SUMMER 2016

Quest

Driving Deep into Genetics and Alcohol

PAYING IT FORWARD: The DREAM STEM Project

ORIGINS OF OBESITY TRACKED IN NEWBORNS

RESEARCH AT NORTH CAROLINA CENTRAL UNIVERSITY

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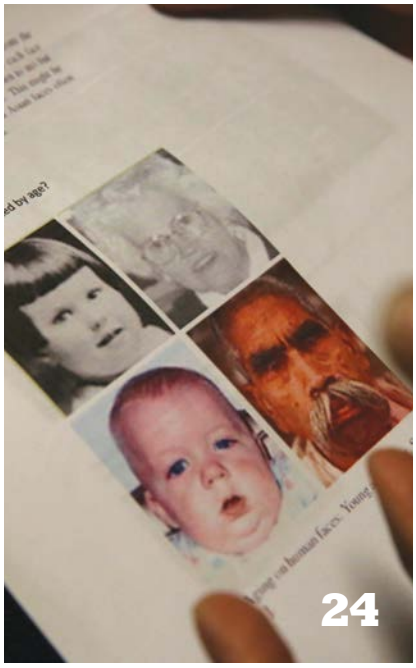

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ON THE COVER

Charlynda Williams-DeVane examines data for clues to the obesity epidemic.
Photo by Ted Richardson

OUR FOCUS ON **STEM RESEARCH**

Dear Friends of NCCU,

The drive for discovery and innovation permeates North Carolina Central University, with research taking place in classrooms, laboratories and workspaces all across campus.

Nowhere is that push more apparent than in the academic arenas of science, technology, engineering and mathematics – also known as the STEM disciplines.

This edition of Quest magazine takes a close look at the work ongoing in STEM, where small – and sometimes quite large – breakthroughs happen each day.

Researchers in the Julius L. Chambers Biomedical Biotechnology Research Institute (BBRI) and the Biomanufacturing Research Institute and Technology Enterprise (BRITE) spend their days exploring important questions whose answers could ultimately lead to longer and better lives.

In this issue, we feature Dr. Gregory Cole, director of the Neuroscience Research Program at BBRI, who is investigating the impact of alcohol use by pregnant women on unborn children, as well as exploring why African-Americans suffer more than their white counterparts with similar rates of alcohol use.

At BRITE, the spotlight is on Jiahua Xie, associate professor of pharmaceutical sciences, who is using tobacco plants to manufacture human therapeutics, a technique that looks promising for developing faster, less costly of treatments for a variety of medical conditions.

Mathematics and computer science are other facets of STEM that also are blazing pathways in research. Professor Alade Tokuta's work, for example, is on track to greatly improve the accuracy of facial recognition technology, which has the potential to impact our day-to-day lives in ways that few can imagine.

Across campus, NCCU researchers are answering questions and solving problems that have the potential to make the world a better place. And as an academic institution, these important endeavors also have the power to bestow research skills, knowledge and thirst for discovery to a new generation of scholars.

Sincerely,

Undi Hoffler
Interim Vice Chancellor for Research
and Economic Development

Quest

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SUMMER CAMP PREPARES FUTURE ENGINEERS, SCIENTISTS

Triangle area middle school students conducted their own research at NCCU during the 2015 ExxonMobil Bernard Harris Summer Science Camp.

The 46 Triangle campers took part in the Mars Lander Challenge to determine how best to design a spacecraft capable of withstanding a planetary landing, while also strengthening their science, technology, engineering and math skills.

University professors and science professionals, including Dr. Bernard A. Harris Jr., the first African-American to walk in space, oversaw the work.

"Dreams are powerful if you have the tools to make them possible," Harris told the young participants. "You are born multitalented with the ability to do anything and be anybody. And you are born for a reason."

The ExxonMobil Foundation provided scholarship support.

BERNARD HARRIS

"The ExxonMobil Bernard Harris camp program is a key avenue for students to experience STEM fields at an early age," said Suzanne McCarron, president of the ExxonMobil Foundation.

The summer marked the 10th consecutive year that the ExxonMobil Foundation and The Harris Foundation have partnered to promote STEM learning and the first year North Carolina Central University was selected as a program site.

"Dreams are powerful if you have the tools to make them possible. You are born multitalented with the ability to do anything and be anybody. And you are born for a reason."

Dr. Bernard A. Harris Jr.

Science camp participants worked in teams to develop mock space crafts capable of making a soft landing and then demonstrated their inventions in a friendly competition.

GIRLS COME TO NCCU TO LEARN TO CODE

MORE THAN 70 GIRLS arrived at North Carolina Central University in July 2015 with a purpose: to learn computer programming, robotics and mobile application development and become part of the digital maker movement.

The workshops for girls ages 7 to 17 were sponsored by Black Girls Code, a California-based not-for-profit organization that focuses on technology education for African-American girls.

NCCU Mary Townes Science Complex was the site of a daylong workshop for 55 girls on July 19, while 18 others came from as far way as New Jersey and Texas to attend a day camp July 20-24.

Queen McNeill, 13, a day camper who attends Durham's Brogman Middle School, said she signed up for the camp because she likes math and wants to learn more about computers and technology.

"I'm especially interested in the laser cutter and the 3D printer," said Queen, who was spending the afternoon in NCCU's Fabrication Laboratory with Professor Eric Saliim.

The Fab Lab contains the 3D printer, a digital sewing machine, and other equipment that are available for hands-on activities by students.

"This lab is set up for people such as yourselves who may one day be majoring in STEM (science, technology, engineering or mathematics)," Saliim told the participants. "This is where you can make your ideas come to life. There are no textbooks, we just make things."

Black Girls Code camp was supported by a grant from Verizon Communications.

"We have five camps at different locations throughout the summer and a number of one-day workshops that help girls of color learn about computer coding, robotics, and other technical skills," said Lake Raymond, program coordinator for the organization. "Right now, women of color are underrepresented in those fields."

Black Girls CODE was founded in 2011 and recently formed a local chapter in the Triangle.

Above: *Professor Eric Saliim shows students how products are made using specialized equipment in the Fab Lab.* ***Left and above left:*** *Students use designs developed with a laser cutter to assemble prototypes of new products.*

RESEARCH SHOWS GAPS IN EDUCATION REGARDING SIKHISM

Staff and faculty from NCCU's Department of History presented research on the Sikh religion and its place in American culture and education at the American Library Association Conference in June 2015.

Danielle Colbert-Lewis, M.L.S, Hafsa Murad, M.L.S., and Jamillah Scott-Branch, M.L.S., all of the library's Reference Department, and Sean Colbert-Lewis, Ph.D., director of teacher education for the Department of History, conducted the work as part of development of a new LibGuide program, "Seeking to Know Sikhs." LibGuides are a popular method of organizing materials and sources for researchers.

Sikhism, the world's fifth largest religion, has an estimated 25 million followers – 250,000 of whom live in the United States. The NCCU team noted a lack of familiarity among Americans about the religion, which originated in India and is most common among certain ethnic groups, including Punjabis.

Sikhism, the world's fifth largest religion, has an estimated 25 million followers – 250,000 of whom live in the United States.

Reviews of social studies textbooks from throughout the U.S. found that only two states, California and Texas, include Sikhism in required studies of global religions in pre-kindergarten through grade 12. More commonly, such texts limit their focus to Christianity, Islam, Hinduism, Buddhism, and Judaism.

In November 2015, Sean Colbert-Lewis introduced the LibGuide and the researchers' findings at the annual National Council for the Social Studies Conference in New Orleans.

Environmental Researchers Raise Concerns over Air Quality

RESEARCHERS AT NORTH CAROLINA CENTRAL UNIVERSITY are examining air quality in urban neighborhoods near campus to see whether vehicular emissions may be posing a health risk.

Dr. John Bang, associate professor in the Department of Environmental, Earth and Geospatial Sciences, and a team of four students are gathering data on air quality, traffic congestion and weather conditions at various locations surrounding the Durham campus.

The measurements are taken over two-week periods and at different times of the year using portable and fixed monitoring devices to allow for deep analysis, Bang said.

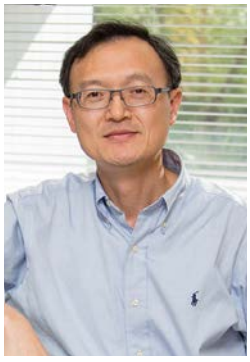
"We are trying to determine how air pollutants may be affecting people in the neighborhoods, particularly minority neighborhoods," said Patricia Kline-Thomas, the study's team leader and master's degree candidate. "We also will look at how traffic from the highways might affect the lungs, trying to see its impacts and possibly find remedies."

For example, planting trees and shrubs alongside busy roadways has been shown to reduce the volume of air pollutants in the immediate vicinity.

Previous national studies have shown that emissions from combustion engines in general can cause lung inflammation and reduce lung capacity – especially among those with heart- and/or lung-related health conditions, but this is the first time the issue has been examined locally, Bang said.

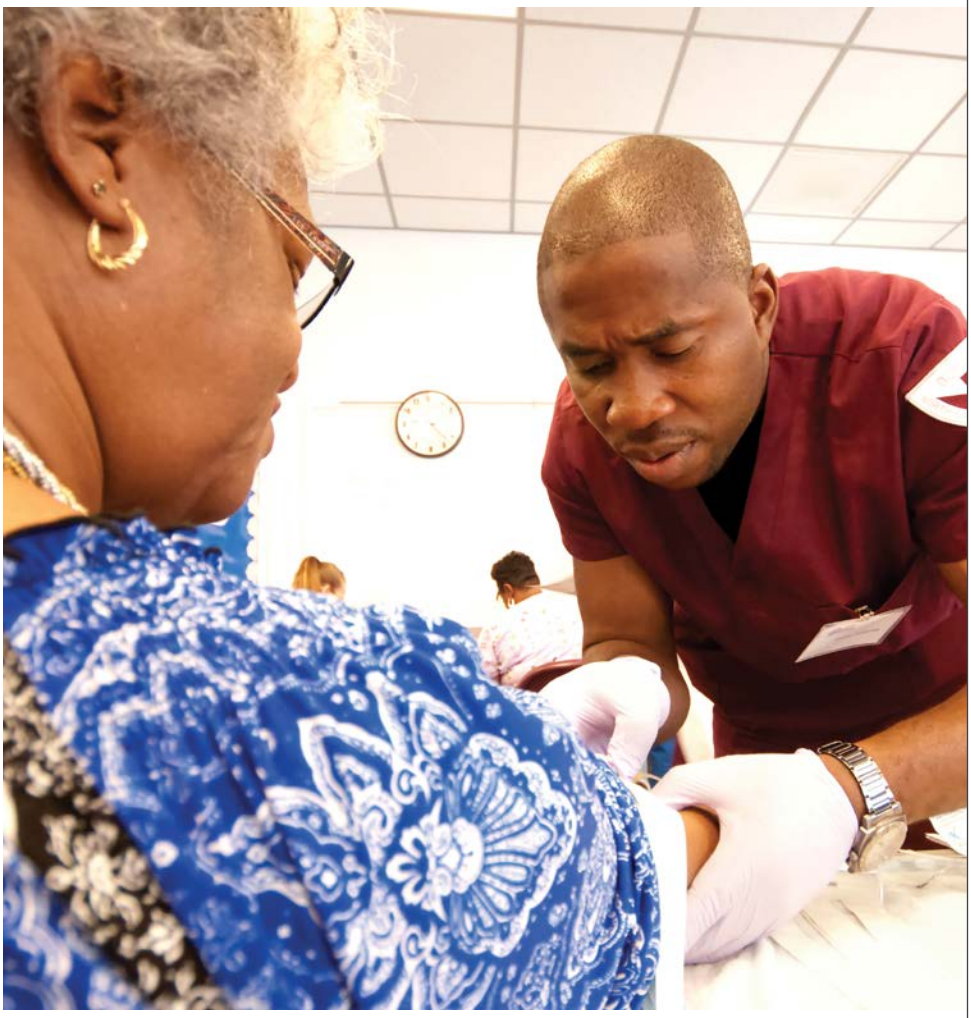
"It's clear that people who walk or bike along a busy street are getting exposed to high levels of pollutants," he said. "How that impacts their health may depend on the frequency of exposure as well as any preexisting cardiopulmonary conditions, such as congestive heart failure, asthma and COPD."

