NC STATE
UNIVERSITY

Department of Food, Bioprocessing and Nutrition Sciences **DIGEST 2014**

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Learn more at go.ncsu.edu/fbns

A GREAT YEAR AND A BRIGHT FUTURE

It's no surprise that food manufacturing and entrepreneurship has emerged as a core direction of the Department of Food, Bioprocessing and Nutrition Sciences. For years the department has provided leadership to the state's agricultural manufacturing sector, from our Entrepreneur Initiative for Food (ei4f), which has helped more than 1,500 aspiring food entrepreneurs since 2010, to the Howling Cow dairy enterprise, which has bolstered North Carolina as a regional force in the dairy industry.

Technologies conceived from research programs in our department have led to the creation of new companies and startup ventures that today are employing more than 500 people in rapidly growing North Carolina businesses.

Fueled by this rich history, the department has set an ambitious new goal: Help the state develop regional centers – or hubs – for accelerating the value-added component of agricultural commodities.

Producers and entrepreneurs would gather at these hubs for education and training on important issues of food processing safety. The hubs also would help aspiring food entrepreneurs develop business plans and generate consumer-ready products for retail operations.

This concept is generating buzz across North Carolina. The General Assembly recently appropriated special funding for a food processing initiative to investigate the potential for food manufacturing to contribute to North Carolina's economy.

The future of food manufacturing in North Carolina is bright. With a ready supply of labor, resources and commodities, food manufacturing will have tremendous impact on the state's economy and ultimately help grow agriculture to a more than $100 billion industry annually.

And, as always, the Department of Food, Bioprocessing and Nutrition Sciences will provide critical leadership to help North Carolina achieve those goals.

Thanks for your support!

Christopher R. Daubert
Department Head

FROM PICKLES TO PROBIOTICS

FBNS processing technologies continue to impact the world

Since the formation of the Department of Food Science in 1961, thousands of students, faculty and staff have passed through the doors of Schaub Hall. As typical in scientific endeavors, research ideas came and went; some endeavors failed and many skyrocketed. Dr. Ken Swartzel, Professor Emeritus of Food Science, is working to compile this information – picking up where others left off before him – to preserve a tangible history of the department.

Of particular interest to Swartzel is not only to document the 87 U.S. patents and three trademarks awarded to FBNS, but also to capture the inventive culture of the department since its inception. To note, FBNS has the only single authored student patent within the entire university. Currently, a plan is in the works to create a display wall in the new Schaub Hall board room to showcase the patents and impacts credited to the department and its distinguished researchers.

As FBNS forges ahead, remembering the past is imperative to future success. A display of the achievements and ingenuity of researchers of the last half-century will remind industry partners of the source of the technology upon which many of their companies were built, so they may continue a partnership with FBNS for future endeavors.

And perhaps more importantly, current and future students will know they stand on the shoulders of those who created a solid foundation upon which they can build and inspire this next generation of scientists to expand and improve the world of food.

Yam, that's good!

Future First Lady Claudia "Lady Bird" Johnson tries instant sweet potatoes while visiting NC State in 1963. NC State food scientist Dr. M.W. "Bill" Hoover is apparently pleased by her approval.

That Seventies Show
From top: Addis Cates, right, of Cates Pickle Co. reviews new varieties; students examine cured hams; sweet acidophilus milk hits the grocery shelves.

Here are a few highlights of technology developed over the years and resulting impact on the world:

The **modern pickle industry** has benefited greatly by industrial improvements from the USDA-ARS food fermentation group. Dr. John L. Etchells led the ARS food science laboratory from 1937 until 1975. His group and that of Dr. Henry Fleming developed the first commercial pasteurization process for shelf-stable pickles, among many other contributions to pickle safety. In the 1990s, Dr. Fred Breidt and his team investigated how to reduce the presence of dangerous bacteria without affecting product quality.

