NCRC is a national leader in the area of nutrition and exercise immunology.

The lab is led by David Nieman, DrPH, FACSM, a professor in the College of Health Sciences at App State and a pioneer in the area of exercise immunology. His research team at the Human Performance Laboratory includes a research manager, research scientist and three research technicians. The lab is funded by the North Carolina General Assembly and corporate partnerships.

The Human Performance Laboratory engages trained and amateur athletes as well as community participants in research studies. App State has contributed over \$500,000 to the local community through stipends earned by research study participants. Research in the Human Performance Laboratory explores the influence of unique plant molecules on age-related loss of muscle mass (sarcopenia), muscle mitochondrial biogenesis and exercise-induced changes in immune function, oxidative stress and inflammation. Through collaborations with partners at the NCRC like the NC State Plants for Human Health Institute and the Dole Nutrition Institute, the Human Performance Laboratory is responsible for advancing new understandings of how the interplay of exercise and nutrition, especially plant phytochemicals, impact human performance.

Dr. Nieman is recognized for groundbreaking findings such as the ability of regular, moderate exercise to lower upper respiratory tract infection rates. His research also established that heavy exertion increases infection rates, and that carbohydrate and flavonoid ingestion by athletes reduces exercise-induced immune dysfunction. Examples of other research findings include:

- Consuming a specific carbohydrate called raffinose that is found in pistachio nuts and other foods before intense exercise can reduce athletic performance.
- Heavy exercise increases the absorption of health-promoting, plant compounds called polyphenols into the bloodstream via the colon.
- Discovery of 13-HODE + 9-HODE as an abundant and stable biomarker to measure oxidative stress during studies involving intense exercise.

For more information visit www.ncrc.appstate.edu.



David Nieman, DrPH, FACSM



Leonard Williams, PhD

NCA&T CENTER FOR EXCELLENCE IN POST-HARVEST TECHNOLOGIES

North Carolina Agriculture & Technical State University's Center for Excellence in Post-Harvest Technologies (CEPHT) conducts cutting-edge research in post-harvest technologies and food science in their main laboratory in the UNC Nutrition Research building and a newly formed lab facility in the David H. Murdock Core Laboratory building. CEPHT employs 40 scientists from doctorate level principal investigators to research technicians and postdoctoral fellows.

CEPHT focuses on post-harvest technologies including research pertaining to processing, preservation, recovery of health promoting food components, storage stability and quality, food safety issues and value-added product development for food and non-food uses.

Director Leonard Williams, PhD, is the lead scientist for food safety and microbiology. He researches the microbiology and epidemiology of foodborne pathogens from food, veterinary and clinical sources. He is a co-lead of a US Department of Agriculture, multi-institutional, \$25 million, five-year grant that aims to reduce the prevalence of norovirus, one of the most common foodborne pathogens. He is also investigating the potential of biomaterials made of "phytochemicals and nanoparticles to inactivate pathogens" on produce and hard surfaces such as countertops.

Guibin Chen, PhD, assistant professor and lead scientist for food processing and engineering, is currently researching functional extruded foods, functional food processing using novel microgel capsules, and active and modified atmosphere packaging of fresh produce. One example of his research is the development of techniques to increase the amount of healthy brans in breads and cereals in order to increase the health benefits for consumers without changing the taste or texture of the products.

Shengmin Sang, PhD, associate professor, specializes in functional foods and studies dietary exposure markers using metabolomics. One of his research goals is to identify bioactive natural products in grains that can be used in functional foods and dietary supplements to prevent chronic diseases such as cancer and diabetes. He recently received a \$2.2 million, five year, R01 grant from the National Institutes of Health's National Center for Complementary and Alternative Medicine to investigate the interaction between black tea polyphenols and gut microbiota and their impact on colitis-associated colon cancer. He works collaboratively with NC Central University Nutrition Research Program to determine how ginger metabolites prevent anemia.



TinChung Leung, PhD

NC CENTRAL UNIVERSITY NUTRITION RESEARCH PROGRAM

NC Central University's (NCCU) Nutrition Research Program is part of the Julius L. Chambers Biomedical Biotechnology Research Institute (BBRI) at the main campus of NCCU in Durham, NC. In their NCRC laboratory, NCCU conducts research to identify and evaluate bioactive natural products from functional foods and herbal medicine. The goal is to use metabolomic and nutrigenomic approaches to find new options to prevent and treat diseases like cancer and diabetes as well as their complications.