The three-year study is funded by the U.S. Environmental Protection Agency and the federal Health Effects Institute.



DR. JOHN BANG ▷

ONGOING FUNDING TO EXAMINE HEALTH DISPARITIES IN MINORITY POPULATIONS



THE NATIONAL INSTITUTES OF HEALTH continued its funding of health disparities research at NCCU through an allocation of $1.13 million in 2015. The university is in the final year of a five-year, $6 million grant provided through National Institute on Minority Heath and Health Disparities. This is the third five-year grant allocation issued for research projects, said Mildred Pointer, director of the Cardio-metabolic Research Program, associate professor in biology, and researcher at the Julius L. Chambers Biomedical/Biotechnology Research Institute (BBRI).

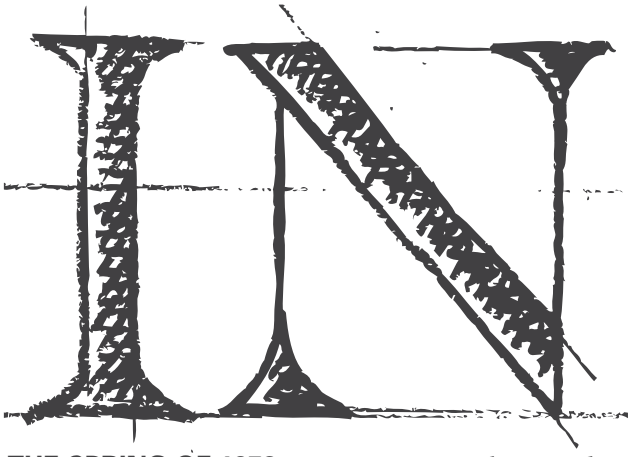
Pointer is co-principal investigator along with Dr. Sean Kimbro, associate professor in biology and pharmaceutical Sciences, of the P20 grant, formerly known as the EXPORT grant. It is the longest running research grant within the BBRI that has been funded by NIH.

AMONG THE PROJECTS THE FUNDS SUPPORT ARE:

- Translational research that uses animal models of hypertension, obesity, and diabetes to discover novel disease mechanisms and then confirming these novel findings in targeted populations (Pointer/Emmanuel Awumey, co-primary investigators, BBRI and Department of Biology)
- Investigation of the pathophysiology of gender differences in risk for cardio-metabolic disease (Maxwell Gyamfi, PI, BBRI)
- Education core that uses critical service-learning as a means of getting students actively involved in the entire research enterprise and, more importantly, having them relate the research to the public directly (Kisha Daniels, PI, School of Education)
- Diabetes family-inclusive education intervention aimed at improving diabetes management (Natasha Greene, PI, Department of Nursing)
- Outreach core that uses a unique approach to encourage community participation in research (Natasha Greene, PI)

"We are extremely proud that we have been able to perform work of this caliber and continue to receive funding," said Pointer, who holds a Ph.D. from Wake Forest University and has post-doctoral experience at the University of North Carolina School of Medicine and Brigham and Women's Hospital at Harvard University.

DREAM STEM Project Encourages Minorities to Reach Their True Potential



THE SPRING OF 1973, a young Caesar Jackson made a decision that would change the rest of his life. His hometown of Tallahassee, Fla., like the rest of the South, was still adjusting to desegregation. Jackson felt restless and out of place in his classes at Leon High School and nearly decided to drop out and find a job. But then a guidance counselor by the name of Julian Adderley asked him to take a quick aptitude test. Each time he returned to the counselor's office, Adderley gave him another little test or form to fill out. Finally Adderley – who happened to be the father of jazz greats Nat and "Cannonball" Adderley – told Jackson he had gotten him into college.

Jackson would start that summer at Florida A&M University as part of the federally funded program Upward Bound, now known for a roster of noteworthy alums, such as Oprah Winfrey and Patrick Ewing. As long as he did well, the 16-year-old Jackson wouldn't have to return to high school to complete his senior year. That first semester of college, Jackson got a 4.0. He eventually graduated summa cum laude with a degree in engineering, earned a master's in the same discipline, and went on to work for 15 years at IBM. Then he returned to school to become the first African-American to earn a Ph.D. in physics from North Carolina State University.

"You don't always appreciate the difference that certain people or experiences have made until you look back on your life," Jackson recalls. "When I was young, I used to tinker with stuff and fix things around the house, but I didn't know about being a scientist or an engineer, and I had no way of seeing how that path could be laid out before me. Basically, Mr. Adderley was my angel unaware, because if it weren't for his guidance I would not likely have gone to college, much less be in the sciences."

Today, Jackson is paying it forward. As professor in the Department of Mathematics and Physics and director of a federally funded program of his own, Jackson is encouraging other young minority students to realize their dreams of a career in the science, technology, engineering, and mathematics (STEM) fields.

THE DREAM

In 2012, Jackson landed a four-year, $1.75 million grant from the National Science Foundation's Historically Black Colleges and Universities Undergraduate Program to help broaden the participation of African-Americans in the STEM workforce. The funding has enabled him to implement a project called DREAM STEM, which stands for Driving Research, Entrepreneurship, and Academics through Mastering STEM. As the name suggests, the project has three main components: granting research opportunities so undergraduates can see themselves as scientists, exposing students to entrepreneurship so they can create their own jobs, and enhancing academics so minorities can be more successful, especially in entry-level STEM classes.

Even though African-Americans make up 12 percent of the workforce, they continue to be grossly underrepresented in STEM fields. When Jackson finished graduate school in 1992, only six of the 790 doctorates in physics awarded in the nation that year – less than one percent – went to blacks. The most recent data from the National Science Foundation indicates that while those numbers have gone up, they haven't kept pace with the overall increase in doctorates. In 2013, only 19 of the 1,902 Ph.D. recipients in physics were black.

"The workforce in science and engineering have primarily been dominated by white males, and that can't be sustained with the changing demographics of the U.S. population," Jackson says. "It is necessary to broaden participation in these fields so that the benefit of diversity comes through. When you bring together people with diverse backgrounds and ways of thinking, those different perspectives are more likely to generate a richer set of solutions that can be applied to the world's problems."

DR. CEASAR JACKSON ▷

Because minorities are so often exposed to traditional images of scientists – think Albert Einstein – it may be difficult to envision themselves in that career. To address this issue, DREAM STEM has created a project component to help students develop a scientific "identity."

"Identity is a critical factor to the participation of minorities in STEM, and it can have a tremendous impact on their retention and ultimate success in a field," Jackson explains.

"If they have not seen someone like them doing science and can't identify with it, they think, 'I can't do it.' So, if they try and fail the first time in a STEM subject, they might say, 'Well, see? I didn't think I could do it in the first place.'

"In our program, we set up situations and environments where students can do science, see their success in doing science, and be welcomed into the science community by experts and peers who acknowledge their role as a scientist."

Each year, the program offers scholarships to new and continuing NCCU students who have declared a major in chemistry, physics, mathematics, or environmental sciences. The scholars receive one-on-one mentoring and gain experience working on an independent research project in a professor's lab. They also have the opportunity to share their accomplishments with other students and faculty through campus-based symposia, as well as to travel to regional and national meetings and present their findings.

In February 2015, Jackson and his program manager Clarissa Grady took eight students to Washington, D.C., for the Emerging Researchers Network Conference, a conference for undergraduates that is sponsored by the American Association for the Advancement of Science. One of the students presenting at the event was DREAM STEM scholar Daquille Campbell, whose research has focused on the creation of a "flock of robots" that mimics the flight patterns of birds to help in search and rescue missions. Campbell's presentation won first place in the math and computer science division and solidified his decision to pursue a career in research.

"I was so nervous before I gave my presentation," Campbell recalls. "I thought, "I'm not a scientist, I don't know what I'm about to do.' Then afterward I felt more confident. And when they called my name for first place, I felt like I was officially a scientist, like I could be right up there with other great minds in the field."

Right: *Sophomore mathematics major Daquille Campbell won a first-place award at the Emergency Researchers Network Conference in February 2015 for a poster highlighting his research conducted through DREAM STEM.* ***Above right:*** *Nicole D. Boone, a sophomore chemistry major, shows her work to Jackson in the Engineering Physics Electronics Laboratory.*

THE CULTURE

The DREAM STEM project develops students who think not only like scientists and engineers but also like entrepreneurs, so they have the option of creating their own jobs when they graduate. Most often scientific researchers focus all their attention on making that elusive measurement, Jackson says, and frequently overlook or fail to recognize their work may have economic value beyond research.

Jackson admits that when he was younger, he thought that the smartest people in the world would be the richest people. But he quickly came to realize that a bright mind and an advanced degree were no guarantee of economic security. Rather, ownership of businesses, products, or simply intellectual property seems a surer way to generate wealth. Therefore, Jackson says it is critical to teach STEM students entrepreneurship skills early in their education.

"I don't think it would be fair to ask students – many of whom come from low-income families who have never sent a kid to college – to make all the sacrifices necessary to earn a degree in a STEM field if they are not going to be substantially better off economically for themselves and their family afterwards," Jackson says. "I've tried to incorporate these ideas of wealth building and economic growth into their training so the students can

think about making a job, not just getting a job, after they leave NCCU."

