MTSU RESEARCH

Research Teams

Vol. 3 No. 1 Spring 2020

Office of Research and Sponsored Programs

TAKING COUNT

From professors to undergrads, it takes a team to untangle a perplexing grapevine

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TRUE DISCOVERY

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Research does not occur in a vacuum. Research is a building block of knowledge that can span years, decades, and even centuries with myriad people and personalities contributing to the aggregation of knowledge. The image of the lone scientist having a "Eureka!" breakthrough moment was never a truism.

Collaboration occurs between researchers within universities, between universities, and between the private and public sectors and across nations and around the world. This issue of *MTSU Research* highlights the personalities and journeys of people who had the opportunity to participate in a research project, with a team, and from that experience build upon their own career trajectory.

You do not exit a research project the same person that you entered. Research transforms knowledge and the person conducting the research. This is true whether the person is a senior professor, a post-doc researcher, a doctoral student, a master's candidate, or an undergraduate entering a laboratory for the first time. I hope you enjoy witnessing the transformation of each person in a research team project and their journeys in this issue of the magazine and that their passions inspire you on your journey.

True Blue!

David Butler
Vice Provost for Research and
Dean, College of Graduate Studies

MTSU RESEARCH

RESEARCH TEAMS

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Office of Research and Sponsored Programs

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I AM true BLUE
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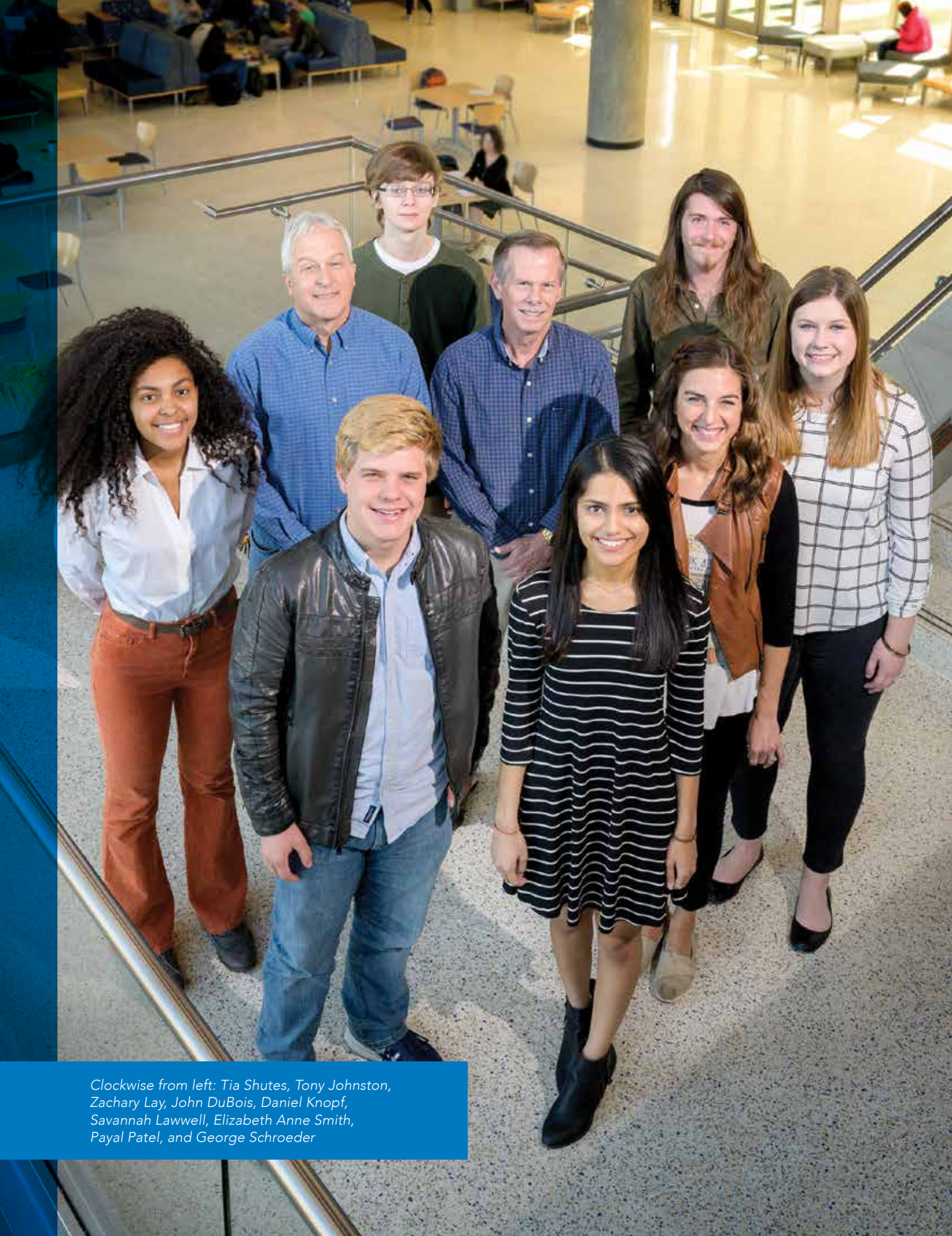

Clockwise from left: Tia Shutes, Tony Johnston, Zachary Lay, John DuBois, Daniel Knopf, Savannah Lawwell, Elizabeth Anne Smith, Payal Patel, and George Schroeder

GRAPE EXPECTATIONS

THE STORY OF A DOGGED RESEARCH TEAM, A CANTANKEROUS PLANT, AND WINE THAT COULD CHANGE THE WORLD

Wine has pervaded human culture for thousands of years, from the Last Supper to the works of Shakespeare to Hannibal Lecter's "nice Chianti." But, despite its global reach, the flow of commercial wines begins in a few distinct regions within two narrow latitudinal bands—one in the Northern Hemisphere, most famously including Tuscany and parts of California, and one in the Southern Hemisphere, encompassing parts of Australia, New Zealand, South Africa, Argentina, and Chile.

The wines most of us recognize, whether or not we drink them, come from one species of grape, which flourishes in the cool nights and warm days specific to those fertile regions.

"The chardonnays, the cabernet sauvignons, the merlots, the pinot noirs, the sauvignon blancs, those are all Vitis vinifera," MTSU Agriculture Professor Tony Johnston said. "The global industry is built on that genus and species—from 95% to 99% of commercial vines. There are just a handful of other species that are commercially grown for wine production around the world."

Zion Market Research projects that the wine industry will reach $423.6 billion in global revenues by the end of 2023. Finding a grape that could flourish outside Vitis vinifera's 20-degree latitudinal range could give whole swaths of the world, many of them quite poor, access to that lucrative market—or at least provide one other means of economic self-sufficiency.

"If another variety of grape can be shown to be viable and produce good-quality product, we can open up the whole equatorial range of the earth to grape production," Johnston said.

In other words, Johnston is not crazy for spending the last 25 years mildly obsessing over Vitis aestivalis, a North American grape commonly known as Norton/Cynthiana.

Photos *Andy Heidt*

NORTON/CYNTHIANA . . . THE OFFICIAL GRAPE OF MISSOURI. BUT LIKE MARK TWAIN AND HARRY TRUMAN, IT'S NOTORIOUSLY SCRAPPY.

Amanda Uhls

Norton/Cynthiana is not on anybody's wine tour. It's the official grape of Missouri. But like Mark Twain and Harry Truman, it's notoriously scrappy. Unlike its delicate cousin in Napa Valley, it shrugs off little things like drought, humidity, diseases, and pests.

Grown primarily in the Mid-Atlantic and Midwest U.S., Norton/Cynthiana is traditionally used for table grapes, juices, jams, and jellies. It makes for delicious wine too, Johnston said. He first worked with it in the mid-1990s as a research assistant at the University of Arkansas, and he believes it has "enormous economic potential"—if it can be propagated.

In the words of a certain Shakespearean prince (and almost certainly a wine drinker), "Ay, there's the rub."

FRUSTRATION BY THE BUCKET

Amanda Uhls is not an expert at propagating Norton/Cynthiana. But having spent an entire fall, winter, and spring trying unsuccessfully to get the darn thing to root, she can tell you a thing or two about not propagating it.

Twice a month from September 2015 through August 2016, Uhls, an Honors Biology student from Kingston, Tennessee, grabbed a 5-gallon bucket and drove to the Rutherford County Agricultural Extension property west of I-24, about 20 minutes from campus. From there she'd take a dirt road to a small plot where Johnston had arranged to plant 200 Norton/Cynthiana vines donated to him by an east Tennessee farmer who'd bought too many. When the dirt road got too muddy to drive on, she had to park her car and make the last part of the trip by foot—a 10- to 15-minute slog.

She'd take maybe 30 cuttings, enough to fill the bucket, haul it back to the car, drive to the greenhouse behind the Science Building, and put the new cuttings in growing medium. Then she'd check all her previous cuttings for roots and record the results.

MTSU Biology Professor John DuBois, a plant physiologist, gave Uhls the project. His goal was to find out when Norton/Cynthiana propagated best.

DuBois had heard horror stories from Johnston about how hard the vine is to propagate in

the traditional manner. Johnston still has vivid memories—or maybe they're flashbacks—of being a doctoral student in Arkansas, trying to root enough cuttings to replace the occasional Norton/Cynthiana vine that failed.

"With every other variety of grapes, we could just take a few cuttings and put them in the greenhouse in the winter, and in the spring go back and plant them, and we'd have plenty of vines," Johnston said. "With this variety, we couldn't take enough cuttings. We literally had greenhouses full of (them) to get a handful of plants in the spring."

After hearing those stories, DuBois had tried to propagate the grape himself because how hard could it be? He took cuttings in March and tried to root them. They died. He got better results from cuttings he took in June, but the majority of those died too. So when he gave Uhls her project in September, he warned her not to get her hopes up, especially before June.

Still, Uhls found it disheartening, making the bi-weekly slog from vineyard to greenhouse and then to DuBois, only to deliver the same one-word report: "Nothing."

"It was very hard, to say the least," she said. "There was one month where I got maybe three or four roots, and it was the biggest deal ever—like, 'I got something!'—and then literally right after that it went right back to zero for the next few months. Every time I would tell Dr. DuBois I had nothing, he'd have to remind me, 'Nothing is still a result.' "

The fact this was Uhls' Honors thesis project at MTSU made everything worse. She was supposed to graduate in December 2016. As the months ticked away with no discernable progress, she started feeling panicky.

"By the end of May, I knew there wasn't enough time to meet with a new advisor to change projects or even do an entire project," she said. "It was kind of scary, wondering whether or not I was going to finish my thesis."

Johnston compares research to that classic definition of war—"long periods of boredom punctuated by sheer terror."

Name: John DuBois
Classification: faculty
From: Cleveland, Ohio
MTSU: 1989-present
Now: Murfreesboro

JOHNSTON COMPARES RESEARCH TO THAT CLASSIC DEFINITION OF WAR—"LONG PERIODS OF BOREDOM PUNCTUATED BY SHEER TERROR."

SURPRISING SUCCESSES

In June, nothing turned to something. Some of the cuttings rooted. Not most of them, but significantly more than zero.

Uhls got enough data to write her thesis and graduate as planned. Apparently undeterred by nine months of research-induced trauma, she accepted a job as a microbiologist at a state of Tennessee public health lab, where she is still happily employed.

DUBOIS GOT ENOUGH DATA TO KNOW THAT HE NEEDED MORE DATA.

DuBois got enough data to know that he needed more data.

He and Johnston agreed that the study was publishable, but not with just one year's worth of numbers.

So DuBois repeated the experiment with another undergraduate Honors thesis student, Nolan Jolley, making the bi-weekly slog—this time from March–October, since DuBois knew the cuttings wouldn't root in winter, the way most grapes do.

Jolley's data supported what DuBois and Johnston suspected: Unlike every other commercially produced grape in the world, Norton/Cynthiana propagates best in June.

"That's not a good time to propagate grapes because they're going to be setting fruits," DuBois noted. "You don't want to be cutting plants at that point."

To summarize: The worst time to propagate Norton/Cynthiana is when it propagates best.

"And even when it's doing well, it's still poor," Johnston offered.

