Building interdisciplinary collaborations among researchers at Mizzou, the network of universities in the University of Missouri System, outside institutions and industry partners is key to leveraging our discoveries. Commercialization of products is also supported by the robust ecosystem at Mizzou that supports the entrepreneurial spirit while building the crucial ties to businesses that enhance and elevate discoveries and bring them to market — products that tackle the grand challenges facing Missourians, the nation and the world.

Our faculty, staff and students are at the heart of early-stage innovation at Mizzou, and this booklet recognizes this year’s inventors. Together with our Technology Advancement Office, MU innovators work to promote discoveries from bench to marketplace and into the hands of consumers.

As the senior research administrator for MU, it is my role to ensure that researchers are in the best possible positions to produce exciting advancements in life sciences and agriculture, engineering, and health sciences among other fields. I also endeavor to spark innovation through the development of collaborations and partnerships creating the collisions necessary among researchers and innovators that help produce marketable technologies.

In 2018, Chancellor Cartwright set the ambitious goal of doubling the university’s research funding over five years. Just over a year and a half later, we’ve announced that our grants from federal funders as well as business and industry investments have contributed to an increase in grant funding of $48 million over the previous fiscal year. Additionally, Mizzou experienced a 29% increase in grant proposals totaling more than $1 billion. These increases will provide the revenues that will increase research output and boost economic development in the region and state. MU’s research enterprise as a whole remains robust. Internal research investments and extramural funding support generated more than $210 million in research expenditures in FY2019. Newly awarded dollars, most coming in the form of highly competitive grants from agencies such as the National Institutes of Health and the National Science Foundation, also saw solid year-over-year gains.

Research initiatives and funding generate faculty innovations, some of which are licensed, patented and further developed in commercial settings. In FY19, Mizzou signed 61 license and option agreements with companies and was issued 40 U.S. patents. In fact, during the last three years, MU’s licensing income totaled more than $12.8 million. Faculty inventors receive a portion of this revenue along with their departments. Mizzou’s portion is reinvested in education and in upgrading our research and technology infrastructure, thus laying the groundwork for future breakthroughs.

We are making great strides to maximize the investments the citizens of Missouri make in our land grant, AAU institution. I hope you will share your ideas for growing our research enterprise at umcresearch@missouri.edu.

Sincerely,

Mark A. McIntosh
MU Vice Chancellor for Research and Economic Development
LAUNCHING MIZZOU TECH

The MU Office of Research and Economic Development welcomes Lisa Lorenzen, Assistant Vice Chancellor, Technology Advancement Office (TAO). Lorenzen, who joined the Mizzou family in 2019, is leading university efforts to leverage the commercial potential of faculty research innovations (often called tech transfer).

Lorenzen most recently served as both executive director of the Iowa State University Research Foundation and director of the Office of Intellectual Property and Technology Transfer at Iowa State.

“Lisa has 20 years of experience in many aspects of economic development, especially in academic commercialization and industry partnerships,” said Mark McIntosh, vice chancellor for research and economic development. “Her background in plant sciences as a computational biologist for Pioneer Hi-Bred International combined with her contract negotiation skills and ability to manage multimillion-dollar research collaborations will greatly enhance the tech transfer process at Mizzou.”

Licensing, Options and Startups in FY2019

STARTUP COMPANIES CREATED WITH MU-LICENSED TECHNOLOGIES

Intelligent Respiratory Devices LLC is developing a technology solution that learns from each patient to automatically control oxygen in premature and low-birth-weight infants. MU inventors: Ramak R. Amjad, Roger Clayton Fales and Timothy Klein

Oncogen LLC is a biotechnology company developing breakthrough targeted therapeutics for cancer. Its proprietary nanoparticle platform delivers chemotherapeutics to tumors with unprecedented precision; thus, increasing treatment efficacy and decreasing overall toxicity. MU inventors: Raghu Raman Kannan, Anandith Upadran and Aijt Prakash Zambre

Peridot Films LLC holds the license and copyright for the independent feature film Peridot about an Apache man in eastern Arizona. MU inventor: Stephen Christian Rozier

Plasmadigm LLC is a company that will commercialize self-confining atmospheric plasmas. The technology was funded by the Office of Naval Research at MU and then spun off for advanced applications. MU inventor: Randy Curry

Quetzal LLC is an educational technology company focused on developing data-driven, highly interactive and engaging software applications for the animal sciences. MU inventors: Maria Haag, William R. Lamberson and Justin Le Tourneau.

