



SCIENCE ALLIANCE

2020/21 Annual Report

THEC State Appropriations Request 2021-2022

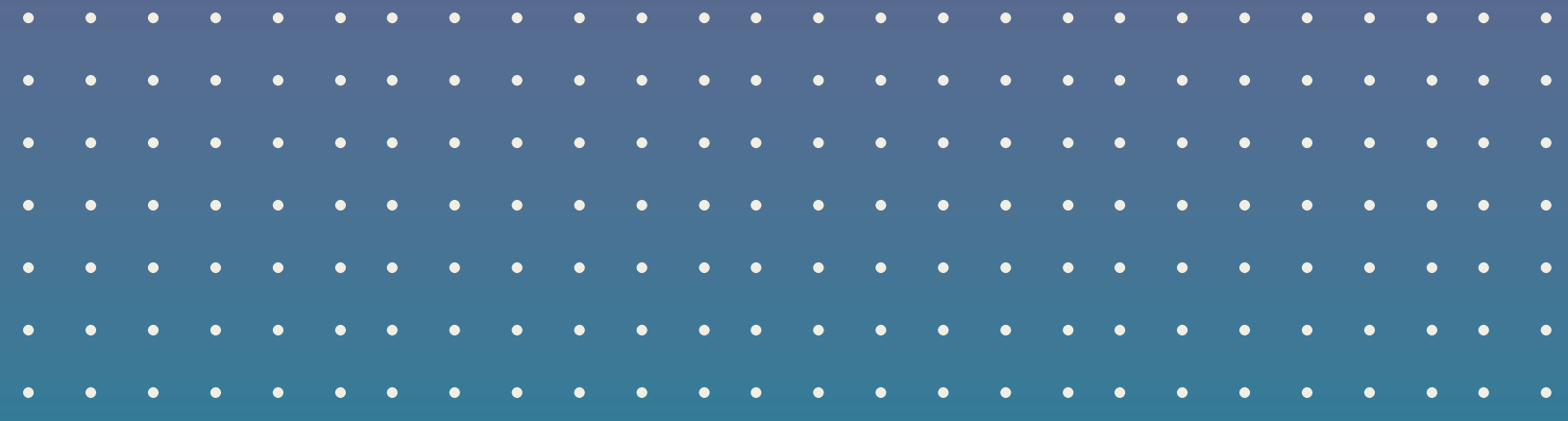


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Executive Summary

As the longest continually operating organization facilitating collaborations between the University of Tennessee, Knoxville, and Oak Ridge National Laboratory (ORNL), the Science Alliance continues to build momentum. In the last two years, despite delays due to COVID-19, our researchers have generated meaningful outcomes in materials science, machine learning, and artificial intelligence.

The last year saw the Science Alliance not only maintain existing commitments to faculty and students but expand them to further enhance the greater research enterprise. In addition to continued opportunities via the Support for Affiliated Research Teams (StART) program, the Science Alliance pivoted the Joint Directed Research Development (JDRD) and released a call with a rapid response COVID-19 focus. This provided near-immediate access to funding for UT researchers to leverage their expertise against a global issue as it was taking place.

The Science Alliance prioritizes relationships with faculty and many of our programs are intended to begin building those relationships at the beginning of a faculty member’s career at UT. Science Alliance funds provide opportunities to develop proof of concept for new ideas that can then expand into novel research paths.

However, the Science Alliance also values relationships with long-term faculty members who have worked to develop lengthy, robust collaborations with ORNL partners. To provide continuing support to these collaborations, this year the Science Alliance launched the Partnership and Collaborative Teams (PACT) program.

Additionally, building on the momentum of the previous year, in 2021 the Science Alliance, in conjunction with the University of Tennessee–Oak Ridge Innovation Institute (UT-ORII), expanded the Student Mentoring and Research Training (SMaRT) program. A total of 19 students from universities across the country converged on UT’s campus over the summer to engage in cutting edge research, supported by graduate students and high-performing faculty mentors.

The Science Alliance’s student support strategy continued to provide extensive graduate student support via direct funding to departments across campus, and individual student awards through the Graduate Advancement, Training, and Education (GATE) program. These two programs alone represent a greater than \$1.6 million investment in the future of research in Tennessee and beyond.

As the university returned to in-person classes and lab work, the Science Alliance worked hard to provide supported faculty and students with compassion and flexibility. Due to the ceaseless efforts of our research teams, faculty, and staff, the university’s research enterprise has continued to build and grow in the face of continued challenges.

This report illustrates the resilience and commitment of a community devoted to the exploration of big and important ideas. Within these pages are success stories, budding collaborations, and academic achievement in the face of adversity. Science Alliance awards continue to invest in the university and its people, building a competitive future for the state of Tennessee.



Shawn Campagna
Faculty Fellow for Research Development
Interim Director of Strategic Programs for UT-ORII

Science Alliance Overview

The Science Alliance is a Tennessee Center of Excellence, established in 1984, and supported annually by the Tennessee General Assembly.

The mission of the Science Alliance is to:

- Hire and support joint distinguished scientists of national note
- Create and support joint institutes
- Share resources
- Bring the University of Tennessee and Oak Ridge National Laboratory together to support technology transfer
- Build areas of common strength
- Provide incentives to attract and retain the highest quality faculty and students
- Strengthen educational opportunities
- Grow government and industrial support of the shared research enterprise.

Science Alliance funding is one critical way that the partnership between UT and ORNL is further advanced. Funds support a variety of significant investments in people and collaborations.

Much of our current collaborative research emphasizes strategic areas of importance to both organizations. Advanced manufacturing, advanced materials and materials science, neutron science, computational science, big data and data science, and bioinformatics are currently among the most prominent UT-ORNL collaborative areas receiving support.

The investment made by the state each year in this important collaboration is greatly appreciated and is instrumental in allowing the Science Alliance to provide a variety of opportunities for innovative and groundbreaking collaborations between people. Great science and discovery come when people-to-people interactions are optimized, not unlike a chemical reaction. A reaction progresses because of interactions, and these funds support those interactions. They hold a decisive role in leveraging the federal investments made at ORNL and UT in our areas of collaborative research and development.



MISSION

The Science Alliance was established in 1984 to improve selected science programs at the University of Tennessee, Knoxville, and to increase collaboration between the university and Oak Ridge National Laboratory (ORNL).

The Science Alliance is composed of four divisions, the original three being **Biological Sciences**, **Chemical Sciences**, and **Physical Sciences**. A fourth division, **Mathematics and Computer Science**, was added in 1986.

Science Alliance Objectives

- Create a strong formal bond between UT and ORNL
- Hire joint UT-ORNL distinguished scientists
- Create joint UT-ORNL institutions
- Share resources and build areas of common strength at UT and ORNL as well as with industry and other institutions
- Contribute to technology transfer
- Provide incentives to attract and retain high-quality faculty
- Strengthen graduate and undergraduate opportunities
- Increase public and professional awareness of UT-ORNL partnerships

Goals and Future Plans

Since its inception, the Science Alliance has been tasked with creating opportunities for meaningful collaborations between the University of Tennessee, Knoxville, and Oak Ridge National Laboratory (ORNL).

The Science Alliance has worked to achieve this goal through the creation of programmatic opportunities for faculty, students, and research scientists alike for over three decades. In the last two years, a new strategic plan was implemented to continue and expand upon these efforts. In addition to the existing Joint Directed Research Development (JDRD) program, a number of new programs were implemented to further enhance the relationship between the university and ORNL.

The Support for Affiliated Research Teams (StART) program, launched in FY20, provides faculty members with up to two years to explore first and new collaborations with ORNL researchers. Awarded projects are required to produce an external proposal including both ORNL and UT participation in order to be eligible for second year funding. The Science Alliance plans to continue supporting StART projects with semi-annual solicitations that provide more frequent opportunities for funding to faculty members.