Xiaho Yang, MD, PhD

NCCU Principal Investigator TinChung Leung, PhD, employs a zebrafish model to understand the molecular mechanisms of diseases and to validate therapeutic compounds including drug-like small molecules and natural products. He specifically uses zebrafish to research the development of cancer and to test compounds to aid in the prevention and treatment of the disease. In collaboration with NC A&T Center for Excellence in Post-Harvest Technologies, Leung showed in a zebrafish model that ginger metabolites can help reduce anemia caused by chemotherapy or renal disease. Research is ongoing to develop the finding into a therapeutic treatment.

Principal Investigator Xiaohu Yang, MD, PhD, studies the isoflavone genistein and its relationship to breast cancer. He also studies the impact of maternal exposure to dietary and environmental factors on the daughter's breast cancer risk, breast cancer drug resistance and the prevention of breast cancer with novel therapeutics. His recent research identified metformin, an anti-diabetes drug, as a potential preventative for HER2/neu overexpressing breast cancer, which is an aggressive form of breast cancer with a poor prognosis that is found in one-third of all human breast cancer cases.



Mary Ann Lila, PhD

NC STATE UNIVERSITY PLANTS FOR HUMAN HEALTH INSTITUTE

The NC State University Plants for Human Health Institute (PHHI) is leading the discovery and delivery of innovative plant-based solutions to advance human health. PHHI's six-leading scientists and their teams research fruits and vegetables to identify nutraceutical properties; improve the nutritional value of crops through traditional plant breeding; and advance post-harvest techniques that keep fruits and vegetables nutrient filled and safe to eat.

PHHI Director Mary Ann Lila, PhD, is leading the study of blueberries and their anti-cancer and anti-diabetic properties. Lila has discovered that health-promoting compounds in blueberries called polyphenols can alleviate the type of neurodegeneration that leads to Parkinsons' disease, and that polyphenols from cranberries, another berry she researches, may be a source for desensitizing individuals to peanut allergies. Lila regularly collaborates with the Appalachian State University Human Performance Laboratory and the Dole Nutrition Institute on joint studies that reveal the benefit of berry polyphenols on human health and performance.

PHHI is also leading a collaboration that includes the UNC Charlotte Bioinformatics Services Division and the David H. Murdock Research Institute to map the blueberry genome. Genome mapping and broccoli and cabbage breeding programs are leading to more nutrient rich varieties with enhanced potential to fight diseases like cancer. PHHI's strawberry breeding program is establishing a variety unique to North Carolina. New methods for cantaloupe and tomato processing that reduce the presence of potentially harmful pathogens are examples of successful projects conducted by scientists in post-harvest research.

Through NC Cooperative Extension, PHHI delivers science-based, educational resources, online tools and workshops that reach extension agents in all 100 North Carolina counties. The resources are aimed directly at helping North Carolina farmers with everything from regulatory changes to business development in new and traditional markets. Extension also has consumer resources that encourage the consumption of fruits and vegetables and educate people on their health benefits.

For more information visit <http://plantsforhumanhealth.ncsu.edu>.



Steven Zeisel, MD, PhD

UNC CHAPEL HILL NUTRITION RESEARCH INSTITUTE

The UNC Nutrition Research Institute (NRI) conducts innovative basic and translational science to understand how individual differences in genetics, epigenetics, and metabolism affect people's requirements for and responses to nutrition. Under the direction of Steven Zeisel, MD, PhD, a leading expert on the nutrient choline, the NRI is developing the field of individually targeted nutrition to enhance brain development, and to prevent or treat diseases like obesity, diabetes, heart disease and cancer. The long-term goal is for individualized nutrition to allow healthcare professionals to be patient-specific rather than generic in treatment and prevention of diseases.

The NRI's faculty scientists and their research teams apply the burgeoning fields of metabolomics and nutrigenomics to study the role of individualized nutrition on wellness, the prevention and treatment of disease and human development. The NRI scientists specifically investigate birth defects, cancer, cognitive development, diabetes, eye disease, fetal alcohol spectrum disorders, gout, heart disease, infertility, memory loss and the interplay of nutritional interactions and environmental influences on disease risk.

Their research has led to findings such as a mother's genes determining if her baby needs extra amounts of the fatty acid DHA for brain development. They have also confirmed that the development of a baby's retina and vision depends on the mother's diet. Collaborating with the Appalachian State University Human Performance Laboratory at the NCRC, the NRI found that vigorous bicycling for up to 45 minutes can burn up to 500 calories and that an afterburn raises a person's metabolism so that another 250 calories are burned in the hours after exercise.

