

2022

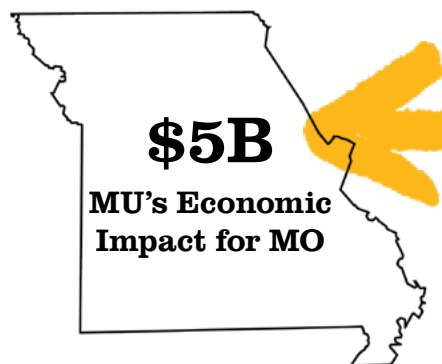
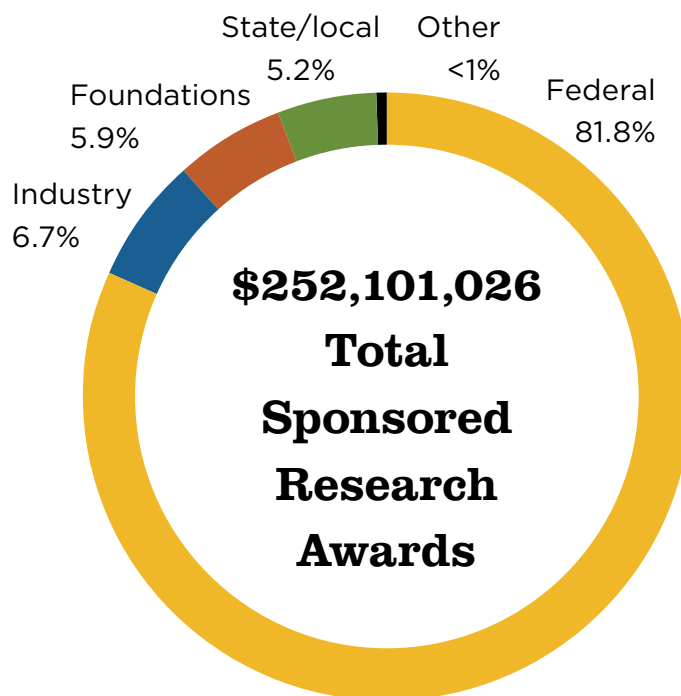
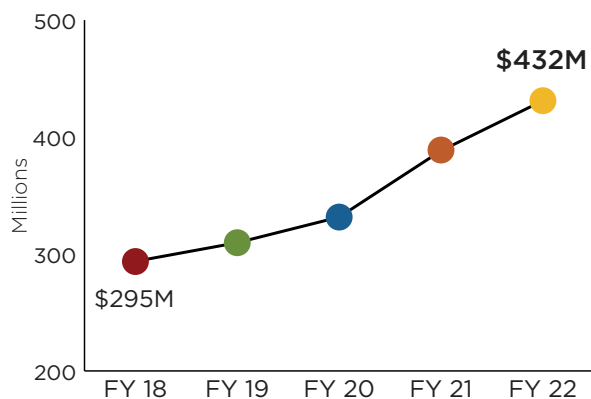
YEAR IN REVIEW



Research, Innovation & Impact
University of Missouri

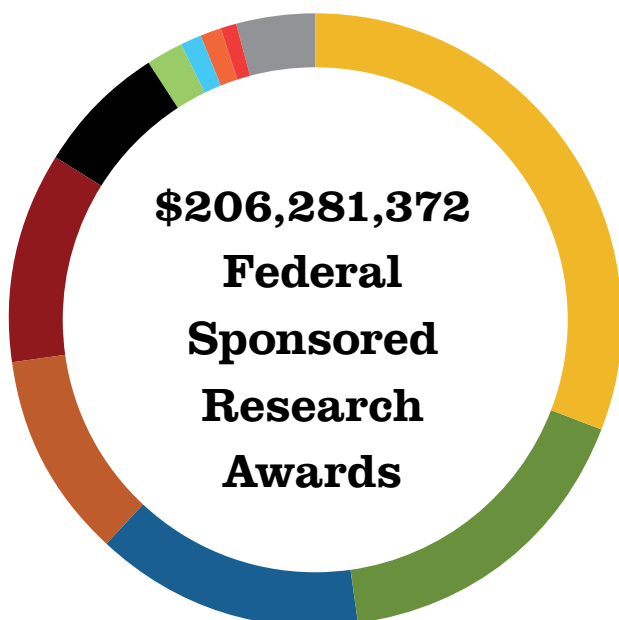
\$432M

Total FY 2022 Research Expenditures



\$989M

Economic Impact of MU Research



National Institutes of Health.....	31%
Department of Agriculture	17%
Department of Health and Human Services-Other	14%
National Science Foundation	11%
Department of Education	11%
Department of Defense	7%
Department of Energy	2%
Department of Transportation.....	1%
NASA	1%
Department of Interior.....	1%
Other.....	4%