The best propagation rate he and DuBois ever got with their cuttings was 30%, he says. That's compared to 90%–95% for most commercial grape varieties.

THE TWO MTSU STUDENTS ARE LISTED AS FIRST AND SECOND AUTHORS . . . IN THE MARCH 2018 ISSUE OF *FOOD AND NUTRITION SCIENCES.*

So the study was bad news for anyone wanting to propagate Norton/Cynthiana through traditional farming methods.

But it was good news for Uhls and Jolley, whose efforts were ultimately rewarded with a publication. The two MTSU students are listed as first and second authors, followed by DuBois and Johnston, of "The Effect of Sample Date and Timing of Cuttings for Maximum Propagation Efficiency of the Grape, Vitis aestivalis 'Norton/Cynthiana,' " in the March 2018 issue of *Food and Nutrition Sciences.*

Being published before graduate school isn't as rare as it used to be, especially for Biology majors at MTSU, DuBois said. But, as more undergraduates get published, the pressure grows on all undergraduates to have research experience if they want to compete for spots in the workforce or graduate school.

Uhls did a particularly good job as an undergraduate setting herself up to succeed. In addition to working in DuBois' lab, she interned two years in the state lab where she eventually was hired. Upon graduation, the state paid her to work part-time and earn her certification as a medical technologist in microbiology. Now as a full-time employee, she's pursuing her master's degree online in Epidemiology.

While Uhls had already landed a great job by the time her research was published, she says having principal authorship of a publication was an important addition to her résumé.

"MTSU has a lot of students that get published, so we're all fortunate to have gone there and to have research-oriented professors who incorporate their students into their work," she said. "But when you do research, it's a big deal whose name goes first on the paper, because that's who is [considered] most responsible for it. It's still surreal to me that there's a published paper with my name listed first."

A FUNGUS AMONG US

It was a trip Johnston took to Honduras 14 years earlier—a study abroad trip totally unrelated to grapes—that eventually led to Uhls getting top billing on a published paper. A fairly new faculty member at MTSU at that point, Johnston hadn't worked with Norton/Cynthiana in ages, although he still puzzled about the irascible plant from time to time.

He had stopped to check out a small, state-run agricultural school in central Honduras when he saw what appeared to be grapevines growing in the distance.

"It was like walking down Main Street and seeing an elephant," he said. "Everything was wrong. The latitude, the environment. I didn't even know they had grapes growing in Central America."

Johnston couldn't stop wondering about what he'd seen, and so on a return trip to Honduras, he went back to that school and asked how and why they were growing grapes there. It turns out that a faculty

member had traveled to Italy, gotten cuttings from a vineyard there, brought them back to Honduras, and established a small vineyard. Proceeds from wine sales were helping fund school operations.

Growing grapes where they don't want to grow isn't easy.

Over the course of several years, as Johnston kept up his relationship with the school, he heard stories about their struggle to keep the vineyard going in a tropical climate. The humidity and hot nights were a big problem, and the insects were an even bigger one, controlled only through pesticides.

While the school managed to make it work, Johnston was told the cost of chemicals alone would be prohibitive for the typical Honduran farmer.

Johnston thought about that, then said, "What you guys need is a better grape."

In 2013, Johnston began hand-delivering Norton/Cynthiana cuttings to the school, bringing down a few hundred cuttings at a time in duffle bags. In 2014, with an International Foundation grant aimed at improving the lives of poor people in developing communities, Johnston purchased new trellis posts and other infrastructure for the little vineyard. He also continued hauling grapevine cuttings down to the school—about 1,500–2,000 total.

Only 12 rooted.

Meanwhile, the school had hired a new director, Mario Turcios, a graduate of Zamorano Pan-American Agricultural School, the flagship agricultural institution for Central and South America. Turcios developed an alternative plan, asking Zamorano Assistant Professor Maria Bravo to clone the cuttings instead.

Although not a traditional farming method, using biotechnology to clone a plant is a tried-and-true process: You take a piece of a live plant, surface sterilize it, remove a tiny piece of tissue, and put that tissue in a sterile dish with a growth medium—a special formulation with nutrients and hormones that will direct the tissue to become callus. From the callus—the plant equivalent of stem cells—you grow a plantlet.

Except not with Norton/Cynthiana.

"I visited Maria's lab several times and saw firsthand the overgrown plates she was encountering," Johnston said. "She actually kept some rooted grape plants in her greenhouse to have a supply of tissue to cut from and literally tried until there were no plants left to work with. Mold would overtake the tissue culture plate within 24 hours—fast."

Johnston hadn't grappled with the grape since 1995, but Norton/Cynthiana had found a new way to confound him.

A BIG-PICTURE PROBLEM

When Johnston first worked with Norton/Cynthiana, the grape was simply a puzzle in an Arkansas greenhouse—an interesting agricultural aberration. Nearly 20 years later, it had developed into a biotechnological conundrum in Honduras, with potentially global economic implications.

That's the sort of big-picture problem the U.S. government wants universities to solve. A project spanning disciplines would almost certainly have broader real-world applications, and interdisciplinary research is now far more likely to attract federal grants, which constitute most research funding for large public universities like MTSU, Johnston said.

INTERDISCIPLINARY RESEARCH IS NOW FAR MORE LIKELY TO ATTRACT FEDERAL GRANTS, WHICH CONSTITUTE MOST RESEARCH FUNDING FOR LARGE PUBLIC UNIVERSITIES LIKE MTSU.

"I'm highly encouraged that the federal grant-making agencies have endorsed the idea of collaboration," he said. "I think it reflects the reality of the problems that we're trying to solve."

The trend has been most obvious with major grant-funding organizations within the federal government, such as the National Science Foundation, Food and Drug Administration, and U.S. Department of Agriculture (USDA), he says.

"They now require that you present collaborative proposals, not individual researchers focused on their research," Johnston said. "They want inter-institutional proposals, they want interdisciplinary proposals, so it's become formalized, the recognition that 'I can't answer all the questions myself; I need other experts to come put their heads on this problem.' And I think it's great. It's taken us a while to come around to the idea that more heads are a lot better than one."

In the spirit of that philosophy, when Johnston got back to MTSU from Honduras, he stopped to talk to Shannon Smith, then a new Molecular Biosciences Ph.D. student working in the plant tissue culture lab in MTSU's new Science Building. Johnston knew that Smith, who earned an Agriculture bachelor's degree before moving to Biology for graduate work, was smart.

Johnston told him about Norton/Cynthiana and how the lab in Honduras was trying to get callus out of tissue culture but was getting nothing but mold. Smith offered to give it a shot himself.

"Shannon did the classic new-graduate-student thing," Johnston recalled. "He said, 'Oh, I can solve that problem. Why don't you just give me some cuttings?' And I laughed and laughed, and I said, 'You know what? You're on.' "

Eight weeks later, Johnston got an update from Smith: "Nothing but mold."

"He'd just learned the first lesson of graduate school," Johnston said. "Don't think you can solve problems in the first swing."

DIGGING IN

To be fair, DuBois had the same response when he heard that Norton/Cynthiana was practically impossible to propagate: He had to try it himself to believe it. And even then, he wouldn't take no for an answer. That kind of tenacity is a prerequisite for a career in research, especially when the researcher's hopes are regularly dashed by the whims of nature.

Beyond any one academic lesson, Uhls says that's the most important thing she learned from her research experience at MTSU—especially those long slogs with the 5-gallon bucket, those nine months of "nothing."

"I learned that not everything is going to happen right away," she said. "A lot of my friends who did research projects ended up with so much data that they had to run statistical analyses, and I would think, 'I have one data point that I'm excited about.' It was kind of nice to see a real-world project rather than a lab-created one. It taught me perseverance and patience."

Through such perseverance and patience, what began as a casual conversation among scientists about a hard-to-propagate grape evolved over the course of a few months into a two-pronged interdisciplinary research project.

Smith, whose doctoral and other lab work had nothing to do with Norton/Cynthiana, nevertheless spent much of the first part of 2015 watching mold overrun tissue culture plates. Meanwhile, DuBois was on a parallel track, taking cuttings from Johnston's little vineyard off campus and watching them not root. Like Smith, he had other irons in the fire too.

Thank goodness for undergraduate Honors thesis students.

SLICING THE PIE

DuBois is particular about the undergraduates he invites to work in his research lab. When he teaches freshman Honors biology, he notices the students who show up to class, who raise their hands, who make good grades, who show intellectual curiosity. Those are the students he seeks out for project work. When students he doesn't know seek him out, he gets a scouting report from their professors.

He's looking for other qualities too—like reliability and the ability to work both independently and as part of a team. Biology students in the University Honors College, who've committed to completing a research-based thesis project, tend to have those qualities.

DuBois and his Honors thesis students have a symbiotic relationship. The students need a research project and a mentor; DuBois needs help with the myriad sub-projects emerging from complex research problems like Norton/Cynthiana.

Name: Aimee Wilson
Classification: 2017 MTSU graduate
From: Murfreesboro
MTSU: Now: Murfreesboro

He cuts up those big projects "like a pie," he said. "Every student takes a slice and works on it."

Thanks to a USDA grant, the Norton/Cynthiana project has been divided into about a dozen slices. No two slices have been alike.

For example, while Uhls was in the vineyard and the greenhouse, slogging and fretting, Aimee Wilson was in the tissue culture lab, fighting fungi. DuBois had brought Wilson, another Biology Honors thesis student, onto the project to help Smith, who had his own research to do.

In his solo attempts to clone the grape tissue, Smith had made a critical discovery: Norton/Cynthiana had a fungal endophyte.

Remember that movie where the babysitter finds out that the scary phone calls are coming from inside the house?

The fungus was coming from inside Norton/Cynthiana.

Smith had gotten pictures of it with an electron microscope.

A fungal endophyte isn't necessarily a bad thing, Johnston says. Who knows? It could turn out that some of the qualities that make Norton/Cynthiana so resilient—its tolerance for drought and humidity, its resistance to pests and disease—are attributable to the fungus that naturally lives inside it.

But that's another project.

LESSON LEARNED

Even before she got her slice of grape project pie, Wilson had distinguished herself in DuBois' lab. Like most newbies, she'd spent time under the tutelage of more experienced undergraduates and grad students, learning basic procedures like sterilization and note-taking—as Smith puts it, "the hundred little persnickety things that protect you in your research."

As a lab hand under Smith and graduate student Matthew Fuller, Wilson "stepped up to every challenge we set for her," Smith said. So he wasn't surprised when, given her own project, she stepped up again.

Wilson picked up where he'd left off, trying to get callus tissue without the mold. Except now the job seemed impossible, given that they'd established the mold lived inside, rather than on, the plant—and that the growing medium was 3% sugar.

"You put fungi together with anything containing sugar, and the fungi will go crazy," DuBois said.

The goal was to find a workaround. The idea the team came up with—putting fungicide in the culture medium—flew in the face of basic laboratory protocol.

"There should be no reason to use an antifungal agent if you're using sterile techniques," Johnston said.

But if researchers never challenged orthodoxy, would there be any new discoveries?

DuBois and Smith worked up various procedures for Wilson to try, all involving fungicides. She plugged away at it.

Finally, success: mold-free callus tissue.

"I had a couple of failures at the beginning, but once I got it, I got it," she said. "Sometimes negative results are a good thing, because it tells you what you're doing wrong, so you can change it and try to get better. That's the biggest lesson that I learned from the whole project."

Now, as a first-year medical student at Virginia College of Osteopathic Medicine in South Carolina, Wilson challenges herself to adopt a new mindset when she's faced with a difficult concept.

"I try to change the way I'm looking at it or the way I'm thinking about it and see if that helps a little bit," she said. "I have to step back and think, 'OK, what am I doing wrong?' and then try to fix it and see if that works. That's something I learned through research."

SHARING THE SPOTLIGHT

Wilson, like Uhls and Jolley, got a publication for her efforts. And, because her research wasn't forced into a seasonal timeframe, it was published significantly earlier than theirs—months before Jolley even began his vineyard slog.

"A Protocol for Endophyte-Free Callus Tissue of the Grape Vitis aestivalis 'Norton/Cynthiana' (Vitaceae)" appeared in the October 2016 issue of *Agriculture Science*. Once again, an undergraduate was first on the author list: Wilson, Fuller, Smith, Johnston, DuBois.