The embodiment of this effort begins with the Research, Discovery and Innovation Summer Institute, an eight-week program that actively engages students in the research and development portion of the entrepreneurship cycle. Along the way, participants receive guidance in designing and building prototypes of their own innovations and also develop a business presentation or "pitch" describing the value proposition of their product. STEM students are also engaged in other professional development activities in entrepreneurship during the academic year and can take elective business courses that focus on entrepreneurship. At graduation, these STEM majors will earn a certificate in technological entrepreneurship to hang along with their diploma.

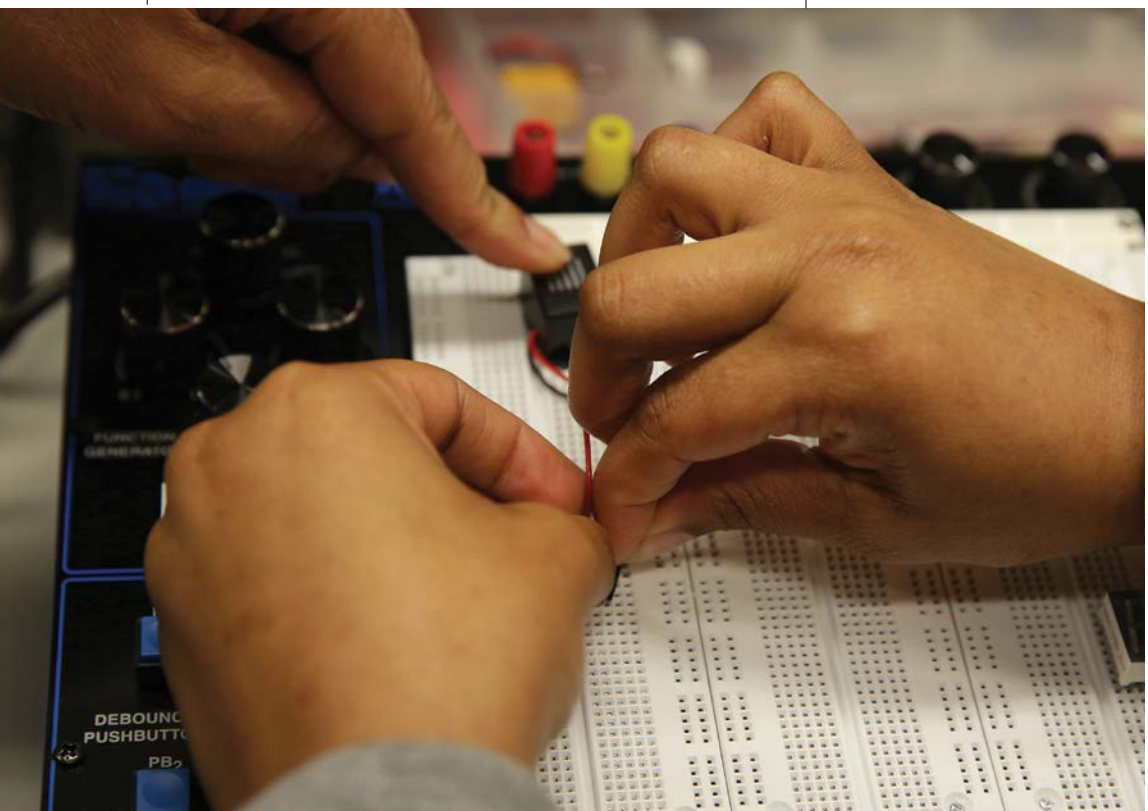
However, a disconcerting number of students – not just at NCCU but all across the country – never complete the STEM degree. According to a 2014 report from the National Center for Education Statistics, roughly half of students planning engineering and science majors end up switching to non-STEM subjects or failing to get any degree. Oftentimes, this attrition occurs following introductory physics, chemistry and mathematics college courses, often called "gatekeeper" classes because they seem to be used by some STEM programs to weed out all but the top-tier students. As part of DREAM STEM, professors at NCCU are engaged in "teaching-as-research" to test more effective methods of teaching science and mathematics at the collegiate level.

"I think our STEM faculty can approach teaching and learning in the classroom with the same scientific method that they use in the laboratory," Jackson explains. "If the issue is improving students' learning, faculty can design experiments, test theories, and determine what works and what doesn't work. In the process, they will become better educators and they will help students be more successful in their program of study."

DREAM STEM has funded two "teaching-as-research" mini-grants to faculty members who are exploring new methods to improve student outcomes. The first project investigates the use of active learning, where students participate in predicting, observing, and explaining classroom demonstrations in physics. The second project utilizes problem-based learning to boost students' understanding of chemistry through real-world applications in the laboratory, such as forensics investigations.

Over time, Jackson will track the trajectory of every student touched by the DREAM STEM project and assess how it has affected their academic performance outcomes, their growth and development in research, and ultimately their retention in and graduation from STEM degree programs.

"We will know we are successful if more of our students are enrolling and persisting in the STEM majors, and if many of them go on to pursue advanced degrees, as well as enter the STEM workforce, or perhaps even start their own businesses after graduation," Jackson says. "This project helps our students see themselves as scientists and enhances their development for competitive entry and leadership in their science careers."



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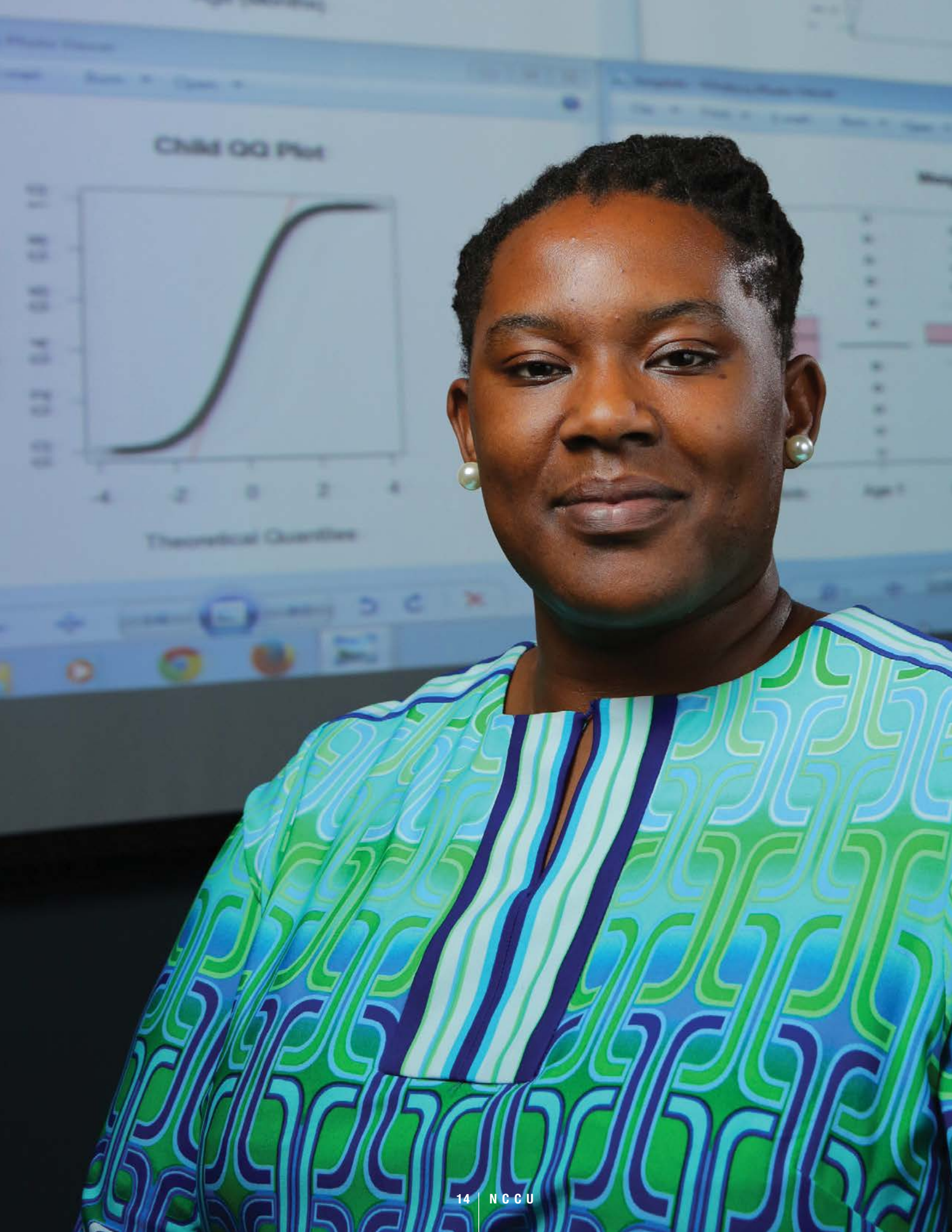
DR. CEASAR JACKSON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Childhood Obesity: Seeing the Bigger Picture

Written by Marla Vacek Broadfoot / Photos by Ted Richardson

AT FIRST GLANCE, obesity seems like a simple disease with an equally simple solution. We gain weight because we consume more calories than we burn; therefore, all we have to do to reverse course is eat less and exercise more. Despite the fact that public health officials have been endorsing this approach for decades, our waistlines continue to expand.

CHILDREN BORN TO OBESE PARENTS ARE MORE LIKELY TO BECOME OBESE THEMSELVES, PERPETUATING A CYCLE THAT HAS TRIPLED THE CHILDHOOD OBESITY RATES IN THE UNITED STATES OVER THE LAST 30 YEARS.

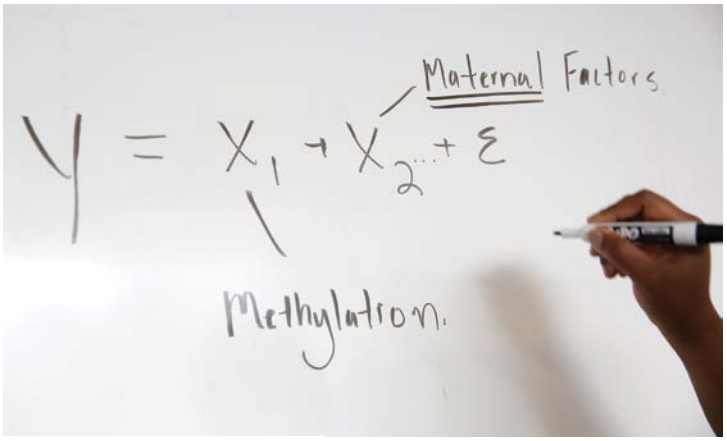
Today more than 36 percent of American adults are considered obese, compared to less than 15 percent in 1990. Children born to obese parents are more likely to become obese themselves, perpetuating a cycle that has tripled the childhood obesity rates in the United States over the last 30 years. Experts are beginning to appreciate that this growing epidemic can't be explained by a straightforward energy imbalance. What once seemed a case of basic arithmetic turns out to be more like advanced calculus, involving multiple factors such as genetics, environment, metabolism, behavior, and cultural norms.

