2015 | Vol. 2

explore

Research at the University of Missouri-Kansas City

MAPPING COSMIC HISTORY

Discovering why galaxies grow

Photo: Student Kyle Scheel, Department of Chemistry
Photograph by: Dan Videtich

explore

2015 | Vol. 2

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UMKC

Tradition of discovery

"All truths are easy to understand once they are discovered; the point is to discover them." – Galileo Galilei

For as long as I can remember I have had an insatiable curiosity, especially about living creatures, and have been fascinated by the discovery of new things. At first, like most kids, it was insects, spiders, reptiles and the like; but, as my educational pursuits led me to microbiology, my discovery tastes became more sophisticated with my palette settling in on bacteria, fungi and viruses. For each of us it's different, but I do believe that there is something inherently human about our quest for knowledge and understanding. Whether we pursue the identification of a new bacterial species; or a new alternate splice junction in a DNA coding region; or a watermark on an unknown medieval manuscript revealing clues to the true authorship; or a "goldilocks planet" tucked away in a galaxy hundreds of light years from our own — discovery yields something that satisfies a piece of our soul.

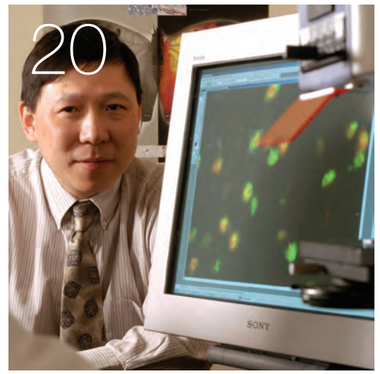
In each case, discovery is the visual reference point that peaks our imagination and satisfies our curiosity. However, discovery is not the story itself, but rather, the denouement to a creative work that may be decades in the making.

Rarely these days are discoveries the product of one individual's efforts. At minimum, a team of investigators, or multiple teams of investigators, work around the globe to contribute bits of information to an ever-increasing foundation of knowledge — like pieces to a puzzle, added bit by bit from many different angles or perspectives. Each contribution shedding more light on an object until at last, a picture emerges. When that picture is confirmed as a new and never-before-described bit of knowledge, a discovery is born. For those that choose a career of scholarship, research and the pursuit of new knowledge … this is the reason we explore!

Whether describing the evolution of the billions of galaxies that paint the portrait that is our universe; or sorting through billions of data points harboring coded clues to our health care challenges; or the structural recognition of a molecular interface that regulates our biological clock; the path to discovery starts with outstanding people — those talented, creative, hard-working individuals that display passion for their discipline. So it gives me a tremendous sense of pride to introduce to you some of the outstanding scholars, researchers and entrepreneurs from our UMKC family that make discoveries come to life. These individuals, their teams and the stories presented here in our second edition of *Explore*, are just a small, but significant, part of the excellence that is UMKC! I hope you are as inspired by their stories, as I am proud to introduce them to you.

Lawrence Dreyfus, Ph.D.
Vice Chancellor for Research and Economic Development

Welcome to
explore



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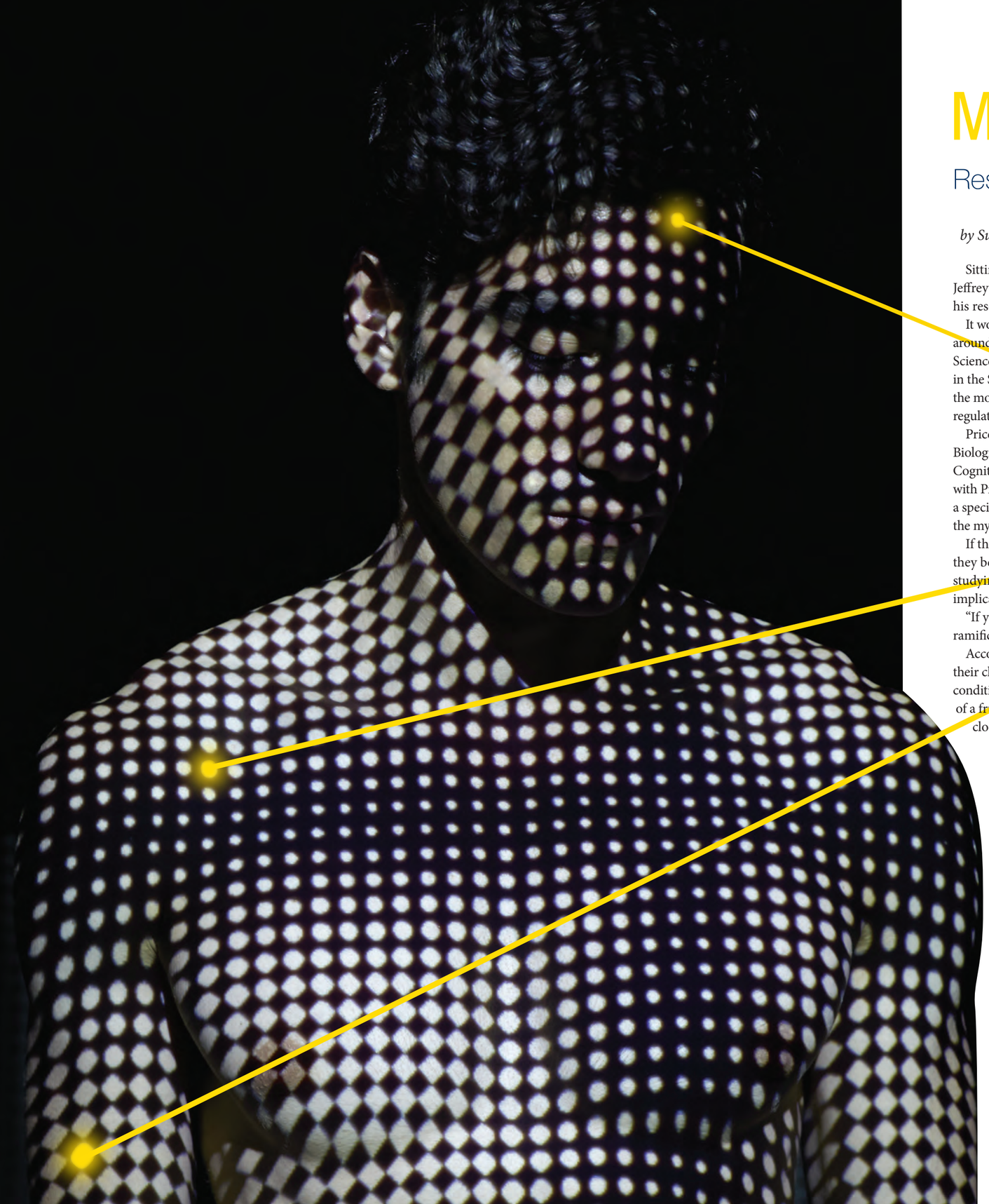


Measuring circadian rhythms

Researchers use fruit flies to discover what makes humans tick.

by Suzanne King Raney

Sitting in his office amid stacks of unkempt papers and books, Jeffrey Price must swat away a fruit fly now and then as he discusses his research.