This last fiscal year also saw the expansion of the Student Mentoring and Research Training Education (SMaRT) program. The Science Alliance worked in conjunction with Oak Ridge Associated University (ORAU) and UT-ORII to recruit a cohort of exemplary undergraduate students from across the country for summer 2021. Students were housed on campus for a 10-week research experience, in which they engaged in research and received professional development opportunities. The program culminated in a research symposium at which students delivered formal presentations and posters to an audience of their peers, faculty members, and administrators.

In addition to support provided to students via the SMaRT program, the Graduate Advancement, Training and Education (GATE) program continued to provide funding to graduate students conducting meritorious, collaborative research through the 2020-2021 academic year. The next cohort was selected at the end of that academic year and began receiving funding in fiscal year 2022. The GATE program operates concurrently with the historical funding Science Alliance provides to many departments across campus for graduate student support, providing an expanded footprint in the development of future research professionals.



As the early stages of the strategic plan have proceeded successfully, the Science Alliance was able to move forward with additional faculty development opportunities. Toward the end of the fiscal year, the Science Alliance launched a program designed to develop research communities that will foster greater interactions between UT and ORNL, and lead to increased meritorious research. The Partnership and Collaborative Teams (PACT) program will fund joint activities such as seminar series, poster sessions, and novel pilot projects for up to three years.

Moving forward, the Science Alliance plans to implement a new Faculty Fellowship program. While the StART program is aimed at nurturing new collaborations between faculty and ORNL researchers, many faculty members at the university have long-term, robust relationships with ORNL scientists. In an effort to support these ongoing collaborations, this program is designed to reward faculty by providing some of the benefits that are enjoyed by distinguished scientists through up to five fellowships.

In order to ensure the Science Alliance continues to provide opportunities and support in line with faculty needs, in FY21 the first Science Alliance Advisory Board convened. The advisory board has worked, and will continue to work, to maintain open communication between the Science Alliance, faculty members, and ORNL staff; as well as serve as a reviewing body for new and ongoing commitments.

Over the next year, the Science Alliance will continue to provide support to faculty members and students engaging in meaningful collaborations with ORNL. Programmatic offerings will continue to reward high-performing faculty and develop research communities capable of pursuing large external awards and build upon the elements of the strategic plan already in place. The Science Alliance will continue to integrate synergistically with the efforts of the University of Tennessee-Oak Ridge Innovation Institute (UT-ORII), including the UT-ORII Seed program to develop multidisciplinary research, further supporting innovation and expanding opportunities for engagement in the local research community.

These initiatives will translate into global scientific and economic impacts, intellectual capacity development and a prepared future workforce for Tennessee. Partnerships with and under the umbrella of UT-ORII will aid the university and ORNL in the development and acquisition of talented scientists and engineers, as well as continuing to provide consistent graduate student support in arenas of global interest.



Distinguished Scientists

The Science Alliance Distinguished Scientist Program supports high-profile joint leadership in research areas where UT and ORNL share complementary strengths. It has been the anchor program of the Science Alliance since 1984.

Distinguished Scientists hold tenured professorship at UT; most also hold a Distinguished Scientist appointment at ORNL, nominally half time at each institution. Appointments include an ongoing discretionary research fund equal to 12 months’ salary.



Elbio Dagotto

Elbio Dagotto, a Distinguished Scientist in UT’s Department of Physics and Astronomy and ORNL’s Division of Materials Science and Technology, primarily uses computational techniques to study transition metal oxides, oxide interfaces, and the recently discovered iron-based high-temperature superconductors. These materials and others studied by his group show promise for both technological applications and advancing fundamental concepts in condensed matter physics.

In addition to mentoring graduate students, Dagotto’s group includes six postdoctoral fellows; Ling-Fang Lin, Yang Zhang, Nitin Kaushal, Pontus Laurell, Narayan Mohanta, and Bradraj Pandey.

Dagotto is the principal investigator (PI) of a multimillion dollar grant from the Department of Energy (DOE) Office of Science, Basic Energy Sciences, Materials Sciences and Engineering Division. After substantial effort, this grant was successfully renewed for an additional three years, beginning October 1, 2021.



Takeshi Egami

Takeshi Egami, a Distinguished Professor in UT’s Department of Material Sciences and Engineering, explores new science involving liquids and gases. His work involves computer simulation (including quantum mechanical calculations) and neutron and synchrotron X-ray scattering experiments.

Egami was recently named an Aris Phillips Lecturer, the most prestigious award given by the Department of Mechanical Engineering at Yale University. He serves as editor of *Advances in Physics*, a position he has held since 2011.

In the last year, Egami’s contract from DOE, Basic Energy Sciences was renewed for an additional three years. Egami’s team, which includes graduate students Zengquan Wang, Yadukrishna Sarathchandran, Leo Zela, and Rudra Bahadur Bista, demonstrated the feasibility of a new technique to study atomic dynamics in liquid. Additionally, the research group used neutron scattering to solve the long-term mystery of the relaxation mechanism in water that makes microwave ovens work. Egami’s research group also includes Jaeyun Moon, postdoctoral fellow, Research Associate Professor Wojciech Dmowski, and Research Assistant Professor Chae Woo Ryu.



External Funding

PRINCIPLE INVESTIGATOR	PROJECT TITLE	FY 21 EXPENDITURES
DAGOTTO	Study of multi-orbital Hubbard models for iron-based superconductors and spin-orbit coupled transition metal oxides using the Density Matrix Renormalization Group technique	\$50,990
EGAMI	Fluid Interface Reactions, Structures and Transport (FIRST): Energy Frontier Research Center	-\$14,355
EGAMI	DMREF: Collaborative Research: Fundamentals of short-range order-assisted alloy design: Thermodynamics, kinetics, mechanics	\$34,886
EGAMI	Atomistic Study of Bulk Metallic Glasses	\$47,502
EGAMI	Fluid Interface Reactions, Structures and Transport (FIRST): Energy Frontier Research Center	\$16,329



Joint Directed Research Development

The Joint Directed Research Development (JDRD) program is one of the Science Alliance’s longest running initiatives. Historically the program provided funding opportunities for university faculty members working collaboratively with ORNL scientists supported by the Laboratory Directed Research Development (LDRD) program.

In 2019, the JDRD program was reformulated to take a narrowed approach, focusing on a list of research areas that facilitate the strategic goals of both the university and the lab. To ensure eligibility for as many faculty members are possible, in light of the narrowed topic areas, the LDRD requirement was removed to allow collaborations with any relevant ORNL researcher.

In April 2020 and in response to the global pandemic, the Science Alliance released a call for the JDRD Rapid Response COVID-19 Focus program. The program provided an expanded focus, offering support for projects related to the investigation of COVID-19 in any relevant discipline. Existing JDRD awardees were given the opportunity to apply for second year funding for their existing work based on the original parameters of the 2019 JDRD program.

JDRD awards continue to run for up to two calendar years. A progressive assessment at the end of year one determines if second year funding will be awarded, based on partnership development and research progress.





Anahita Khojandi

Sepsis is a body’s extreme reaction to an infection. This life-threatening condition typically occurs as a result of a pre-existing infection and has a mortality rate of around 40 percent. Survivability often depends on early identification and timely treatment of the condition. Anahita Khojandi, associate professor of industrial and systems engineering, seeks to improve sepsis outcomes by improving methods of early detection by combining Bayesian frameworks and machine learning to develop a holistic means of peeking into the future of potential sepsis patients.

“It’s actually one of the major causes of death in hospitals. It’s important to detect sepsis early,” said Khojandi. “For every minute a patient is in a non-sepsis state, there is a probability they will end up in sepsis. It’s a very small probability, especially when you’re looking at one minute, but then think about that over two or three hours. It’s compounded.”