Luckily, ClarLynda Williams-DeVane has never been afraid of math. As a child, she used to read old math textbooks for fun. She went to high school at the NC School of Science and Math, majored in mathematics in college, and earned a Ph.D. in bioinformatics. Today, she is a "big data" scientist at North Carolina Central University's Biomedical/Biotechnology Research Institute, working to combine reams of information from a multitude of sources to generate a more complete understanding of complex diseases like obesity.

◁ *ClarLynda Willams-DeVane, right, discusses her study showing how a mother's habits may increase the likelihood of obesity for her children.*

A CAUSE FOR BIG DATA

Such "big data" is constantly being generated all around us. Every click on our keyboard, every photo we post to Instagram, every trip to the store adds to the growing body of data on virtually all aspects of our everyday lives. As a result of this relentless data collection, more data has been accumulated in just the last two years than had been over the prior course of human civilization. This wealth of information can be mined for all sorts of patterns, from categorizing the most common texting typos to detecting signs of terrorist activity. Williams-DeVane believes big data also holds the key to addressing some of humanity's most pressing health issues.



Above: *Multiple types of data are combined to provide a better understanding of obesity's origins.*

"As technology has improved, and with the advent of big data, we have the opportunity to understand things we would never have had the opportunity to understand before," she explained. "Big data is everywhere. Businesses use it to determine that they should put the milk and the bread on opposite sides of the store, and to decide which coupons to give which customers. I think it is about time that we use it to understand ourselves and our bodies."

However, finding the right answers among these vast sources of data is a huge challenge. The sheer scale of the data that is being collected every day, and the speed with which it is being added to the bank of knowledge, has far outstripped traditional methods for analyzing and handling such information. Not only do researchers need to develop new techniques to deal with this immense volume of information, but they also have to find ways to contend with disparate types of data, such as email messages, cholesterol levels, video surveillance, or GPS locations. Trying to integrate those different types of data is about as simple as trying to make a picture out of pieces of cardboard, auto parts, and fruit salad.

"It is difficult, but it has to be done," said Williams-DeVane. "The old approach was to focus on just one type of data, such as genomic data or nutritional data, and then use that to understand this disease that is really complex. But usually that is not enough, and you need different types of data so you can look at the problem from multiple different angles and try to get a better picture of this complex disease."

Williams-DeVane is currently using big data to explore a very complex idea: that the likelihood of children developing obesity might be determined while they are still in the womb. In collaboration with researchers at Duke, UNC, and NC State, Williams-DeVane is looking at a number of genetic markers of environmental exposures in blood samples from the umbilical cords of newborns and then correlating them with body mass index and other measures of obesity as the children grow up.

The first type of data she is enlisting is epigenetic data, which looks at alterations to the "on-off switches" that control whether specific genes are activated. Though the instructions for all cellular activities lie within their genes, whether a particular gene is turned "off" or "on" is determined by the presence or absence of specific chemical tags or methyl groups – methylation – along the DNA in each cell. These epigenetic tags can change throughout life in response to chemical and environmental exposures, even while the underlying DNA remains the same.

"The cool part about epigenetics is that it controls how our genome works, and in some cases it may be modifiable," said Williams-DeVane. "For example, if you are looking at data from someone who had weight-loss surgery, you will see epigenetic changes to reflect the fact that the surgery has lowered their risk of certain diseases. It is interesting now to study childhood obesity using newborn cord blood because presumably the data will reveal how genetics, as well as what the mother was exposed to while the child was actually in utero, could determine the child's chance of becoming obese."

Through the Newborn Epigenetics Study (NEST), the research team has gathered data from about 450 cord blood samples with more than 485,000 methylation sites scattered along DNA. For each of these

samples, the researchers also have basic information such as maternal age, number of pregnancies, known maternal exposures like smoking or alcohol, socioeconomic status, and gender of the child. Williams-DeVane is now testing a number of different computational models to determine which combination of factors might ultimately determine a child's body mass index or BMI, a standard measure of obesity. For example, one model might assume that a combination of methylation patterns, gender of the child, mother's socioeconomic status, and mother's smoking habits influence whether or not a child will become obese.

The approach requires a lot of back and forth with other members of the team, which contains experts in both childhood and maternal obesity as well epidemiologists. Once Williams-DeVane has developed a model that looks good on paper, she plugs it into the computer and waits to see how the data shakes out. Though she believes she has gotten close a couple of times, she still hasn't landed on a model that can predict which children will become overweight or obese and which will maintain a healthy weight.

"You get so excited, you think you've finally got it, you finally understand it, you've got this childhood obesity thing figured out, and then you get the results back and realize you have to go back to the drawing board," she explained. "But then you just have to keep at it, because even the small steps that we make toward understanding a public health issue like childhood obesity can make a huge difference."

NOT NECESSARILY CREATED EQUAL

The steps that Williams-DeVane has made so far have yielded interesting insights into health disparities that could explain why some children are more susceptible to developing diseases related to obesity, such as asthma. For example, people of differing socioeconomic status are generally exposed to different levels of environmental contaminants, such as pesticides or smog, and these different exposures could determine disease risks. Presumably, the epigenetic patterns of the children would reflect these differences. But even more striking than the differences between the haves and the have-nots are the differences between the sexes. Males overall tend to have a higher rate of DNA methylation than females, though no one is quite sure why. As the newly appointed scholar for Building Interdisciplinary Research Careers in Women's Health at NCCU and Duke University, Williams-DeVane has freedom to develop research and to collaborate with researchers in the NEST project, such as North Carolina State University's Cathrine Hoyo, Ph.D. The program, which is part of the National Institute of Child Health and Human Development, was created to promote interdisciplinary research and transferable findings that will benefit the health of women, such as sex and gender differences in biology, health or disease outcomes. Williams-DeVane is now actively studying these differences and their impact on her models of childhood obesity.

"For a lot of species, sex is determined by epigenetics, not by an X or a Y chromosome," said Williams DeVane. "Epigenetics could also be determining a lot about us as human beings. People are surprised when they haven't found a lot of genetic diversity between races or sexes, but there is diversity when you look at the epigenetic profile. I think that that is probably the key to a lot of the complex diseases that we have been looking at for many years and not getting an answer. We might have simply been looking in the wrong place."

Right now she is focusing on epigenetics, but soon she plans to add in another generator of big data, metabolomics. Metabolomics provides a chemical

Below: *Researcher Williams-DeVane explains how obesity is often linked with other illnesses, such as asthma.*

snapshot of the metabolites – such as lactic acid and sugars – that are left behind by specific cellular processes. The presence or absence of certain metabolites could indicate what substances or pollutants a mother was exposed to during pregnancy.

After Williams-DeVane has found a way to integrate data from epigenetics and metabolomics, she will begin building on her model with information from yet another source, the microbiome. The microbiome looks at the diverse array of bacteria that coexist with our body's cells. Many studies have indicated that these microbes – estimated to outnumber human cells by 10 to one – could play a role in obesity by boosting the appetite or enhancing the body's ability to absorb fat.

Through this methodical process, Williams-DeVane hopes to develop a more complete picture of childhood obesity, one that combines the many variables that increase a child's risk of developing the disease. While she wants to continue to look for patterns that explain why some kids become obese and why some do not, she also recognizes that not all cases of childhood obesity are created equal. There are likely different types of obesity, with different causes that warrant different interventions.

Williams-DeVane hopes to collect enough data to be able to separate obesity into smaller subgroups, much like she did when studying childhood asthma as a postdoctoral fellow at the Environmental Protection Agency. There, she found that certain patterns could distinguish between asthmatics whose illness was triggered by an allergic reaction versus those whose illness stemmed from a metabolic abnormality. Identifying the different ways that obesity can emerge in children will help clinicians more effectively address the obesity epidemic.

"If we could fix childhood obesity, we could not only save children from the emotional and psychological effects of being obese, but we could also decrease the prevalence of obesity in adults," explained Williams-DeVane. "There has to be a reason for the steep increase. It is hard to believe that it is simply that people eat too much and don't exercise. There have been inactive people for a long time. If we could find an environmental trigger, such as a chemical in the processed foods we eat, we could reduce those exposures. But we'll never know until we get a clear picture of what the disease actually looks like."

If we could fix childhood obesity, we could not only save children from the emotional and psychological effects of being obese, but we could also decrease the prevalence of obesity in adults."

— CHARLYNDA WILLIAMS-DeVANE, PH.D.

A FRESH START FOR TOBACCO

NORTH CAROLINA'S CASH CROP COULD BE A SURPRISING SOURCE OF LIFE-SAVING MEDICINES

Written by Marla Vacek Broadfoot / Photos by Ted Richardson

Tobacco is not exactly known for its health benefits. The plant contains dozens of chemicals that cause cancer, hundreds of other poisons that damage the heart and lungs, and a substance called nicotine that is one of the most addictive in the world. But despite its well-deserved bad rap, the tobacco plant might yet have a chance for redemption.

Researchers are currently restructuring tobacco's genetic code to produce a variety of life-saving medicines, from vaccines against cervical cancer to serums that treat Ebola infection. The technique, known as "biopharming," may revolutionize drug development by creating pharmaceuticals faster, cheaper, and more effectively than traditional brick and mortar facilities.

Jiahua Xie, an associate professor of pharmaceutical sciences at NCCU's Biomanufacturing Research Institute and Technology Enterprise (BRITE), is among those improving tobacco's reputation. For the last nine years, Xie has been developing ways to turn tobacco plants into biological factories that manufacture human therapeutics alongside its own proteins.

"Plants have tremendous potential as a new source of drugs and therapeutic compounds," Xie says. "The only trick is in the genetic engineering, but once you have created the transgenic plants you can grow them just like regular plants. You can scale up production very easily, simply by acquiring a bit more land, more soil, sunlight, and water."

TURNING OVER A NEW LEAF

Before he joined the faculty at NCCU, Xie worked at Vector Tobacco, a Mebane-based company that develops and manufactures "healthier" cigarette products. There, he became intimately familiar with the genome of the tobacco plant. Xie and his colleagues cloned the gene for nicotine and effectively eliminated it in tobacco plants, an advance that led to the first nicotine-free and low nicotine cigarettes on the market.

His expertise in genetically engineering tobacco was quickly recognized within the industry. Xie was inundated with high-paying job offers to work in China, a country that produces more tobacco and has more smokers than anywhere else in the world. He turned them all down.

"I told them I couldn't do it," recalled Xie. "I didn't want to continue working on a product that – even with our tweaks – was still causing health problems like cancer, emphysema, and heart disease. I would rather use tobacco to do something else. Tobacco plants are good plants, and I knew they were capable of producing good things."

The first thing to come to mind was biopharmaceuticals – drugs that are generated by a menagerie of living organisms, including soil bacteria, tropical plants, and barnyard animals. This area of drug development has seen an explosion of activity over the last 25 years, as scientists have sought alternatives to the traditional method of synthesizing drugs from a mixture of chemicals in the laboratory.