It would probably be more surprising if there were no insects buzzing around him. Price, an associate professor of the School of Biological Sciences and the Department of Neurology and Cognitive Neuroscience in the School of Medicine at UMKC, has made his life's work studying the molecular makeup of fruit flies. He wants to figure out exactly what regulates the tiny organisms' circadian rhythms.

Price and Samuel Bouyain, the UMKC School of Biological Sciences and Department of Neurology and Cognitive Neuroscience colleague who is collaborating with Price on his current research, have zeroed in on a specific protein they believe has potential to unlock the mystery of how the fruit fly's "clock" works.

If they can figure out how to manipulate that clock, they believe the discovery could inform scientists studying human circadian rhythms, which could have implications in many areas of health research.

"If your clock is out of sync, there are very serious health ramifications," Price says.

According to research, night shift workers who don't sleep when their clock tells them to are more likely to end up with cancer, heart conditions, diabetes and other diseases. Since the molecular structure of a fruit fly circadian clock is very similar to that of a human circadian clock, the jump from bug to person probably isn't terribly far.

"I believe this is going to apply to humans," Price says.

Price and Bouyain, also an associate professor of biology, published research last year about a new protein in the neuroscience journal *Neuron*. The protein, they call "bride of double time" specifically relates to the protein "double time," that Price discovered in 1992 as a post-doc in New York.

The double time protein regulates fruit flies' circadian rhythms. But it is also tied to many other functions. If the flies don't have it, they won't survive, so turning it off isn't an option. But the bride of double time/double time pair seems to be a more specific target that could help scientists control the sleep clock without affecting anything else.

Price found the bride of double time protein three years ago, but he didn't know much about it other than the fact that it was paired with double time — and it was related to the fruit flies' circadian rhythms. As he was trying to figure out more about the new protein, he turned to Bouyain, who offices across the hall. Bouyain, who heads an X-ray crystallography lab in biological sciences, was intrigued.

"The question is, what is this protein?" Bouyain says.

He joined Price to help find an answer and eventually developed a blue print of the new protein's structure.

"My lab figured out how it looks in three dimensions," Bouyain says. "As we did this, we figured out how it might function."

The researchers hope they can move to the next step, which is understanding how the protein associates with other proteins like double time. If they can do that, there may be chemicals that can inhibit that association. And that could be the key to regulating the clock.

"Humans don't have bride of double time, but they have proteins that look like it," Price says.

And proteins that look alike often act alike, he says.

"For me, what keeps me digging, is that regulating these proteins is at the core of the clock," Price says. "My goal is to find the real gears."

Meet the researchers

Samuel Bouyain, DPhil
Associate Professor, Division of Molecular Biology and Biochemistry, School of Biological Sciences

RESEARCH INTERESTS: Molecular mechanisms that control protein phosphorylation and coordination of cell adhesion and cell signaling

JOINED UMKC: 2006

Jeffrey Price, Ph.D.
Associate Professor, Division of Molecular Biology and Biochemistry, School of Biological Sciences

RESEARCH INTERESTS: Post-translational control of circadian rhythms and the links between apoptosis and circadian rhythms

JOINED UMKC: 1999

Rebuilding a centuries-old process

Photograph by: Dan Videtich

John T. Kevern, associate professor of civil and mechanical engineering, handles samples of permeable concrete in the lab.

Kevern has engineered a new approach to making one of human civilization's most fundamental building materials: CONCRETE.

by John Martellaro

When it comes to improving a centuries-old industrial process, it's hard to imagine a more complete job than John T. Kevern, Ph.D., is crafting at UMKC's School of Computing and Engineering.

Kevern's approach to making concrete costs less than the current standard; reduces the product's carbon footprint in two different ways; saves energy; and recycles waste that would otherwise end up in landfills — all with no impacts on the product's strength or durability.

Considering that concrete is the most widely used man-made material on earth — irreplaceable in applications ranging from building construction to energy production, transportation, power generation and water/sewer systems — that's a significant advance.

And yes, you can find individual buildings, roads, bridges, pipelines and power plants made without concrete. But humans have yet to produce a material with sufficient strength that can be produced in such volume at such a low cost. That's why it is the most ubiquitous man-made product on the planet.

It's also been around for, oh, 8,000 years or so. So why is the process being re-engineered in the 21st century in Kansas City?

Because Kevern's knowledge of the chemistry and physics of making and using concrete — and of the properties inherent in certain waste products — enabled him to see possibilities that others had missed.

Concrete is composed of three primary ingredients: water; an aggregate (usually a mix of gravel and sand); and Portland cement. The making of cement is the key to the process. It's made by heating limestone, clay and sand in a high-temperature oven, or kiln. During this process, the limestone undergoes a chemical conversion, from calcium carbonate to calcium oxide. This chemical reaction releases carbon dioxide — the greenhouse gas primarily responsible for global climate change — into the air. Burning fossil fuels to heat the kiln also produces carbon dioxide.

Kevern's research has focused on using widely available waste material to replace some of the cement in the concrete mixture. These waste products do not have to be heated in the kiln and do not release carbon dioxide on their own, reducing CO2 emissions in two ways while saving energy.

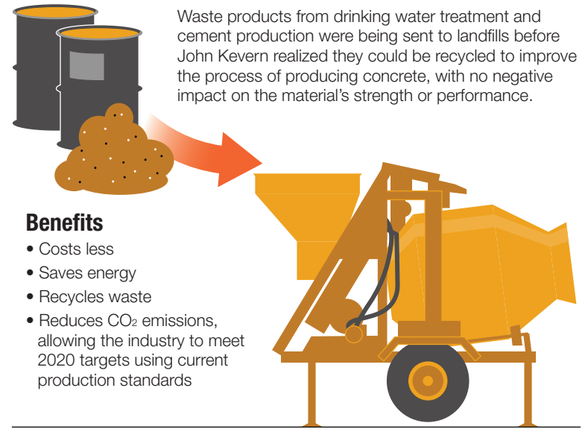
Kevern has received two UM System FastTrack Innovative Research awards to further his research into using two common waste materials, drinking water treatment sludge and high carbon/high sulfur fly ash (fine particles of combustion residue), in concrete. Both materials are typically sent to landfills.