Khojandi believes the incorporation of a dynamic Bayesian framework will help account for ongoing changes in patients’ bodies, allowing for a decrease in misdiagnoses. Additionally, over the course of her work, Khojandi’s team identified a gap in the literature regarding bias in machine-learning decision-making and has extended their methodology to look more directly at mitigating that bias. Thus far, her project has had success with modeling, and has generated publications and two external NSF proposals.

Michela Taufer



Neural networks—computational systems conceptually modeled after the human brain—are an increasingly effective tool in modern data analysis. One challenge facing scientists using neural networks is the nature of their data. Different types of data require the use of different neural networks. Dongarra Professor of High-Performance Computing Michela Taufer hopes her JDRD project will make identifying the correct neural networks easier.

“The challenge is that different sciences have different data representation, and different experiments within a scientific domain have different types of data,” said Taufer. “One neural network that identifies specific patterns may work well for one data set, but if you change or expand the data set, the neural network may fail.”

Taufer’s JDRD team has been working on developing a framework for identifying the best neural networks for analyzing particular data sets, decreasing the amount of time a scientist has to spend looking for the best tool to use with their data. Her work thus far has been presented at the 12th Joint Laboratory on Extreme Scale Computing workshop and the first Robust Science Café. Additionally, one paper has been published and another is in preparation for submission.



Dustin Gilbert

Contact with contaminated surfaces is one of the most common ways for illness to spread. A person carrying a pathogen touches something, like a doorknob, then another person touches that object and they can be infected by that pathogen. In between these contacts, the pathogen has to survive on the object, and in a large enough quantity to infect another person. Dustin Gilbert, assistant professor of materials science and engineering, wants to make it impossible, or at least unlikely, for pathogens to survive on a surface.

“If you come into contact with a surface containing pathogens, you could get sick from it, so it’s important to have surfaces that are inhospitable environments for pathogens so they just die quickly rather than being picked up and infecting another person,” said Gilbert.

Most commonly used surfaces are not good at killing pathogens. Pathogens on stainless steel, for example, can take up to five days to die on the surface; on cloth surfaces the timeframe is closer to weeks. However, there are a variety of metals that do a great job killing pathogens. Historically, colloidal silver and brass have both been used for their anti-pathogenic properties. Gilbert’s team wants to leverage the naturally occurring anti-pathogenic properties of these metals to create a more thoroughly inhospitable surface.

“Our idea was to take several of these bioactive metals and put them together into an alloy so effective that whatever pathogen lands on the surface will be attacked by multiple modes of action thanks to the properties of the individual metals,” said Gilbert. “Our goal is to protect against a broader spectrum of pathogens and kill them faster.”

Traditionally, testing these alloys would be a lengthy, laborious process in which each composition is fabricated one piece at a time and tested individually. To overcome this issue Gilbert leveraged his experience in nanotechnology to develop a nanoscale film, enabling him to test thousands of compositions in a single sample.

His team collaborated with Thomas Denes, assistant professor in the Department of Food Science at the University of Tennessee Institute of Agriculture (UTIA), and Anne Murray, a postdoc in Ecology and Environmental Biology, to conduct pathogen testing on the various alloy compositions. Once complete, the team came together to develop an understanding of the ways in which materials science and biology can work together to address pathogens. The results have been promising and the teams have a joint publication in progress.

Gilbert has also worked with his ORNL collaborators, Ying Yang and Easo George in the Alloy Behavior and Design Group, to develop a better understanding of high entropy alloys like those used in his project. Next, he wants to determine which of the alloys that most effectively kill pathogens can be manufactured in bulk. Additionally, Gilbert is generating a proposal for NSF based on the preliminary findings from this work.





Heidi Goodrich-Blair

Since humans began settling into agrarian communities, communicable diseases have been a threat to human health. Part of what makes infectious diseases so dangerous is their ability to evolve and mutate, which can have a variety of effects from easier transmission to more deadly symptoms. The question of how to curtail this evolution has important implications for human health, and is one that Heidi Goodrich-Blair, David and Sandra White Professor and Head of Microbiology, is investigating with her JDRD project.

Outbreaks of infectious diseases have been recorded for thousands of years in communities across the globe, including the black death, the 1918 influenza, and more. On average, infectious diseases collectively kill more than 17 million people per year.

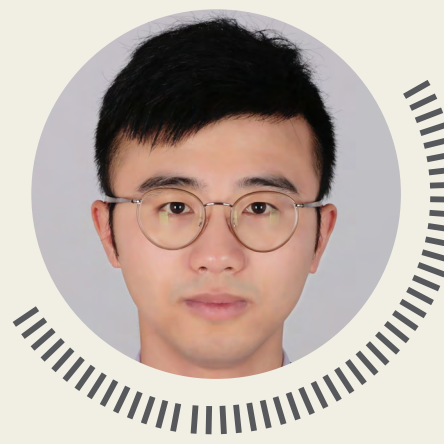
“Microbial infectious disease is a serious public health issue for the world,” said Goodrich-Blair. “One of the most serious aspects of it is that not only are we getting new emerging infectious diseases, but the ones that we are already familiar with and have been effectively controlling using antibiotics are now becoming resistant to the arsenal of antibiotics we have available to us.”

Goodrich-Blair is looking for ways to control infectious diseases while sidestepping the rise in antimicrobial resistance. Her JDRD work focuses on using tailocins from bacteriophages. A bacteriophage is a virus that attacks a bacterium by infecting it with the bacteriophage’s DNA. This often results in the destruction of the bacteria, but because of the presence of DNA the process could potentially cause the bacteria to evolve. A tailocin is essentially the part of the bacteriophage used to infect a target bacterium, without the attenuating DNA information.

“Tailocins aren’t going to replicate, they don’t have any nucleic acid material associated with them. They are simply a syringe mechanism. Bacteriophages send these tailocins out and they stick to the outside of a bacterial target cell, then they punch a hole in the cell which then causes it to break down,” said Goodrich-Blair.

While tailocins may be a useful tool for disrupting disease cells without causing them to mutate, the process is not without difficulties. In order for a tailocin to be effective, it must be the right tailocin for the particular bacteria it is targeting. Goodrich-Blair’s team is investigating the molecules that determine specificity in an attempt to develop a set of molecular tools to help researchers more successfully target bacteria.

“The more you know about that specificity, the more you would be able to tailor and design tailocins that would be able to target a specific range of bacteria,” said Goodrich-Blair.



Shuai Li

The role buildings play in spreading disease has been at least suspected since a 1974 study determined a recirculating ventilation system spread measles from one sick student into 14 different classrooms of children. With the arrival of COVID-19 in early 2020, renewed attention has been given to how buildings could accelerate, or potentially inhibit, the spread of illness. Shuai Li, assistant professor in the Department of Civil and Environmental Engineering, is pursuing these questions with his JDRD project.

“There is an urgent need to understand and prevent pathogen transmission within rooms and buildings,” said Li. “In my project, we’re trying to understand what factors are most important both from a building operation and design perspective, and from the human activity perspective.”

Built environments, or buildings, are especially relevant to the spread of disease. The average person spends approximately 90% of their time in built environments, including homes, office buildings, schools, and stores. Not only can these spaces be crowded, but in the case of public buildings, hundreds of people can move through them in the course of a single day, many of whom could be carrying pathogens. In a 2019 study, approximately 90 percent of surveyed adults admitted to knowingly going to work while sick.

According to Li, there are three primary paths of disease transmission: close contact, touching an object someone sick has touched, and airborne contact. While all of these may occur in a built environment, contact with contaminated objects or surfaces and airborne transmission are two areas in which building design and operation interventions could help mitigate the spread of illness.