Prior to the work in the 1970s of Dr. Tom Blumer and Mr. John Christian, the **cured country ham industry** was seasonal, wasteful and of extremely low volume. Their research on refining the steps in production – curing, salt equalization and aging – along with the development of a self-contained refrigerated system for curing ham, transformed the industry in North Carolina. Within ten years, Staler Hams in Greensboro grew from producing 50 hams per year to tens of thousands per year.

Dr. M.W. "Bill" Hoover is known for numerous industrial successes. He received many of the first U.S. patents in the department, including **honey-roasted peanuts**, a huge industrial success. Former Lt. Governor, Jimmy Green, commercialized this product. Later it was purchased by Anheuser-Busch Inc. and then formed the Eagle Brand Snack Foods Division based in eastern North Carolina.

Drs. Marvin Speck and Stan Gilliland developed **sweet acidophilus milk** – one of the first commercial probiotics. This was one of the three products trademarked in the department and it brought in millions of dollars for further research and promotion.

During the early 1980s, a process was developed to extend the shelf life of **liquid whole eggs**. This multiple-patent process changed the industry worldwide, again bringing in millions of dollars in royalties to the university. The licensee, Michael Foods Inc., became the world's largest egg processing company and recently sold for $2.3 billion.

Probiotic research driven by the Klaenhammer laboratory yielded many advances in understanding how **probiotic lactic acid bacteria** elicit

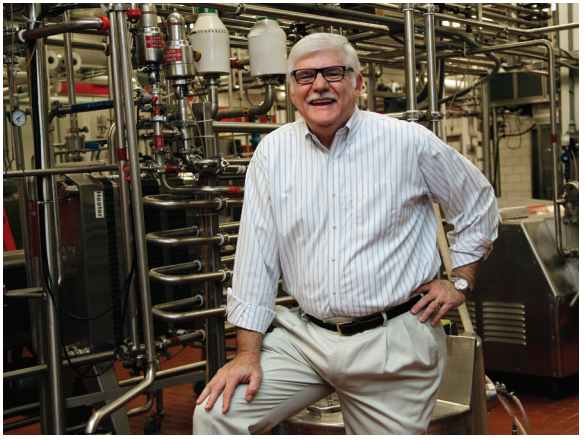
benefits to health and well being. In over 30 years of research, the program discovered the key mechanisms by which fermentation bacteria protect themselves from viruses and employed those mechanisms to develop phage resistant bacteria for dairy fermentations. Millions of dollars in research and technology investments were developed industrially and commercialized in both probiotic cultures and the fermentation bioprocessing fields.

Several companies have been incorporated in North Carolina using the department's food processing technologies: Webbco Inc., testing lab; MicroThermics, lab and pilot food processing equipment; YAMCO, sweet potato utilization; UltrAseptics, aseptic technology; Thermalytics, continuous flow thermal evaluation tools; Aseptia/Wright Foods, aseptic food processing. One particular success story: YAMCO uses **sweet potatoes** that were being left in the fields due to unacceptable shape or size – an estimated 30 percent of the crop. Now, they are processed as an aseptic puree ingredient based on the research done in FBNS and USDA-ARS, and nothing is left in the fields. The newest addition to the FBNS startup list is Carolina Dairy – a yogurt processing plant in Biscoe, N.C.

The **Thermal Scanning Rigidity Monitor** (TSRM) was marketed as a laboratory tool by Drs. Ming C. Wu, Tyre Lanier and Don Hamann. Units were made in Raleigh and sold throughout the world. A spin-off of this technology became a new instrument for evaluating the quality of surimi. Meat gels have also benefited from the use of this valuable instrument.

Many developments in **surimi technology** came out of Dr. Tyre Lanier's lab. Drs. Lanier and David Green developed scallop medallions. In this process, small scallops were formed into large higher valued scallops. Again, an industry was changed forever.

FBNS scientists have generated an extraordinary body of work over the last half-century that includes many more innovations than those listed here. It is upon this foundation of success that the department launches its next 50 years of innovation. We thank all those who have supported our efforts and encourage everyone to continue their support for the exciting years ahead.