Did You Know?

The UM System has made the list of “Top 100 Worldwide Universities Granted U.S. Utility Patents” annually since the National Academy of Inventors and the Intellectual Property Association began publishing it in 2013.
MU Inventors With U.S. Patents Issued in FY2019

ANIMAL & PLANT BIOTECHNOLOGY

Immune-cell-deficient, transgenic, cloned miniature pig

Transgenic swine are used to study human disease, development, progression and treatment of diseases and strategies for tissue and organ transplants.

Patent 10,058,079: MU inventors Randall S. Prather and Khoi Lee

Genetically modified swine resistant to the porcine respiratory and reproductive syndrome virus

PRRS is a viral disease that causes reproductive failure and respiratory tract illness leading to widespread death in herds, costing the swine industry billions annually. PRRS-resistant pigs have been developed and are being commercialized.

Patents 10,080,553 and 10,091,975: MU inventors Randall S. Prather, Kevin D. Wells and Kristin M. Whitworth

Artificial activation of unfertilized mammalian oocytes, or egg cells

An approach for more efficient livestock cloning that yields more yolk cells than with the same number of eggs from embryo transfer.

Patent 10,190,093: MU inventors Khoi Lee and Randall S. Prather

Sperm stimulating additive

This semen preservation technique increases efficiency of livestock artificial insemination, a necessity for increased meat production.

Patent 10,070,889: MU inventors Peter Sutovsky and Young-Joo Yi

Transgenic plants resistant to cyst nematodes

Cyst nematodes, notably in U.S. Crop yield losses. Genes have been identified that provide resistance to nematodes in soybean, potato and other valuable crops.

Patents 10,231,383 and 10,246,722: MU inventors Melissa Jessop, Darin C. Bohn, Amy Bestop, and Jan-hyung Wang

Patents 10,294,489 and 10,070,614: MU inventors Pramod Jalisatgi, Marion Frederick Hawthorne and Alexander V. Safonov

Peptide-based compounds for melanocyte-stimulating purposes.

Cyclic peptides that bind to melanocyte-stimulating, hormone-producing melanoma allow clinicians to image and detect noninvasively and treat melanomas and their metastatic spread.

Patent 10,265,428: MU inventor Yubin Mao

Borane compounds for cancer treatment

This inexpensive chemical process enables commercial production of boron compounds that can be used in Boron Neutron Capture Therapy (BNCT) for treatment of invasive, malignant cancer tumors.

Patents 10,018,939 and 10,179,795: MU inventors Satish S. Jalali, Marina Francesco Hawthorne and Alexander V. Safonov

Cholesterol biosynthesis inhibitors

As agents to treat tumors

A repurposed small molecule targets the cholesterol biosynthesis pathway for the treatment of cancer.

Patent 10,143,418: MU inventors Ethan M. Tudor, Yanmin Liang, Xiaoqian Zhou, Sam Z. Grinstein and Sheng-Yao Huang

Gold multicomponent nanomaterials
to detect and treat cancer

Gold nanoparticles with cancer targeting, imaging and therapeutic properties are used to diagnose and treat EGFR-expressing cancers.


Heart-disease therapy targeting KCNQ channels

Products that inhibit production of KCNQ channels treat heart disease or epilepsy.

Patent 10,064,842: MU inventor Xiaoqian Zhou

A treatment for Q fever

Veterinarians, farmers, processors, and others who work with livestock can receive this biologic treatment against the listerioybaccharid of Coxiella burnetii, which causes Q fever, a worldwide zoonotic infection.