To make biopharmaceuticals, researchers insert genetic material into their plant or animal of choice. The resulting "bioreactors" then convert their foreign cargo into proteins, just as they do with the rest of their genomes. Eventually, the therapeutic proteins can be harvested along with other products such as eggs, milk, seeds, flowers, and leaves from the genetically modified organisms. The approach has generated plant- or animal-made versions of a medications, including insulin, contraceptives, and blood-clotting agents.

↘ **PROFESSOR JIAHUA XIA EXAMINES SAMPLES OF TOBACCO THAT HAVE BEEN GENETICALLY ALTERED.**

Researchers are currently restructuring tobacco's genetic code to produce a variety of life-saving medicines, from vaccines against cervical cancer to serums that treat Ebola infection. The technique, known as "biopharming," may revolutionize drug development by creating pharmaceuticals faster, cheaper, and more effectively than traditional brick and mortar facilities.

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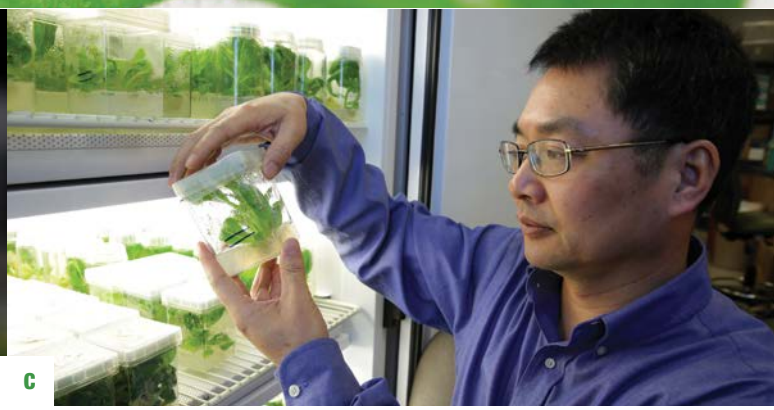


B C

NATURE'S OWN FACTORIES

Xie could see that tobacco was uniquely poised to contribute to the biopharming revolution. The plant is relatively simple to cultivate and grows from seeds to full-grown plants in a period of weeks. Its green elephantine leaves contain copious amounts of protein, many times more than crops like corn, alfalfa, and rice. Plus tobacco absorbs foreign DNA more easily than other plants, making it an ideal target for genetic modification.

All Xie had to do was figure out what drug to make first. He decided to focus his efforts on erythropoietin (EPO), a hormone that prevents anemia by helping the body make more red blood cells. This drug has become a popular blood-doping agent because it can boost the amount of oxygen the blood can carry to muscles, giving athletes more endurance. EPO also has more legitimate applications, with synthesized versions of the hormone regularly used to treat anemia developed by patients undergoing chemotherapy for cancer, as well as those suffering liver failure or who have HIV.

About 15 years ago, researchers noticed that EPO had another role besides pumping up red blood cells. The hormone can also protect tissues from the damage wrought by heart attack, stroke, diabetes, and autoimmune disease. Unfortunately, a much larger amount of EPO is required to achieve such protection than is used to treat anemia. At such high doses, the drug essentially thickens the bloodstream, triggering blood clots and injuring vital organs.

"Interestingly, these nasty side effects can be avoided by removing tiny sugars called sialic acids from the surface of the EPO protein," Xie notes. "However, that seemingly simple step makes it even more time-consuming and expensive to produce the protein in the quantities needed for it to be used in the clinic."

Plants offer a straightforward, cost-effective solution to producing enough protein. Unlike the animal or human cells typically used to synthesize EPO, plant cells don't add sialic acids to their proteins in the first place. As a result, EPO comes off the assembly line ready to go, no further structural modifications necessary. Plus, production costs approximately 50 times less in plant cells than in mammalian cells.

As simple as it sounds, Xie and the researchers in his laboratory still had to perform a bunch of fancy genetic maneuvers

D

A. Upper Left: Tobacco leaves are protein-rich, and they absorb DNA easily.

B. Upper Right: Tobacco plants can be grown from seeds in just a few weeks.

C. Below Left: Scientists use plants to develop therapeutic proteins that can be used to fight diseases in humans.

D. Xie describes tobacco as a cost-effective growth medium.

to get the system to work. First they cut and pasted together pieces of DNA to create a "transgene" that contained the instructions for making the human EPO protein. They inserted this transgene into the plant's genomic blueprint, so EPO would become one of the building blocks of the tobacco plant. After the tobacco was fully grown, a final trick remained – isolating the one human protein out of the tens of thousands of plant proteins stored in its leafy appendages.

Once they had this new form of the EPO protein in hand, Xie's research team tested its ability to shield cells from damage. They took a special batch of mouse cells – which other laboratories have used to study brain health and Alzheimer's disease – and treated it with a toxic agent called staurosporine along with their plant-derived EPO protein. The researchers found that the sialic acid-free EPO saved almost half of the cells from imminent death, performing even better than regular EPO in side-by-side comparisons. They published their results in 2013 in the journal PLoS One, and are now testing the drug on cells implicated in heart disease and diabetes.

THE NEXT GENERATION OF TOBACCO

Despite his successes, Xie swears he doesn't have a green thumb. He finds gardening a bit tedious, and gets most excited when he is working at the bench splicing together the genetic code of different species. He tells each new student that joins his laboratory that there is more to plant research than merely digging around in the soil.

"We are trying to do something that no one has ever accomplished before, and that can be difficult," explains Xie. "It isn't like a textbook laboratory experiment. Every day brings a challenge, because you are doing real research. Once you solve one step, you move to the next challenge, and then the next and the next. That is how science progresses."

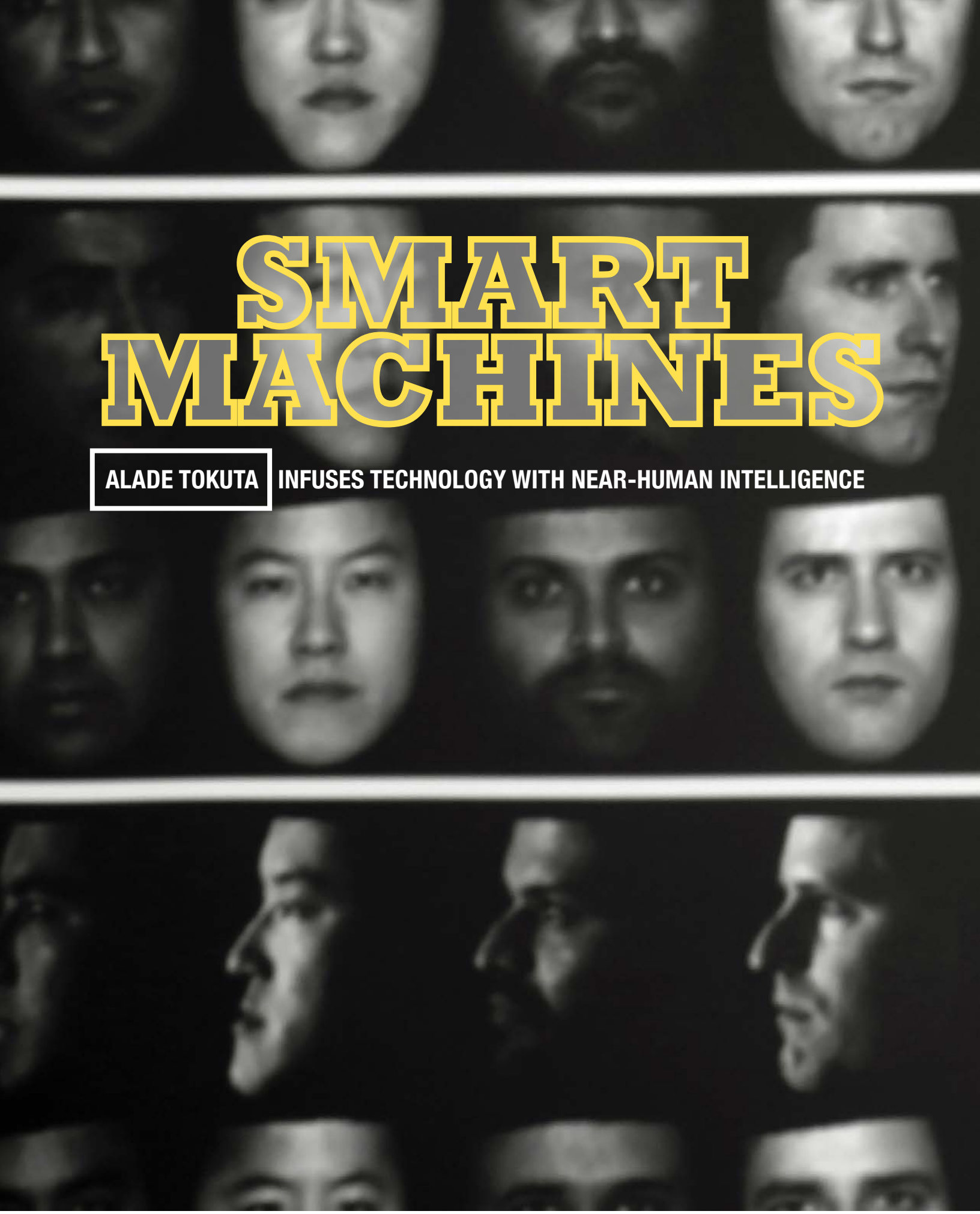
Xie has taught many people that lesson. So far, he has trained 13 undergraduate students and seven graduate students. He gives all of his trainees the opportunity to contribute to research discoveries in his laboratory, and most of them have published papers on their projects.

Due to their advances, North Carolina's cash crop could become even more profitable. One hectare of regular tobacco plants can yield as much as 15,000 kilograms of fresh leaves, valued at about $10,000. If that same tract of land were used to grow transgenic tobacco instead, Xie calculates it could produce as much as 7,500 milligrams of EPO, worth up to $7.5 million dollars. He has filed a patent on his technology and is applying for grants to continue to push his research forward.

But before the state's tobacco fields can start churning out this pharmaceutical, Xie still has to prove that the drug is safe and effective by conducting studies in animals and clinical trials in humans. He has assembled a team of researchers to help with these efforts, including Ping-An Li, a neuroscientist at NCCU, and David Sane, a cardiologist at Virginia Tech Carilion School of Medicine and Research Institute.

Xie also has funding from the North Carolina Biotechnology Center to engineer tobacco plants that can produce other drugs besides EPO. Because most proteins require sialic acids, Xie has to figure out how to make plants add these sugars onto its proteins in order to expand its product line.

"My goal is to engineer tobacco plants that are capable of producing a wide range human therapeutics, easily and inexpensively," states Xie. "Now when I drive past tobacco fields, I see plants that are full of promise. Tobacco can be made good again, and it can have a positive impact on human health."