That's what tenure and full professorship will get you, DuBois said: the freedom to shine the spotlight on your students.

"Once I was at the top of the ranks and couldn't go any higher, the pressure was off," he said. "I didn't need to promote myself anymore. I'd always focused on my students—maybe 50% on them and 50% on me—but now I could focus on them 100%. The job became so much more fun."

Smith has the same inclination to share the spotlight. Maybe that's because he plans to do research in the private sector, so he'll never have to worry about tenure. Or maybe DuBois has rubbed off on him.

Norton/Cynthiana paper wasn't Smith's first publication, "but it's one of my prouder ones," he said, "simply because I was in a mentorship position with that one. I trained Aimee, and to see her get that accomplished—I'm more proud of that than I am of some of my other publications."

Norton/Cynthiana was Fuller's first publication, although he's now a doctoral student with two more under his belt. But he also deflects to the undergraduates on the grape project.

"They spent hours and hours and hours getting that experiment to work," Fuller said. "Shannon and I were there too, but we had our own experiments, so there was a fair amount of initiative they had to put in, and they did a really fantastic job. We watched them start off as students and end up as scientists."

Name: Rebekkah Riley
Classification: undergraduate
From: Murfreesboro
MTSU: 2016–present
Now: Murfreesboro

The team culture of DuBois' lab stays the same even as the team itself is continually changing.

At the undergraduate level, the student-to-scientist cycle begins anew each year. Smith, who hopes to wrap up his own research project in a year or two, is overseeing a new group of lab hands, as well as new Honors thesis students working on their own slices of grape project pie. Some are trying to learn more about the mold living inside Norton/Cynthiana; others are trying to grow new Norton/Cynthiana plants that don't carry the mold at all.

AT THE UNDERGRADUATE LEVEL, THE STUDENT-TO-SCIENTIST CYCLE BEGINS ANEW EACH YEAR.

As of October, Hannah Hall ('18), a former undergraduate Honors thesis student and now a lab technician for DuBois, had found small roots on some of the callus plates, and current Honors thesis students Rebekkah Riley and Sara Moore have been trying to generate plantlets a different way, using callus from flower tissue.

"Once we get a plantlet from this callus and actually get it to grow, we can watch that plant and see whether it takes up the mold," Johnston said. "Does it survive without the mold if it doesn't take it up? How does it affect the fruit quality or the fruit flavor or the viability of the plant? As a lot of science does, one question leads to a million more."

TIME TO SHINE

Wilson might well be a practicing physician by the time all those new questions are answered. In research, you're playing the long game. But there are wins all along the way.

In 2016, just before Wilson graduated from MTSU, Johnston invited her and DuBois to go back with him to Honduras. He was taking a group of students on an agricultural tour there through the Tennessee Louis Stokes Alliance for Minority Participation (TLSAMP) program, and Zamorano University would be one of their stops. Bravo was interested in seeing the new protocol for getting mold-free callus from Norton/Cynthiana.

When the group arrived at Bravo's lab, Wilson turned to DuBois.

"So, you're going to do this, and I'll assist you?" Wilson asked.

"No," he said, "you're going to do it, and I'll assist you."

Wilson looked surprised, DuBois recalled, but she stepped up.

As Zamorano faculty and students looked on, she demonstrated the procedure with DuBois handing her instruments, "like she was the surgeon and I was the attending nurse," the professor said.

When they walked out of the lab, they were both glowing. DuBois says one of the highlights of his job is watching students mature as scientists. And that's something he's uniquely positioned to do.

DuBois always teaches an early-morning session of freshman-level Honors biology, so often he's the first teacher an Honors College student has at MTSU. Then as an Honors thesis advisor, he ends up working with many of those same students in a research capacity over the next three years and watching them grow.

"I've found it very rewarding to listen to them at their thesis defense, often in their senior year, when they speak with confidence and conviction about their research," he said.

So, for DuBois, watching Wilson present her research procedure was far more gratifying than presenting it himself would have been.

"When Tony told us that he wanted us to do this presentation, I told myself that Aimee was the one who did the work, that this was her project, her thesis," he said. "She knew this stuff, and it would be a good experience for her. So I just thought she needed to take the lead, and I needed to step back and let her shine."

Thanks to DuBois, Johnston, and Norton/Cynthiana, many more MTSU students will get a chance to shine too. MTSU

Savannah Lawwell, Payal Patel, Tia Shutes

Photo *Andy Heidt*

THE CULTURE OF TISSUE CULTURE

WHEN LAB WORK GETS ROUGH, THE LITTLE THINGS MEAN A LOT

One of the greatest pleasures of being part of a research team is celebrating each other's accomplishments and supporting each other through the rough patches. That sense of camaraderie can be a lifesaver for students in the lab, because for all its rewards—personal and professional—research also can be tedious and frustrating.

Payal Patel, a senior Biology major who works with hemp tissue in John DuBois' lab, said its atmosphere of collegiality helps offset the pressures inherent to college life. That's important, because until she began doing research, she didn't realize how time-consuming it would be.

"Working with a team in a research setting makes a huge difference," Patel said. "Not only have I made friends within this lab team, but we all look out for each other. College can be stressful, and sometimes it may seem like you simply don't have enough hours in the day to get work done."

She says everyone on the team, including DuBois, pitches in to help each other out, and DuBois is always available to talk—"whether it's about lab questions or life in general."

Savannah Lawwell, a sophomore Biology major, was "pleasantly surprised" at how welcome she felt when she joined DuBois' research team as a freshman. He taught her intro biology class, and after hearing him discuss his research with hemp tissue, she asked him for a spot in his lab. It's rare for undergraduates to get research experience so early, and DuBois is selective about the students he chooses to work in his lab. But he gave her a spot, pairing her with a more experienced team member, Rachel Bailey.

"I loved working with her," Lawwell said. "She was very patient with me and explained what we were doing every step of the way."

At the end of spring semester, DuBois took the whole team out to lunch, where Lawwell got to know everyone. Now it "honestly feels like a little family," she said.

Kayla Thomas ('18), now a second-year medical student at Meharry Medical College in Nashville, said those team gatherings were a highlight of working in the DuBois lab. Little things like that can soften the blow of big things—like the time all her tissue culture plates got fungus and she had to start over on her undergraduate Honors thesis project.

"Our lab lunches were pretty cool," Thomas said. "After you'd done all the hard work, you'd go out to eat and give updates about your project or get congratulated for defending your thesis or for getting into med school. It was also a chance for us to get together and not talk about tissue culture." MTSU

Name: Savannah Lawwell
Classification: undergraduate
From: Chapel Hill
MTSU: 2018–present
Now: Murfreesboro

Name: Payal Patel
Classification: undergraduate
From: Selmer
MTSU: 2016–2019
Now: Murfreesboro

Name: Tia Shutes
Classification: undergraduate
From:
MTSU:
Now: Murfreesboro

Shannon Smith

THE GO-TO GUY

WHEN YOU'RE A RESEARCH ASSISTANT, SOMETIMES YOU GET TO SLEEP

Name: Shannon Smith
Classification: Ph.D. candidate
From: Florida
Now: Murfreesboro

Photo *Andy Heidt*

For a guy who's seriously into research, Shannon Smith doesn't take himself too seriously.

Asked to explain his doctoral focus (plant biotechnology), he says, "I poke plants to make them do things."

He pauses and then adds, helpfully, "Depending on what they do, we can learn about their genetics, how compounds work, and the like."

Asked what research assistants do, Smith replies, "We're equipment that the university uses and then hangs up at the end of the day on a closet on the third floor."

He laughs.

"They don't put us in closets. We can go home . . . we just don't sometimes."

That last bit isn't far from the truth, according to former MTSU undergraduate Honors thesis students who worked with Smith in the plant tissue culture lab in the Science Building. Over and over, his name came up as the guy who put his shoulder to the wheel when the students hit a tough patch in their research for Biology Professor John DuBois.

Kayla Thomas ('18), the Meharry medical student, remembers Smith and then-master's student Matthew Fuller taking care of her tissue culture plates whenever she had to go home to Memphis.

Xoe Thacker ('18) says she would ask Smith for help with her research project when she got overwhelmed trying to juggle the responsibilities of work and school.

"I had two jobs on top of being in the Honors College," Thacker said. "A lot of times, I had to do as much work as I could on the weekends before I went to my serving job, and Shannon would meet me there at 8 a.m. on a Saturday and help me get my plates done."

Technically, Smith is a research assistant for Biology Professor Elliot Altman. He also has his own doctoral research to conduct in the Molecular Sciences Ph.D. program. But because he works in the tissue culture lab, where most of DuBois' Honors thesis students do their research, he's been instrumental to their projects. And when they get published—as Thacker and Thomas did together in 2018—he's generally a co-author.

A COMFORTABLE PRESENCE

At any given time, DuBois advises as many as eight undergraduates on their Honors thesis projects. He's most involved at the beginning—helping them settle on a research subject and apply for an Undergraduate Research Experiences and Creative Activity (URECA) grant—and at the end, when they're refining and revising their thesis. In the interim, he relies on Smith to do the day-to-day work with the undergraduates in the lab: teaching them basic protocol, demonstrating specific procedures, and putting out (figurative) fires.

Without Smith's hands-on help, DuBois said, there's no way he could advise so many Honors thesis students—plus, students are more comfortable with Smith in the lab setting.

DuBois had suspected that for a while before Thacker confirmed it. He was walking through the lab, stretching his legs as much as anything, when he paused to watch Thacker work.

She looked up at him. "What?"

"Huh?" he said, startled. "I'm not evaluating you. I'm just watching."

"Please leave," she said. "You're making me nervous."

The memory makes DuBois laugh.

"I guess we faculty intimidate students," he said. "I don't know why."

So DuBois and Smith worked out an unofficial arrangement: Smith would manage the lab, and DuBois would handle everything else—writing, ordering supplies, etc.—and of course be on hand when problems came up.

"I only go in the lab when I have to," DuBois said. "Because when students are working with alcohol and flame and tissues and stuff like that, they have to be really careful about what they're doing. So the last thing I want to do is go in there and make them nervous. The students are just more comfortable with Shannon in the lab."

Given the demands of his multiple roles, Smith doesn't have much time to call his own. Then again, it's hard to imagine that this "huge applied plant nerd" would choose to spend his time any other way.

MOUNTAIN ROOTS

You can draw a straight line from Smith's past to his future. He grew up in an unincorporated area in the mountains of east Tennessee, where his front yard was a vegetable garden—before urban gardening was a thing.

"My lawn wasn't grass. It was rows of vegetables: corn, beans, things growing in pots through hydroponics. That's what I came home to when I was a kid," he said. "That made me think plants were cool, because you could use them to get food and other things."

His research interest is using plants for medicine—an ancient application now achieved in the lab. The focus of his doctorate project is ginseng, a plant whose root is prized in Asia for its medicinal qualities. It grows wild in parts of the Appalachians, including Tennessee's Great Smoky Mountains National Park, where poachers dig up the roots for sale to China.

Smith hopes that by cultivating ginseng in the lab, he can find a way to satisfy the voracious demand for the plant, thus mitigating the ecological damage being done to a landscape he loves.

After Smith finishes his doctorate, he plans to go into the private sector to continue his work in plant biotechnology and medicinal plant research.

"Industry is hungry for people who have built up the skill sets and the problem-solving that scientists build up," he said.

Even though he's technically a student, Smith's skill set is impressive. When he discusses turning genes on and off in the lab, altering the chemistry of plant tissue to make it produce new compounds or reproduce, the scientist's power over plants sounds almost godlike. Nevertheless, nature finds a way to get the upper hand.

Smith is hoping to finish his doctorate in a year or two. But that's up to the ginseng, he said. MTSU

BREAK GROUND

MTSU's **Biology M.S.** program emphasizes research and preparation for further graduate study as well as employment with public agencies and private businesses.

This research-based degree requires a **thesis stemming from original research** the student conducts. The research project is planned in collaboration with a faculty member.