The water softening process produces a damp, high-calcium waste that is non-toxic but had little commercially feasible re-use potential. Kevern was the first to hypothesize that both the high calcium solids and the moisture could be beneficial to concrete. The tightly bound water contained within the waste is released during the cement hydration process, reducing cracking and improving the hydration efficiency of the cement particles.

"By using this waste material, we can immediately reduce the embodied CO2 in concrete by 10 to 15 percent without impacting strength or performance," Kevern says. "This means that our research will allow the cement industry to meet 2020 CO2 targets without any modification to the existing production process."

Illustration by: Gentry Mullen

CONCRETE PRODUCTION GETS GREENER



Waste products from drinking water treatment and cement production were being sent to landfills before John Kevern realized they could be recycled to improve the process of producing concrete, with no negative impact on the material's strength or performance.

Benefits

- Costs less
- Saves energy
- Recycles waste
- Reduces CO_2 emissions, allowing the industry to meet 2020 targets using current production standards

> "By using this waste material, we can immediately reduce the embodied CO2 in concrete by 10 to 15 percent." – John T. Kevern

Ground limestone, which is chemically similar to water-softening waste material, is already widely used in Europe and Canada to reduce CO2 emissions, but less so in the U.S. The European Union allows concrete in certain applications to contain up to 30 percent limestone, while Canada allows a 15 percent maximum. The U.S. allows only 5 percent, but will likely move to the 15 percent standard sometime next year.

As for the fly ash, this waste product from combustion is collected from smokestacks. Smokestack "scrubbers" designed to reduce air pollution often use carbon, which combines with the fly ash before it is collected. Again, Kevern saw the carbon in the waste — already used once as a pollution filter — as an opportunity to enhance the filtration capabilities of concrete.

Kevern has partnered with Megan Hart, Ph.D., an SCE colleague, to research using this high-carbon, high-sulfur fly ash in permeable concrete — a special type of concrete that allows rainwater to seep through and into the groundwater table below the pavement. In addition to reducing runoff, permeable concrete also improves water quality because many of the pollutants in groundwater are attracted to concrete. Kevern and Hart hypothesized that much like a water filter, this high-carbon fly ash could make permeable concrete an even more effective agent for removing pollutants in the groundwater.

The UMKC researchers have been awarded a National Science Foundation EAGER grant and UM Fast Track grant for investigating the use of fly ash in permeable concrete to remove heavy metals and organic pollutants in groundwater. Currently in the U.S., about 131 million tons of fly ash are produced annually, of which only 50 percent is beneficially reused. This enhancement has to potential to be more effective, at a much lower cost, than the current techniques. The pollutant removal research is in the laboratory phase with the Department of Energy Superfund, and Department of Defense field testing is anticipated shortly.

John T. Kevern, Ph.D., PE, LEED
Associate Professor of Civil and Mechanical Engineering, School of Computing and Engineering

RESEARCH INTERESTS: Concrete mixture proportioning; development of sustainable construction materials related to concrete; pervious concrete mixture design, construction and testing; concrete material analysis; development of testing procedures and pavement performance; durability of concrete materials; beneficial material by-product utilization

JOINED UMKC: 2008

Photograph by: Dan Videtich

Using light and colored gels, doctoral student Melissa Morris locates a watermark in a fifteenth-century book.

Uncovering the paper trail

With the help of changing light frequencies and specialized state-of-the-art software, researchers reveal previously invisible images.

by Gail Borelli

UMKC researchers are using 21st century scientific methods to follow a paper trail across medieval Europe.

The interdisciplinary project by principal investigators Virginia Blanton, Ph.D., professor of English and department co-chair; Reza Derakhshani, Ph.D., associate professor of computer science and electrical engineering; Nathan Oyler, Ph.D., associate professor of chemistry; and Jeff Rydberg-Cox, director of classics and ancient studies, is a collaboration at the nexus of science and humanities.

"No one investigator could do this project," Blanton says. "It takes a web of talents and knowledge among disciplines to complete."

The researchers are using multispectral analysis to help uncover the history of medieval books, with a goal of developing a center to encourage interdisciplinary collaboration on the topic. The center would serve as a training ground for graduate students, a venue for undergraduate research and a base for faculty research, Rydberg-Cox says. It also would be an incubator for licensable technologies that would allow small libraries to analyze works in their own collections.

The researchers have designed and built an apparatus that captures images at wavelengths along the electromagnetic spectrum. Those images provide information about early books invisible to the naked eye. For example, multispectral imaging can reveal the ghostly lettering of text previously scraped or erased and then overwritten in different ink. It can distinguish the pages that were touched — and used — most often. And it can detect the unique chain-and-laid-line pattern created by each papermaker's mold.

Additionally, chemical analysis differentiates the quality of inks and pigments used in a book, offering clues to the intended audience. Researchers glean other information by studying books' bindings, fonts and watermarks.

"If we can isolate chain-and-laid lines alongside a watermark, and thus identify a particular mold for a given sheet of paper, we can work to match it against other paper used in other books, which would tell us something about the use of paper across all printing," Blanton says. "Watermarks can help us locate a given paper maker, identify a region of production and isolate trade routes for paper."

When pieced together, the researchers' findings will provide important insights into the economic, political, religious and societal happenings of medieval Europe.

The UMKC team has been busy analyzing a 1486-87 edition of *Summa theologica*, written in the mid-1400s by the archbishop of Florence to guide priests in instructing parishioners. The printed volumes — owned by Conception Abbey in northwest Missouri — have taken up temporary residence in a tiny lab in Cockefair Hall on Volker campus, where researchers have taken visible-light photographs of every page. An extensive history of the book's physical attributes has been written, and multispectral images are being made of select pages.

Machines that perform this kind of spectroscopy are expensive and exceed the budgets of most small libraries, Rydberg-Cox says. So the UMKC researchers have built their own spectrometer from cameras, filters and lenses scavenged across campus. Eventually they hope to post do-it-yourself instructions for their spectrometer online, as well as tutorials on how to conduct multispectral imaging of medieval manuscripts and books printed within 100 years of the invention of the printing press (1450). The goal is to make the process so affordable and understandable that even small libraries and student researchers can participate and contribute.