SMART MACHINES

ALADE TOKUTA INFUSES TECHNOLOGY WITH NEAR-HUMAN INTELLIGENCE

Above: A study published by Alade Tokuta will help determine how age impacts gender recognition.

At Super Bowl XXXV, hidden cameras snapped pictures of 71,921 football fans as they shuffled through the turnstiles at Raymond James Stadium.

While the crowd watched the Baltimore Ravens and the New York Giants take the field, security officials settled themselves in front of a bay of computers. Aided by facial recognition software, they scanned their surreptitious snapshots for matches to a database of known criminals, from shoplifters to terrorists. The software eventually picked out 19 people who resembled individuals with outstanding warrants for a variety of petty crimes. Unfortunately, every single one of those matches turned out to be false.

The technology has come a long way since the failed experiment of the 2001 "Snooper Bowl." Computers are quickly becoming as adept as the human brain at recognizing people's faces. Hard to believe? Just upload an image to Facebook and watch as the app tags the faces before you've even registered who is in the photograph.

Facial recognition technology has permeated everyday life, and its applications reach far beyond law enforcement and social media. Today, facial recognition is being used by retailers to identify big spenders, by conservationists to track the dwindling tiger population, and by techies to train robots to do our bidding.

Alade Tokuta, a professor of mathematics and physics at NCCU, says that even though the possible applications seem endless, facial recognition technology still has its limits. His

laboratory studies the science of facial recognition and is developing ways to help it reach its full potential.

"Facial recognition technology works wonderfully under the ideal conditions," Tokuta says. "Think about how, on TV shows, the culprit always looks up at the camera as if to say, "Hi mom!" so the camera can snap a good shot. That isn't what happens in real life."

Images may be captured in poor light, and people often move. "Now you see them, now you don't," Tokuta said.

"The perpetrator could be committing a crime yards away from the camera. We are trying to develop a system that works well in all those cases. There are so many challenges that still need to be solved."

THE ANATOMY OF A FACE

Scientists believe that the human face is composed of about 80 distinguishing features — characteristics like wide-set eyes, high cheekbones, and a square jawline. Facial recognition software creates a digital image. Some methods also mark individual features with dots, like faces marred by a case of chicken pox. By measuring the distance between each of those dots, features can be converted into a numerical code or "faceprint." Like a fingerprint, each faceprint is unique and can be used to pick individuals out of a crowd.

The technology largely reflects the internal programming people use to recognize faces. The human brain has a way of naturally assessing the coordinates of facial features, like the eyes and nose, and running that information through its memory bank to determine if the face belongs to someone they have seen before.

"One of the things that we have found useful in trying to solve very complicated problems is to gain a better understanding of how nature does it," Tokuta explains. "We study other animals, insects, all kinds of creatures, to see what kind of solutions they employ. That is the concept of bio-inspired features, and we use it to guide our thinking as we improve upon this technology."

For example, research indicates that humans are good at recognizing faces because they have had lots of practice. Babies learn to distinguish their caregivers from complete strangers by noticing who responds to their cries with a hug or bottle of milk. They continue to hone these skills as they grow into adulthood and their social connections expand. Several studies have found that we sometimes have trouble distinguishing people of a different race – cue the distasteful phrase "they all look alike" – because we spend most of our time interacting with members of our own race.

If people can improve facial recognition through experience, it could be likely that computers can, too, said Tokuta, who keeps this idea in mind when he is creating new computer algorithms for facial recognition. These algorithms may be quite simple, relying on only a few measurements, such as the distance between the eyes or the curvature of the nose, to distinguish a face. Or they may be quite complicated, incorporating dozens of complex calculations. Tokuta uses hundreds of images to train the computer on each new algorithm, and then scores how well the computer can spot an individual face among the masses. After adjustments, he sends another set of images to the computer. The goal is to train the machine to identify faces with near-human accuracy.

Though it remains far from perfect, this technology has already served a variety of purposes. Navy Seals used it to confirm the killing of 9/11 mastermind Osama bin Laden, and the State Department uses it every day to process visas. Tokuta would also like to see facial recognition software play a role in some situations where the target image has not been captured on camera, such as the vast number of cases where law enforcement officers must rely on police sketches drawn from accounts

Professor Tokuta inspects a bank of networked machines in his lab that enable intensive computational analysis.

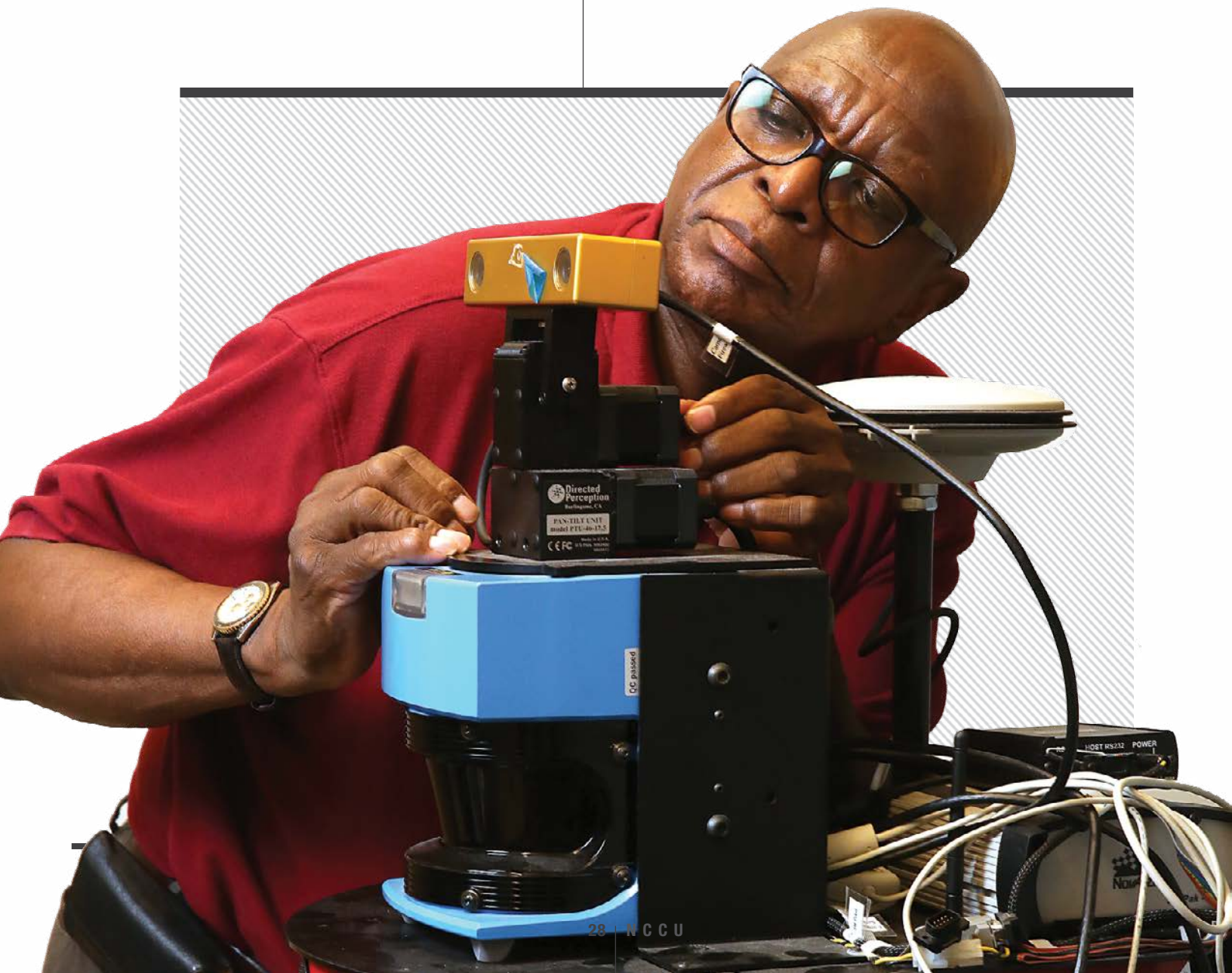
We have a lot of problems to solve. The fun part is developing new technologies to help promote the kind of solutions that have a big impact. Sometimes it is just a question of peeling away the layers, so that every researcher contributes a little bit."

— ALADE TOKUTA, Ph.D.

of eyewitnesses and victims. These sketches are hung in post offices or shown on the local news in hopes that someone will recognize the perpetrator and come forward. An undergraduate student in Tokuta's laboratory, Terry McKoy, has been developing a set of algorithms that can link police sketches to a database of mugshots, so officers have a better chance of locating the suspects. Though Tokuta is wary of sharing the details of the new technique at this early stage, he calls it a "revolutionary new approach" that could give a high-tech boost to the traditional methods of law enforcement.

TOMORROW'S TECHNOLOGY

With a background in computer science, it is not surprising that Tokuta would be enthusiastic about technology's rise to prominence in modern life. He fondly refers to the "Internet of Things," the notion of a future where everyday objects are embedded with electronics, software, sensors, and connectivity so that practi-



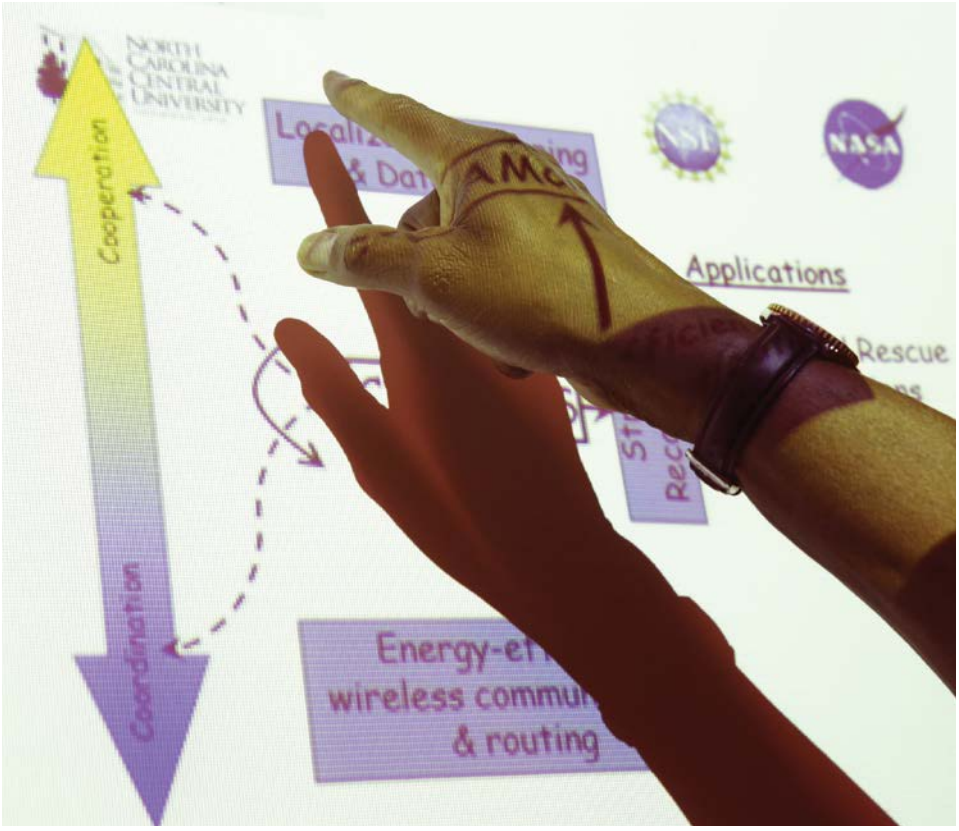
cally any activity can be automated. These smart objects could automatically perform any number of duties, while also sensing and interacting with you and your environment. And Tokuta sees facial recognition software as a big part of that future.