Faculty in the department are involved in research projects that are both **field-based** (such as studies on snake migrations, seed germination, and plant mating systems) and **laboratory-based** (including natural projects research, genomics of trout strains, and cell migration studies).

Graduate teaching assistantships are available to high-quality applicants and provide a monthly stipend and tuition waiver.

The department is housed in an innovative, state-of-the-art, **$121 million Science Building** comprising more than 250,000 square feet of classroom, research labs, and study spaces.

Research areas include:

- Behavioral ecology
- Biology education
- Cell biology
- Environmental toxicology
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APPLICATION DEADLINE

for the M.S. programis **March 1** for Fall admission and **Oct. 1** for Spring.

TRUE GROWTH

mtsu.edu/programs/biology-ms

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Reita Nirankari Agarwal

LESSONS FROM THE LAB

DOCTOR APPLIES RESEARCH TECHNIQUES TO PROCESS IMPROVEMENT

Name: Reita Nirankari Agarwal
Classification: Ph.D. candidate
From: Delhi, India
Now: Murfreesboro

Dr. Reita Nirankari Agarwal's biologic specialty is humans, not plants, and it's been nearly 30 years since she was Biology Professor John DuBois's first research assistant, collecting and studying soil samples from cedar glades in middle Tennessee. Yet the experience continues to shape the way Agarwal analyzes and solves problems—skills central to her career in medicine.

An internal medicine physician with master's degrees in Biology, Business Administration, and Applied Clinical Informatics, Agarwal divides her time between the Nashville area, where she is owner/medical director of a primary care practice and an adjunct assistant professor at Vanderbilt University's School of Nursing, and Memphis, where she works at the Veterans Affairs (VA) Medical Center. She has worked at VA hospitals in Nashville and Murfreesboro as well.

At the VA, Agarwal doesn't do traditional scientific research; she focuses on process improvement. But, in doing so, she finds herself emulating DuBois' structured method for planning and implementing a controlled experiment. She says he taught her how to break down a project into its components—fieldwork versus lab work—and then find the relationships between the results.

"I was on the quality management committee at the VA hospital in Murfreesboro for about five years, and I think that same philosophy recalled me to go back and read how you set up a process improvement, how you look at things and plan things," Agarwal said. "The only background I had . . . was my first experience (with DuBois) in planning and implementing something, and collecting info and analyzing it."

Agricultural samples in Dr. DuBois' lab

HANDS-ON HELP

DuBois taught laboratory procedure in an equally structured manner, Agarwal said—an approach she found comforting as a new master's student who hadn't been in a lab since high school. She recalls that whenever he taught her something new, he would stay with her until she could do it confidently on her own.

She leveraged that lab experience, as well as a published paper in which DuBois acknowledged her contributions, to get a more advanced research assistant position at Vanderbilt. Agarwal wasn't there long—she entered medical school in Memphis few months later—but she was there long enough to realize that DuBois' hands-on style was not typical for a principal investigator (PI). In the larger lab at Vanderbilt, there was more separation between research assistant and PI.

"I had a wonderful professor, there too, but over there they showed me once, and I was on my own," she said. "If I struggled, I struggled until I told them, 'Hey, I'm having trouble.' "

While DuBois spent a lot of time training her at the front end, his investment paid off in fewer mistakes, Agarwal said. Besides, she never had the feeling that if she made a mistake, she was "done for."

"He worked side by side with you and taught you—not just as your professor but as your equal," she said.

At the time, she was a fairly recent immigrant from India, still adjusting to an unfamiliar environment, still feeling very much like a "foreigner." But with his down-to-earth demeanor, DuBois made her feel comfortable.

"Of course, it had been two years, but still I was different, and he never made me feel that," she said. "He made me feel like I was one of them. He accepted me the way I was."

That's not a lesson about research, but it's definitely about getting good results. MTSU

Our **Fermentation Science** master's, a concentration in the Professional Science M.S., combines leading-edge, advanced science classes with graduate-level business management courses designed to enhance career success.

- **36 credit hours** total, with a complex, capstone internship instead of a thesis
- Train for advanced work for businesses that employ fermentation to create end products, including the food, chemical, pharmaceutical, and water treatment industries
- Covers applied fermentation of specific types of food as well as the production of probiotics, bioprocessing, sensory evaluation, and food and industrial microbiology

70%+ of M.S. in Professional Science students receive job offers from their internship

Admission requirement: Undergraduate or graduate degree in a relevant field such as agriculture, biology, brewing science, chemistry, food science, or microbiology

MTSU graduates have excelled in professional pursuits such as:

- Biomanufacturing
- Bioprocess engineering
- Brewery operations direction
- Chemical engineering
- Enology
- Ethanol operations
- Fermentation engineering
- Fermentation process development
- Manufacturing science
- Pharmaceutical engineering
- Production of probiotics
- Water treatment

APPLICATION DEADLINES:

March 1, Fall admission

October 1, Spring admission

TRUE RESEARCH

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Fermentation Science

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Tony V. Johnston

FERMENTATION SCIENCE MAKES A SPLASH

BREWING AND WINEMAKING ARE SEXY SUBSETS OF THIS CRITICAL INDUSTRY

Name: Tony V. Johnston
Classification: Professor
From: Louisville, Kentucky
MTSU: 1994–present
Now: Murfreesboro

Photos *Andy Heidt*

Sure, "fermentation" doesn't sound as hip as "brewing and winemaking." But you can't do the last two things without the first thing, which is critical to a variety of industries—some even more important than producing a dark IPA with hints of passion fruit.

That's why, when it was suggested that MTSU start a brewing and winemaking program (which certainly seemed reasonable based on industry data or on the number of beer taps per square mile in downtown Nashville), Agriculture Professor Tony Johnston recommended widening the scope.

Johnston, a fermentation expert, said industries need scientists who understand the metabolic process through which microorganisms change the chemistry of a substance in a desirable way. Our ancestors didn't know about microorganisms, but they knew how to make yogurt, preserves, and sourdough bread. Now that we depend on grocery stores to feed us, we've lost that ancestral knowledge, and the industries that produce fermented foods—including beer and wine—need people who understand the science behind them.

"I suggested that we create a program focused on fermentation, and then we could have the flexibility to use beer and any other fermented food as a vehicle for us to teach the science. Then our students can go work anywhere they want that employs fermentation," Johnston said.

Name: Kayley Stallings
Classification: undergraduate
From: Murfreesboro
MTSU: 2016–present
Now: Murfreesboro

MORE THAN "ALCOHOL CLASS"

Now in its third year, MTSU's Fermentation Science program boasts 29 undergraduate and six graduate students as of the Fall 2019 semester.

Kayley Stallings, a senior majoring in both Biochemistry and Fermentation Science, was among the first students to join the program. She entered MTSU planning to research antibiotics, but with the emerging interest in alternative ways to prevent and treat bacterial infections, she's expanded her focus to include gut biome research, too. This school year she started a new project studying microbial growth in kombucha, the fermented tea that most people hadn't heard of a decade ago but that reached $1.24 million in global sales in 2018.

Stallings was so intrigued by the potential (and the science) of fermentation that she founded the Fermentation Association, which is open to any MTSU student.

"We try and do more hands-on things than you could normally do in class," she said. "Fermentation is an interesting program. It has multiple applications in everyone's everyday life. It's not just an 'alcohol class'—there are many applications beyond the alcoholic realm, such as pharmaceuticals, food production, and water treatment."

That last application is where the new program has already made a splash, Johnston said:

"Last semester, one of the most satisfying things that happened in this program, as far as I'm concerned, is that the city of Murfreesboro water treatment department contacted Biology and Fermentation Science, looking for students to come work in the water treatment plant," he said.

Most people don't know that wastewater is treated by fermentation, he said, adding, "Everybody's septic tank is a big fermentation tank."

MTSU's Fermentation Science program is one of only four in the country, although there are plenty of universities with brewing and winemaking programs. In fact, one university recently scrapped its brewing and winemaking program to launch a Department of Chemistry and Fermentation Sciences.

If their septic tanks weren't working, they knew which way the wind was blowing. MTSU

IMAGINE THE POSSIBILITIES

The **Molecular Biosciences Ph.D.** interdisciplinary program focuses on the study of biological problems at the molecular level using a research-oriented course of study.

Doctoral candidates initially engage in bench research with faculty mentors and later design and conduct independent research.

- Numerous lab opportunities
- Research and teaching assistantships available on a competitive basis
- Can apply up to 16 graduate hours of previous master's level coursework toward 65-hour degree

Admission requirement: Bachelor's, master's, or doctoral degree in biochemistry, biology, chemistry, or a closely related subject

Graduates have accepted post-doctoral fellowships and internships at St. Jude Children's Research Hospital, National Science Foundation, Virginia Tech Center for Drug Discovery, and Procter & Gamble.

Faculty come from the departments of Biology, Chemistry, Mathematical Sciences, and Physics and Astronomy, offering students a truly diverse education. Areas of potential research also include:

- Biochemistry
- Biotechnology
- Cell biology
- Ecology
- Environmental toxicology
- Evolutionary biology
- Immunology
- Microbiology
- Molecular modeling
- Structural biology

APPLICATION DEADLINES:

January 31 to be considered for graduate assistantships for Fall

September 30
Spring admission

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Misty Griffith

A WORKSHOP IN MENTORING

HOW GOOD TEACHING BEGAT MORE GOOD TEACHING

When Biology Professor John DuBois met Misty Griffith ('14), she had been working on her master's thesis project at MTSU for a year and a half already.

"I'd already done most of my literary research and had most of my scientific method planned out, and I had preliminary research results," she said. What she didn't have was an advisor to oversee completion of her project.

Griffith's previous thesis advisor had lost his graduate faculty status, and the other graduate faculty specializing in her research area, microbiology, had full advising loads. So she turned to DuBois, who agreed to take her on despite the fact that he's a plant physiologist, not a microbiologist.

He read her research proposal and talked to her former advisor to get up to speed about her objectives and progress.

"I didn't say, 'We've got to change your whole thesis over to what I'm doing, because she was way past halfway. She only had a couple more experiments to do ... My whole goal here is to work with students and help students as much as I can, and I really felt sorry for her," DuBois said.

With his guidance, Griffith wrapped up her final experiments and then got to work writing, revising, and defending her thesis. The whole process took about a year, far less time than most master's student/advisor collaborations. But the impact of that year still reverberates in Griffith's career today.

"Without exaggeration, Dr. DuBois was the single most valuable mentor of my experience at MTSU," she said.

TEACHING THE TEACHERS

Griffith was teaching biology as an adjunct at Motlow State Community College when she enrolled in the MTSU master's program. She wasn't interested in research; she was happy where she was. But she knew she would never become tenured faculty there with just a bachelor's degree.

Her goal, in essence, was to get more letters behind her name. What she also got along the way was a yearlong workshop in mentoring from DuBois.

Now Griffith is an assistant professor of natural science at Motlow, and right where she wants to be: in the classroom, not the lab. Still, in her day-to-day dealings with students, the question that often pops into her mind is "How would Dr. DuBois handle this situation?"

At MTSU, Griffith watched him strike the perfect balance of motivating his students without micromanaging them. As an advisor for the international honor society Phi Theta Kappa (PTK) at Motlow, she adopted that same approach when she oversees students' literary research:

"I find myself telling the students, 'If you want this, you've got to go out there and get it. I can help you, but you have to do the work on your own.' That's something I always loved about Dr. DuBois' mentorship style," she said. "He had a really nice way of pushing you to your goals but letting you figure out how to get there."

During her career at Motlow, Griffith's own approach to teaching and advising has attracted many accolades, including an International PTK Distinguished Advisor Award, 2019 Motlow Faculty Excellence Award, and 2019 National Institute for Staff and Organizational Development Award for excellence in teaching at a community college. MTSU

Name: Elizabeth Anne Smith
Classification: undergraduate
From: Houston
MTSU: 2017–present
Now: Nashville

THE NONTRADITIONAL RESEARCHER

AT MTSU, PARENTHOOD, SCHOOL, AND RESEARCH ARE A WINNING COMBINATION

Take a quick survey of college students in a science lab, and most will tell you they were STEM kids growing up. Elizabeth Smith was too, but she fought it for years.