Dr. Ken Swartzel *led the department for 11 years and developed two research centers that work closely with industry and government to get food science innovations into the marketplace. His work has resulted in dozens of patents and has spawned six companies statewide.*

In 2013, the Institute of Food Technologists honored him with its highest award for lifetime achievement and the Raleigh News & Observer *named him Tar Heel of the Week. While flattered, Ken says his allegiance is still to the Wolfpack.*

THE SCOOP ON HOWLING COW®

Alli Davis admits it. She names the cows.
Davis, all of 22 years old, wears her sandy blonde hair back in a ponytail. She stands at the end of a row of calf corrals in a gray T-shirt and muddy boots. The calves see her. They're all between 2 and 8 weeks old and are built like stocky little deer. They bounce around like big puppies. The conversation comes to a dead stop. Calves have that effect on people.

There's one named Shamrock. The youngest ones, the twins on the end, are named Lucy and Ethel. One in the middle is named Butter. Her mom's name was Peanut. There's another one named Jelly. Davis wants to name the next one Sandwich. "Nobody thought that was a good idea," she says in a thick Tennessee accent.

Alli Davis, herd manager at NC State's dairy farm, has been a key link between the farm and the Howling Cow team. Cows respond to names, she says. She knows this because she was raised on a dairy farm with 600 cows. Sure, the names are cute, but Davis has an underlying seriousness about her. "It's not a job," she says. "Dairy farming is a way of life."

To find Davis and her cows, you have to drive south from downtown Raleigh on Lake Wheeler Road, until the apartment complexes and pines start to peel away. First you pass the white-fenced turf fields. Then you pass the place where they keep the swine. Then you turn left into NC State University's Dairy Research and Teaching Farm. You roll up a long gravel drive that ends just past a big oak tree, next to the new milking parlor where 20 cows at a time can sidle up, rump first and give milk. It's far enough out to feel like a world away from campus, but close enough to see Raleigh's tallest buildings poking over the treetops. It's here that Davis cares for 190 cows, a number that's representative of an average North Carolina dairy farm. Most of them are black-and-white Holsteins with some brown Jerseys mixed in. They're milked twice a day, at 7 in the morning and 7 at night. She needs to keep them happy. "Happy cows give good milk," she says.

This is where it starts.
The place is meant for milking, but also for watching. For decades, students have been coming to NC State University to learn the trade – how to raise cows, take their milk, pasteurize it, process it, and turn it into everything from 2 percent milk to ice cream and cheese. The technical side, the technology and the training, has always been a part of daily life here.

In 2008, that life was threatened. The Great Recession sent state universities scrambling to find places to cut back and the cost of running a 389-acre farm seemed to be too high. Elsewhere in the country, universities started selling off big chunks of their herds both to make money and to save their future dairy programs. There was a worry that the farm and many of the cows, which supply the milk for NC State's dining halls as well as state prisons, might fall victim, too.

Howling Cow ice cream helped save the farm.
Back on campus, Gary Cartwright sits in his office on the ground floor of Schaub Hall and pulls up a website listing 54 things to do at NC State. At the top of the list: Eat a scoop of Howling Cow ice cream. "Since its inception, we've been No. 1," he says. "We're beating 'going to class.' "

Food Science students *try to keep up with orders at the State Fair.*

Cartwright runs the Dairy Enterprise System at NC State, which takes the raw milk from the farm near Lake Wheeler, pasteurizes it, and sends it off to dining halls and state prisons. Those sales made the Dairy Enterprise System self-sufficient. And sales allowed students to experiment with making cheese and ice cream.

All of Howling Cow's products originate on NC State's dairy farm. After the milk is collected and processed, Gary Cartwright and Carl Hollifield oversee its sale on campus. But students weren't able to learn a valuable side of the business – how to sell what they made. "In the past, because we could not sell and market to the public, everybody around the department would taste it and say how great it was and then you'd throw it in the dumpster when it expired," Cartwright says.