"Really, we are more focused on the process of discovery and less focused on the results," Blanton says.

In the second phase of their research, which began in August 2014, the UMKC team is studying a 16th-century Gregorian chant book held in the LaBudde Special Collections at UMKC's Miller Nichols Library. The researchers already know that some chants were scraped off and rewritten. Others were adapted to be performed by female instead of male cantors — information of special interest to musicologists and monastic historians.

The team, with collaborators from the University of Missouri in Columbia, will also turn its attention to a liturgical text, produced in Eastern Europe about 1500, that belongs to Special Collections and Rare Books in Ellis Library at MU.

Since its launch two years ago, the research project has received $250,000 funding from three sources: the Digital Humanities Start-Up Grant program of the National Endowment for the Humanities, the University of Missouri Research Board and the University of Missouri System Interdisciplinary Intercampus Research Grant Program. The team is seeking additional funding for what promises to be a long-term project. Following the paper trail that leads from medieval printers in Europe to modern libraries throughout Missouri is a multifaceted task that will catalyze interdisciplinary study across UMKC for years to come.

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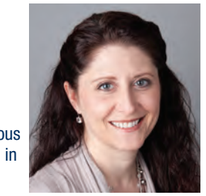
→ LEARN MORE ABOUT THE PROCESS AT INFO.UMKC.EDU/RESEARCH.

Researchers are analyzing medieval books borrowed from Conception Abbey in northeast Missouri.

Meet the researchers



Virginia Blanton, Ph.D.
Professor of English and Department Co-chair, College of Arts and Sciences

RESEARCH INTERESTS:
Medieval hagiography and religious ritual; representations of women in religious culture

JOINED UMKC: 2002

Reza Derakhshani, Ph.D.
Associate Professor of Computer Science and Electrical Engineering, School of Computing and Engineering

RESEARCH INTERESTS:
Biomedical signal and image processing

JOINED UMKC: 2004

Nathan Oyler, Ph.D.
Associate Professor of Chemistry, College of Arts and Sciences

RESEARCH INTERESTS:
Developing and applying solid-state NMR methods to determine structural constraints

JOINED UMKC: 2005

Jeff Rydberg-Cox, Ph.D.
Professor of English and Director of the Classical and Ancient Studies program, College of Arts and Sciences

RESEARCH INTERESTS:
Digital humanities and computation analysis of ancient Greek texts

JOINED UMKC: 2000

Mapping
cosmic history

Researcher wants to understand how and why galaxies grow.

by Bridget Koan / Photography by Dan Videtich

Our cosmic address is one galaxy, the Milky Way, but there's a universe teeming with a zoo of 100 billion galaxies. UMKC Associate Professor of Physics and Astronomy Daniel H. McIntosh, Ph.D., is trying to find out how that happened.

"We know that soon after the Big Bang there were ZERO galaxies," he says. "We also know the first proto-galaxies were tiny compared to our home galaxy. So how did we get to where we are now?"

Galaxies are huge collections of normal matter, stars, gas and dust made out of atoms like people. They are held together by gravity that astronomers believe is mostly from dark matter, McIntosh described.

"As the universe ages, expansion and gravity accentuate regions of greater and lesser dark matter density, thereby creating a 'cosmic web' of galactic beacons mapping the universe in both time and space," he says. "We're mapping cosmic history when we study distant galaxies."

> "We can study galaxy populations from the early universe and compare them to current galaxies."
>
> – Daniel H. McIntosh

As a basic researcher, McIntosh likes to answer questions and considers himself an extragalactic astronomer and a galaxy demographer. The data he collects and his interpretations provide important new tests for current and future theoretical models of galaxy formation.

"The more we learn, the more questions we have," he says. "This is why doing science is so fun!"

Specifically, McIntosh wants to know how galaxies grow. By grow, he means learning how galaxies add more stars. Astronomers understand that one way galaxies grow is when they collide and merge together; it's the most spectacular growth mechanism, but not the only. He said the question is if it is the most important growth mechanism. So he is looking for galaxies getting ready to merge or that have recently merged. Galaxies are the only places that stars form. If there's no star production, McIntosh said there's no planets and no chemistry for life.

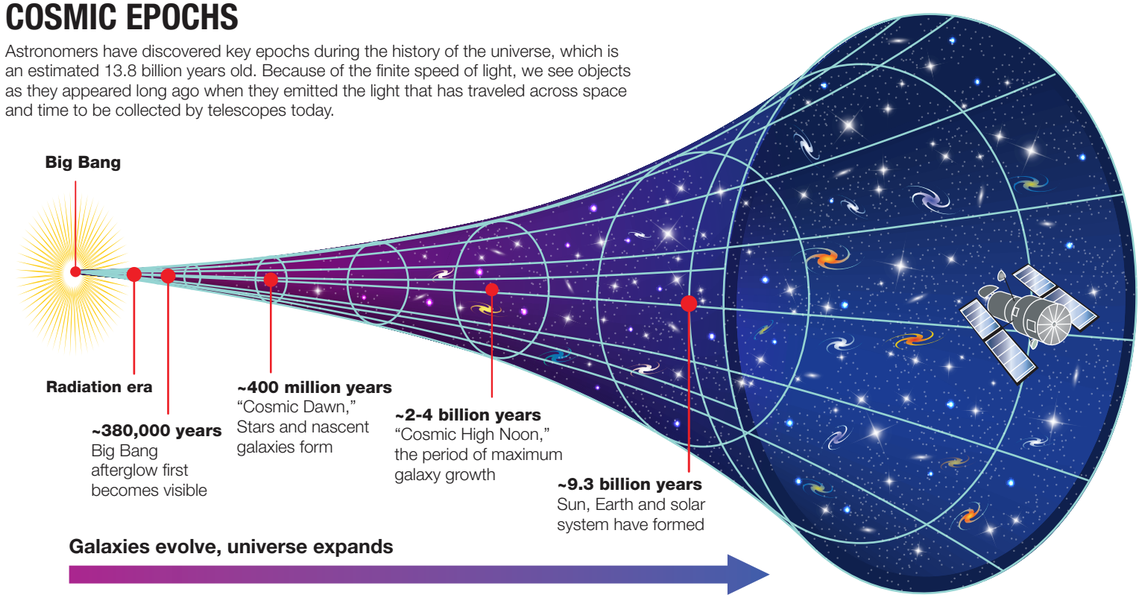
The Galaxy Evolution Group, which McIntosh founded in 2009, focuses on the formation and evolution of galaxies.