“We want to know how we can adjust a building’s ventilation or how we can adjust the design and layout of a building to reduce the potential area of contamination,” said Li. Li’s co-PI on this project, Professor of Civil and Environmental Engineering Qiang He, is tasked with collecting and analyzing air and surface samples from a built environment to establish the distribution and characteristics of pathogens in that environment. Li will then use machine learning to establish connections between the attributes of the building and the dynamics of the pathogens found there.

His team is working with both Chris Schadt and Melissa Cregger in the Biosciences Division at ORNL, leveraging their virus modeling capabilities to allow for more accurate assessments of the built environment and the risk of transmission.

Li’s JDRD project grew out of an existing collaboration with He, who Li met when he began his career at UT in 2017. Together they have submitted two proposals to NSF and are investigating future joint funding opportunities with Schadt and Cregger.

“Ultimately, we want to develop the knowledge, technology, and tools to combat illness and promote environmental health and hygiene. Environmental health, particularly in the built environment, leads to better human health,” said Li.



Support for Affiliated Research Teams

The Support for Affiliated Research Teams (StART) program provides funding for up to two years to faculty members exploring first and new collaborations with ORNL researchers. Funded proposals are eligible for second year funding following a performance-based evaluation, including the preparation of an external proposal.

StART is the first Science Alliance program to offer two semi-annual deadlines, in an effort to provide faculty members with greater flexibility and additional access to funding throughout the year. In its second year, the StART program funded eight projects in areas ranging from machine learning in materials science to neuromorphic computing.



Mashid Ahmadi

Materials science has played an important role in the creation of many modern technologies, from lithium batteries to improved steels. The development of new materials has led to innovation in a variety of fields, but the process can be lengthy and inefficient. Mashid Ahmadi, assistant professor of materials science and engineering, hopes to contribute to the development of a better process.

“The historical approach to materials development has been random; basically they mixed a bit of one molecule and a little bit of another element and then examined the properties of this new material for suitable applications,” said Ahmadi.

Ahmadi’s team is working with materials for optoelectronic applications, such as solar cells. Solar cells have historically been expensive, partly due to the high cost of materials used to create them. Ahmadi’s StART project is using a combination of experimental techniques and machine learning to create a more effective means of selecting the most beneficial material compositions for this application.

Ahmadi’s work on this project served as a foundation for the NSF CAREER award she received this year, and has generated several publications. Additionally, her team has found themselves on the cutting edge of machine learning assisted automated synthesis, a critical technique for her project.



Hugh Medal

The Materials Genome Initiative, or MGI, is a multiagency initiative to increase the speed of advanced materials development and production. A key MGI program, the Materials Project, has amassed a database of hundreds of thousands of materials with their predicted properties—information that would normally require repeated experimentation to discover.

Knowing that materials can exist, however, is not the same thing as successfully creating them. The question of how best to develop these predicted materials is a large one in materials science, and Assistant Professor of Industrial and Systems Engineering Hugh Medal is attempting to make inroads in this area with his StART project. His team is collaborating with Haixuan Xu, associate professor of materials science and engineering and a former Science Alliance JDRD awardee, to create a simulation that can predict how to produce these materials.

“We’re working together to come up with a technique that can tell us how, given a predicted material that’s really interesting, what processing do we need to apply over time to be able to grow that material,” said Medal. In its second year, Medal’s project has generated a white paper for the Army Research Office and deepened the collaboration between the two teams.



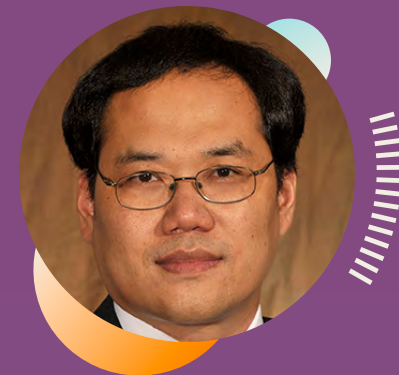
Sindhu Jagadamma

Carbon cycling is the way carbon is recycled or moved around from the atmosphere into organisms and soil and back out again. Changes to any component of the process have the ability to impact the carbon cycle, but the potential effects of soil composition are not well understood.

“It’s really important to understand the different drivers of carbon cycling in soil in order to build healthy soils and promote sustainability,” says Assistant Professor of Biosystems Engineering and Soil Science, Sindhu Jagadamma. “The role of manganese in influencing carbon decomposition is relatively unknown, especially in agricultural soils.”

In the second year of her project, Jagadamma and her team have moved forward with experiments to develop an understanding of the role of manganese in both nitrogen-fertilized and non-fertilized soils. Their preliminary findings, which were presented at the Ecological Society of America 2021 Meeting, showed the addition of manganese to nitrogen-fertilized soil significantly reduced the emission of potent greenhouse gas nitrous oxide. She expects the understandings generated from this research to contribute directly to healthy and climate-resilient agricultural systems.

Jagadamma has also submitted a proposal to the U.S. Department of Agriculture which will build upon her StART work and aims to understand the role of manganese in relation to soil organic carbon, a critical driver of soil health.



Xiaopeng Zhao

Brain-computer interfaces, BCIs, sometimes called mind-machine interfaces, essentially create a direct line of communication between the brain and an external device. BCIs are being investigated for uses in mapping, assisting, and even repairing cognitive, sensory, and motor functions.

Xiapoeng Zhao, professor of mechanical, aerospace, and biomedical engineering, has historically worked on the development of BCIs for a variety of applications, and is now leveraging that experience in a collaboration with Zhiming Gao in ORNL’s Fuel, Engines and Emission Research Laboratory. Zhao’s team is developing a BCI for use in connected vehicle technology.

“We want to understand human memory and attention in general—so basically the executive function,” said Zhao. “We’re working on the human side, so we look at how humans experience driving or riding. Can we detect the intention or emotion of that person and use it to improve the experience?”

Zhao’s work has implications beyond vehicle technology, including in the medical field. Thus far the project has generated several publications and an additional external grant application.



Zhenbo Wang

Connected and automated vehicles, or CAVs, have continued to capture the attention of researchers who are attempting to address some of the fundamental problems with connective vehicle technology. Zhenbo Wang, assistant professor of mechanical, aerospace, and biomedical engineering is tackling one of these problems: intersections.

“What I’m doing with this project is trying to better control ground vehicles based on traffic signal changes,” said Wang. “The traffic signal will broadcast information to oncoming vehicles, and we want to know how we can optimize the motion of the vehicle to, for example, minimize fuel consumption.” Wang’s StART team hopes to develop a control strategy for vehicles using traffic signal phase and time data to make real-time speed adjustments in response to information received. These adjustments will contribute to better fuel efficiency and a host of other benefits.

He and his partners have made significant progress on both traffic signal control and vehicle speed control, and produced a journal article based on this research. In the future, Wang would like to extend this work to address more complex and challenging transportation issues. Potential applications could include corridor and network-level traffic coordination and control, novel transportation concepts like urban air mobility, or integration of traffic management and control with battery technologies or the electrical grid.



Johnathan Brantley

Plastics are one of the most common materials in use today. From food and drink containers to car parts, they are present in most facets of modern life in a variety of forms. The versatility of plastics is due in large part to their ability to be changed and customized. It is this process of customization that inspired Assistant Professor of Chemistry Johnathan Brantley's StART project.

"What we're interested in is understanding how we can control the structures of polymers because the structure of the polymer, or common plastic, really dictates its physical properties," said Brantley. "Very tiny changes in a polymer can impact the properties of that polymer in really profound ways." These kinds of structural changes can mean the difference between a hard hat or a trash bag.

Brantley's team hopes to develop a way to more easily manipulate these polymeric structures to better customize their properties. They believe the way to do this is by building a polymer with a structural handle that can be manipulated in order to achieve a particular characteristic.

"We are trying to design new types of plastics that will allow us to tailor the properties of that plastic, and by extension the applications that it might find. This could be on the front end, when you're making the plastic itself, or at the end of its life such that it could degrade into a new polymer with new applications," said Brantley.