The reason was a state law known as the Umstead Act, which doesn't allow state government institutions to sell things that compete with private business. There are some exceptions. One of them allowed NC State to sell its ice cream once a year, at the State Fair. The size of the scoops became legendary. The wait in line was sometimes a half-hour long.

So Cartwright and others figured that if they could sell their ice cream, their students would learn a valuable lesson and all of that ice cream wouldn't go to waste. Other universities with dairy programs, like Penn State, Cornell and Wisconsin had retail ice cream shops powered by their own collegiate cows. Why not us?

In 2005, with the blessing and support of the state's dairy industry, the General Assembly gave NC State's dairy an exemption to the act, allowing direct sales to the public, so long as the ice cream and other dairy products were sold on campus and the proceeds went back to support the dairy program. A few years later, they came up with the Howling Cow name and went to work.

"Everything needs to have a return," Cartwright says. Before the farm was brought into the Dairy Enterprise System in 2009, it was nearly 100 percent taxpayer-supported. Now it's close to 30 percent. There are plans to open up an agricultural education center at Schaub Hall to let the public see where their milk is made. "I don't worry about it being a success," Cartwright says. "I worry about how we'll handle all the people that show up."

Cartwright walks into the red-tiled Feldmeier Dairy Processing Lab, where stainless steel pipes and tanks are strewn about. He shows me the spot where, every day, rain or shine, a tanker truck pulls in with milk from the cows at Lake Wheeler. They work when everyone else is off. "The cows don't cross their legs on holidays."

From there, the raw milk sits in a holding tank before being separated into things like skim milk, heavy cream and whole milk. After that, it's heated and pasteurized and homogenized, using a contraption made up of a series of metal tubes before it's pumped into a holding tank. There, the different types of products are created. There are more than a dozen flavors. The chancellor

Branding plays a key role *from packaging to product delivery. "We may not have Ben and Jerry's budget, but our branding is just as professional – and fun."*

The chancellor *concocted his own flavor of Howling Cow, then unveiled it to a few hundred friends on campus.*

himself came up with the idea for Wolf Tracks ice cream, made of vanilla, chocolate, caramel and chunks of fudge. It's Howling Cow's best seller.

Howling Cow is sold all over campus, from the Talley creamery to the Hunt Library to residence hall convenience stores. And that's where the marketing comes in. NC State had been making its own ice cream since the mid-1940s, but once they were allowed to sell it, they needed a name. Howling Cow was born. Now, that brand appears on ice cream and milk and whatever else students can dream up. Back in his office, Cartwright reaches up to a shelf and pulls down a prototype milk carton with a slick graphic of a cow wearing a sweatband and earbuds. It's chocolate milk fortified with whey protein – a workout-recovery milk called PowerPack™.

It used to be that students only worried about making the product. Now, they worry about how to sell it. In the case of PowerPack, students had to figure out how much it should cost and how to make it NCAA-compliant so student-athletes could enjoy it. The dairy program has changed during the past 30 years, but so have the students. In the old days, many students just wanted a career, Cartwright says. "They were going to buy a house, have a family, and hopefully not get moved all around the country. I think the students now know the reality of that has changed," he says. "They want to know the impact of what they're doing."

Around lunchtime, the food court at the new student union is packed and students flit in and out of the Talley Market convenience store. Howling Cow logos – featuring a cow in profile with a red, white and black eye (a milkflower, Cartwright claims) – are plastered behind the ice cream counter in a Warhol-esque variety of colors. Students stop in to get what they need. But they also walk up to the counter to get what they want.

There are a lot of flavors to choose from. Andrew Wegener, a sophomore from Oxford, wants Cookies & Cream. He's big on ice cream, he says, but not a connoisseur. He knows Howling Cow is made on campus, but not much else. He's never had Howling Cow before. He interrupts himself to take a bite. "This is good," he says.