"The current model is that all galaxies start off as strong producers of stars, but over time a sort of 'galaxy capitalism' occurs in which the most heavy-weight galaxies, those with the most stars, do not produce stars themselves," McIntosh says. "Yet, they appear to grow the fastest while the star-forming galaxies do all of the work but do not grow in terms of stellar wealth. This is an intriguing mystery."

McIntosh is also co-investigator and collaborates on the Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey. CANDELS is the largest Hubble Space Telescope survey ever of distant galaxies.

COSMIC EPOCHS

Astronomers have discovered key epochs during the history of the universe, which is an estimated 13.8 billion years old. Because of the finite speed of light, we see objects as they appeared long ago when they emitted the light that has traveled across space and time to be collected by telescopes today.



Sources: Daniel McIntosh, Ph.D.; Space Telescope Science Institute

Illustration by: Gentry Mullen

Photography by: Debra Meloy Elmegreen (Vassar College) and the Hubble Heritage Team

Previous page: Daniel McIntosh enjoys visiting Powell Observatory in Louisburg, Kansas, home to the Ruisinger telescope, one of the largest telescopes available for public viewing in a five-state area (star field credit: ESO/C. Malin). *Above:* An image from the Hubble Space Telescope of an epic collision between two galaxies. These galaxies will eventually merge to form a new larger system.

Telescopes on Earth and in space measure different wavelengths of light emitted by faraway galaxies.

"Light has a wonderful property. Its speed is constant. That effectively means that our telescopes are like time machines because it takes millions or billions of years for light emitted by distant galaxies to reach Earth and deliver information about the state of these objects from a time when the universe was much younger," McIntosh says.

"The tricky part is due to the fact that the expansion of the universe shifts the light we observe to redder wavelengths. This makes it more difficult for us to observe galaxies from different times in the past at the same wavelengths of light."

High-tech instruments, such as the Hubble Space Telescope, have changed how we see the universe. McIntosh said Hubble's optics, science instruments and spacecraft systems work together to capture a wider range of wavelengths from the cosmos than we see with our eyes, convert it into digital data and transmit it back to Earth.

"Now we can see the detail in faraway galaxies that we could only see in near galaxies. For the first time, we can study galaxy populations from the early universe and compare them to current galaxies," McIntosh says. "This is really cutting edge."

Daniel H. McIntosh, Ph.D.
Associate Professor of Physics and Astronomy,
College of Arts and Sciences

RESEARCH INTERESTS: The growth of galaxies over cosmic time

ACCOMPLISHMENTS: College of Arts and Sciences 2014 Alumni Outstanding Teaching Award; co-authored more than 85 publications appearing in leading scientific journals; secured seven grants for $427,000 for development of the astronomy program

JOINED UMKC: 2008

explore more | Like Daniel McIntosh, Mark Brodwin, assistant professor of astronomy and physics, is making a name for himself. Turn to page 22 to learn more about Brodwin's work with NASA.

Illustrations by: Neil Nakahodo

A new program takes small, flourishing businesses and gives them a boost to bigger growth.

by Portia Stewart

Maria Meyers, director of the UMKC Innovation Center, has been pioneering programs that promote entrepreneurship since she joined UMKC in 2003. The tools: the interconnecting programs that form a network of resources for businesses in the Kansas City area and beyond. Each program is designed to work solo or in concert to form a symphony of services to help create, grow and sustain businesses — and to help them continue to thrive and reach new heights.

"The Greater Kansas City Chamber of Commerce put together five big goals to take Kansas City forward into the future, and one of those goals was to make Kansas City America's most entrepreneurial city," Meyers says. "The UMKC Innovation Center has always had a strong role in creating a strong entrepreneurial ecosystem for the Kansas City region, and we're helping out on this area too."

Over time, local leaders developed areas for the community to work on together to buid a good entrepreneurial environment in Kansas City, Meyers said. The goals developed include:

1. Improve capital structures and access in Kansas City
2. Engage larger corporations into the ecosystem
3. Increase the pipeline of new research that churns into economic opportunities
4. Grow the talent needed to run the companies, with an emphasis on the IT talent
5. Tell the story about Kansas City's entrepreneurial successes
6. Continue to offer great, organized resources to encourage business growth

"The business outreach services that the university has extended to the community have always been strong, and they have continued to grow over the past few years. And you see those embodied in the Innovation Center," Meyers says. "Back in 2005, the university decided that they were going to put an emphasis on entrepreneurship by supporting the Bloch School's Regnier Institute. We see a number of the schools involved in entrepreneurship, including the School of Law, School of Computing and Engineering and the Conservatory of Music and Dance. So, we certainly see it across campus."

In 2014, the UMKC Innovation Center was awarded one of only eight "ScaleUP! America" program contracts from the U.S. Small Business Administration. Designed to both promote growth and strengthen the entrepreneurial ecosystem, the ScaleUP! program will select two cohorts each year to learn and grow by developing connections within the Kansas City region. These two business cohorts will learn to fine-tune their strategies to work in harmony through the FastTrac GrowthVenture entrepreneurship curriculum — a flexible, 30-hour course.

Since ScaleUP! is a five-year program, it will continue to grow, with two qualified business cohorts participating in each session. Meyers says it's an example of how the Innovation Center is continuing to build on the business community and leverage funding outside of the community to support entrepreneurs inside the community.

"We keep building on our previous experiences, and we utilize the huge network of people in the community to support those businesses," Meyers says. "So essentially what you can do is take an idea or business and wrap a lot of resources around it to help it grow."

explore online

→ READ MORE ABOUT THE INNOVATION CENTER'S PROGRAMS AT INFO.UMKC.EDU/RESEARCH.

The UMKC Innovation Center supports about 3,000 aspiring and existing business owners in the Kansas City area each year.

KCSourceLink is now in more than 20 regions across the U.S.

Maria Meyers
Director, UMKC Innovation Center

RESEARCH INTERESTS:
Entrepreneurship and economic development

ACCOMPLISHMENTS:
Director of UMKC Innovation Center; Founder, KCSourceLink and U.S.SourceLink. The center's suite of programs include Digital Sandbox KC, Whiteboard 2 Boardroom, KCSourceLink, MOSourceLink, U.S.SourceLink, UMKC Small Business and Technology Development Center, Missouri Procurement Technical Assistance Center and Artist INC. They are designed to help emerging and existing business owners hone their business basics, evaluate commercialization opportunities and connect with the right resources.