One potential application for this technology is gas separation. Gas separation can be used to purify mixed gases into individual gases. This could have applications across a wide range of areas, including oxygen concentrators like those used for medical oxygen, or in the creation of industrial gases used for biotechnology, agriculture, and electronics.

Tomonori Saito, Brantley's ORNL collaborator and research scientist in the Chemical Sciences Division, shares Brantley's interest in the manipulation of polymers for different applications. Once Brantley's team has created the polymers, Saito's team will work to characterize their properties and suitability to specific applications.

Brantley expects this project to contribute to important foundational understandings of ways in which polymers may be manipulated to achieve certain characteristics.

"We are really geared toward understanding the fundamental principles that govern the physical properties of polymers," said Brantley. "While we may not envision a specific application, if we understand how to control the physical properties of a material, then it becomes much easier to make these tailor-made plastics that have a specific subset of properties for a given application."



Jian Liu

Digital data breaches have been a growing area of concern for a number of years. In 2020 alone, more than 1,000 individual data breaches occurred, affecting nearly 156 million people. This can be a particular point of distress for researchers working with machine learning as the data sets required are enormous and may contain personal information. Jian Liu, assistant professor in the Min H. Kao Department of Electrical Engineering and Computer Science, believes federated learning may provide a method for machine learning that could mitigate the danger to personal data.

"Most machine learning models are based on centralized training, which means users need to upload their data to a remote server. This raises some very critical privacy issues. Federated learning distributes the training process to a user's device, enabling them to keep their data locally on the device," said Liu.

With federated learning, users could collaboratively train the machine learning model on their personal devices, using their personal data. Once the training is complete, the model will have learned from the users' data without recording that data onto an external server, helping the users maintain control of their data and privacy.

Researchers at Google first developed federated learning in 2017 and have since deployed it in a number of ways. One of the most common of these is predictive text. When a user interacts with a mobile phone's suggested texts, they are essentially training that phone to make better predictions each time. In 2018, Google launched a similar feature for Gmail accounts called Smart Compose, which uses manually entered text to predict the next portion or remainder of a sentence.

Liu's StART team is hoping to find a reliable, trustworthy means of leveraging federated learning for other machine learning applications, a process not without potential issues.

"You can imagine with federated learning, there are billions of mobile devices which can contribute their data to improve the model. However, we cannot know whether a particular device is a trustworthy device. Maybe that device is malicious or belongs to a malicious user" said Liu.

Despite the potential privacy concerns, centralized-learning approaches can validate both the quality and label accuracy of their training datasets. Federated learning may open up new vulnerabilities due to its inherent "distributed-training" nature. Liu's StART project aims to begin developing attack-resilient and privacy-preserving AI models for federated learning that will manage these issues.

Liu's team includes Jiabin Zhang, staff scientist in ORNL's Computer Science and Mathematics Division, and Luyang Liu, research scientist at Google. Liu has included preliminary results from this project in an NSF proposal and expects to generate an additional external proposal. The team has published one paper and expects to have more prepared by the conclusion of the project.



Subhadeep Chakraborty

Driver inattention is the leading cause of traffic accidents in the U.S., resulting in thousands of deaths per year. Inattention can be the result of driver fatigue, texting, loud music, or even daydreaming. Whatever the cause, when a driver's focus strays, lives are put at risk. Associate Professor of Mechanical, Aerospace, and Biomedical Engineering Subhadeep Chakraborty's work with biometric sensing could help minimize that risk.

Biometric sensing is the process of gathering information about a human, in this case the driver of a vehicle, such as where they are looking or their heart rate. Data gathered from a driver can subsequently be cross referenced with information about the vehicle itself and its surroundings to assess the situation and determine if the driver is behaving normally.

"Our physiological responses are tied to what the vehicle is doing and what is going on around the vehicle at the same time," said Chakraborty. "Looking at these three things simultaneously will allow us to determine if a driver's behavior is normal or something that could become dangerous. We can then act upon that by sounding an alarm for a sleepy driver or vibrating the steering wheel to return a distracted driver's attention to the road."

He cautions that for this technology to be effective, it must be accurate enough to avoid regular false alarms. Chakraborty's team has developed a head mount containing a series of sensors capable of collecting biometric data as well as information about a driver's gaze. The next step is to integrate that head mount with a driving simulator and begin building a data set, which will use both UT and ORNL equipment.

"Our lab setup is drawn from high-end gaming systems and uses a head-mounted display. We can control the environment and get immediate data from the simulations. We can use this to gather driving data and safely simulate distractions by asking participants to solve puzzles or play memory games," said Chakraborty.

From there, his team hopes to also gather data via a state-of-the-art simulator located in ORNL's Connected and Autonomous Vehicle Environment (CAVE) Laboratory. This simulator mimics the experience of driving by removing a vehicle's wheels and mounting the hub directly to four dynamometers. The full steering capability with torque feedback based on the current simulated vehicle dynamics make the simulation feel more realistic. This could translate to more accurate biometric data and fewer false alarms for potentially distracted drivers.

Chakraborty was previously the recipient of Science Alliance funding for his work on connected vehicle technology. That work involved several cross-disciplinary collaborations on campus that now, in addition to being applied to his StART project, have created opportunities for approaching his work from a holistic perspective.

"I don't think these kinds of projects have any boundaries anymore. It's a mechanical engineering topic, it's a computer science topic, it's a civil engineering topic," said Chakraborty. "Ultimately, we are trying to address a safety issue, and that issue is multi-dimensional and needs to be looked at from a variety of perspectives. Fortunately, we have built a community capable of doing that."



Student Support

Integral to the charter of the Science Alliance is this principle: Science Alliance funding will be used to “provide incentives to attract and retain the highest quality students and strengthen the educational opportunities for both UT and ORNL.” Consequently, each year a portion of the Science Alliance’s funding is distributed directly to two colleges within the university with the express purpose of supporting graduate education and research. As a result, many students have had occasion to add significantly to the foundation of their future careers through direct support provided by Science Alliance.

Riley Tavassoli, graduate student working with Subhadeep Chakraborty, has contributed significantly to the development of the testing apparatus for Chakraborty’s StART project. In just a few short months, he managed to solve a long-standing technical problem with the simulator, and is contributing to an NSF proposal currently in development

Jian Liu’s StART project is supporting multiple graduate students, working in the field of federated learning. **Yue Cui** is working on privacy preserving depression diagnostics, and **Syed Irfan Ali Meezra** s investigating fairness issues related to federated learning. Both students are engaging in research critical to the development of their careers, as well as the success of the project.

Kate Higgins is in her second year of work with Mashid Ahmadi’s JDRD project. She has developed an automated workflow for automated synthesis and characterization of materials using a robot. Her most recent work with machine learning investigates the automated creation of metal halide perovskites in the search for stable compositions.

Anahita Khojandi’s graduate student, **Zeyu Liu** is focused on bi-level frameworks that combine machine learning models with decision-making models. In its current application, Liu’s work involved real-time prediction of sepsis for patients in the ICU. He has recently published a study on this work and has a second under review.

Yifang Zu, graduate student working on Shuai Li’s JDRD project, conducted research to model the 3D building environment and develop methods to assess the impacts of that environment on pathogen transmission and exposure.

Many Science Alliance funded graduate students are actively collaborating with ORNL scientists. They have earned additional funding for their work from a variety of sources, including the National Science Foundation, the Department of Energy, and NASA. Many of them also serve as mentors to the undergraduate students on their teams. The contributions made by these scholars not only prepare them for future careers, but also serve to ensure a foothold for the University of Tennessee, and the state of Tennessee, in the future of the nation’s scientific community.