Dear Friends,

Congratulations to University of Missouri faculty, staff and students on all your research and creative work successes during 2022. MU's research and scholarly activity are pushing the boundaries of what's possible by supplying the world with life-saving medical radioisotopes, creating new works and exploring frontiers that will positively impact Missouri and beyond. The following pages showcase the efforts and achievements of the MU community.

We have a lot to celebrate. The university's major research investments are better serving MU's people, facilities and programs. Only a year old, the Roy Blunt NextGen Precision Health building is the cornerstone of the NextGen Precision Health initiative, the most ambitious research endeavor in our university's history. The 10-year, \$1.5 billion MizzouForward investment, a transformative strategy for the future of MU, is adding more support to our research mission, and helping build and upgrade research facilities and instruments, including the MU Research Reactor West facility, projected to be completed in 2024, and the newly opened MU Veterinary Medical Diagnostic Laboratory. The initiative also includes investing in the next generation of researchers by helping students engage in world-class research activities.

The Division of Research, Innovation & Impact is empowering MU researchers and scholars in their endeavors. Our goal is to assist the MU community in increasing the quantity and quality of proposal submissions and grow our collaborative, cross-disciplinary and team proposal submissions. The division also supports the funding of high-quality, advanced technology cores and drives the creation of new centers and institutes. Establishing the Strategic Proposal Development Service team and strengthening our Research Analytics team means MU's researchers and scholars have new and better resources. The division also is making new hires and bolstering existing research support programs such as the Research Development Fellows programs and the division's website, so our MU community has the needed support for their research quests and creative works.

The University of Missouri is heading toward new heights through its research breakthroughs and creative works. Thank you all for your pursuit of challenging questions, your hard work and dedication and your passion for everything you do.

Tom Spencer
Vice Chancellor for Research
Curators' Distinguished Professor
Scientific Director, NextGen Precision Health

FY 2022 Awards

\$1.5B

Total proposals
submitted

919

Distinct
investigators
received awards

1,165

Total number of
awards received

54

Awards of
\$1M+

*all awards



MU Research Reactor supplies critical medical isotopes

After an unexpected reactor shutdown in Europe in early 2022, the world faced a disruption in the global supply of critical medical radioisotopes used for medical diagnoses and treating diseases such as cancer. The **MU Research Reactor (MURR)** increased its production to meet the demand for these life-saving radioisotopes. MURR's researchers are working tirelessly to make the world a better place through their explorations and developing novel research isotopes and radiochemicals. A \$20 million addition slated for completion in 2024 will expand MURR's global impact through new multidisciplinary research and testing laboratories.



Blake Meyers elected to NAS

Blake Meyers, a professor of plant science and technology, was elected as a member of the National Academy of Sciences — one of the highest honors a scientist can receive. His research focuses on the analysis of small RNAs in plants. He has led the development and application of DNA sequencing technologies to make fundamental

discoveries about the biology of plants, including mechanisms of disease resistance, function and regulation of genomes, epigenetic mechanisms and regulatory RNA. Meyers holds a joint appointment with MU and the Donald Danforth Plant Science Center.



MU generates \$5 billion in economic impact

As the state's largest and most comprehensive university, MU's reach extends far beyond campus. According to a recent economic impact report, that reach **generated \$5 billion for the state's economy** in fiscal year 2021; supported 49,937 direct and indirect jobs, both full time and part time; and contributed \$281.8 million in state and local taxes.