JOINED UMKC: 2003

Illustration by: Getty Images

Connecting the dots

A former Cerner executive works with researchers and clinicians to harness the power of "big data."

by David Martin

Physicians spend a significant portion of their day entering notes about their patients into computers, and the demands of digital recordkeeping can become a burden. But in addition to providing instant access to a patient's complete medical history, electronic health records create a wealth of information for researchers.

Mark Hoffman and his team work to pull new discoveries from the data entered by doctors and allied health professionals. As director of the Center for Health Insights, he stands at the intersection of technology, research and health care. The School of Medicine created the center in 2013 to lead the effort to provide research informatics capabilities to UMKC researchers and other stakeholders. Hoffman and his team have already worked with clinicians and researchers in the schools of Medicine, Dentistry, Nursing and Heath Studies and in the Department of Psychology to apply the power of computer science to the troves of information collected in hospitals, clinics and laboratories.

Biomedical informatics is the process of connecting the dots of medicine and data. "Big data" can take many shapes, from genetic sequencing of the Ebola virus to contextualizing a patient's chart with census tract information.

Hoffman hopes that as informatics provides new insights, the value of collecting electronic health records, or EHRs, and other data collection efforts will become more obvious.

"For many physicians, the EHR is just seen as an impediment — it slows them down. Or that's the perception," he says. "But when you can start to show them, 'Here is the reason why this is valuable,' then you can see the light bulb go on. Then they start to see, this actually is worth some time."

Hoffman keeps a poster-sized rendering of the first map of the human genome on the wall of his office in the School of Medicine. Trained as a microbiologist, he was a vice president at Cerner Corp. before arriving at UMKC in 2013. At Cerner, he led efforts in genomics, research and public health.

For Hoffman, the transition from the corporate world to an academic institution was a smooth one. In addition to maintaining a publication record while at Cerner, he worked with a number of the company's academic clients.

"That gave me a really good frame of reference to understand what really makes a difference in terms of accelerating a research agenda," he says. "So when I came here, I was able to draw on that and develop an immediate strategy of things that I thought we could start with."

One of the first projects Hoffman and his team tackled was to make available REDCap, a web-based platform for faculty, students and staff to capture data in a secure environment that complies with privacy regulations protecting patient information. The Center for Health Insights has also been involved in an effort to install a framework of tools that provides a view of clinical data collected at Children's Mercy Hospitals and Clinics. The information is "de-identified" to protect patients' privacy.

With his roots in microbiology, Hoffman was particularly excited by a project to analyze and disseminate information on antibiotic resistance at Children's Mercy.

"When we share what we've built with the infectious disease physicians and see their eyes just go, 'Wow, we can finally do this,'" Hoffman says. "To see the transformation they can provide is very satisfying and to know that work might impact how they treat kids and manage their antibiotic utilization."

School of Medicine Dean Steven L. Kanter, who completed a fellowship in biomedical informatics, says UMKC is well positioned for the future of big data.

"Mark Hoffman recruited a strong team and quickly began to build capabilities that will make a real difference," he says. "In a very short time, the Center for Health Insights has made a valuable contribution to our efforts to understand and improve health."

Hoffman is putting his data science skills to wide use. He has worked with Katherine Bloemker, an associate professor in the School of Computing and Engineering, to produce 3D-printed models of a vertebra and the dengue virus. "Part of informatics is data visualization," he says, holding the baseball-sized model of the virus in the palm of his hand. "This is the most tangible visualization you can come across."

> "The Center for Health Insights has made a valuable contribution to our efforts to understand and improve health."
>
> – Mark Hoffman

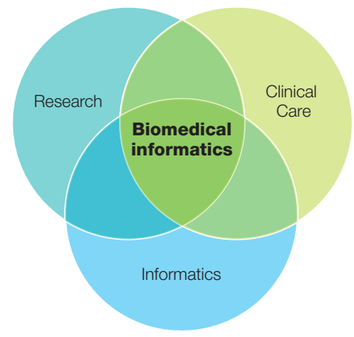
Hoffman is also collaborating with researchers in the School of Computing and Engineering and Department of Architecture, Urban Planning and Design at the University of Missouri-Columbia on a project that involves the same technology featured in "The Hobbit" series and other Hollywood films. The team is using motion capture technology to measure performance in the School of Medicine's clinical skills training facility. Cameras will record early learners as they install central lines on mannequins and perform other simulations in an effort to see how their movements differ from those of experienced physicians.

Working with engineers and architects allows Hoffman to see different ways technology is being used to address challenging questions. He likes the idea of applying "an engineering mindset" to the struggles he sees in medical research and the delivery of health care.

"What can we do with informatics to solve real problems?" he asks. "What are creative approaches that push technology to the maximum to answer these complex questions?"

WHAT IS BIOINFORMATICS?

Bioinformatics emerged in response to rapid advancements in molecular biology and genomics research. It provides scientists with the tools, information technologies and analytical methodologies to manage the large volumes of data generated by their research — and to harvest insights from the information collected.