The UNC NRI employs a staff of scientists and administrative personnel who have attracted over \$24 million in grants and contracts from government, foundation and corporate funders since opening in 2008. The NRI houses a metabolic kitchen, clinical facilities, a cognitive assessment suite, offices suites, state-of-the-art laboratories and the only whole-room human calorimeter in North Carolina. The NRI is committed to community engagement through free scientific seminars, a monthly e-newsletter and recruiting volunteers for research studies.

For more information visit www.uncnri.org.



UNC CHARLOTTE BIOINFORMATICS SERVICES DIVISION AND CHARLOTTE RESEARCH INSTITUTE



Cory Brouwer, PhD

As the first academic organization to join the NC Research Campus (NCRC), UNC Charlotte has developed an extensive presence on campus that spans bioinformatics to business and entrepreneurial support.

BIOINFORMATICS SERVICES DIVISION

UNC Charlotte's Bioinformatics Services Division at the NCRC applies bioinformatics to the discovery, development and application of novel computational technologies to help solve important biological problems. The interdisciplinary team is made up of experts in bioinformatics and biostatistics who are versed in analyzing and interpreting complex and multidimensional data garnered from today's high-throughput technologies. Their expertise is expansive ranging from plant pathway analysis to working with clinical data to the emerging field of metagenomics, the study of bacteria in the environment.



Robert Wilhelm, PhD

From their office in the David H. Murdock Core Laboratory building, UNC Charlotte's team collaborates regularly with almost every partner at the NCRC. They also provide academic researchers, healthcare organizations and biotechnology and pharmaceutical companies not located on the NCRC assistance with specialized computer systems and software, data management solutions, data analysis and design and development of new research and technologies.

CHARLOTTE RESEARCH INSTITUTE

The Charlotte Research Institute (CRI) at UNC Charlotte and the NCRC serves as a portal for business-university partnerships. CRI is led by Robert Wilhelm, PhD, vice chancellor of research and economic development and professor of mechanical engineering and engineering science. The institute accelerates the growth of small businesses and university start-ups and develops intellectual capital through collaborations with industry, government and academia. CRI science and engineering ventures are driven by the internationally known results of its research centers in Precision Metrology, eBusiness Technology and Optoelectronics. CRI's research vision encompasses bioinformatics, biomedical engineering and science, cyber defense and network assurability, infrastructure, design, environment and sustainability, life science, nanoscale science, motorsports, visualization and biology.



UNC GREENSBORO CENTER FOR TRANSLATIONAL BIOMEDICAL RESEARCH

The University of North Carolina at Greensboro's Center for Translational Biomedical Research investigates disease pathogenesis and the development of novel interventions for prevention and treatment.



Zhanxiang Zhou, PhD

Co-director Zhanxiang Zhou, PhD, and his research team study alcohol-induced fatty liver disease (FLD) and the effect of nutritional interventions on the prevention and treatment of the disease. He's uncovered organ-organ mechanisms and dietary deficiencies underlying the development of alcohol-induced FLD. He has also discovered dietary interventions including zinc and niacin supplementation that prevent and even reverse some of the liver damage caused by alcohol-induced FLD in animal models. Although the disease is common, there are no treatments approved by the US Federal Drug Administration (FDA). Zhou is working to develop treatments that can progress through clinical trials and FDA approval to become some of the first approved therapeutic treatments for FDL.



Quibin Zhang, PhD

Co-director Quibin Zhang, PhD, is an expert in bioanalytical chemistry. His National Institutes of Health-funded research focuses on developing ultrasensitive methods of measuring lipids, which play a role in disorders such as diabetes and cancer. His other major project centers on discovering protein biomarkers for early diagnosis of type 1 diabetes, a devastating disorder occurring mostly in children.



EXAMPLES OF SCIENTIFIC FINDINGS

EXERCISE

Appalachian State University (App State) participated in a study with scientists in China that was published in the *Journal of Sport and Health Science*. The study revealed that in just six weeks diet and exercise caused weight loss in obese children and lowered their blood pressure, cholesterol, insulin resistance and other risk factors for metabolic diseases like diabetes that could emerge later in their lives.

In collaborative research studies between Dole Foods, NC State University Plants for Human Health Institute and App State, an alternate route of bioavailability and a 14-hour, metabolic spike after eating a protein complex enriched with polyphenols from blueberries and green tea was found. The results revealed that exercise helps the body absorb beneficial plant compounds called polyphenols and keeps them elevated in the body for a longer period of time. Additional research found that eating polyphenols before intense exercise may reduce the occurrence of viral infections in athletes. These findings were published in *PlosOne* and *Phytotherapy Research*.