A few minutes later, Troi Perkins, a zoology major from Snow Hill, stops in. She likes Strawberry and Chocolate Chip Mint, but today she's branching out to Salted Caramel Cheesecake. Troi's parents are from Vermont and Ben & Jerry's is her favorite ice cream ever. "This stuff tastes like Ben & Jerry's," she says.

Cartwright and his coworker, Carl Hollifield, walk through the food court, and a campus nutritionist sees them. "Hey! The ice cream guys!" she says before chatting them up, while students keep lining up inside the store for Butter Almond, Pecan Krunch, and Java Bean.

"Give somebody an ice cream cone, and it has a power all its own," Cartwright says. "It makes people smile."

Reprinted with permission from **Our State** *magazine, June 2014*

YUCKY OR YUMMY?

New method developed by FBNS researchers gauges kids' liking of fruits and vegetables

Getting children to eat fruits and vegetables – especially the green ones – is no small feat. Researchers at North Carolina State University are trying to change that.

Drs. Suzie Goodell and Virginia Carraway-Stage developed an innovative pictorial method to assess preschoolers' liking of familiar fruits and vegetables, expanding on earlier work from others in the field. Their goal, according to Goodell, assistant professor of nutrition science at NC State, was to develop a better tool that researchers could use with nutrition education programs designed to improve fruit and vegetable intake in children.

The project, Carraway-Stage's doctoral dissertation as Goodell's former student, was featured in the journal *Appetite* in April 2014. In the months following publication, it has garnered national and international attention.

"We've heard from researchers all over the U.S. and world wanting to know more about our tools and our work," said Carraway-Stage, now an assistant professor of nutrition science at East Carolina University. "We want this to be a resource that people can use in their own work and we're happy to partner with them to further the larger goal of helping children increase fruit and vegetable consumption as part of a healthy diet."

Goodell added, "The beauty of this tool is that anyone in the world could use it, no matter what language they speak, because the assessment method is based entirely on photographs."

So how does it work?

During the testing period, trained research assistants sat down with preschoolers of ages 3 to 5 at several different Wake County Head Start centers. Using an iPad, the research assistant would show 20 different fruit and vegetable images, one at a time, to the child. At the bottom of each image was a series of five choices, illustrated by a range of "super yummy to super yucky" faces. The child would be prompted to point to the face that best demonstrates his or her level of liking for the particular fruit or vegetable.

The data were collected and assessed by Goodell, Carraway-Stage and their team and they determined that the method was effective through observation and statistical analysis. The resulting tool and associated materials are free and available for use by contacting Goodell at suzie_goodell@ncsu.edu.

"At the beginning of this process three years ago, we started out with more than 200 photos," said Carraway-Stage, who also served as photographer for the project. "We were able to refine them through testing to develop a collection of 20 images."

Recalling an incident in which one child mistook spinach for "a scary monster," Goodell said, "We needed to know that the pictures we were taking were being seen the way we wanted them to be seen."

More than 50 NC State students were involved in the process, doing everything from data collection to photo assessment. Several students conducted related honors research and capstone projects, presenting at national conferences and meetings. This was a welcome byproduct of the project, Goodell said.

"For us, it's about building collaborations and strengthening research evaluation processes," Goodell said. "It's also very much about building capacity within our students to make them stronger when they go out into the workforce. We want to give them opportunities for exposure."

Goodell and Carraway-Stage continue to collaborate, most recently working together on a USDA grant proposal for nutrition education projects at North Carolina Head Start programs.

Read about their project in Appetite *at sciencedirect.com/science/article/pii/S0195666313004984*

FBNS IN THE NEWS

NC State is a national leader in food processing technologies, which in turn are creating jobs in our state. Dr. KP Sandeep talks about microwave heating and aseptic food processing techniques developed in FBNS.

video.unctv.org/video/2365157414

The increasing popularity and interest in craft beer has far-reaching effects in the local economy, community and agriculture. Dr. John Sheppard discusses a new innovation: brewing wasp yeast beer.