The next generation of technology will be able to gauge your mood, track your activities, and monitor your behavior. Tokuta says cars may soon be outfitted with facial recognition software to prevent theft. These same tools could also be used to protect you from yourself, in cases where the faceprint is a match but your eyes or countenance indicate you are too inebriated or exhausted to drive. In that case, the car might not start, or it might sound a warning for you to slow down and go to a rest area.

Software could be designed to detect not just changes in facial features, but also movements and behaviors that might be indicative of nefarious deeds. Surveillance cameras or even robots outfitted with this kind of technology could potentially spot suspicious activity and alert nearby authorities of a possible threat. Imagine being able to catch the Boston Marathon bombers before they had time to detonate their bombs, or stopping school shooters before they launch their attacks. Tokuta is working to create technology that could accomplish such feats, which he says could go a long way toward deterring crime and saving lives.

"Essentially, we want to be able to tell what somebody is doing, regardless of the conditions," Tokuta said. "What if someone is in danger, not because a crime is being committed but because they are having a heart attack? We may be able to incorporate biometrics, such as changes in blood pressure, heart rate, and skin tone that indicate when a person is not well. A face is just a face, and there is so much more we can learn by looking at a person's actions."

Several months ago, Tokuta's laboratory began laying the groundwork for a program that can teach computers to decode human behavior. They brought in several students and asked them to complete a series of harmless tasks – walking across the room and opening a door, sitting down and reading a book – all the while recording their movements with infrared, near infrared, and regular cameras. Now they are pooling together all the footage to see if there is a formula that can precisely define each activity – walking, reading, and the like – so that the computer can recognize it every time.



Professor Tokuta points out details on a graph that illustrates thematic thrusts of his research group.

The goal, as with many of Tokuta's projects, is to train machines to do what humans do naturally – recognize someone on the street, sense when something is wrong, navigate an unfamiliar route. In theory, computer-based systems should be able to outperform humans on most tasks and, by some measures, they already do. Take self-driving cars. Computers don't drink or text, they don't get tired or distracted, and they have zero reaction time.

Google has claimed that its latest autonomous vehicles are "safer and smoother" when steering themselves than when humans take the wheel. Tokuta and many other researchers disagree, arguing that these vehicles need to be tested in less than ideal conditions before they can be deemed ready to hit the road. Recently, the U.S. Army Research Laboratory sent him images of real roadways, some taken when the weather wasn't clear and lanes not always well marked. Tokuta is running through these images to develop a formula to help computers recognize the rules of the road, just like he has been training them to recognize faces or human behaviors.

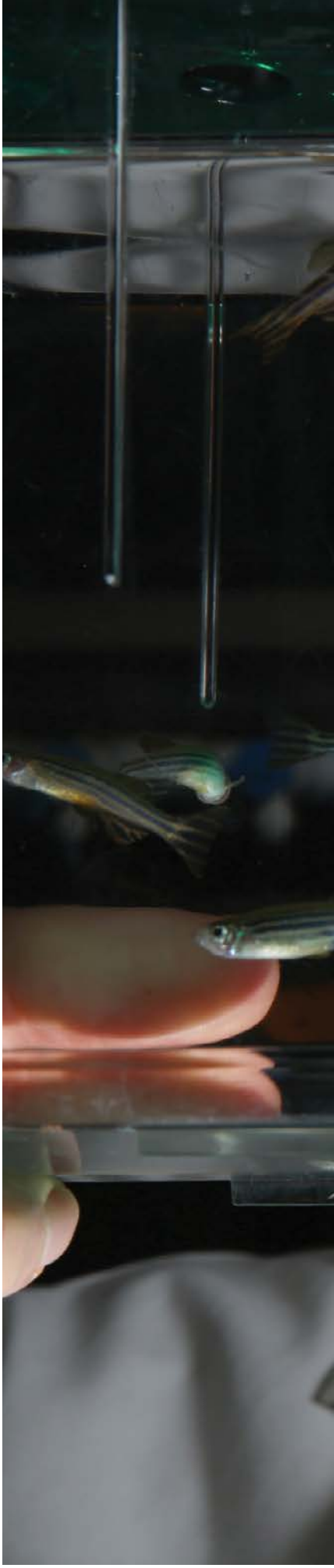
"We have a lot of problems to solve. The fun part is developing new technologies to help promote the kind of solutions that have a big impact," Tokuta said. "Sometimes it is just a question of peeling away the layers, so that every researcher contributes a little bit. And before you know it, we find a solution that we never would have thought possible."

EXPLORING THE **DANGERS** OF ALCOHOL

Written by Marla Vacek Broadfoot
Photos by Ted Richardson

ALCOHOL AFFECTS EVERYONE DIFFERENTLY.

Some people seem completely unfazed after a night of downing shots, while others get pounding headaches from just a few sips of wine. These differences have greater implications than whether you can hold your liquor. Scientists are learning that the consumption and consequences of drinking vary widely – not just from person-to-person, but also among ethnic and racial groups, placing entire subsets of the population at higher risk of consequences including alcoholism, organ failure and birth defects.



FOR EXAMPLE, black teenagers typically drink less than their white counterparts, yet they are more likely to die from liver cirrhosis when they get older. Likewise, even though more blacks than whites abstain from drinking while they are pregnant, the incidence of fetal alcohol syndrome among blacks is about seven times higher than among whites. These disparities in alcohol-related diseases may be tied to the slightly different genetic makeup of the ethnic groups, but other biological, environmental, and social factors also undoubtedly play a role.

In 2010, NCCU was awarded a U54 partnership grant from the National Institute on Alcohol Abuse and Addiction to create a new program in alcohol research on health disparities. Known as the U54 Collaborative Minority Alcohol Research Center Development program, it is led by noted neuroscientist Gregory Cole and was the first of its kind to receive such funding. By pairing up researchers from the University of North Carolina's Bowles Center for Alcohol Studies in Chapel Hill and NCCU's Biomedical/Biotechnology Research Institute (BBRI) in Durham, alcohol research at both universities has been enhanced and more minorities, who are underrepresented in alcohol research and education, are being brought into the process.

Over the course of the partnership, NCCU has gone from having no active alcohol research on campus to eight laboratories examining the effects of alcohol on the body. The specialists have trained more than 20 students in alcohol research, generated multiple grant submissions and authored a dozen articles that have appeared in research publications. The program has inspired a number of additional ongoing projects – among them, studies of how alcohol consumption can hamper fetal development, trigger cancers, and kill brain cells. The U54 grant was renewed in 2015.

THIS IS YOUR BODY ON ALCOHOL

When you take a drink, the alcohol is quickly absorbed through the walls of your stomach and small intestine into the bloodstream. The alcohol-laden blood then travels to the liver, the organ primarily responsible for metabolizing the drug. There, alcohol is first converted to acetaldehyde, a cousin of the embalming agent formaldehyde. This chemical intermediate is what makes you feel flushed or nauseous when you've had one too many, and researchers have learned that it also may induce the DNA damage that underlies many types of cancers. Luckily, in most people acetaldehyde is quickly converted into acetate, a relatively innocuous substance that renders most of alcohol's pleasurable effects.

However, for a pregnant woman, even a fleeting dalliance with alcohol can expose her unborn child to the toxic metabolite and cause irreparable physical and cognitive damage. Alcohol crosses the placental barrier and its presence can stunt growth, create facial abnormalities, and damage neurons and brain structures leading to a variety of problems, ranging from mild ADHD to severe learning impairment. It is estimated that at least one out of every 100 children in the United States is affected by this continuum of defects known as fetal alcohol spectrum disorders (FASD).

"Alcohol can cause problems for a developing baby throughout pregnancy, even at early stages when a woman doesn't know she's pregnant," said Cole, professor and chair of biology at NCCU and director of the Neuroscience Research Program within the BBRI. "We still don't know how much alcohol, if any, is safe for expectant mothers. One of our goals is to develop better tools to measure alcohol's effects in the developing brain so we can get a better idea of how it causes so many different problems."

Through the U54 grant, Cole has partnered with UNC's Kathy Sulik, one of the world's experts on alcohol-induced birth defects. In the early 1980s, Sulik conducted the seminal studies in mice that demonstrated alcohol was the cause of fetal alcohol syndrome (FAS). Cole has expanded this work to his model organism of choice, zebrafish. His previous research into this small, striped aquarium fish focused on a protein called agrin that is needed for nerve cells and muscle cells to communicate with each other. Cole found that interfering

Left and Above: Student researchers work under the supervision of Professor Gregory Cole to examine how genetic material may influence the effect that alcohol has on health. This research is funded through the National Institute on Alcohol Abuse and Addiction.

"We are discovering that there is a cascade of different molecules interacting to give you these birth defects, and if any of them are disrupted, you get an effect. Plus, some genetic variants could make certain individuals or minority groups even more susceptible to alcohol's damaging effects."

— GREGORY COLE, PH.D.

Researchers in Gregory Cole's lab dissect out genes related to alcohol exposure and study them to determine which may be most likely to be affected by the active ingredients in alcohol.

with the function of this protein in zebrafish embryos resulted in organisms with small eyes, a signature feature of fetal alcohol syndrome.

Cole has gone on to model other features of this human disorder in zebrafish, whose transparent bodies make it easy to observe their inner workings as they develop. By adding alcohol to their tanks at different times during development, he can generate a whole spectrum of alcohol-related abnormalities in zebrafish, including tiny eyes, shrunken brains, and behavioral problems. Kids with fetal alcohol spectrum disorders are known to be antisocial, prone to ADHD or learning disabilities, and have a tendency to take risks. Similarly, Cole's zebrafish keep their distance from fellow fish while swimming in schools, have trouble learning tricks in their tank, and brazenly explore the surface of a new tank while their more cautious counterparts wait it out.