The report also noted that MU's research generated \$988.8 million in economic impact, supported more than 6,800 jobs and produced \$55.2 million in state and local taxes. The commercialization of research and medical innovation within Missouri executed by MU and its collaborating partners, employment of world-class researchers and the attraction of federal research funding leads to significant additional economic expansion and employment. With a 25-to-1 return on investment for Missouri taxpayers, an investment in MU is an investment in Missouri.



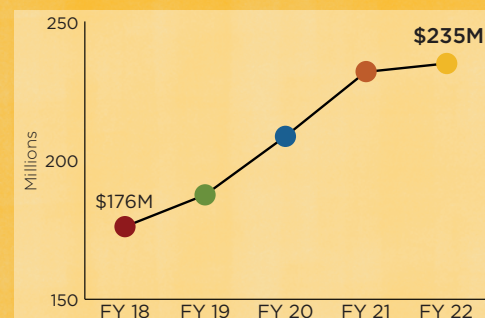
Three MU faculty named 2021 AAAS Fellows

Three MU professors were named 2021 Fellows of the American Association for the Advancement of Science for their distinguished efforts in advancing various fields of science. The recipients were **Lee-Ann H. Allen**, professor and chair of molecular microbiology and immunology, and the George Trimble Endowed Chair for Excellence in Medicine; **Susan Renoe**, associate vice chancellor for research, extension and engagement in the Division of Research, Innovation & Impact, and assistant professor of strategic communication; and **Cheryl S. Rosenfeld**, professor of biomedical sciences. The association is the world's largest general scientific society and publisher of the journal *Science*.

FY 2022 Expenditures

\$235M

Externally sponsored research expenditures



Externally sponsored research expenditures

33%

Growth over five years



Roy Blunt NextGen Precision Health building fuels MU research

Open for one year, the Roy Blunt NextGen Precision Health building is home to MU researchers making significant strides in scientific discovery and the development of important therapies, such as in the Clinical Translational Science Unit, which provides the space, staff and equipment

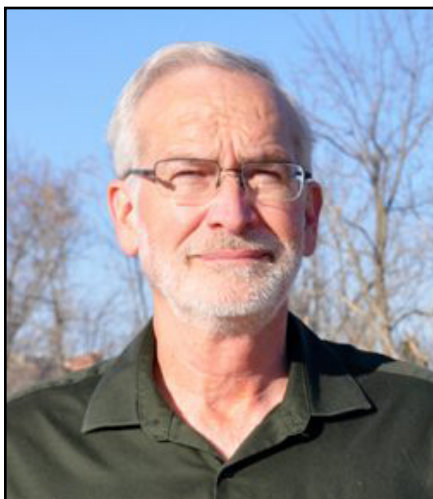
to conduct first-in-human clinical trials. The \$221 million, 265,000-square-foot NextGen building is a regional hub of life-saving research and anchors the NextGen Precision Health initiative, which is a collaborative effort to leverage the research strengths of MU and the UM System's three other research universities. NextGen researchers are focused on developing treatments and cures for some of the most pressing challenges in health care, including cancer, diabetes, heart disease, Alzheimer's, infectious diseases and infertility. In June 2022, **W. David Arnold** was named the executive director of the initiative.



Helping detect novel SARS-CoV-2 variants

Marc Johnson, professor of molecular microbiology and immunology at MU, is a member of a multi-institutional team of researchers tracking new COVID variants. The team detected at least four "cryptic" variants of SARS-CoV-2, the virus that causes COVID-19, in samples of wastewater from New York City's public sewer system. MU researchers also are working with the Missouri Department of Health and Senior Services and the Missouri Department of Natural Resources to assist Missouri officials with statewide tracking of COVID-19 using human waste.





Prather's work paves historic path

When news broke earlier this year about the first-ever partial heart transplant that saved a 2-week-old baby, reports didn't include the deeper story — that the surgery was made possible by technology pioneered 20 years ago using pigs from MU.

Randall Prather, a Curators' Distinguished Professor and director of the National Swine Resource and Research

Center, has been working behind the scenes for decades on genetically modifying pigs to prevent diseases that threaten both swine and humans. Recently, his research with pigs has been directly linked to successful transplants in humans, including a transplanted pig heart into a human patient. The transplant success stories are another example of how Prather's longtime work with pig genetics has helped make MU the go-to source for genetically modified pigs used worldwide to push discoveries forward. Years of research in Prather's lab have helped create pigs that are now used to study a range of ailments, including cystic fibrosis, retinitis pigmentosa and cancer. Many other technologies have been developed as well, such as those to develop a heart and kidney that resist hyperacute rejection after transplant.