Patent 10,233,213: MU inventor Guoquan Zhang

Nocturnal gastrointestinal disorder treatment

Administration of buffered proton pump inhibitor controls nocturnal gastric acid disorders.

Patent 10,045,973: MU inventor Jeffrey G. Phillips

Pain management using novel carbon-based sodium channel blockers

Demonstrates how carbon-based sodium channel blockers can treat acute pain.

Patent 10,202,780: MU inventors George R. Krocke, Yula Stevruyagina and Marion Frederick Hawthorne

Activity analysis, fall detection and risk assessment

An integrated sensor network and associated risk assessment algorithms alert caregivers about changes in an elderly person's gait and activity patterns, possible indicators of physical and cognitive health problems.


A nonthermal, plasma gas device for dental treatments

Surface Heat treatment device uses cold atmospheric plasma to improve the clinical performance, durability and longevity of dental fillings, crowns and other procedures.

Patent 10,299,887: MU inventors: Qingsong Yu and Hao Li

High-resolution 3D tissue imaging using optical polarization tractography

This medical imaging platform visualizes early tissue abnormalities at the cellular level in skeletal muscles, nerves, teeth, cartilage, heart muscles and blood vessels, which enables diagnosis and prediction of diseases, such as coronary artery disease associated with an increased risk of heart attack.

Patent 10,131,045: MU inventors: Gang Yao, Dongsheng Duan and Yubo Wang

Detection of sepsis and other bacterial infections

An approach for more efficient livestock cloning that yields more live births with the same number of in vitro embryos transfer.

Patent 10,101,059: MU inventors Hongbin Ma and Peng Cheng

High energy-density atomic micro battery

This lightweight, long-life nuclear micro battery is designed for use in space applications.

Patent 10,082,770: MU inventors: Jee Wan Kwon, John David Robertson and Tungtewei Wacharasindhu

Separation of chemically pure osmium from metal mixtures

Improved process separates osmium from production byproducts. Osmium can be used as a target for the production of radioisotopes in cyclotrons or reactors.

Patent 10,087,530: MU inventors: Leonard Marion III, Stacy L. Wilde, Hendrik P. Engelbrecht and Cathy S. Cutler

Low-temperature production of zinc oxide nanowire

These high-quality nanowires can be grown on virtually any substrate at a reduced cost for use in photovoltaics, piezoelectric devices and other applications.

Patent 10,026,111: MU inventors: Jee Wan Kwon and Baek Hyun Kim

Nano-gap grading devices with enhanced optical properties

This technology allows users to view single molecules using a relatively inexpensive microscope instead of a costly confocal microscope.


Manufacturing multilayer nanograting structures

This is an improved fabrication method for making nano-gap grading devices.

Patent 10,033,357: MU inventors: Shubhra Gangopadhyay, Sangho Bok, Sam illah Pathan, Chiran Joseph Mathai, Saginik Basuray, Keshab Gangopadhyay, Byian Chen, Sheila Grant and Aaron Wood

Thermally driven heat pump

This heat pump includes a low-temperature evaporator for evaporating cooling fluid to remove heat.

Patent 10,010,059: MU inventors Hongbin Ma and Peng Cheng

Diagnostic & Detection

Detection of multiple bacterial species

A rapid, accurate and low-cost PCR-based assay screens for bacterial contamination in food and antibiotic-resistant bacteria in medical samples.

Patent 10,901,177: MU inventors Aizin Mustapha and Prashant Singla

Therapeutically and Prophylactically Active Compounds

Nanoparticle-based single molecule nucleic acid detection

Diagnostic platform provides sensitive and selective detection and quantification of nucleic acids for applications in agriculture, plant, and human health.

Patent 10,273,527: MU inventors Li-Qun Gu, Yong Wang and Kai Tian

Fluorescent chemical sensors for biological amines

This fluorescent chemical sensor enables the detection and visualization of select neurotransmitters in the brain.


Detection of multiple bacterial species in biological or food samples

This biosensor array can rapidly detect and quantify bacteria at low concentrations from surfaces swabbed at places like hospitals and food processing plants.