"While I was always interested in science, I was intimidated by math," said Smith, a senior Biology student and a lab technician for MTSU Biology Professor John DuBois. "I always felt more naturally confident in reading and writing, which is why I earned a bachelor's degree in English. Now I'm coming back to attempt what I was a bit intimidated to do originally."

Since childhood, Smith dreamed of being a wildlife biologist. But, once she started down a different course, Smith kept going, as people tend to do. After earning her bachelor's degree at Texas A&M University, she stayed to get a master's degree in Education. Smith taught high school English for four years before finally deciding to go back to the college crossroads and start a new path.

Her husband had a new job in Nashville, so she explored her options in the area. She said MTSU offered everything she was looking for: affordability, a reasonable drive time, opportunities for research experience, and great day care around the corner—there were her two young boys to consider. They complicated her decisions about whether and where to go back to college.

"Even though it adds lots of challenges, I sure love my little guys," she said. "I'd love to have another in the future, too."

Photos *Andy Heidt*

THE PARENT TRAP

Smith says being a parent makes her appreciate her research experience at MTSU all the more. Unlike many other students, who have more flexibility and can even travel to get experience if they need to, she's geographically limited by family responsibilities.

"I've really grown to love MTSU because it offers so many opportunities to both commuter students and traditional students," she said. "Above all, I feel like the majority of professors here care about their students, rather than you being just a face. They want to help you find what you're interested in and see you succeed."

Since DuBois is a plant physiologist, Smith hasn't had the chance to work with animals, which is her ultimate goal. But she's confident that the three biology projects she's worked on so far will give her an edge when she applies to graduate school. Smith is also learning about the logistics of research funding, thanks to a large, corporate-financed project she's been working on since spring.

"I've ended up with a better understanding of how research funded through companies works, which I believe will be useful to me in the future, as funding is always a necessity," she said.

While Smith has a tentative career path planned out, she's keeping an open mind. She says she might not even pursue her original dream—she also can see herself teaching biology at a community college.

Besides, she has wildlife at home. MTSU

Shelley Sinha

THE LIFELONG LEARNER

POST-DOCTORAL WORK OCCUPIES RARIFIED SPACE IN THE LAB

Name: Shelley Sinha
Classification: Visiting Researcher
From: Ghaziabad, India
MTSU: 2018–present
Now: Murfreesboro

You can't move halfway around the globe without experiencing a little culture shock. But for Shelley Sinha, having experience in a global culture—the research laboratory—helped ease the transition.

All researchers are lifelong learners, but Sinha exemplifies the expression. In her native India, she earned bachelor's degrees in Botany, Biology, and Chemistry, a master's degree in Botany, and then a Ph.D. in Plant Pathology. Her doctoral focus was fungal endophytes—fungi that inhabit plant tissue. Then she had a baby and put her academic career on hold. But Sinha continued her education, browsing scientific journals online while her daughter napped.

When she moved with her husband to Nashville in 2017, Sinha gave herself a few months to adjust. She then started a different kind of online research.

"I googled the names of colleges nearby and found MTSU. Then I looked up the Biology Department and found Dr. John DuBois and Dr. Tony Johnston. I forwarded them my résumé, and they called me," she said.

Sinha had what they needed: the expertise to help them learn more about the fungal endophyte in the grape Norton/Cynthiana, the focus of a multifaceted collaborative project. They had what she needed: an opportunity to continue her education as a visiting researcher.

Though Sinha is part of the research team, most of her experiments are done solo. Post-doctoral work is a rarified space in the lab. But Sinha feels at home there; science is a universal language. Sometimes, she says, she'll take a break from her own work just to see what the student researchers are doing. She gets great joy from seeing the next wave of lifelong learners. MTSU

Cassandra Mihalko

ONE AND DONE

RESEARCH EXPERIENCE IS GOOD FOR STUDENTS, EVEN IF THEY DON'T DO IT FOREVER

John DuBois has a saying: "Nothing is still a result." He says it to students in his biology lab when their experiment elicits no response. The absence of a response is still telling them something.

The same holds true when students try out research and it doesn't elicit an emotional or intellectual response in them. Research isn't for everyone, DuBois said, and especially for students in STEM fields, it's best to find out early whether it's for them. He teaches Honors freshman biology and encourages his students to start doing research their sophomore year.

He also advises six to eight Honors Biology students at a time, and during their thesis defense he'll routinely ask, "What did you learn about yourself from this experience?"

Every once in a while, he says, the response will be, "I learned I'm not really into research. This isn't what I want to do for the rest of my life."

"That's good news," he tells them. "That's a result. Now, let's go find something you want to do."

BITTERSWEET

Cassandra Mihalko ('18), who graduated from the Honors program with a bachelor's in Biochemistry, got her first hands-on lab experience with DuBois, making media and learning other basics. The work was fun and so were the people.

"I fell in love with it," she said.

So she was excited to begin her own undergraduate thesis project, extracting an anti-inflammatory compound from a plant called King of Bitters. That's when things got real.

"It was very demanding, because it isn't on your own timeline," Mihalko said. "You have to go with what resources you have, get your thesis approved, and write. Working with plant tissue is very, very difficult. It's just a slow process."

The project ground on for a year. (DuBois nicknamed her "the Queen of Bitters.")

Xoe Thacker

"I really thought for a while that I would like to do lab work for a living, and I loved it; but it's not something I could do forever," Mihalko said. "You have to constantly be attentive and very careful. The lab is no place for a clumsy person like me."

Still, she's glad that she stuck with the project, especially now that she's applying to physician assistant programs.

"What I've learned is that grad schools want better writers, and Dr. DuBois really helped me with that," she said. "I remember being in his office, painstakingly reading over my writing, tweaking and fixing and adding. It made me a stronger writer. That was a huge plus for me applying to grad school."

GOOD ODDS

Xoe Thacker ('18) also graduated from the Honors program, with a double major in Biology and Psychology. She got her foot in the door of DuBois' lab by making good grades and "doing whatever I could, wherever I was needed," including a stint in the Science Building greenhouse.

She was interested in plant-based medicine, and DuBois had just received a grant to study hemp, which has medicinal qualities. Soon Thacker had her own hemp project, with DuBois as her advisor.

The project required a year of research, during which Thacker made "lifelong friends" in the lab.

"I learned a lot, and not just about academics," she said. "It's just good to hear other people's perspectives. I learned a lot about politics, about religion, just from being in that lab for so many hours. You start talking about the hard stuff. I really liked working with a team."

Thacker also learned that as much as she enjoyed lab work, she didn't want to do it for a living.

"I know that sounds crazy, because I did my whole thesis in a lab, but that was part of the experience that made me think, 'This is really cool, but maybe just not for me,' " she said.

Right now, Thacker is taking a year to work and consider her next step. She's thinking of going into environmental engineering—"still science-driven, but not sitting in a lab, pipetting stuff every day."

It's not uncommon for Honors thesis students to take a "gap year," and the odds are in their favor, said John R. Vile, dean of University Honors College. Between 75% and 80% of Honors thesis students at MTSU go on to professional or grad school within two years of graduating. MTSU

Photo *Eric Sutton*

BLUE RAIDER BEER GARDEN

The **Blue Raider Beer Garden**, first of its kind in college football, is located at field level in the south end zone of **Johnny "Red" Floyd Stadium**.

Different Steel Barrel craft brews and grilled food are available for purchase, along with free lawn games and tables with umbrellas.

Students in MTSU's **Fermentation Science** program help create small-batch brews that are served exclusively in the beer garden—each ale with a different name themed to the week's opponent.

The Blue Raider Beer Garden also is available on the upper concourse of **Murphy Center** in Section D during **men's and women's basketball games**.

Must be 21 or older with a valid photo ID to enter the Blue Raider Beer Garden

Purchase football and basketball game tickets at
GoBlueRaiders.com/tickets
or 615-898-5261

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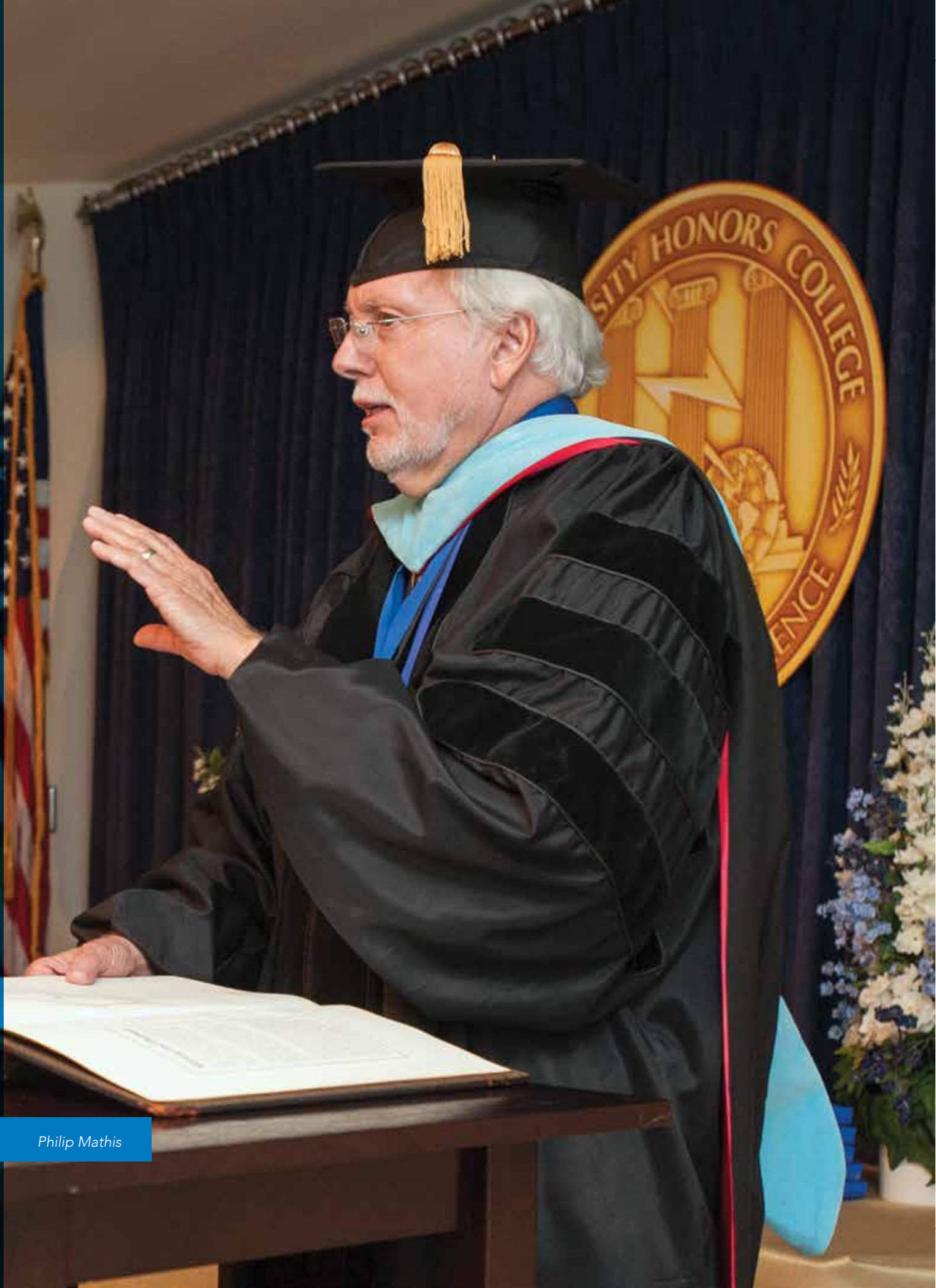


Philip Mathis

THE EVOLUTION OF THE LAB

HOW THE LONE RESEARCHER GAVE WAY TO A VERTICALLY INTEGRATED TEAM

Before he switched over to science in graduate school, Philip Mathis was a History major. He also had a long tenure as a Biology professor at MTSU, where he taught for 42 years and served as Dean of the University Honors College from 2004 until he retired in 2008. So, when Mathis discusses the team approach to academic research, which is especially common in the natural and social sciences, he tends to take the historical view.