Joining the fight against non-small cell lung cancer

MU researchers are identifying new minimally invasive biomarkers to develop a blood test for the early detection of non-small cell lung cancer, one of two main types of lung cancer. This blood test also could help identify potential drug resistance in patients in more advanced stages of the disease. **Chiswili Yves Chabu**, an assistant professor of biological sciences, and his team have been addressing the pressing need for strategies to detect lung cancer early when the survival chances are significantly greater. The new method could potentially complement other existing diagnostic approaches, such as lung imaging, to reliably detect lung cancer very early.



Using recycled plastics to make the roads of tomorrow

MU researchers are adding different recycled materials to create sustainable asphalt that is stable, economical and easily produced. Led by **Bill Buttlar**, the Glen A. Barton Chair in Flexible Pavement Technology in civil and environmental engineering, researchers in the Mizzou Asphalt Pavement and Innovation Lab are examining how adding different recycled materials to asphalt can change the pavement. The lab is testing what happens to asphalt when recycled plastics from single-use packaging are added to the mix, including real-world testing on a 4-mile stretch in Columbia.

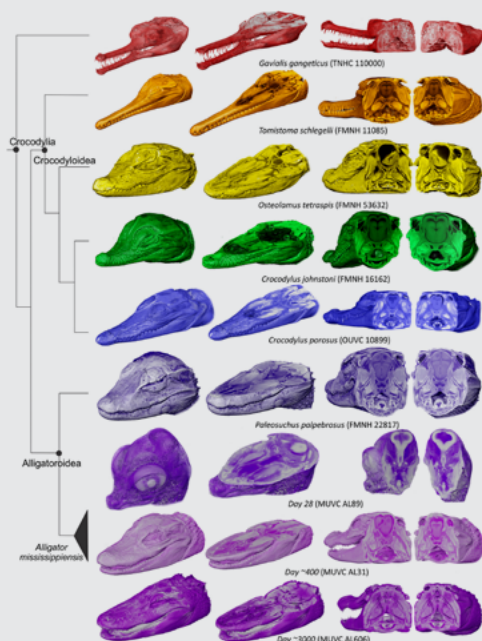




From analog to digital

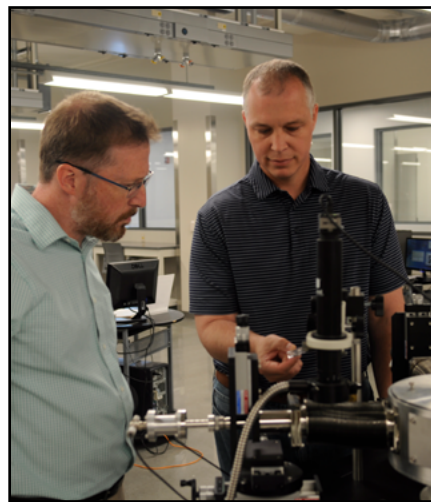
Instead of scalpels or scissors for anatomical research, MU researchers are applying artificial intelligence (AI) to see inside an animal or a person — down to a single muscle fiber — without ever making a cut.

Casey Holliday, an associate professor of pathology and anatomical sciences, is using the high-tech approach in his lab to study the bite force of a crocodile and other research topics. AI can teach computer programs to identify a muscle fiber in an image, such as a CT scan. Then, researchers can use that data to develop detailed 3D computer models of muscles to better understand how they work together in the body for motor control.



Signaling 'stressed-out' plants

An MU plant scientist has discovered a new way of measuring stress in plants, which comes at a time when plants are experiencing multiple stressors from heat, drought and flooding because of extreme weather events. The discovery involves a once-maligned collection of molecules called reactive oxygen species (ROS), which are produced by anything that uses oxygen. But **Ron Mittler**, Curators' Distinguished Professor of Plant Science and Technology, has uncovered a redeeming quality of ROS — their role as a communication signal that can indicate whether plants are stressed out. His ongoing work is uncovering a new view on the importance of ROS and the relation of plant stress to crop loss.