Tissue storage and preservation

This tissue preservation system more than doubles the storage time and increases the total viability of orthopedic grafts and tissues used in bone and tissue transplants, leading to more successful surgeries and increasing the supply of available grafts.

Patent 10,039,277: MU inventors: James L. Cook and Aaron M. Stoker

Tapered ostecochondral allograft device

This orthopaedic medical device creates a tapered bone and cartilage implant for the knee with a matching joint cavity that reduces surrounding tissue damage and improves surgery outcomes.

Patent 10,085,970: MU inventors: Ferns M. Pfeffer, Aaron M. Stoker and James L. Cook

Weightlifting machine enabling independent control of eccentric and concentric movements

Device focuses muscle strength training on the eccentric (weight lowering) rather than concentric (weight lifting) motion for improved strength building.


ENGINEERING SOLUTIONS
THERAPEUTICS & TREATMENTS

Peptide-based compounds for melanoma treatment
Cyclic peptides that bind to melanocyte-stimulating, hormone-producing melanoma allow clinicians to image and detect noninvasively and treat melanomas and their metastatic spread. Patent 10,265,426: MU inventor Yulin Mao

Borane compounds for cancer treatment
This inexpensive chemical process enables commercialization of boron compounds that can be used in Boron Neutron Capture Therapy (BNCT) for treatment of invasive, malignant cancer tumors. Patents 10,105,899 and 10,179,795: MU inventors Satish S. Jalasatagi, Marian Frederick Hawthorne and Alexander V. Safonov

Gold multicomponent nanomaterials as agents to treat tumors
A reprogrammed small molecule targets the cholesterol biosynthesis pathway for the treatment of cancer. Patent 10,144,113: MU inventors Prabhas P. M. Nukera, Yayan Liang, Xiaoqiong Zou, Sam Z. Gilter and Shang-You Huang

Cholesterol biosynthesis inhibitors to detect and treat cancer
Gold nanoparticles with cancer targeting, imaging and therapeutic properties are used to diagnose and treat EGFR-expressing cancer. Patent 10,317,400: MU inventors Rathugran Kannan, Ajit Zambre and Anandh R. Upendran

Heart disease therapy targeting KCNQ1 channels
A peptide-based compound targets KCNQ1 channels to treat heart disease or epilepsy. Patent 10,064,842: MU inventor Xiaojian Zou

A treatment for Q fever
Veterinarians and farmers, and others who work with livestock can receive this biologic treatment against the lopetysaccharide of Coxiella burnetii, which causes Q fever, a worldwide zoonotic infection. Patent 10,213,215: MU inventor Guojun Zhang

Nocturnal gastrointestinal disorder treatment
Administration of buffered proton pump inhibitor controls nocturnal gastric acid disorders. Patent 10,045,973: MU inventor Jeffrey G. Phillips

Pain management using novel carboxane-based sodium channel blockers
Demonstrates how carboxane-based sodium channel blockers can treat acute pain. Patent 10,202,776: MU inventors George P. Krocke, Yula Seryugina and Marion Frederick Hawthorne

Activity analysis, fall detection and risk assessment

A nonthermal, plasma gas device for dental treatments
Surface Heating (SH) device uses cold atmospheric plasma to improve the clinical performance, durability and longevity of dental fillings, crowns and other procedures. Patent 10,299,887: MU inventors: Qingsong Yu and Hao Li

High-resolution 3D tissue imaging using optical polarization tractography
This medical imaging platform visualizes early tissue abnormalities at the cellular level in skeletal muscles, nerves, teeth, cartilage, heart muscles and blood vessels, which enables diagnosis and prediction of diseases, such as coronary artery disease associated with an increased risk of heart attack. Patent 10,131,049: MU inventors: Ganguo Yu, Dongsheng Duan and Yuanbo Wang

Rapid detection of sepsis and other bacterial infections
Detects sepsis in biological fluids in 24 to 36 hours by using high-throughput screening methods to measure the change in capacitance of growing bacteria. Patent 10,273,922: MU inventors: Shamik Gangopadhyay and Sachin Patwardhan