wunc.org/post/beers-north-carolina

Researchers have found a way to extract the "good stuff" from fruits and vegetables for use in other foods. Dr. Mary Ann Lila with the Plants for Human Health Institute discusses the most recent research and its importance to human health.

science.unctv.org/content/fruit-infusion

NC State startup Aseptia scored near the top of the prestigious Inc. 5000, an annual list of the fastest-growing privately held companies in the United States. Drs. Ken Swartzel and Josip Simunovic are featured in this article about the company's FBNS roots.

news.ncsu.edu/2014/08/nc-state-startup-one-of-the-fastest-growing

'CUT AND REPLACE' GENE EDITING

The ability to edit select DNA sequences of interest – to add, delete, activate or suppress specific genes – is the holy grail of genetics research, including the molecular basis for many diseases.

Dr. Rodolphe Barrangou uses a system called CRISPR-Cas to take aim at certain DNA sequences in bacteria. CRISPR stands for "clustered regularly interspaced short palindromic repeats," and Cas is a family of genes and corresponding proteins associated with the CRISPR system. Essentially, bacteria use the system as a defense mechanism and immune system against unwanted invaders such as viruses; now, that same system is being harnessed by Barrangou and colleagues to quickly and precisely target certain genes for editing.

An associate professor of Food, Bioprocessing and Nutrition Sciences, Barrangou is now working on a new set of genome editing tools that cuts the targeted DNA and sets the stage for precise genetic modifications. His work holds promise in manipulating relevant bacteria for use in food and biotechnology applications and in model organisms used in agriculture, biotechnology and medicine.

news.ncsu.edu/2014/10/cif-2014

Dr. Rodolphe Barrangou *in the lab.*

Before he fed spacemen

NASA apparently frowns on photos being shared, so we'll show another side of our versatile Ryan Dowdy – explaining the science of food to Brad Sneeden Marine Science Academy middle school students during a visit to CMAST in summer 2013.

FORMER FBNS UNDERGRAD ACCEPTED INTO NASA PROGRAM

It's not every day an English-major-turned-food-scientist gets a chance to work with experts at the National Aeronautics and Space Administration (NASA), but that's how Ryan Dowdy had the good fortune to spend his summer.

Ryan worked in the NC State Seafood Laboratory, part of FBNS, in Morehead City as a Center for Marine Sciences and Technology (CMAST) Summer Scholar. He was accepted into the NASA National Space Biomedical Research Institute's 2014 Summer Apprenticeship Program.

The 11-week program provided him the opportunity to join ongoing research projects and gain hands-on experience in space biomedical research, space nutrition and the NASA Advanced Food Technology Program. Dowdy's career plan is to pursue emerging technologies in the field of food science that provide safe, nutritious, flavorful and affordable food worldwide.

Dowdy focused his CMAST undergraduate research on the use of ozonated microbubble technology in processing fresh catfish filets. He graduated from the University of North Carolina Chapel Hill in 2010 with a bachelor's degree in English, then completed a baccalaureate in Food Science in May 2014 from NC State. Dowdy is now a Ph.D. student in Food Science & Technology at the University of California Davis, where he works on sustainable microbial desalination in the Simmons Lab.

CLASS BOOSTS SUSTAINABILITY AT HOWLING COW CREAMERY

Next time you enjoy a glass of NC State's Howling Cow milk know that it's being produced more sustainably than ever. This spring, Dr. Clint Stevenson's quality control in food and bioprocessing science class focused on improving sustainability in Howling Cow's creamery, which processes up to 400,000 gallons of milk each year.

Using Six Sigma management techniques, student teams researched the facility's processes and chose to focus on enhancing efficiency of the case washer, which cleans reusable plastic cases that transport milk.

"This project exposed students to a real-world problem that encouraged them to apply their skills and knowledge to seeking out sustainability problems and solving them," Stevenson said.