Explainable AI framework might speed up the innovation process

Derek Anderson, an associate professor of electrical engineering and computer science, and **Matt Maschmann**, an associate professor of mechanical and aerospace engineering, are embodying the age-old adage of “work smarter, not harder” by using artificial intelligence (AI).

Supported by a two-year, \$4.875 million grant from the U.S. Army Engineer Research and Development Center, the duo is developing a theoretical framework around “explainable AI” to describe how the next generation of AI can be integrated into the innovation process for designing new and existing materials.



Elevating voices

Cristina Mislán, an associate professor of journalism studies, is exploring the impact of climate and environmental disasters on marginalized communities in New Orleans and the Gulf Coast and how those events are covered by media. She is also examining how members of those communities are taking action, enduring the conditions and speaking out. Mislán plans to

extend her research to Puerto Rico and compile her findings into a creative nonfiction book, written for a broader audience.



Cosmic dust

Aigen Li, a Curators' Distinguished Professor of Astronomy, is studying images taken by NASA's James Webb Space Telescope of a galaxy named M82 — located 12 million light years away from Earth — in a search for answers to the mysteries of space. After examining more than 10 hours of infrared images and data from the M82 galaxy, Li will use the information he collects for his research in understanding the important role cosmic dust plays in the formation of stars and galaxies.



MizzouForward: investing \$1.5 billion into MU

Announced earlier this year, the boldest plan in the university's history — **MizzouForward** — is already showing results. The 10-year, \$1.5 billion plan is using existing and new resources to recruit new faculty, enhance staff to support the research mission, build and upgrade research facilities and instruments, augment support for student academic success, and retain faculty and staff through additional salary support. The university has welcomed more than 30 new MizzouForward tenured or tenure-track faculty in seven schools and colleges, and almost all of them have brought existing federally funded projects to supplement the great work already happening at MU. These faculty are focused on priority research areas for the National Institutes of Health, the National Science Foundation, the Department of Energy, the Department of Defense and more.

30+

MizzouForward faculty hires



Personalizing the fight against flu

While emerging viruses might overshadow the annual flu season, the virus continues to be a top priority for **Henry Wan**, a virologist at MU, who believes understanding and preventing influenza is paramount. Wan's long-term goal is to customize the annual influenza vaccine into personalized medicine. As the director of the NextGen Center for Influenza and Emerging Infectious Diseases — which opened in late 2022 — Wan is working to make his goal a reality. The \$6.5 million project includes space for replicating both extreme hot and cold climates, which is an important factor in the study of infectious disease transmission.



MU explores how to boost science education, literacy

MU researchers are applying \$12 million in grants from the U.S. Department of Education to use a video game to teach science lessons to middle schoolers and also develop speech recognition software to improve literacy outcomes for second graders. **James Laffey**, professor emeritus of education and human

development, and his team are partnering with MU's eMINTS National Center and the Missouri Research and Education Network to expand his video game to more classrooms across the country. **Betsy Baker**, a professor of education and human development, also is working with eMINTS on her speech recognition software that takes a talk-to-read approach with students.



Building 'smart' for a sustainable future

An interdisciplinary team of **MU researchers spanning arts and science, business and engineering** is designing "smart buildings." The researchers are innovating how a building's energy use is detected, analyzed and optimized to decrease greenhouse gas emissions and energy consumption. Buildings account for 40% of the United

States' energy consumption, and smart buildings can integrate building modeling, simulation and sensor technology to contribute to a more environmentally sustainable world.



MU study highlights how electronic records may improve patient care

When a patient gets transferred from a hospital to a nearby specialist or rehabilitation facility, it is often difficult for personnel at the new location to access the patient's electronic health records. A study led by **Kate Trout**, an assistant professor of health sciences, highlights how the use of electronic health records has resulted in better quality of care. The study also can direct the next steps of government programs to ensure various health care organizations use electronic health records to quickly access a patient's records, reduce waste and speed up decision-making to improve patient health outcomes.