Source: National Cancer Institute

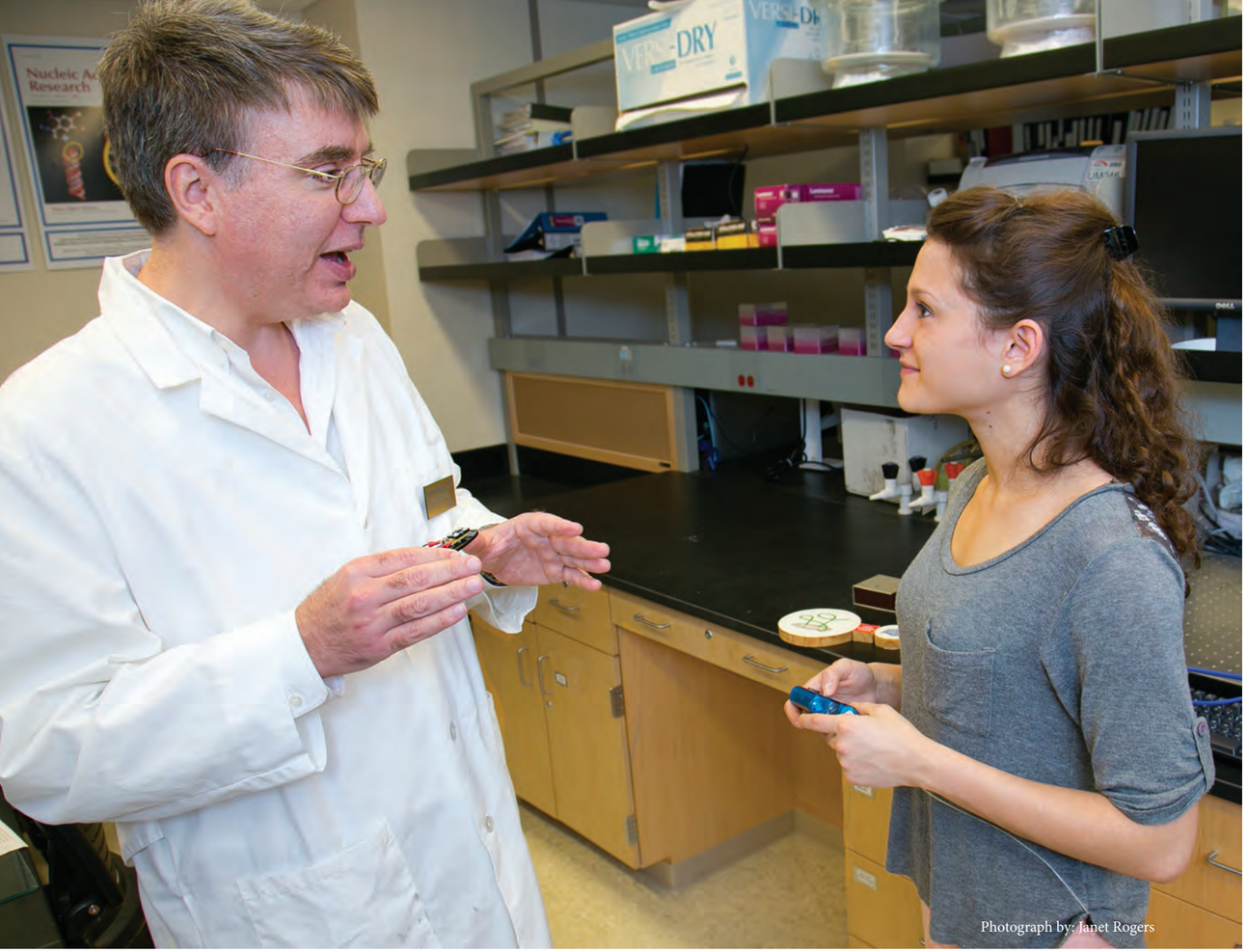
Illustration by: Gentry Mullen

Mark Hoffman, Ph.D.
Director of the Center for Health Insights, School of Medicine

RESEARCH INTERESTS: The use of informatics to answer biomedical questions at the nano, micro and macro levels

ACCOMPLISHMENTS: Inventor on 16 issued patents in the United States and Australia; first to anticipate pharmacogenomic decision support; designer of the Clinical Bioinformatics Ontology; led regional and national infectious disease surveillance initiatives

JOINED UMKC: 2013



Photograph by: Janet Rogers

Professor Simon Friedman discusses his insulin-delivery invention — photoactivated depots — with Amy Johnson, who has type 1 diabetes.

Fewer needles, no tubes

UMKC researcher invents non-invasive insulin delivery, offering hope for those with diabetes.

by Stacy Downs

Amy Johnson, who has type 1 diabetes, has already benefitted from research. But if an invention from the UMKC School of Pharmacy can make the leap from lab to real life, Johnson will benefit even more.

The 2014 UMKC graduate is currently tethered to the latest-greatest insulin-delivery system: a pager-sized pump connected through a tube in the abdomen.

"It beats the alternative of eight injections a day, which is definitely not my cup of tea," says Johnson, who was a UMKC Trustees' Scholar and biology major. "But the pump has its drawbacks. I still have to change my pump infusion site every other day and I hit a nerve sometimes, which is painful. Sometimes I get the tubing caught on a doorknob. I've had to have one overnighted to me because it broke after I bumped into a door handle."

So Johnson is intrigued by a novel insulin-delivery method that UMKC researchers are developing in the School of Pharmacy. The breakthrough could affect tens of millions of people with type 1 and 2 diabetes by replacing needle sticks with a beam of light.

"We're aiming to improve the lives of diabetics all over the world," says UMKC Pharmacy Professor Simon Friedman, who with his collaborators, has developed a new insulin-delivery method called a photoactivated depot or PAD.

Johnson wishes the PAD insulin-delivery system was already available. But, for now, it is years away from entering the marketplace.

The PAD would not only benefit the lives of people worldwide, but locally in Jackson County, Missouri, alone, where more than 48,000 people are living with diabetes, or nearly one of 10 county residents.

Here's how the PAD works: Insulin is linked to an insoluble polymer by a connection that can be broken with light. The insulin depot is then injected just under the patient's skin. When needed, insulin is then released from the polymer by a pulse of light through the skin.

> "We're aiming to improve the lives of diabetics all over the world."
>
> – Simon Friedman

The appropriate amount of insulin is then free to be absorbed into the body. Since one injected depot can contain a large amount of insulin, the PAD has the potential to eliminate hundreds of injections. In addition, because the length of the light pulse dictates the amount of insulin released and light can be administered at any time, the release of insulin is more finely controlled with the PAD system.

If successful, the PAD would eliminate the need for an insulin pump, like the one currently worn by Johnson, and it would be replaced with an armband device the size of a tiny mp3 player. All insulin pumps use a tube that connects the outside reservoir of insulin to the inside of the patient.

This introduces many problems, including clogging of the tube, irritation and infection, leading to poor outcomes. The PAD eliminates this physical connection to the outside world, allowing the insulin to be released non-invasively with a beam of light.

Friedman and his student co-authors, Piyush Jain and Dipu Karunakaran, have already successfully developed the first generation of PADs.

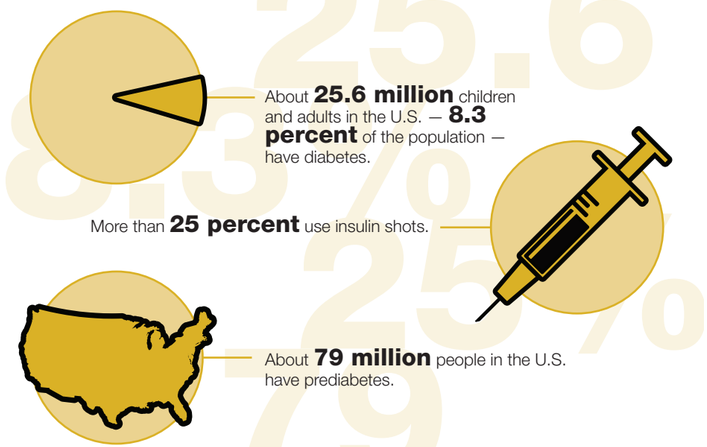
The results were published in 2013 in *Angewandte Chemie*, the highest ranked weekly chemistry journal in the world. The journal's reviewer called the research "a paradigm shift" and "truly innovative." This research has the potential to directly impact the health outcomes of millions worldwide.