For most students, who are preparing for careers in food science, this project was their first experience with sustainability issues in manufacturing. "This project incorporated real-world experiences, which have not only extended my knowledge of defining, measuring and analyzing quality but also added to my confidence and resume," said student Alexis Elia. "It has been an honor to help improve sustainability [at Howling Cow]."

sustainability.ncsu.edu

MAKING A DIFFERENCE IN FOOD SAFETY TRAINING

Members of a project team led by Drs. David Green and Fletcher Arritt are making their mark nationally in an effort to establish an integrated food safety system for the U.S. Food and Drug Administration (FDA). In 2011, FBNS was awarded a five-year collaborative grant by the FDA Division of Human Resource Development to help establish the system through uniform national standards in training and certification of federal, state, local, territorial and tribal public health authorities.

The project team, an 11-member group representing NC State and other universities and regulatory interests, is responsible for development and delivery of four national training courses – acidified food products, aseptic processing of foods, low acid canned foods and shellfish patrol evaluation. The model program, now in the third year of development, has to date delivered five acidified food courses and one aseptic food course to 200 federal and state investigators. The new FDA acidified foods and aseptic food processing courses are being offered online in Fall 2014. Each course also requires a face-to-face segment in order to receive certification and continuing education unit credits. A state-of-the-art training room was constructed in Schaub Hall to provide a dedicated space to offer these courses.

Additionally, the acidified food products course was adapted in 2014 for use in food industry training. The acidified foods curriculum book is on sale nationwide through a cooperative agreement with the Grocery Manufacturers' Association.

AWARDS AND HONORS

USDA-ARS South Atlantic Area Technology Transfer Award
Dr. Ilenys Perez-Diaz, Ms. Janet Hayes
and Dr. Suzanne Johanningsmeier

Pride of the Wolfpack
CALS Award for Excellence
NC State Award for Excellence Nominee
Ms. Carol Reilly

Pride of the Wolfpack
Ms. Paige Luck

Early Professional Achievement Award
Society for Nutrition Education and Behavior
Dr. Suzie Goodell

Todd M. Bozicevich Education and Collaboration of the Year Award / US Food and Drug Administration
Dr. Fletcher Arritt

2014 NC State Bio & Ag Outstanding Alumnus
Dr. Kenneth R. Swartzel

GUTIERREZ-RODRIGUEZ JOINS THE FACULTY

Dr. Eduardo Gutierrez-Rodriguez, assistant professor and Extension specialist, joined the department in late 2013. He came to NC State from the University of California Davis where he received his graduate degrees in horticulture and soils and biochemistry.

The main objective of his program is to bridge the gap between university and industry in the realm of fresh produce safety. Through a combination of applied and basic research tied to a strong Extension component, Gutierrez-Rodriguez's program will provide the educational and scientific tools needed to inform consumers about fresh produce safety risks as well as train farmers and industry personnel in good agricultural practices and risk analysis.

KLAENHAMMER ENTERS PHASED RETIREMENT

Distinguished University Professor and William Neal Reynolds Professor, Dr. Todd Klaenhammer, has directed research programs on the genetics of lactic acid bacteria used as probiotics or as starter cultures for food, bioprocessing and biotechnology applications for more than 30 years. He joined NC State in 1978, holding faculty positions in the departments of Food, Bioprocessing and Nutrition Sciences; Microbiology; and Genetics; as well as functional genomics and biotechnology programs. His group has published more than 270 articles.

Klaenhammer studied genetic approaches to improving lactic acid bacteria, the "good" bacteria used in fermented food and yogurt. He investigated the molecular mechanisms responsible for the survival and activity of probiotic bacteria in the gastrointestinal tract to develop live bacterial delivery systems for oral vaccines. He also directed the Southeast Dairy Foods Research Center, which conducts research and develops new technologies for processing of milk and its components into dairy product ingredients.