The future of finance

MU finance professors are exploring research shaping the future of investing and trading, from machine learning to the importance of Cushing, Oklahoma. The separate projects of **Michael O'Doherty, Kuntara Pukthuanthong, Michael Young** and **Kateryna Holland** include collecting information about stock returns from 39 developed countries to discover whether stocks are riskier-than-thought investments; examining Cushing's crude oil storage facility and its effect on crude oil prices; using machine learning to predict stock returns from news photos; and studying how terrorist activity in the U.S. over the past three decades influences investors.



FY 2022

Technology Advancement

107

**New inventions
disclosed**

17

**U.S. patents
issued**

63

**Technologies
licensed and
optioned by
commercial
partners**



Past suffering can affect future praise

An interdisciplinary team of MU researchers — including **Philip Robbins**, an associate professor and chair of philosophy, and **Paul Litton**, interim dean of law — discovered that people tend to give more praise to someone for their good deeds as an adult after discovering that person also has had to overcome adversity or suffering earlier in life, such as abuse and neglect as a child. The findings can help to narrow a knowledge gap found in both psychology and philosophy, two disciplines that study human behavior.



Study examines how texting may help reduce avoidable hospitalizations from nursing homes

Kimberly Powell, an assistant professor of nursing, is leading an MU research team that is examining how a common form of communication — texting — can be used by nursing home staff to speed up decision-making and prevent the decline of residents' health that can lead to costly and traumatic hospital transfers. The team is analyzing the effectiveness of a HIPAA-secure text messaging platform used in an earlier study by staff in 16 Missouri nursing homes that could help nursing homes across the country adopt similar technology to improve the quality of care delivered to their residents.



Service through business ownership

MU is one of only six universities in the country that offers the **Entrepreneurship Bootcamp for Veterans (EBV)** program, which provides post-9/11 veterans with no-cost entrepreneurial training and small business management skills. Nineteen veterans from across the country completed a 30-day online business course before spending a week this

summer on the MU campus for the residency portion of the program. The national EBV program relies on its consortium of university partners to provide a rigorous and intense curriculum each year.



Largest MU federal grant to help Missouri farmers

Rob Myers, an adjunct associate professor of plant science and technology, is leading a team of researchers who are using a \$25 million U.S. Department of Agriculture grant — the largest federal research, education and extension grant ever awarded to MU — to help farmers adapt to the changing climate. The five-year project is aimed at helping Missouri farmers adopt climate-smart practices to improve the resiliency of their crops and livestock. The collaborative grant includes working with partners across the state.

FY 2022 By the Numbers

12

Research centers

16

Advanced technology cores

54

Arts and humanities/ research development fellows

33

MU faculty authors
(2021)



Examining drug patents

Brand drug companies are sometimes villainized for “evergreening” or manipulating the law to extend the period of exclusivity for drugs beyond their 20-year patent, a practice critics say unfairly prevents competition from generic drug companies. But a study co-authored by **Erika Lietzan**, William H. Pittman Professor of Law and Timothy J. Heinsz Professor of Law, of more than 200 drugs found generic versions of all the drugs were available before their patents expired, raising questions about data being used by policymakers to prove evergreening exists.



MU faculty publish creative works

Thirty-three MU faculty members were celebrated for publishing 31 books and disseminating their research to the broader community. The scholarly works included collections of short stories and covered topics such as agroforestry and ecosystem services, T. S. Eliot, machine learning and artificial intelligence in marketing and sales, Missouri history and the power of love, among others.



Interdimensional collaboration

MU researchers in various disciplines are using virtual reality, augmented reality, mixed reality and artificial intelligence to enter the **metaverse** and explore new research, push technical boundaries and expand classroom concepts. MU work in the metaverse includes textile and apparel management students testing new products using avatars in virtual settings, and health professions researchers improving the health and well-being of adults through smart, home-based technology.