Graduate Student Support by Department

DEPARTMENT	TOTAL SUPPORT	# OF STUDENTS	HIGHLIGHTS
BIOLOGY	\$305,305	41	Supported student generated 27 publications and more than half of students developed or maintained an ORNL affiliation, including with the National Institute for Computer Sciences and the Spallation Neutron Source. Awards include the Yates Dissertation Award, the Paul Blakely Award for Science Writing and, an NSF Graduate Research Fellowship.
CHEMISTRY	\$156,119	31	Chemistry students supported by Science Alliance had multiple ORNL and governmental affiliations, including with DOE, NSF, and NIH. They co-authored more than 20 publications and one student received the Excellence in Polymer Graduate Research award at the American Chemical Society national meeting. Another student has contributed to a provisional patent.
EARTH & PLANETARY SCIENCES	\$41,444	5	80 percent of funded students generated a total of five publications in their field. One student gave a presentation at the American Geophysical Union Fall Meeting. Two of the five students have conducted research in conjunction with a national laboratory, including ORNL and Argonne National Laboratory
ELECTRICAL ENGINEERING & COMPUTER SCIENCES	\$94,560	15	Supported students maintained both governmental affiliations, such as DOD and NSF. EECS graduate students are heavily recruited by industry and a member of this cohort joined Apple in October 2021. These students co-authored six publications and presented at four conferences. One student was a Bodenheimer Fellowship awardee and another earned the Gonzales Outsanding Graduate Teaching Assistant award.
GEOGRAPHY	\$7,541	2	Two graduate students are currently being supported in geography. One is developing a thesis analyzing hurricane induced power outages, and the other is addressing the opioid epidemic in Tennessee through their dissertation.
MATHEMATICS	\$91,808	19	All funded mathematics students engaged in affiliations with external institutions, including ORNL, DOD, DOE, and Los Alamos National Laboratory. This group of students generaged 13 publications with 14 more in development, as well as 18 presentations. Two students are participating in NSF funded research, and one received a grant from the Centers for Disease Control.
PHYSICS	\$221,154	27	Supported students co-authored nine publications. More than 90 percent of students maintained a relationship with ORNL. Eight students are working directly with the Shull Wollan Center at ORNL, and two students are engaging in collaborative research with ORNL and Los Alamos National Laboratory. Additionally, one student is participating in NSF funded research.
PSYCHOLOGY	\$9,986	2	Both supported students are engaged in ORNL affiliated research via Joint Faculty appointee Ralph Lydic. Both students have co-authored publications and one earned first place in the American Society for Pharmacology and Experimental Therapeutics poster presentation for the Division of Neuropharmacology.

Graduate Advancement, Training, and Education

The Science Alliance has a long history of supporting graduate students via assistantships and fellowships awarded by individual departments, now known as the Graduate Advancement, Training, and Education (GATE) program, to support meritorious, collaborative research between the university and ORNL. This program will continue to provide opportunities to students currently studying at our university and will also help recruit the next generation of scientists moving forward. We are now beginning the next phase of this program by offering full graduate research assistantships to students based on the merit of their research. GATE awardees receive a twelve-month appointment, including a stipend, tuition waiver, and health insurance.



2020-2021 GATE Awards



Matthew Baucum
Department of Industrial & Systems Engineering

Matthew’s research combines healthcare operations and data analytics, and will investigate techniques for more efficient weaning of medical patients from ventilators. Matthew’s earlier academic work in quantitative psychology laid a foundation for a nuanced approach to the fusion of theory-driven classical operations research and modern advances in data science that will serve to guide his continuing research to improve chronic and critical healthcare.

Sarah Brawner
Department of Ecology & Evolutionary Biology

Sarah’s research investigates the role of environmental variation across a variety of climates. Her interest in the interconnected systems of the planet led her to focus on the ecological, genetic, and genomic interactions among trees and soil microbiomes in the context of climate variations. For her dissertation, she plans to study these interactions in the contrasting environments of sky islands and contiguous mountain ranges in the Southwestern U.S.



Kristen Butler
Department of Earth & Planetary Sciences

Kristen’s area of study is soil biogeochemistry-the study of the biological, geological, chemical, and physical characteristics that govern soil composition. Specifically, her research looks at the impact of manganese cycling on the carbon cycle and its greater impacts on global climate change.

Madeline Davis
Department of Biochemistry, Cellular & Molecular Biology

Maddie’s work investigates the details of protein import into chloroplasts, a pathway that is critical for photosynthesis and chloroplast biogenesis. Understanding this process could shed light on the “gateway” through which proteins travel into chloroplasts, which are foundational components of nearly all ecosystems.





Liz Denison

Department of Microbiology

Liz’s work focuses on the microbial communities of peat bogs, specifically *sphagnum*, and how microorganisms may influence larger ecosystem processes. Peatlands have been identified as one of the most valuable, and most vulnerable, ecosystems on the planet. She hopes her work will contribute to predictive models of how *sphagnum* will be impacted by warming temperatures.



Michelle Lehmann

Bredesen Center for Interdisciplinary Research and Graduate Education

Michelle is exploring ion-transport membranes for non-aqueous battery systems. After spending ten years working as a veterinary technician, she enrolled at the University of Tennessee to pursue an education in chemical engineering and is currently pursuing a degree in energy science and engineering. She hopes her research will yield significant impacts for battery technologies.

Rajesh Ghimire

Department of Physics & Astronomy

Rajesh’s research focuses on instrumentation development, data acquisition, and analysis of large data sets to better understand nuclear reactions. An understanding of nuclear reactions can lead to developing an understanding of nucleosynthetic processes in deep cosmos. Rajesh hopes to use this work to expand his expertise in experimental nuclear physics.



Samara Levine

Department of Nuclear Engineering

Samara left an industry career as a nuclear engineer to pursue research. Her work, which seeks to investigate radiation damage in reactor structures, has led to collaborations with ORNL and Lawrence Berkeley National Laboratory researchers. Her continuing research may ensure safer conditions for the generation of clean energy by fission and fusion systems.



Adrien Green

Department of Physics & Astronomy

Adrien’s work centers on the development of secure quantum communications, or the introduction of the laws of quantum mechanics into encryption to develop more secure means of communication. He hopes his work will contribute to the innovation necessary to make such technology widely accessible to the greater public.

Viswanathan Gurumoorthy

Department of Genome Science & Technology

Viswanathan’s research investigates intrinsically disordered proteins, or IDPs. IDPs have been shown to play a causative role in diseases such as cancer. He hopes to continue to address the knowledge gap in the study of proteins and their potential impact in a variety of systems.



Mohammad Aminul Haque

Min H. Kao Department of Electrical Engineering & Computer Science

Aminul has always been fascinated by technology and electrical engineering. Focusing on the area of nanotechnology, his work seeks to bridge the disciplines of physics and electrical engineering. He hopes his research on 3D-printed polymer structures will lead to a career in industry-oriented research and nanoelectronics fabrication.





Francis Okejiri

Department of Chemistry

Francis’s research focuses on pollution from vehicle emissions, specifically carbon monoxide which is highly toxic to humans. Carbon monoxide has been linked to a number of respiratory illnesses and can be fatal to humans in relatively small doses. He hopes to develop crystalline materials that can transform carbon monoxide into the less toxic carbon dioxide.



Huihui Sun

Department of Biosystems Engineering & Soil Science

Huihui’s research focuses on soil environmental microbiology, specifically the role of viruses in soil. Viruses are known to play important roles in a given ecosystem, from carbon cycling to breaking down contaminants. Her work seeks to determine the effect of water in soil on the distribution of viral populations within that soil.

Nick Oldham

Department of Entomology & Plant Pathology

Nick’s work focuses on the effect of urban landscapes on wetlands and their associated pollinators. Specifically, his research investigates fly populations critical to the plant communities found in eastern Tennessee wetlands. As a self-described bug lover, Nick hopes his work will support UT-ORNL collaborations as well as educate broader audiences on the importance of pollinators.