BS, microbiology; MS, PhD food science, University of Minnesota
Fellow, American Association for the Advancement of Science
Fellow, American Academy of Microbiology
Fellow, American Dairy Science Association; Appert Award, 2007
Fellow, Institute of Food Technologists; Borden Award, 1996
Elected into the National Academy of Sciences, 2001
University of North Carolina O. Max Gardner award, 2009
International Dairy Federation Elli Metchnikoff award, 2010

IN MEMORIAM

Joyce A. Taylor passed away on November 16, 2013. Joyce was a seafood education specialist for North Carolina Sea Grant at the NC State Seafood Laboratory from 1974 to 1996, where she became known as the "Guru of Seafood." Joyce received recognition and numerous awards for developing a statewide Extension education program to promote North Carolina seafood. She is best known for leading a dedicated group of Carteret County Extension volunteers, known as the Nutrition Leaders. Under her leadership, the Nutrition Leaders created kitchen-tested seafood recipes using commercial species harvested by North Carolina fishermen. Only the best earned the approval of Joyce and her team, to be included in the newsletter *Mariner's Menu*, and later in the resource manual *Mariner's Menu: 30 Years of Fresh Seafood Ideas*, which is still widely sold and used by home cooks today. Joyce retired in 1996, but continued to work part-time with Sea Grant and the Seafood Laboratory on special projects until 2012.

Professor Emeritus Dr. Arthur P. "Artie" Hansen passed away on December 7, 2013. Hansen received his bachelor's and master's degrees from the University of Georgia and his doctoral degree in food and flavor chemistry from Penn State. After completing his graduate education, Hansen joined the department as a professor, where he was employed for 37 years. During his tenure at NC State, Hansen became one of the world's foremost researchers in aseptic processing and packaging of dairy products. He lectured globally and consulted with major food companies on food, nutrient and flavor interactions with packaging. With more than 200 publications, articles and abstracts written from his research, his impact on the food industry is substantial.

PARTNERS AND DONORS

FBNS Endowed and Annual Scholarships

American Dairy Products Association Scholarship

Benjamin Wesley Kilgore Food Science Scholarship Endowment

Burton M. Newell Award

Christie Abigail "Abbi" Fleming Dairy Science Scholarship Endowment

Dixie Flyers Association, Inc. Dairy Manufacturing Scholarship

Dr. Frank and Rachel Kirby Thomas Food Science and Family and Consumer Sciences Scholarship Endowment

Dr. Isadore and Cynthia Peppe Food Bioprocessing and Nutrition Sciences Scholarship Endowment

Dr. Peggy Foegeding Memorial Food Science Scholarship Endowment

Duong, Green and Gharst Food Science Leadership Award Endowment

Food Science Club Endowment

Fred Tarver Poultry Products Scholarship Endowment

Harvey L. and Kathleen R. Barnes Scholarship Endowment

Hase H. and Lena M. Smith Scholarship Endowment

H. Hawkins Bradley Scholarship Endowment

Ivan D. and Lillian T. Jones Food Science Scholarship Endowment

J. Frank & Margaret B. Neely Scholarship Endowment

James L. and Diana G. Oblinger Scholarship Endowment

John Rushing Southeastern Food Processors Association Endowed Scholarship

John and Kellie Rushing Food Science Freshman Scholarship

Leonard and Frances Crouch Scholastic Achievement Award Endowment

Mose and Helen Kiser Scholarship Endowment

Neil and Nancy Web Memorial Scholarship Endowment

NC Meat Processors Association Scholarship Endowment in Memory of John Long

Robert N. Wood - NC Dairy Products Association Memorial Scholarship Endowment

T.W. Garner Food Company (Texas Pete) Scholarship Endowment

Victor and Maryetta Jones Scholarship Endowment

Endowments Supporting FBNS Faculty and Programs

Burton M. Newell Food Science Library Endowment

David H. Murdock Distinguished Professorship Endowment

Don Hamann Memorial Lectureship Endowment

Phi Tau Sigma Professional Development Endowment

Russell S. Flowers Teaching and Training Endowment for Food Safety and Quality

Tarheel Supplymen's Endowment for Excellence in Food, Bioprocessing and Nutrition Sciences

Thomas N. Blumer Endowment

W. L. Clevenger Department of Food Science Endowment for Excellence

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