Impedance sensor for bacteria detection
This biosensor array can rapidly detect and quantify bacteria at low concentrations from surfaces swabs taken at places like hospitals and food processing plants. Patent 10,274,492: MU inventors: Mahmoud Almasri, Shibayan Chakma, Shuang Wang, Majed El Dweik, Nad Sadi Yuksei, Ibrahim Jasim and Jaiyu Liu

Tissue storage and preservation
This tissue preservation system more than doubles the longevity of dental fillings, crowns and other procedures. Patent 10,039,277: MU inventors: James L. Cook and Aaron M. Stoker

Tapered osteochondral allograft device
This orthopedic medical device creates a tapered bone and cartilage implant for the knee with a matching joint cavity that reduces surrounding tissue damage and improves surgery outcomes. Patent 10,080,970: MU inventors: Fergus M. Pfeiffer, Aaron M. Stoker and James L. Cook

Weightlifting machine enabling independent control of concentric and eccentric movements

Thermally driven heat pump
This heat pump includes a low-temperature evaporator for evaporating a cooling fluid to remove heat. Patent 10,101,059: MU inventors: Hongbin Ma and Peng Cheng

High energy density atomic micro battery
This lightweight, long-life nuclear micro battery is designed for use in small medical devices and implantable medical devices. Patent 10,082,770: MU inventors: Jae Wan Kwon, John David Robertson and Tungtwee Wacharasindhu

Separation of chemically pure osmium from metal mixtures
Improves separation processes of metal mixtures used in industrial products. Osmium can be used as a target for the production of other metallic elements. Patent 10,087,503: MU inventors: Leonard Manson III, Stacy L. Wilder, Hendrik P. Engelbrecht and Cathy S. Cutler

Low-temperature production of zinc oxide nanowire for use in micro electromechanical systems
This technology allows users to view single molecules using a relatively inexpensive microscope instead of a costly confocal microscope. Patent 10,073,203: MU inventors: Shubhra Gangopadhyay, Venumadhav Korampally, Sagnik Basuray, Keshab Gangopadhyay and Prashant Singhal

Nano-gag grading devices with enhanced optical properties
This technology allows users to view single molecules using a relatively inexpensive microscope instead of a costly confocal microscope. Patent 10,073,203: MU inventors: Shubhra Gangopadhyay, Venumadhav Korampally, Sagnik Basuray, Kunal Bob, Samiullah Pathan, Cherian Joseph Mathai, Prashant Singhal, Sagnik Basuray, Keshub Gangopadhyay, Bijan Chen, Sheila Grant and Aaron M. Stoker

Manufacturing multi-layer nanograting structures
This is an improved fabrication method for making nanograting arrays. Patent 10,103,357: MU inventors: Shubhra Gangopadhyay, Sangho Bok, Samual Nath Paton, Cherian Joseph Mathai, Sagnik Basuray, Keshub Gangopadhyay, Byian Chen, Sheila Grant and Aaron M. Stoker

Fluorescent chemical sensors for biological amines
This fluorescent chemical platform enables the detection and visualization of select neurotransmitter amines in real-time. Patent 10,222,390: MU inventors: Timothy Glass and Kenneth Hette; Patent 10,301,673: MU inventors: Timothy Glass, Kevin Gillis and Kenneth Hette

Detection of multiple bacterial species in biological or food samples
A rapid, accurate and low-cost PCR-based assay screens for bacterial contamination in food and antibiotic-resistant bacteria in medical samples. Patent 10,901,177: MU inventors: Asin Mustapha and Prashant Singhal
MU inventors with technologies licensed to a company

- Laila Al-Khashti
- Mitchell Allen
- Ramak R. Amjad
- Jerry L. Atwood
- Andrew Biggs
- Pengyin Chen
- Michael Wayne Clubb
- Joan R. Coates
- James L. Cook
- Melissa Crisel
- Randy Curry
- Joshua Dakota
- Dongsheng Duan
- Roger Clayton Fales
- Kevin Gillis
- Timothy Glass
- Erin Grannemann
- Maria Haag
- Christy Hultton
- Gary S. Johnson
- Raghuraman Kannan
- Timothy Klim
- Yi Lai
- William R. Lamberson
- Justin Le Tourneau
- Teresa E. Lever
- Lila Zare