The concept of "the lab" as a vertically integrated team working toward a common goal—faculty as principal investigator (PI), mentoring graduate students who in turn mentor undergraduates—is relatively new to science education, he said.

From the 18th century, when science was first taught at college, to the mid-20th century, the laboratory was the domain of the professor. Rather than teaching the tools of research and encouraging students to use those tools to make their own discoveries, the PI would do research solo, reach a conclusion, and then teach the students what was learned.

"Authority had to present [science] to the naïve and interpret it for them," Mathis said. "Students didn't get to play the role of scientist."

THE SOLO SCIENTIST

That was true to some extent even when Mathis was a graduate student—which he was three times. In 1967, he became the first MTSU student to receive a Master of Science degree with a thesis, inspiring the head of the Biology Department to hire him on the spot—and later grant him leaves of absence to get Ph.D. degrees at Vanderbilt University and the University of Georgia.

While pursuing those doctorates, Mathis taught himself how to do scientific research and writing.

"I just acquitted them by assimilation and role model," he said.

Photo *J. Intintoli*

Mathis certainly hadn't learned them as an undergraduate, where his only exposure to the elements of research—data analysis, experimental design, writing and revising a paper—was reading results in scientific journals.

His advisors were experts whom he could turn to for guidance; otherwise he operated alone. He and his advisors never worked together on a project, his or theirs.

CREATING NEW KNOWLEDGE

The evolution of research, where "the lab" has become synonymous with a research team of faculty and students, benefits everyone involved, Mathis said.

Undergraduates and graduate students find science more exciting when they are active participants in their education, not simply confirming someone else's scientific findings, but exploring and advancing science themselves.

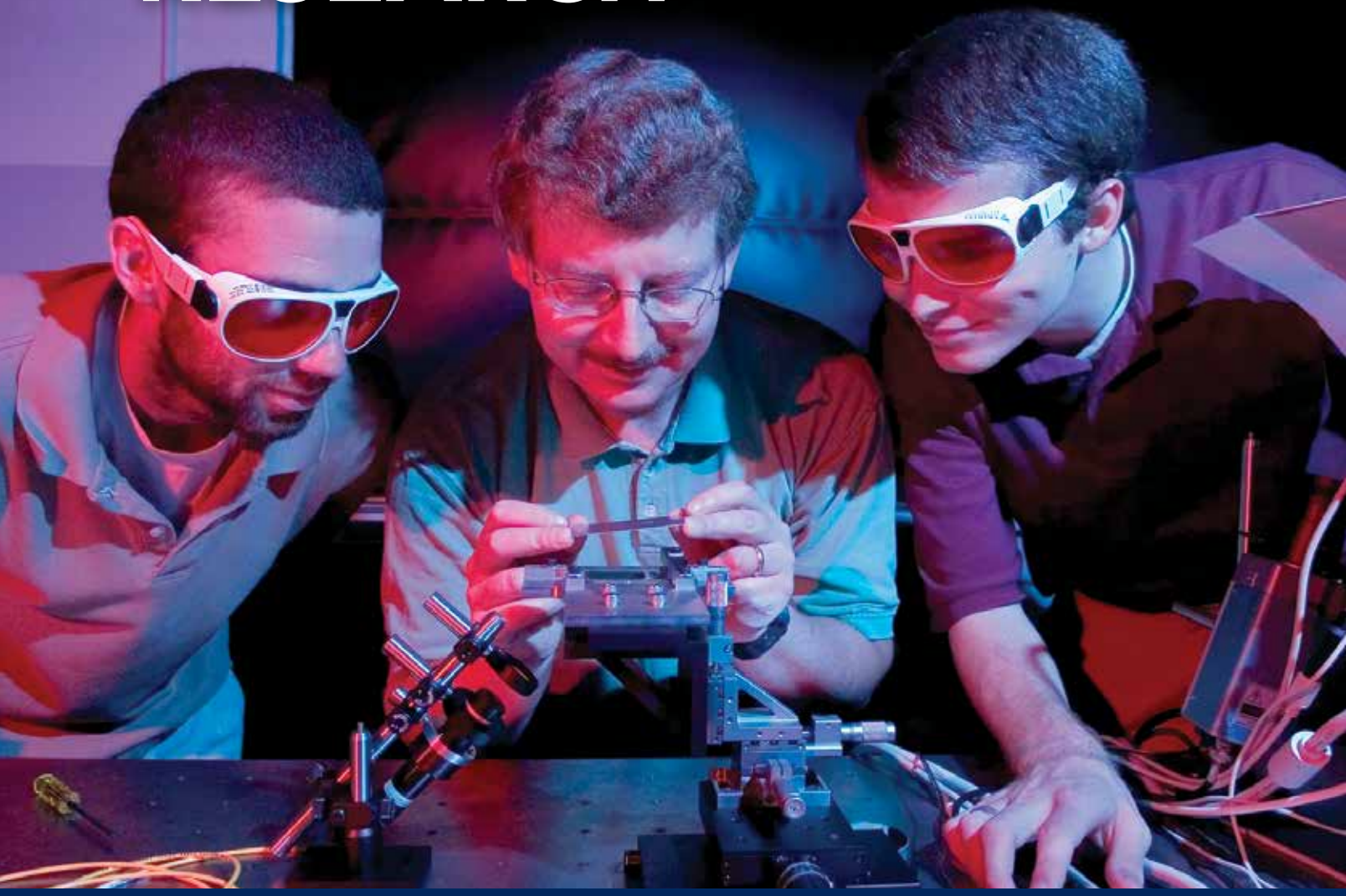
"It creates a foment of intellectual curiosity that's not quite there when everything is received as a second-hand conclusion," Mathis said. And, when students are more engaged in discovery and analysis, their enthusiasm is contagious, he adds. "There's nothing that stimulates a professor more than knowing the students are interested in the project that they're researching and have a stake in the game."

At MTSU, the evolution of the lab (or wherever the team does its work) has been catalyzed by the evolution of the University itself, from a teaching institution to a research institution.

"Major research universities, which MTSU is bordering on now, are as concerned with the development and creation of new knowledge as with dispensing current knowledge," Mathis said. "You've got the internet, textbooks, lectures, and so on; there are many ways to find out what's already known. But science education would be much duller if all we did was state what other people have found out and never tried our own hand in it."

After all, he says, good scientific research begins with a question. MTSU

UNDERGRADUATE RESEARCH



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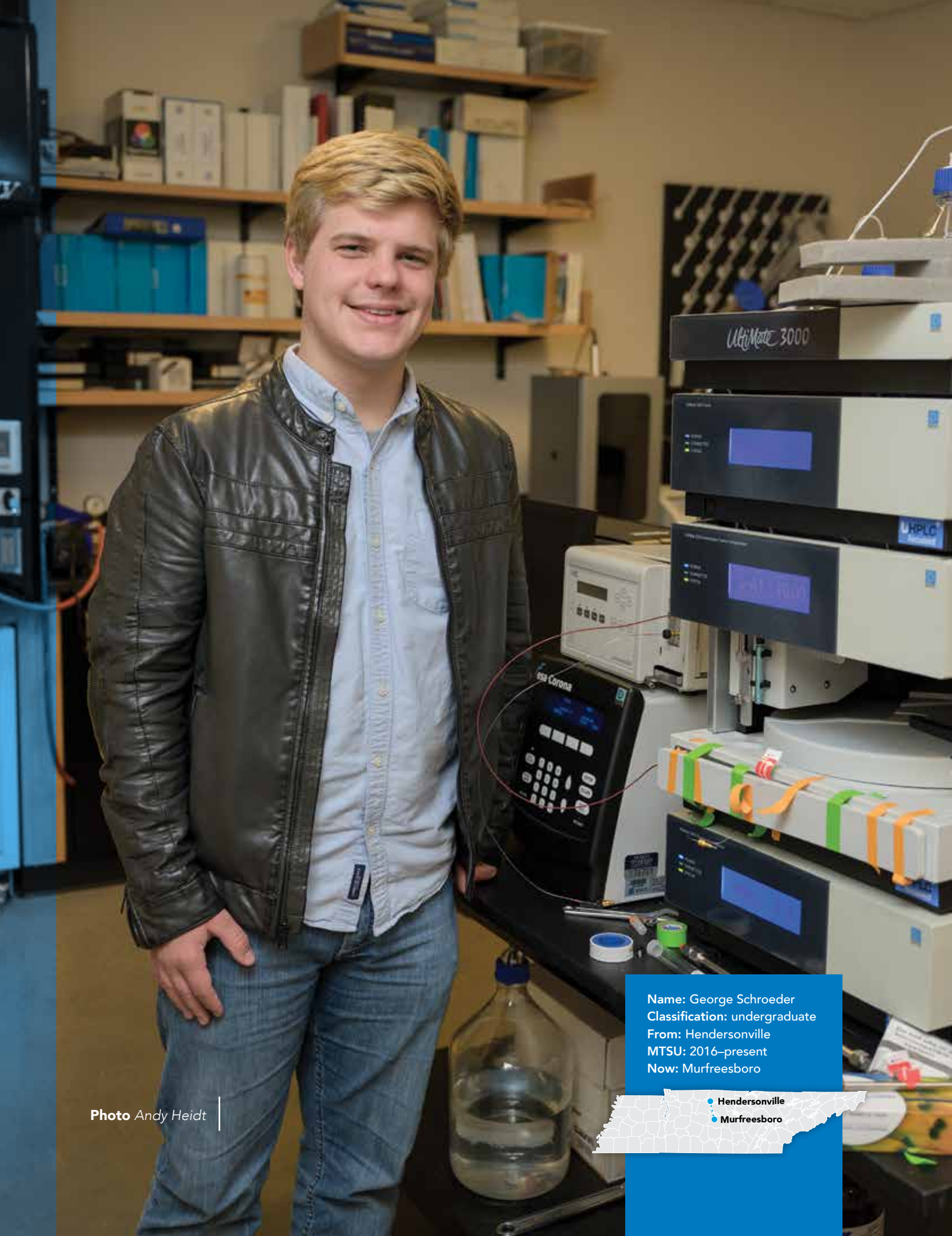


Photo *Andy Heidt*

Name: George Schroeder
Classification: undergraduate
From: Hendersonville
MTSU: 2016–present
Now: Murfreesboro

JOLLY GOOD FELLOW

RESEARCH GIVES STUDENTS AN EDGE— A WINNING ATTITUDE GIVES THEM STAYING POWER

The MTSU Honors program, particularly its research-based thesis requirement, is designed to give its graduates a competitive edge—and the numbers seem to back that up. John Vile, dean of the University Honors College, says 75%–80% of Honors graduates end up in professional or grad school within two years.

"Still, I can't necessarily say that Honors was what made the difference in them going forward, although it seems to help for sure," he said.

In other words, it takes a go-getter to sign up for something hard and stick with it for four years.

So if the Honors College is full of go-getters, what sort of student is selected to be a Buchanan Fellow—one of the 20 incoming freshmen a year who receive full tuition and fees, a book allowance, and money for study abroad through the Honors program? Last year, 360 freshmen applied for those 20 spots.

George Schroeder makes a pretty good prototype. A senior Biology major set to graduate in Spring 2020, he has qualities that, beyond book smarts, are a recipe for long-term success: flexibility, tenacity, and boundless intellectual curiosity.

It's not unusual for a boy to want to be a pro football player. A kid can dream, right? But for Schroeder, who loved sports, that dream was "grossly unrealistic." Congenital health issues, including a heart defect, meant he had to recalibrate.

"So in middle school I poured myself into music and academics," he said.

His left and right brains were still arguing when Schroeder came to MTSU. Medicine or music? Ultimately his left brain won out. His sophomore year, after six months of research, he set his sights on going to graduate school to become a physician assistant, a highly competitive field.

Besides looking good on a résumé, Schroeder's Buchanan scholarship put him on a path to getting in the lab as early as possible. He'll have completed several research projects by the time he graduates.

"I'm very grateful to have received such an amazing scholarship, and I'm glad that it pushed me into getting research experience," he said.

EMBRACING EACH CHALLENGE

Schroeder works in Professor Paul Kline's chemistry lab, isolating active compounds from ginseng root for Biology Professor John DuBois. He'll use some of the work for his Honors thesis; the rest will be included in a separate, published paper that Schroeder will co-author.