Cole and his laboratory are using these models to further explore the idea that agrin is a molecular target of alcohol. One by one, they are dissecting out each of the genes involved in alcohol exposure, starting with agrin but also looking at signaling molecules like fibroblast growth factor and the sonic hedgehog (SHH) gene, and feel-good chemicals such as dopamine. The findings have been well received by other scientists in the field. A 2014 paper produced with lead author Chengjin Zhang, a research associate in the Cole laboratory, was published in the journal Neurotoxicology and Teratology and became one of the most downloaded that year.

"We are discovering that there is a cascade of different molecules interacting to give you these birth defects, and if any of them are disrupted, you get an effect," explained Cole. "Plus, some genetic variants could make certain individuals or minority groups even more susceptible to alcohol's damaging effects."

A LIFE-LONG PROBLEM

Alcohol isn't just dangerous to the unborn child – it has been linked to more than 60 diseases, the vast majority of which don't appear until later in life. Heavy drinking increases the risk of many types of cancer, including mouth, esophagus, breast, bowel, and liver cancer. For example, oral cancer is about six times more common in drinkers than in non-drinkers. Though the increased risk of oral cancer is well documented in humans, scientists have been hard-pressed to find an animal model that enables them to study how alcohol makes normal cells turn cancerous.

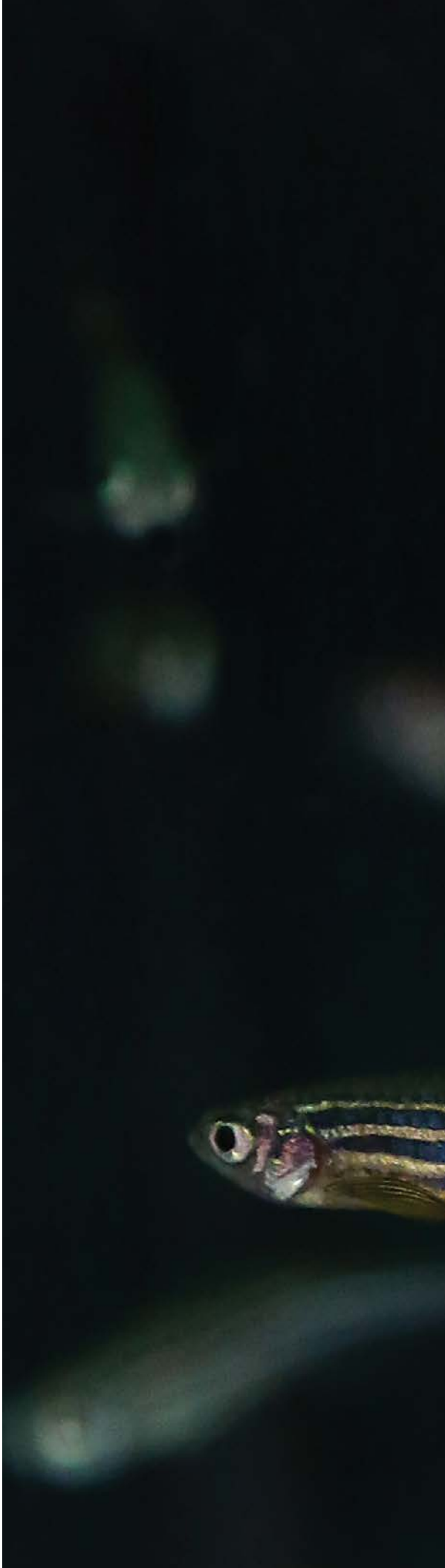
Through another of the U54 grant's three main research projects, cancer researchers Xiaoxin Chen of NCCU and Paul Godfrey of UNC paired up to develop mouse models of alcohol-induced oral cancer. In their study, the researchers treated mice with a known cancer-causing agent called 4NQO and then gave them either water or 8 percent grain alcohol for four months. They found that exposure to the hard stuff doubled the incidence of oral cancer by skewing metabolism of arachidonic acid, a toxic fat responsible for chronic inflammation. The discovery lends insight into the molecular underpinnings of the development of oral cancers and points toward new targets for the prevention of this disease.

In addition to cancer, alcohol abuse can cause anemia, cardiovascular disease, liver cirrhosis, depression, and dementia. Drinking copious amounts of alcohol alters your brain chemistry and can actually shrink your brain. Doing other drugs, like tobacco or marijuana, can make these damaging effects even worse. NCCU chemist Somnath Mukhopadhyay has a special interest in how cannabinoids, the natural components of the Cannabis sativa, the marijuana plant, alter the brain.

In collaboration with UNC neuroscientists Fulton Crews and Ryan Vetreno, Mukhopadhyay performed a number of experiments in rats to look at the relationship between cannabinoid and ethanol exposure on the brain. The researchers showed that each of these substances on their own block the growth of new brain cells and cause old ones to die, and that they have devastating synergistic effects when they are combined. They also showed that treating rats with a chemical that blocks the effects of cannabinoids on brain cells can protect them from the damage wrought be alcohol consumption, indicating that the organ's response to the two drugs are inextricably linked.

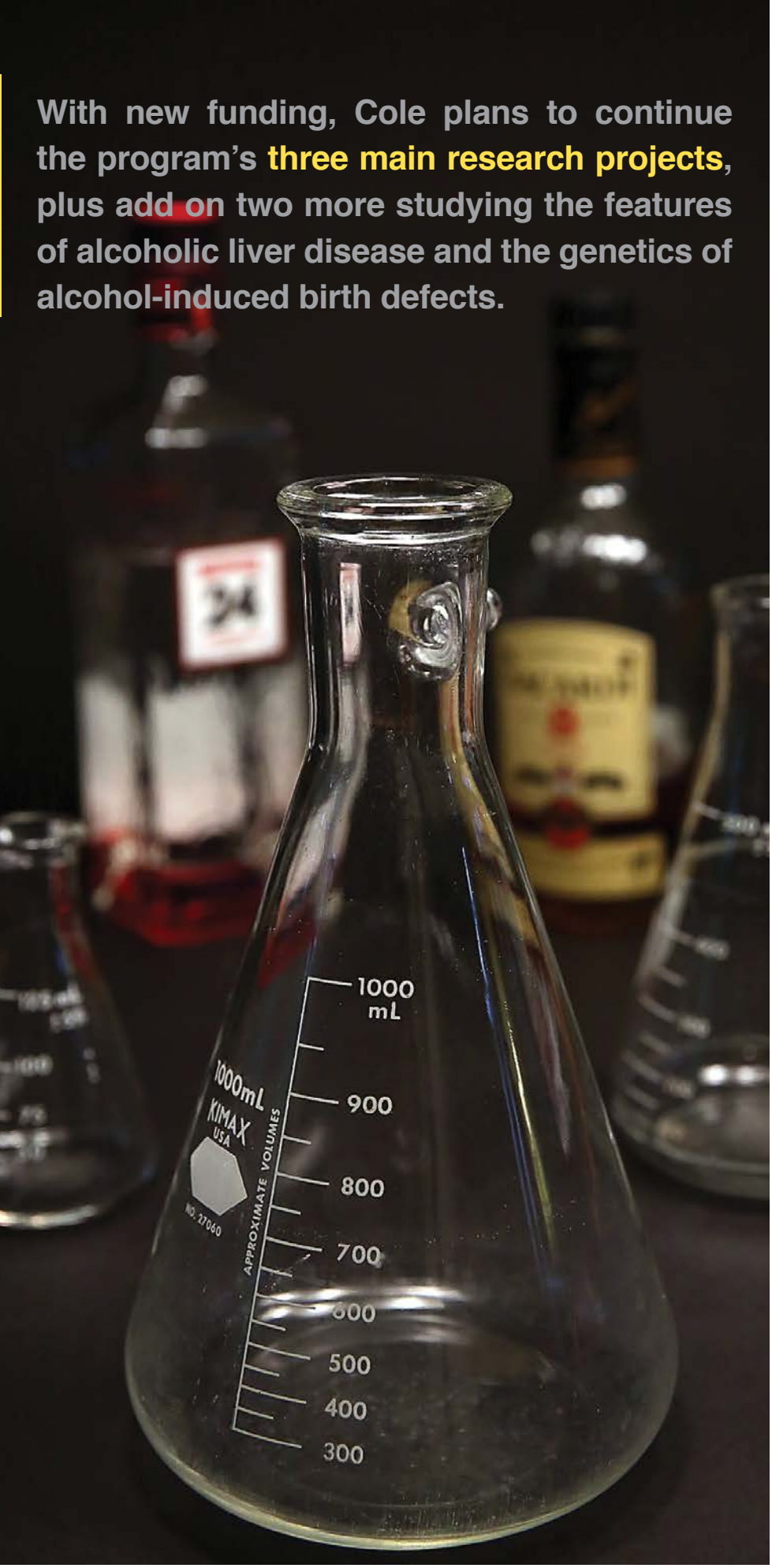
LAYING THE GROUNDWORK

Though the research coming out of the U54 program has generated valuable knowledge about alcohol and its effects on the body, Cole is quick to note that its greatest contribution may be in exposing large numbers of NCCU students to the issues of drinking and health disparities among various ethnic groups. Eleven graduate students and



Cole has gone on to model other features of this human disorder in **zebrafish**, whose transparent bodies make it easy to observe their inner workings as they develop. By adding alcohol to their tanks at different times during development, he can generate a whole spectrum of alcohol-related abnormalities in zebrafish, including tiny eyes, shrunken brains, and behavioral problems.

With new funding, Cole plans to continue the program's three main research projects, plus add on two more studying the features of alcoholic liver disease and the genetics of alcohol-induced birth defects.



more than 20 undergraduate students are now receiving training in alcohol research. Of the master's degree candidates and undergraduate students who graduated after becoming involved in alcohol research, five are enrolled in Ph.D. programs at research-intensive universities and three are in health professional programs.

"The involvement of NCCU students in alcohol research has provided experience and education enhancing the development of future leaders of the African-American community and educating them on alcohol health disparities," Cole said.

Cole is particularly proud of a student in the master's degree program, Princess Ojiaku, who is now at the University of Madison-Wisconsin working toward a combined master's in public policy and Ph.D. in neuroscience. In 2014, Ojiaku received a prestigious MacArthur Foundation fellowship for the study of socioeconomic factors and their influence on neurodevelopmental disorders, such as fetal alcohol syndrome.

Five years since its start, the funding that established the U54 Collaborative Minority Alcohol Research Center Development program at NCCU was renewed in 2015 for another five years with $4.5 million in funding. With new funding, Cole plans to continue the program's three main research projects, plus add on two more studying the features of alcoholic liver disease and the genetics of alcohol-induced birth defects. He hopes to further increase the number of faculty conducting alcohol research and the number of students graduating with an interest in the field.

"Ultimately, we would like to inspire researchers at minority-serving institutions like NCCU and elsewhere to study the alcohol-related problems that underlie health disparities in the African-American community," stated Cole. "Together, if we can understand what is causing these differences, then we can develop some real solutions."

Mary M. Townes Science Complex

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For more information about research at NCCU vist www.nccu.edu or call 919-530-6893

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