STARTUP COMPANIES CREATED WITH MU-LICENSED TECHNOLOGIES

- Intelligent Respiratory Devices LLC: develops a technology solution that learns from each patient to automatically control oxygen in premature and low-birth-weight infants. MU inventors: Ramak R. Amjad, Roger Clayton Fales and Timothy Klim

MU inventors with technologies optioned to a company

- Syed Barzuddin
- Sagun Basuchandran
- Kunal Bhatnagar
- Sangho Bok
- Bhurin Chen
- Gary Francis Clark
- Peter Cornish
- Reza Esfandi
- Keshab Gangopadhyay
- Shubhra Gangopadhyay
- Ambar Ghosh
- Shaen Feng
- Alysa Grant
- William A. Jacoby
- Venu Mohan
- Korampally
- Chenn Joseph
- Matha
- Drew Edwin Menke
- Avinash Pathak
- Samullah Pathan
- Valery A. Petrenko
- Thomas P. Quinn
- George P. Smith
- Aaron J. Wood
- Xiaoqin Zou

Did You Know?

The UM System has made the list of “Top 100 Worldwide Universities Granted U.S. Utility Patents” annually since the National Academy of Inventors and the Intellectual Property Association began publishing it in 2013.
Building interdisciplinary collaborations among researchers at Mizzou, the network of universities in the University of Missouri System, outside institutions and industry partners is key to leveraging our discoveries. Commercialization of products is also supported by the robust ecosystem at Mizzou that supports the entrepreneurial spirit while building the crucial ties to businesses that enhance and elevate discoveries and bring them to market – products that tackle the grand challenges facing Missourians, the nation and the world.

Our faculty, staff and students are at the heart of early-stage innovation at Mizzou, and this booklet recognizes this year’s inventors. Together with our Technology Advancement Office, MU innovators work to promote discoveries from bench to marketplace and into the hands of consumers.

As the senior research administrator for MU, it is my role to ensure that researchers are in the best possible positions to produce exciting advancements in life sciences and agriculture, engineering, and health sciences among other fields. I also endeavor to spark innovation through the development of collaborations and partnerships creating the collisions necessary among researchers and innovators that help produce marketable technologies.

In 2018, Chancellor Cartwright set the ambitious goal of doubling the university’s research funding over five years. Just over a year and a half later, we’ve announced that our grants from federal funders as well as business and industry investments have contributed to an increase in grant funding of $48 million over the previous fiscal year.

Additionally, Mizzou experienced a 29% increase in grant proposals totaling more than $1 billion. These increases will provide the revenues that will increase research output and boost economic development in the region and state. MU’s research enterprise as a whole remains robust. Internal research investments and extramural funding support generated more than $210 million in research expenditures in FY2019. Newly awarded dollars, most coming in the form of highly competitive grants from agencies such as the National Institutes of Health and the National Science Foundation, also saw solid year-over-year gains.

Research initiatives and funding generate faculty innovations, some of which are licensed, patented and further developed in commercial settings. In FY19, Mizzou signed 61 license and option agreements with companies and was issued 40 U.S. patents. In fact, during the last three years, MU’s licensing income totaled more than $28.8 million. Faculty inventors receive a portion of this revenue along with their departments. Mizzou’s portion is reinvested in education and in upgrading our research and technology infrastructure, thus laying the groundwork for future breakthroughs.

We are making great strides to maximize the investments the citizens of Missouri make in our land grant, AAU institution. I hope you will share your ideas for growing our research enterprise at umcresearch@missouri.edu.

Sincerely,

Mark A. McIntosh
MU Vice Chancellor for Research and Economic Development

MU’s Entrepreneurial Ecosystem Elevates Research