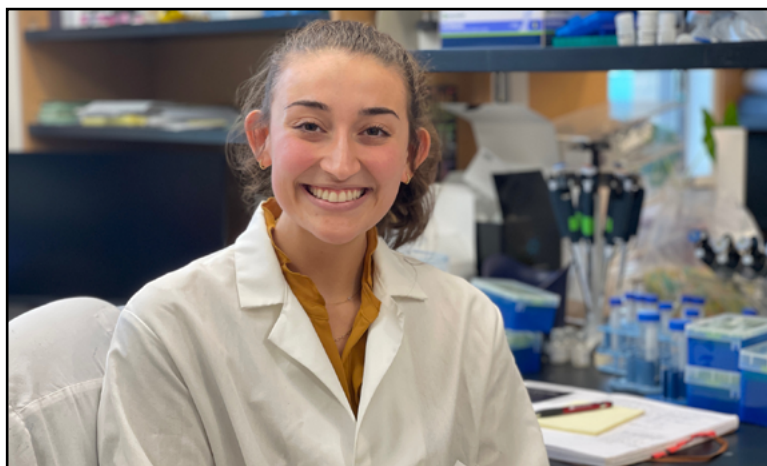


The students behind his research

Hongbin “Bill” Ma, chair of mechanical and aerospace engineering, has many achievements to credit from his research, and Ma is fostering the next generation of researchers and creators. Students are currently helping Ma work on research projects that involve heat pipes for supersonic vehicles, greenhouses that will lower the temperature in the summer, a gas-powered hot water heat pump system, drink-now coffee mugs and evaporative cooling technology for air conditioners.

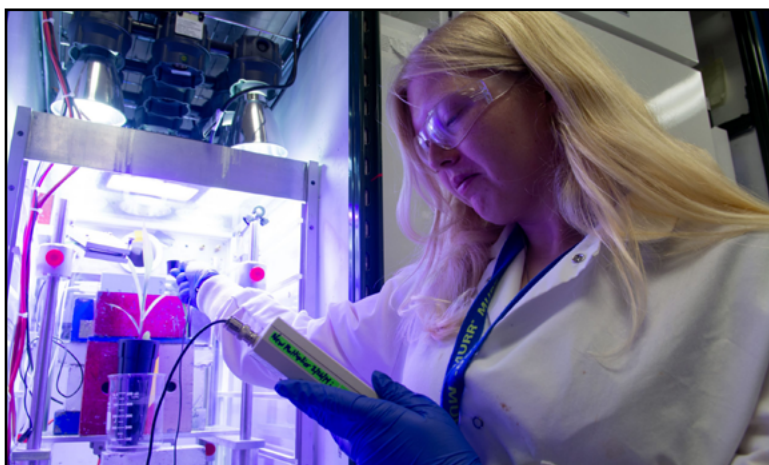
Student builds foundation for career as a physician

Leah Lepore, a junior biochemistry major, works for MU-based biotechnology startup Shift Pharmaceuticals in the Bond Life Sciences Center under Chris Lorson, professor of veterinary pathobiology and co-founder and chief scientific officer of Shift. Lepore is part of a team working on a novel therapy for people affected by Charcot-Marie-Tooth Type 1A, a disease that affects one in 2,500 people.



Sophomore's path includes becoming MU study author

Richard Ferrieri, a research professor of chemistry, and a team of MU researchers are examining the impact of smoke on plant growth after a wildfire. The team added liquid smoke to the soil where a plant is growing and found it could enhance the plant's natural defenses and increase its ability to resist pests and diseases. **Randi Noel**, a sophomore plant sciences major, was first author on a study about the discovery published in the *International Journal of Molecular Sciences*.





Research, Innovation & Impact

University of Missouri

New programs support MU research, scholarly activity

Since the start of the year, MU has invested in several new Division of Research, Innovation & Impact programs to increase the quantity and quality of proposal submissions, and strengthen collaborative, cross-disciplinary and team proposal submissions. Supported by the MizzouForward initiative, MU established the **Strategic Proposal Development Service** to support faculty and generate new research and scholarly activity grants and funding. The 10-person team assists MU researchers and scholars with large or strategically important grant proposals. Since its beginning earlier this year, the program has helped researchers and scholars prepare more than \$100 million in grant proposals. The division also is offering new educational and professional development programs and providing resources, support and training through its Research Development Fellows, Arts and Humanities Research and Creative Works Fellows, NSF CAREER Club, The Connector, Broader Impacts, Research Analytics and a new division website.

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