Learning how to run a project has been a major benefit of that research experience, he said: "It's forced me to be intentional about solving my own problems or finding the right person to help me with them."

Recently he took on a second research project, working in the microbiology lab under Professor Mary Farone.

With every project and every new lab, there are new things to learn, not the least of which is how to use powerful analytic instruments, Schroeder says. But he has embraced each challenge that comes.

"I've also run into more problems in the lab than I can keep track of, but that's really all part of the experience," he said. "I don't know anyone whose research went smoothly, without an issue."

Patience, and good humor—Schroeder has those qualities, too. We suspect they'll serve him well, both in the lab now and as a physician assistant later. MTSU

The Paul W. Martin, Sr. Honors Building

A COMPETITIVE EDGE

MTSU GIVES UNDERGRADUATES VARIOUS WAYS TO GET RESEARCH EXPERIENCE—A KEY TO GETTING AHEAD IN COLLEGE AND BEYOND

Research experience is one of the best ways for undergraduates to distinguish themselves as they compete for prestigious scholarships, enter the workforce, or apply to graduate or professional programs. For that reason, MTSU encourages early exposure to scientific or scholarly research and provides a variety of opportunities through the University Honors College, Undergraduate Research Experience and Creative Activities (URECA) grant program, and Undergraduate Research Center.

HONORS COLLEGE REQUIREMENTS

To graduate from MTSU's University Honors College, students must:

- Maintain a minimum 3.25 GPA
- Complete at least 29 semester hours in Honors coursework
- Complete an Honors thesis project

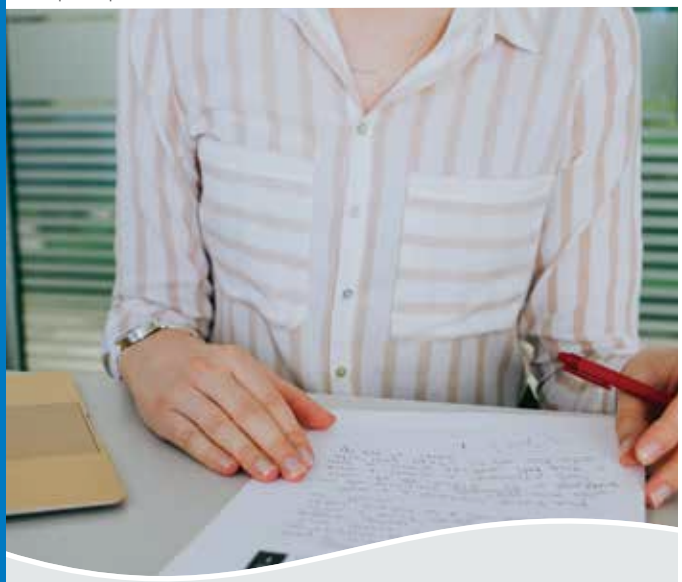
UNIVERSITY HONORS COLLEGE

As the value of undergraduate research has grown, MTSU Honors College Dean John R. Vile has made it a priority for Honors students. While Honors courses have inherit benefits, such as smaller class size, students get far more out of the Honors experience when they complete all the program requirements, particularly the thesis project, Vile says.

Since Vile became dean in 2008, the average number of Honors theses produced per year at MTSU has grown from 15 to 85—essentially all the students who graduate from the program. Those students come from a wide variety of academic disciplines, but they tend to have one thing in common: success after graduation. And they attribute much of that success to research they did as Honors students.

"Our people who go to graduate school almost uniformly report back that the thesis was one of the most valuable projects that they did, so we're committed to it," Vile said. "While there's always a written component to the thesis, we've also been flexible enough that if someone is in mass media or music or art, if there's something creative they can do, we certainly allow them to do it."

Photo *J. Intintoli*



THE WRITE STUFF

One of the happy side effects of undergraduate research is that it hones students' writing skills, which employers and advanced degree programs value.

Biology Professor John DuBois, who advises six to eight Honors thesis students at any given time, said he spends much of his one-on-one time guiding them through the writing and revision process.

"Not only do I edit what they write, but we get together and talk about why I'm editing it that way, so they get the foundations of how we do things in science," he said.

Applying for an Undergraduate Research Experience and Creative Activity (URECA) grant at MTSU, something DuBois encourages all his Honors thesis students to do, is another way to hone those skills, he says. Even if they don't win a grant, the competitive application process teaches the mechanics of writing a grant proposal for research funding.

URECA recipient Kaitlyn Berry, a senior Psychology major, said her research experience taught her that "grant and article writing is a majority of what the process is. Where 30% of your time may be devoted to experiments, the other 70% will be solely toward writing."

About half of incoming Honors students receive a scholarship specific to the Honors College.

Every year through the Buchanan Fellowship program, 20 freshman Honors students receive full tuition and fees, a book allowance, and money for study abroad. In return, the recipients must commit to completing the Honors program, including a thesis. Last year there were 360 applicants for those 20 spots, Vile said.

A similar but newer program, now funding 30 spots per year, was developed for students transferring into the Honors program for their last two years, usually from community college. "We don't give them quite as much, but it's about double what they would get if they just got a regular scholarship," Vile said.

Although most universities offer an Honors track for undergraduates, MTSU's program has more rigorous standards than many others, Vile said. As a result, it attracts higher-caliber students who are more likely to stick with the program.

"Maybe the number of classes they take at comparable programs is 18 hours instead of 29, or in some cases they don't have a thesis or creative project as a requirement for graduation," he said. "For better or for worse, that weeds people out."

URECA GRANTS

Biology Professor John DuBois has noticed a disparity among the undergraduate Honors thesis students he advises: Some can afford to do research, and some can't.

"A lot of students have jobs while they go to college, so they're off waiting tables or working at a store, and they can't be here on campus doing lab work," he said. "The nice thing about URECA is it basically pays students to do their research."

DuBois routinely encourages his Honors thesis students to apply for an URECA grant, which can range from $500 to $3,500. (All nine of the Honors thesis students who have worked for him researching the Norton/Cynthiana grape, one of his ongoing projects, received URECA grants.)

"This project changed my expectations of professional research quite a bit. Completing my senior thesis [in high school] was a wonderful opportunity, but I didn't have to go through any Institutional Review Board screening, grant writing, and proposal process. This URECA project was a crash course in research, and I'm very grateful for it."

—**Mark Blackmon**, junior, Social Work, URECA recipient, from Murfreesboro

Roughly $135,000 in URECA grants are awarded annually, said Jamie Burriss of MTSU's Office of Research and Sponsored Programs (ORSP), which manages the program. A longstanding faculty committee reviews and rates the proposals and awards grants based on available funding.

Students can apply for a URECA grant every fall, spring, and summer semester. They must have a project proposal and a faculty mentor. Burriss notes that professors like DuBois, who metes out parts of his own research projects to Honors thesis undergraduates and encourages them to apply for the grant, puts students ahead of the game. But applicants can also come to the ORSP for help finding a research project (which doesn't have to be in their major) and a suitable mentor.

Besides opening up research opportunities to more undergraduates, URECA also gives them valuable experience in applying for research funding, DuBois says.

"They've got to fill out the form, write their narrative, justify their supplies, and create a small budget," he said. "So they go through the competitive grant process, and I tell them, 'Once you get one, you can put that on your résumé. You've gotten a research grant.' "

The URECA program is getting more applications every semester, Burriss said. From the 2017–18 to 2018–19 academic years, the number jumped from 102 to 162, an increase of 60%. From Fall 2018 through Summer 2019, her office funded a total of 80 individual and four summer team awards.

As the program has grown, Burriss has improved follow-up to ensure that grant recipients complete their projects. She also has created more ways for them to leverage their research experience, including several annual events where they can present their projects to faculty and peers.

As a result of the research and presentation experience URECA provides, "we're seeing a huge gain in students going to grad school," Burriss said. "They've also built relationships with their mentors, so they have somebody in their court when it comes to applying to some of the most prestigious institutions."

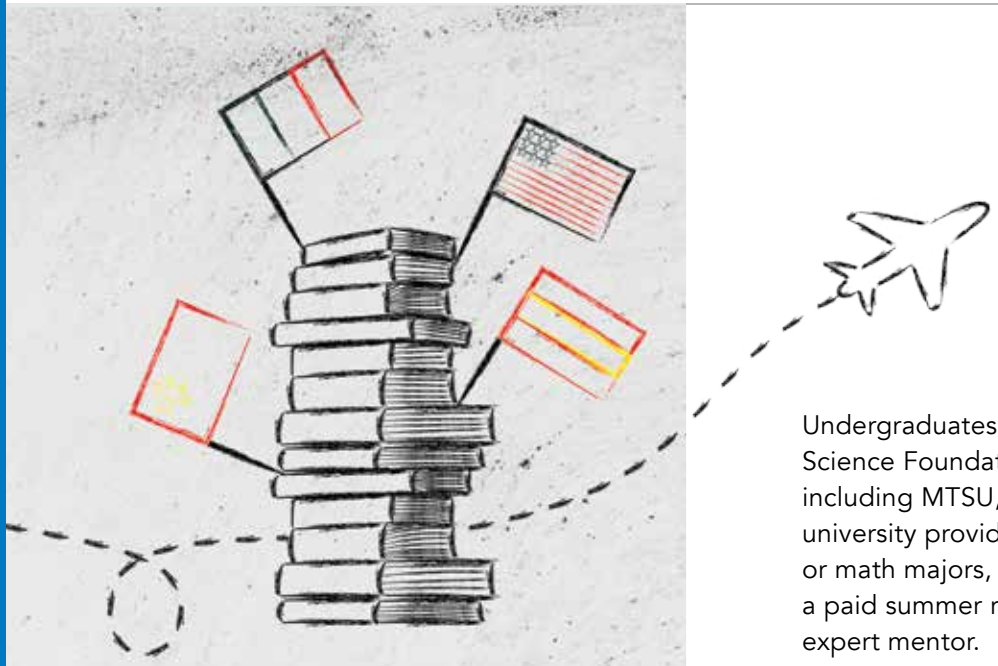
EXTERNAL SCHOLARSHIPS

The relationship between student research and external scholarships that fund student research has become "a chicken-and-egg thing," Vile said. In order to get a prestigious award, such as a Fulbright or Goldwater scholarship, it's increasingly necessary to have research experience.

That's another reason MTSU encourages and provides opportunities for undergraduate research, he said. The University has learned what competitive scholarship programs are looking for—with research experience near the top of the list—and more MTSU students are winning these awards as a result.

Since 2008, MTSU students have won 18 Fulbright Awards to teach or study abroad, six science students have won Goldwater Scholarships, eight received Goldwater honorable mention commendations, and there have been finalists for Rhodes and Marshall scholarships.

Additionally, in the same time period, 18 students have been selected for Research Experience for



PERKS FOR TRAVELING STUDENTS

To encourage study abroad and other research-related travel by undergraduates, MTSU tries to defray some of the out-of-pocket expenses involved. For example, students invited to present their research at a conference can apply to the Undergraduate Research Center to receive up to $400 to put toward national travel or $500 for international travel, Honors College Dean John R. Vile says.

The Honors College also will cover the cost of a U.S. passport for its students' school-related travel.

"That might not seem particularly important, but I think it has an impact," Vile said. "It's a lot easier to think about going abroad if you have a passport than if you don't. It's sort of like the old poll tax—it's just a buck, but if you don't have it or you're not prepared for it, it's a bigger obstacle than it might seem."

Undergraduates (REUs), sponsored by the National Science Foundation. About 125–150 universities, including MTSU, host REU programs. Each host university provides 10–12 science, engineering, or math majors, primarily from other institutions, a paid summer research opportunity with an expert mentor.

Noting that REUs pay $5,000–$7,000 for 10–12 weeks of work, Vile said, "If I could have done that in college, you can bet your boots I wouldn't have been out in the hot sun every summer selling books door to door."

As the Honors College has increased resources for its Undergraduate Fellowships Office, which connects students to external research funding opportunities, there's also been a steady increase in the number of MTSU students who receive scholarships, Vile says.