FUNCTIONAL/MEDICINAL FOODS

NC A&T State University Center for Excellence in Post-Harvest Technologies demonstrated in an animal model that the polyphenols in peanut skins can lower lipid (fat) levels in the blood. Lipid levels correlate directly to the incidence of cardiovascular disease. This finding, published in *Food Chemistry*, may lead to a functional food ingredient from peanut skins geared to lowering fat levels in the blood.

Reported in *Brain Research*, NC State University Plants for Human Health Institute

working with Purdue University and Rutgers University demonstrated that anthocyanin and proanthocyanidin compounds extracted from blueberry and grape seeds are effective against the neurodegeneration, or loss of nerve cell function in the brain, brought on by Parkinson's.

NC State scientists developed flours in which peanut proteins were bound with polyphenols from plants like blackcurrant, cinnamon, cranberry and green tea. In animal models, the flours lessened the allergenic effect of the peanuts. The findings were published in the *Journal of Agricultural and Food Chemistry*.

In *Theoretical and Applied Genetics*, UNC Charlotte with NC State University Plants for Human Health Institute reported the creation of a new genetic linkage map designed to facilitate the study of Brassicaceae, which includes plants like broccoli and cabbage.



EXAMPLES OF SCIENTIFIC FINDINGS (CONTINUED)

CANCER AND DISEASE PROGRESSION

NCA&T scientists have published in journals including *Molecular Nutrition, Food Research* and *PloS One*, numerous findings about the cancer fighting characteristics of shogaols, a component in dried ginger, and avenanthramides, polyphenols found in oats.

In *Cancer Prevention Research*, a NC Central scientist reported that metformin, a drug commonly used for the treatment of type 2 diabetes, has the potential to prevent HER2/neu overexpressing breast cancer, which is an aggressive form of breast cancer with a poor prognosis that is found in one-third of all human breast cancer cases.

Working together, NC A&T and NC Central University published findings in the *Journal of Agricultural and Food Chemistry* that showed using a zebrafish model that 10-gingerol, a natural compound in ginger, is a potential treatment to prevent anemia caused by chemotherapy or renal disease.

UNC Charlotte Bioinformatics Services Division published in *PloS One* the identity of a set of genes previously not implicated in oxidative stress, a biological process that is involved in aging and apoptosis (cell death), which is an underlying cause of cancer and many other chronic diseases.

UNC Greensboro Center for Biomedical Translational Research discovered that zinc deficiency is a risk factor in the development of alcoholic liver disease. Similarly, niacin deficiency plays a role in the development of alcoholic fatty liver disease, and similar to zinc, supplementation can reverse some of the liver damage. These findings were published in *PLoS One* and *Alcoholism Clinical and Experimental Research*.


PERSONALIZED NUTRITION

The UNC-Chapel Hill Nutrition Research Institute reported in the journal of the *Federation of American Societies for Experimental Biology* (FASEB) that folate deficiency can induce premature hearing loss.

UNC researchers published in the *American Journal of Clinical Nutrition* that seven to nine year-olds who eat higher levels of omega-3 fatty acids compared to omega-6 fatty acids have improved cognitive abilities.

The UNC-Chapel Hill Nutrition Research Institute published in the *International Journal of Women's Health* that the essential nutrient choline obtained through food or dietary supplements ensures pregnant women optimal maternal liver and placental function and fetal development, and in *Current Opinion in Clinical Nutrition and Metabolomic Care*, that choline is vital to the physiological pathways involved in proper liver function as well as dysfunction that can lead to fatty liver disease and other disorders.





“Real collaboration – those rare times when people from different organizations come together with passion and purpose and accomplish dramatically more than any agency or person could do alone.”

Mark L. Rosenberg,
Executive Director of The Task Force for Global Health

Collaboration is imperative for **SUCCESS**. The complexity of the global health problems far exceeds the capacity of individual organizations and governments to deal with them effectively.”

James E. Austin,
*Eliot I. Snider and Family Professor of Business Administration,
Harvard Business School, and author of The Collaboration Challenge*

The practices of true collaboration are those practices of **awareness**, listening and speaking that bring us into openness and receptivity.

Rob Lehman,
Chair of the board of trustees of the Fetzer Institute

Great discoveries and inventions invariably involve the cooperation of many minds.

Alexander Graham Bell

At the NC Research Campus, **great minds** are employing collaboration as the common denominator in the fight against disease, and the shared fulcrum to make the scientific discoveries that are improving the prognosis for human health worldwide.

David H. Murdock,
Founder of the NC Research Campus

Transforming Science at the Intersection of
Human Health, Nutrition and Agriculture



www.NCResearchCampus.net

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