Xin Wen

Department of Physics & Astronomy

The study of turbulence has implications in an array of real-world scenarios, from transportation to medicine. Xin’s research seeks to effectively quantify and test turbulent flow through the use of liquid helium. He plans to engage in multiple collaborations on this work, including with ORNL, the Joint Institute for Computational Sciences, and the National High Magnetic Field Laboratory.



Sreya Paladugu

Department of Materials Science & Engineering

Sreya is investigating metal oxide catalysts under acid gas exposure through neutron and x-ray scattering. She hopes her work will contribute to materials discovery and design for energy applications, and create an opportunity for collaborations with industry partners.



Matthew Whisenant

Department of Mechanical, Aerospace & Biomedical Engineering

As renewable energy technology continues to develop, existing infrastructures may provide stumbling blocks making it difficult to implement these technologies. Matthew’s research centers on hydropower, utilizing machine learning to develop more efficient turbines. He hopes his work will contribute to future increases in renewable energy use.

Nitesh Shah

Department of Civil & Environmental Engineering

The critical nature of road access was made clear to Nitesh in the wake of a devastating 2015 earthquake in Nepal. His work in transportation planning has led him to focus on sustainability, user behavior, and safety of shared micromobility-a potential solution to urban transportation issues like congestion and pollution.



Yi Yang

Department of Materials Science & Engineering

Stainless steel is a widely used material in pipes for oil refineries, power plants, and nuclear energy systems. Failed welds in these pipes can have dramatic consequences. Yi’s research investigates these welds and potential causes of their failures. She hopes to then generate a predictive model for industrial use in safety monitoring.



Tyler Steiner

Department of Nuclear Engineering

A lifetime of natural curiosity brought Tyler to the field of nuclear engineering for space applications. Nuclear thermal propulsion has been chosen by NASA to send humans to Mars, but a testbed for simulating the specific conditions this mission will experience does not yet exist. Tyler’s research will contribute to the development of such a test bed in an ongoing UT-ORNL collaboration.

Student Mentoring and Research Training

In an effort to deepen its existing commitment to student support, the Science Alliance launched the Student Mentoring and Research Training (SMaRT) program in 2020. The SMaRT program is designed to provide a 10-week summer research experience to undergraduate students from across the country. Students participated in collaborative research with UT and ORNL faculty and staff, and received mentorship from a cohort of graduate students from a variety of disciplines.

In its inaugural year, the SMaRT program was forced to reformulate in order to comply with COVID-19 related safety precautions, both at the university and at ORNL. The 2021 cohort, while still bound by a number of safety precautions, was able to fully engage in the research process with faculty mentors. Traveling from universities spanning the country, from the University of South Florida to Harvard University, students arrived in late May to live on the university campus and work with UT faculty, including a number of UT-ORNL Governor’s Chairs.

The research experience concluded with a research symposium. Each student, in conjunction with their faculty and graduate student mentors, developed research posters and formal presentations describing the research they conducted over the course of the program.



SMaRT Student Support

The Science Alliance’s support of students engaging in research extends well beyond graduate students. Since the creation of the JDRD program, Science Alliance funds have been used to bolster research opportunities for undergraduate students as well. In 2020, in a more expansive approach, the Science Alliance launched the first full year of the SMaRT program to both provide direct support to undergraduate students, and provide experiences and professional development key to a future career in research. Over the summer, SMaRT students worked with faculty members on UT-ORNL focused research projects, developing skills and knowledge in a variety of relevant fields.

Jahziel Chase was co-mentored by Governor’s Chair for Microbiology and Civil and Environmental Engineering, and Professor and Associate Department Head of Chemistry Shawn Campagna. Chase investigated the impacts of bacterial haloacid dehalogenase (HAD) enzymes in the defluorination process.

Governor’s Chair for Environmental Biotechnology Terry Hazen’s student **Syndey DeBlander** leveraged wastewater-based epidemiology to study the bacterial community’s ability to predict SARS CoV-2. Building on UT’s existing program of wastewater sampling put in place during the 2020 academic year. She determined the wastewater bacterial communities in her experiment could not confidently predict SARS CoV-2, but suggested an increased sample size and metagenomic analysis could be used in future experiments.

Ariel Scott worked with Mike Kilbey, professor of chemistry. As part of hersummer work experience, Scott worked on a study using controlled polymerization techniques to create and characterize block copolymers. Block copolymers have a wide range of applications including adhesives, footwear, and pharmaceutical applications.

Faisal Kimbugwe used similarity analysis to develop thermal signature maps from infrared data as a means of better understanding the inconsistencies in components created via the L-PBF additive manufacturing process. Working in Governor’s Chair for Advanced Manufacturing Suresh Babu’s lab, Kimbugwe and other team members generated results suggesting that similarity analysis could be effective for thermal signature mapping.

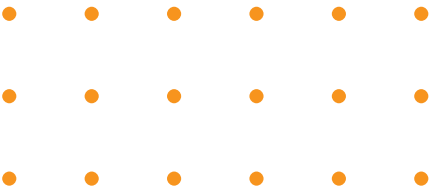
Computer Science student **David Rose-Franklin** worked with machine learning for the automation of computational tasks in chemistry. Under the supervision of Konstantinos Vogiatzis, assistant professor of chemistry, he worked on the development of a method to predict ring structures in molecules with a high degree of accuracy.

This year’s SMaRT students participated in a summer work experience with university faculty members engaged in ORNL affiliated research, and presented their work to their peers and mentors at the inaugural SMaRT Research Symposium. They received professional development instruction in a variety of areas, providing a solid foundation upon which to continue building their research goals. They have investigated areas critical to the future of both the university and the state of Tennessee, and gained skills and knowledge integral to a career in research.



Undergraduate Student Support by Department

DEPARTMENT	TOTAL SUPPORT	# OF STUDENTS
BUSINESS ANALYTICS & STATISTICS	\$2,637	1
CHEMICAL ENGINEERING	\$7,773	3
CHEMISTRY	\$21,256	8
CIVIL & ENVIRONMENTAL ENGINEERING	\$4,773	3
ELECTRICAL ENGINEERING & COMPUTER SCIENCES	\$7,049	2
INDUSTRIAL & SYSTEMS ENGINEERING	\$13,775	8
MECHANICAL AEROSPACE AND BIOMEDICAL ENGINEERING	\$39,109	27
NUCLEAR ENGINEERING	\$2,637	1



UT-ORNL Joint Institutes

The Science Alliance has historically provided support to five UT-ORNL joint institutes which link distinct, complementary resources in select, high-priority scientific and engineering fields for the university and national laboratory. With the launch of the University of Tennessee-Oak Ridge Institute (UT-ORII) in fiscal year 2021, four of the five institutes were sunset to develop this new locus of UT-ORNL collaboration.

UT-ORNL Joint Institute for Advanced Materials

The Joint Institute for Advanced Materials promotes interdisciplinary research and education related to developing new materials with superior properties, such as greater toughness and high-temperature strength, or those that can be tailored to support new technologies, such as pocket-sized supercomputers.

UT-ORNL Joint Institute for Biological Sciences

The Joint Institute for Biological Sciences supports interdisciplinary, crosscutting research that accelerates progress in complex bioenergy and bioenvironmental systems. It also aids access by UT-ORNL faculty, staff and students to state-of-the-art capability in genomic, transcriptomic, proteomic, and metabolomic analysis of biological and environmental systems.

UT-ORNL Joint Institute for Computational Sciences

The Joint Institute for Computations Sciences (JICS) advances scientific discovery and state-of-the-art engineering and computational modeling and simulation. JICS takes full advantage of the petascale and beyond computers in the DOE National Center for Computations Sciences and UT’s National Institute for Computational Sciences.