Vile further recommends that students consider study abroad—not just for its own sake, but because it can provide research opportunities that, in turn, make students more competitive for grants or scholarships later. If they don't know a second language, they also can gain a competitive edge by learning one through MTSU's Center for Accelerated Language Acquisition, which is housed in the Honors College.

GETTING AN EARLY START

Vile suggests that freshmen and sophomores do volunteer work for a faculty member now to be more competitive for research opportunities later—even if volunteering means tending plants or sterilizing lab instruments.

Xoe Thacker ('18) initially approached DuBois about volunteering because she'd seen his name on some interesting research posters in

the Science Building. Her first assignment was working in the Science Building greenhouse, but then DuBois put her on the team for his Norton/Cynthiana grape research project. The research she did for him became her thesis project and also was published as part of a larger paper.

Another of DuBois' Honors thesis students, Aimee Wilson ('16), began volunteering in the lab after her freshman year—"just to get my hands dirty." Like Thacker, Wilson also ended up with a thesis project whose findings led to a professional publication. She then was invited to go on a grant-funded trip to Honduras to present a lab procedure that she helped develop.

"I feel as if having published, having studied abroad, and having such a long research experience under my belt really strengthened my application" to medical school, said Wilson, now a student at Virginia College of Osteopathic Medicine in Spartanburg, South Carolina.

Getting early experience in research can change the trajectory of an academic career—by opening the door to new, funded research opportunities and by allowing a student to try life in the lab before jumping in with both feet.

"It's one thing for somebody to explain how to do something—and another thing to actually go out there and do it," Vile said.

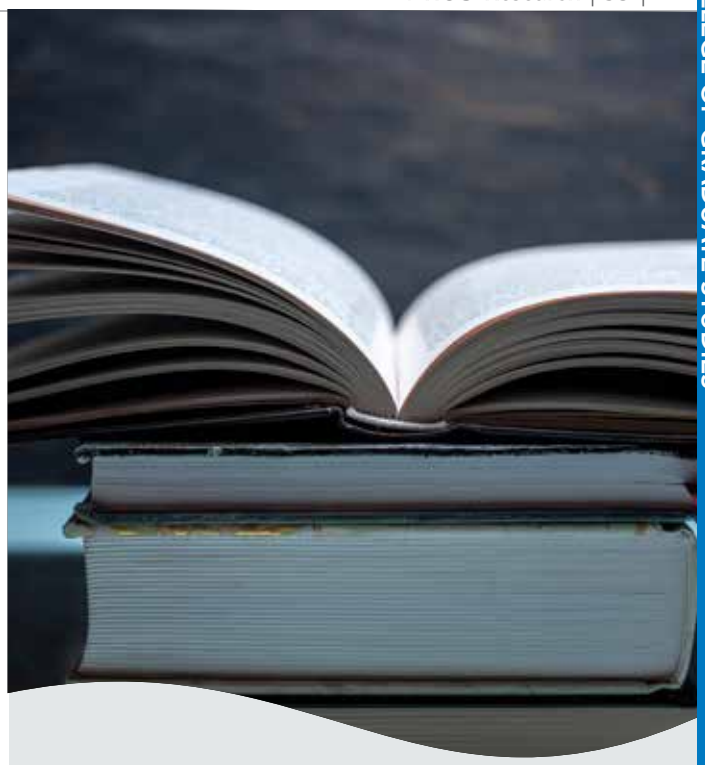
Matthew Fuller, like Wilson, started college aiming to go on to medical school. But when he started working in a lab to support that goal, he realized he didn't want to leave.

"I was fascinated by the research side of things," he said.

Now a Molecular Biosciences Ph.D. student, Fuller is two years into his research and expects to put in another three to four years before entering the biotechnology industry, perhaps in diagnostics.

"I'd like to take what I've learned and apply it to real-world problems and actually make a living with that," he said.

Wherever research leads a student, the student will be better off for having done it. MTSU



GETTING PUBLISHED

Whether they're trying to land a good job, a spot in graduate school, or a competitive grant or scholarship, undergraduates with published research have a big advantage.

Being published as an undergraduate isn't typical, but it's more common than it used to be, particularly in Biology, MTSU Professor John DuBois said. In that department, student research is typically published as part of a larger, faculty-led team project, with team members as co-authors.

While external publication of an entire undergraduate Honors thesis is rare, MTSU students from a wide variety of academic disciplines may submit a thesis or other written research for consideration to *Scientia et Humanitas*, a peer-reviewed journal sponsored by the Honors College. *Collage* offers a similar platform for student literature and fine art.

Jolene Gordon, Specialist-Research and Sponsored Programs,
Jamie Burriss, Program Manager Sponsored Programs,
Samantha Cantrell, Specialist-Research and Sponsored Programs

SHOW ME THE MONEY

NOBODY LOVES GRANT WRITING, BUT RESEARCH WON'T GO FAR WITHOUT FUNDS TO BACK IT UP

Nobody is driven to academic research by a passion for grant writing. Nevertheless, finding external funding for research projects is big part of a university faculty member's job.

MTSU's Office of Research and Sponsored Programs (ORSP) maintains the pipeline through which research funding flows. It helps faculty members find and apply for grants and hone their grant writing skills.

While the ORSP routinely handles regulatory and legal details that are part of any external funding contract, staff also can help faculty with other related bureaucratic tasks, said Samantha Cantrell, a pre-award/proposal development specialist.

"The administrative burden of external funding is getting heavier and heavier," she said. "We're trying to carry that burden so faculty members are freed up—so their time is mostly spent not on filling out the paperwork to buy a test tube, but on actually putting something in the test tube and testing it."

Here, Cantrell, her ORSP colleagues Jamie Burriss and Jolene Gordon, and Biology Professor John DuBois share their insights on this important but largely invisible component of academic research.

1. EFFECTIVE GRANT WRITING IS EVERYTHING.

It's not unusual for a new faculty member never to have written a grant proposal before, said Burriss, program manager. The ORSP provides services and resources to fill in that experience gap, such as grant writing workshops and one-on-one help with proposal development.

To give real-world experience in competitive grant application, the ORSP administers an internal awards program for junior faculty members. The program accepts proposals in the fall and allots grants of up to $10,000 per proposal. The winning proposals are selected based on their merit and quality, especially their potential for securing external funding, Burriss says.

Photo *Darby Campbell*

"It's a comprehensive application that aims to mimic the national application [process] so that when it comes time to seek external funding, faculty are prepared," she said.

Applicants whose proposals aren't selected receive feedback so that they can rework and resubmit them in the spring. The program awarded four grants in Fall 2018 and another 12 in Spring 2019.

2. FINDING THE RIGHT FUNDING "FIT" IS CRITICAL TOO.

Part of the art of getting a grant is evaluating both the grant solicitation and the funding agency to determine whether the opportunity matches what the researcher has in mind.

For purposes of transparency, federal grant programs publish abstracts of their previously funded research. Gordon, a pre-award/proposal development specialist in the ORSP, suggests that potential grant applicants browse through those abstracts to get an idea of the goals behind the program.

"While you don't want to emulate what other people have done, it can give you a good idea of whether that program is a good fit for what you'd like to do," she said.

3. MOST UNIVERSITY RESEARCH IS GOVERNMENT FUNDED.

For an institution like MTSU—a large, academically diverse public university without a medical school or law school—federal agencies like the National Science Foundation, U.S. Department of Agriculture, and National Endowment for the Humanities offer the most funding opportunities.

While presidential or congressional mandates can dictate the types of projects that get funded, "it can take a while for [a mandate] to trickle down," Cantrell said. That can cause a lag effect when an initiative changes directions under a new administration—like when George W. Bush's No Child Left Behind educational initiative became Barack Obama's Race to the Top.

4. "BIG-PICTURE" RESEARCH GETS THE BUCKS.

In the humanities as well as the natural and social sciences, the days of doing research in a silo are fading fast, Cantrell said. Research proposals have the best shot at getting grant funding if they seek to solve a big-picture problem rather than simply advancing knowledge in one narrow field. An environmental research project could be enhanced by including historical, economic, and political perspectives, for example.

"What I've learned about proposal writing over the years is that the impact of the research project is stressed: Inevitably, this is all going to help people at some point. So even if you're in the lab doing chemistry or you're looking at some cells under a microscope, there needs to be a broader impact," Cantrell said.

5. GETTING RESEARCH FUNDING IS LIKE GETTING CREDIT.

In other words, you need some of it to get more of it.

"By having an active research program, securing funding seems a bit easier," DuBois said. "Outside funding sources seem more willing to give you research money if they know you have a strong, successful research program in place."

6. MTSU'S TEACHING FOCUS ATTRACTS SPECIAL GRANTS.

MTSU has been increasing its research focus and infrastructure for years, and it's steadily attracting more research funding as a result. But the University's growing profile as a research institution has not diminished its commitment to education—a reflection of its roots as a teaching school. That makes MTSU particularly competitive for grants intended to improve or enhance student learning experiences such as the R15 Academic Research Enhancement Awards from the National Institutes of Health, which are designed to give undergraduates research experience, Gordon said.

7. INDUSTRY-FUNDED RESEARCH IS A DIFFERENT GAME.

Government agencies and large nonprofits solicit research project proposals through a standardized public process. Private businesses generally don't. Instead, they come up with a project and approach a researcher who is qualified to take it on.

That means getting a corporate-funded research project often boils down to who you know, DuBois said.

A corporate project he shares with Biology Professor Mary Farone, testing a plant disinfectant for Nashville-based Aseptic Health, came to him through their departmental colleague Elliot Altman, a consultant for the company.

Aseptic Health had originally asked Altman to do the research, but he declined and referred them to DuBois and Farone.

"We have to be careful of the appearance of conflict of interest, especially if they want to test something," DuBois explained. "With independent testing, you don't want to have your own people or one of your consultants doing the testing."

The corporate project turned out to be a paid opportunity for two of DuBois' senior Biology students too, as he wrote their lab technician positions into the contract.

8. RESEARCH CENTERS FOSTER COLLABORATION–AND FUNDING.

The establishment of 17 research centers and institutes at MTSU has generated more interdisciplinary projects and, therefore, more potential to attract funding. For example, the Tennessee Center for Botanical Medicine Research, which includes faculty from Biology and Chemistry, enables DuBois to send his students to Paul Kline's chemistry lab to isolate and analyze plant compounds. That collaboration has facilitated DuBois' research into medicinal plants such as ginseng and hemp, which are the focus of a lucrative 10-year study funded by Murfreesboro-based Greenway Herbal Products. MTSU

Photo *Andy Heidt*

IF YOU BUILD IT . . .

SCIENCE BUILDING HAS OPENED THE DOOR TO NEW STUDENTS AND NEW RESEARCH

When MTSU built its 250,000-square-foot, $121 million Science Building, the University was sending a powerful message about its commitment to scientific teaching and research. That message has been received—not just by faculty, but also by prospective science students who visit the state-of-the-art facility during campus tours, said Biology Professor John DuBois.

Before the long-overdue building opened in 2014, "the biggest thing that held us back—us being the Biology and Chemistry departments—was facilities," DuBois said. Those departments were housed in the Davis Science Building, where all the laboratories were dedicated to teaching. Any research projects had to be packed up or moved when class was in session.

"To get funding, you had to have dedicated research space," DuBois said.

Since the new Science Building was constructed, the number of grants and other funding won by the Chemistry and Biology faculty has gone up, he says—and as a result, the number of students coming to MTSU to do science research has

Photo *Andy Heidt*

increased too. The Biology Department is now the top producer of undergraduate Honors theses at MTSU, DuBois says.

"I've got eight Honors thesis students right now, and four are writing and defending them this fall. There's no way I would have been able to do that in the old building. I would have maybe one or two, and that was it," he said.

Raj Ghosh, now a post-doctoral associate at the University of Missouri Metabolomics Center, was a Ph.D. student at MTSU working closely with Chemistry and Biology faculty, including DuBois, when the Science Building opened.

"Having worked at a few other places, I can say that MTSU is growing in stature as a research institution," Ghosh said. "The University is still transitioning from primarily a teaching institution to a research institution. The new Science Building has definitely changed the culture of research at MTSU." MTSU

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