UT-ORNL Joint Institute for Nuclear Physics and Applications

The Joint Institute of Nuclear Physics and Applications links UT, ORNL and Vanderbilt University research to promote and support basic nuclear physics research and nuclear and radiological applications of common interest to the participants.

UR-ORNL Shull Wollan Center, a Joint Institute for Neutron Sciences

The Shull Wollan Center promotes worldwide neutron scattering collaboration among researchers in biological and life sciences, energy sciences, polymer science, condensed matter physics, and computational sciences.

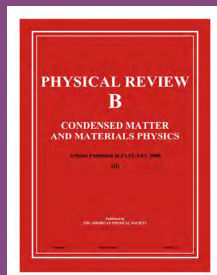
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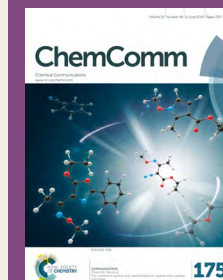
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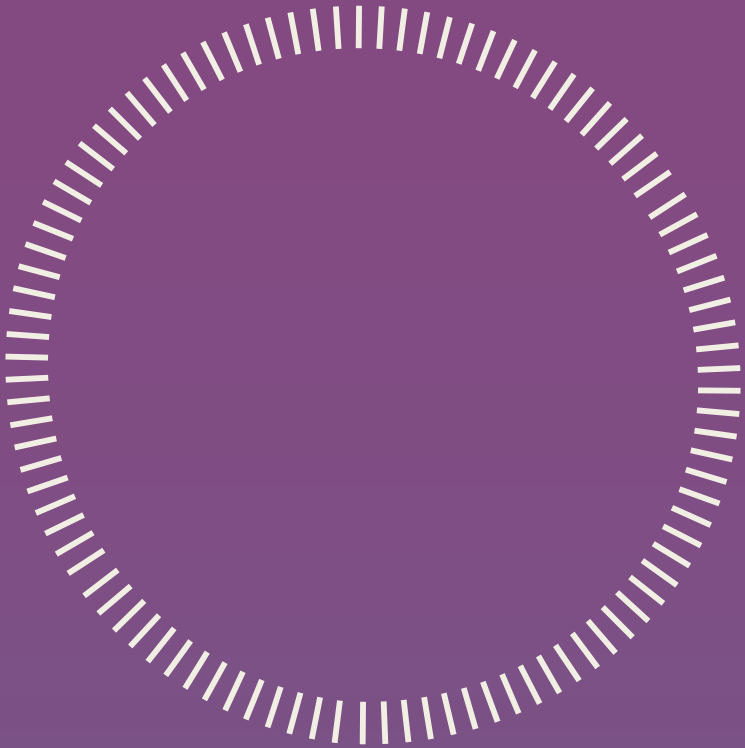
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Schedule 7

CENTERS OF EXCELLENCE ACTUAL, PROPOSED, AND REQUESTED BUDGET

Institution: The University of Tennessee

Center: The Science Alliance

	FY 2020-21 Actual			FY 2021-22 Proposed			FY 2022-23 Requested		
	Matching	Apprpr.	Total	Matching	Apprpr.	Total	Matching	Apprpr.	Total
Expenditures									
Salaries									
Faculty	\$456,749	\$436,179	\$892,928	\$470,451	\$449,264	\$919,716	\$493,974	\$471,728	\$965,702
Other Professional	\$251,799	\$360,186	\$611,985	\$259,353	\$370,992	\$630,345	\$272,321	\$389,541	\$661,862
Clerical/ Supporting	\$68,387	\$224,335	\$292,722	\$70,439	\$231,065	\$301,504	\$73,961	\$242,618	\$316,579
Assistantships	\$224,346	\$1,690,595	\$1,914,941	\$231,076	\$1,741,313	\$1,972,389	\$242,630	\$1,828,378	\$2,071,009
Total Salaries	\$1,001,281	\$2,711,295	\$3,712,576	\$1,031,319	\$2,792,634	\$3,823,953	\$1,082,885	\$2,932,266	\$4,015,151
Longevity (Exclude from Salaries)	\$6,028	\$4,462	\$10,490	\$6,209	\$4,596	\$10,805	\$6,519	\$4,826	\$11,345
Fringe Benefits	\$275,588	\$366,970	\$642,558	\$283,856	\$377,979	\$661,835	\$298,048	\$396,878	\$694,926
Total Personnel	\$1,282,897	\$3,082,727	\$4,365,624	\$1,321,384	\$3,175,209	\$4,496,593	\$1,387,453	\$3,333,969	\$4,721,422
Non-Personnel									
Travel	\$3,192	\$822	\$4,014	\$50,000	\$100,000	\$150,000	\$100,000	\$105,000	\$205,000
Software	\$0	\$198	\$198	\$100	\$204	\$304	\$107	\$214	\$321
Books & Journals	\$2,986	\$1,869	\$4,855	\$3,076	\$1,925	\$5,001	\$1,011	\$2,021	\$3,032
Other Supplies	\$8,156	\$57,691	\$65,847	\$250,000	\$500,000	\$750,000	\$75,000	\$75,000	\$150,000
Equipment	\$0	\$0	\$0	\$800,000	\$1,600,000	\$2,400,000	\$0	\$0	\$0
Maintenance	\$14,751	\$0	\$14,751	\$15,000	\$0	\$15,000	\$25,000	\$0	\$25,000
Other (Specify):									
Prof Services & Memberships	\$0	\$4,992	\$4,992	\$2,500	\$5,142	\$7,642	\$2,699	\$5,399	\$8,098
Printing, Duplicating, Binding	\$0	\$399	\$399	\$200	\$411	\$611	\$216	\$432	\$647
Communications	\$1,174	\$955	\$2,129	\$1,209	\$984	\$2,193	\$516	\$1,033	\$1,549
Computer Services	\$696	\$348	\$1,044	\$717	\$358	\$1,075	\$188	\$376	\$565
Grants and Subsidies (Student Fees)	\$429,820	\$333,946	\$763,766	\$1,000,000	\$2,000,000	\$3,000,000	\$379,765	\$340,000	\$719,765
Contractual & Special Services	\$49,761	\$9,022	\$58,783	\$200,000	\$400,000	\$600,000	\$5,000	\$10,000	\$15,000
Insurance, Interest & Bad Debt	\$2,973	\$3,752	\$6,725	\$3,062	\$3,865	\$6,927	\$2,029	\$4,058	\$6,087
Awards - Student Aid	\$2,000	\$0	\$2,000	\$2,060	\$0	\$2,060	\$2,500	\$0	\$2,500
Other Expenditures	\$2,385	\$2,257	\$4,642	\$2,457	\$189,000	\$191,457	\$89,224	\$198,450	\$287,674
Cost Sharing	\$0	\$73,864	\$73,864	\$1,424,241	\$2,174,912	\$3,599,153	\$50,000	\$165,466	\$215,466
Total Non-Personnel	\$517,894	\$490,115	\$1,008,009	\$3,754,621	\$6,976,800	\$10,731,422	\$733,255	\$907,449	\$1,640,704
GRAND TOTAL	\$1,800,791	\$3,572,842	\$5,373,633	\$5,076,005	\$10,152,009	\$15,228,015	\$2,120,709	\$4,241,418	\$6,362,127
Revenue									
New State Appropriation		\$3,937,609	\$3,937,609		\$4,039,446	\$4,039,446		\$4,241,418	\$4,241,418
Carryover State Appropriation		\$5,747,796	\$5,747,796		\$6,112,563	\$6,112,563			\$0
New Matching Funds	\$1,800,791		\$1,800,791	\$5,076,005		\$5,076,005	\$2,120,709		\$2,120,709
Carryover from Previous Matching Funds			-			-			-
Total Revenue	\$1,800,791	\$9,685,405	\$11,486,196	\$5,076,005	\$10,152,009	\$15,228,014	\$2,120,709	\$4,241,418	\$6,362,127



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