In people with type 1 diabetes like Johnson, the pancreas no longer makes insulin. The beta cells have been destroyed and they need insulin shots to use glucose from meals.

People with type 2 diabetes make insulin, but their bodies don't respond well to it. At first, the pancreas produces extra insulin to make up for it. But over time it isn't able to keep up and can't make enough insulin to keep blood glucose at normal levels.

Complications from diabetes include heart disease and stroke, high blood pressure, blindness, kidney disease, nervous system damage and amputation.

BY THE NUMBERS



Source: American Diabetes Association

Illustration by: Gentry Mullen

Simon Friedman, Ph.D.
Professor of Pharmacy,
UMKC School of Pharmacy

RESEARCH INTERESTS:
Bioorganic chemistry/chemical biology; gene expression, structure-based ligand design, molecular recognition; targeting of nucleic acid/protein interfaces; researching fundamental issues of ligand/receptor binding energetics

JOINED UMKC: 1999

Illustration by: Todd Davidson/Getty

Unlocking the mystery

Years of study bring researchers closer to explaining how drug addiction works.

by Kelly Edwards

John Wang, M.D., Ph.D., enjoys a challenge. Figuring out just what it is in the human brain that causes an addiction to drugs — cocaine, heroin and amphetamines — has held his attention now for more than two decades.

As the School of Medicine's acting associate dean for research, Wang has good reason to doggedly seek answers. The National Institute on Drug Abuse estimates that the abuse of illicit drugs costs the United States about $11 billion annually in overall health care expenses alone. Add expenses related to issues such as crime and lost work productivity into the mix and that number explodes to about $193 billion, according to the agency.

"Drug addiction is a major problem socially, economically and medically," Wang says. "And it's a big challenge in the research field. It's a global issue and it's growing among young people."

Wang joined the research faculty at the School of Pharmacy in 1998 and moved to the School of Medicine as the Westport Anesthesia Services/Missouri Endowed Chair in Anesthesia Research six years later. He currently serves as the school's acting associate dean for research. In his fifth-floor laboratory at the School of Medicine, Wang has established one of the top addiction research units in the country and earned an international reputation as a researcher and scholar in the field of drug addiction.

He and his team have been working to determine the role a particular chemical neurotransmitter — known as a glutamate receptor — located in the brain plays in the addiction process.

They identified a subtype of these chemical transmitters, called NMDA receptors, as an important link for psychostimulants such as cocaine to stimulate motor activity. Cocaine, however, also increases the release of dopamine, another chemical neurotransmitter that actually inhibits NMDA receptors from generating motor activity in the brain. Current tests are focusing how NMDA glutamate receptors adapt to a long-term use of drugs and how they contribute to develop an addiction to them.

"All the efforts we are making here are to find the cause, which is the basis for a therapeutic development," Wang says. "If you want to develop effective drugs for treating these addictions then you have to find out why; why do these addictions occur?"

That's the million-dollar question. Or in Wang's case, $3.5 million — which is what the National Institutes of Health is currently pouring into two ongoing grant-supported research projects in Wang's research laboratory and that's on top of the more than $5.7 million in NIH funding the projects previously received.

In addition, Wang's research team is studying the pharmacological mechanisms of anesthetic drugs. Wang said that while a medically induced insensitivity to pain can be effectively produced through the use of a wide variety of anesthetics, the basic molecular function of anesthesia and the potential adverse effects of anesthetic agents are still poorly understood.

Wang began his major work in addiction research while conducting his postdoctoral training at Beijing Medical University. There he met and worked with Jisheng Han, M.D., one of China's top neuroscientists and a leader in addiction research. He also grasped the broad effects of drug addiction, not only on the individual addict but also to the hardships it causes families. Today, Wang said his collaborations on addiction research extend to working with scientists throughout Europe and Asia as well as in the United States.

"China is one of the countries having a big problem with drug addiction," he says. "It's a global problem and we have to take a global approach."

After more than 20 years of study, Wang said he and scientists across the globe working together have made small steps toward finding the answer. By understanding how the brain cells function in relation to one another when introduced to cocaine and other similar drugs, scientists have developed therapies that are now in clinical trials for treating cocaine and other drug addictions.

"It's not just my efforts," Wang says. "It's a big group of researchers all over the world, different scientists working toward the same goal, all working together to find the cause of drug addiction. I think we are getting closer but I think we will still need years and years of research to finally answer the question."

John Q. Wang, M.D., Ph.D.
Acting Associate Dean for Research and Professor, Departments of Anesthesiology and Basic Medical Science, School of Medicine

RESEARCH INTERESTS: Specializes in the study of the molecular mechanisms for addictive properties of drugs and the molecular mechanisms for anesthesia induction

Accomplishments: Internationally recognized researcher in molecular regulation of neural function in substance abuse, pain and cognitive function; author of *Drugs of Abuse: Neurological Reviews and Protocols*, a collection of basic techniques for the neurological study of abusive drugs

JOINED UMKC: 1998

UNDERSTANDING DRUG ABUSE

An estimated **23.9 million Americans** ages 12 and older have either used an illicit drug or abused a psycho-therapeutic medication within the last month.

Of the more than 2.8 million new users of illicit drugs in 2012, more than half are **less than 18 years old**.

The National Institute on Drug Abuse calls drug addiction a "brain disease." By understanding how illicit drugs affect the brain, researchers can develop effective treatments to help people stop abusing drugs and return to productive lifestyles.

Source: Substance Abuse and Mental Health Services national survey, 2012

Illustration by: Gentry Mullen

spotlight

Meet astronomer Mark Brodwin, assistant professor of physics and astronomy. When he's not researching and discovering unique galaxy clusters, he's working as a NASA-nominated member of the Euclid Consortium mission, which is intended to launch in 2020.

What sparked your passion for astronomy?

As a child, I was always amazed by the night sky. However, growing up in a big city, I had no idea what it really looked like. I devoured books on the planets and was a huge "Star Trek" fan. When I got my first look at Jupiter and Saturn in a telescope comparable to the Warkoczevski Public Observatory here at UMKC, I was hooked.

What are you currently working on?

I'm finishing up a paper on the X-ray properties of a very distant, massive galaxy cluster. I'm also working on a Hubble Space Telescope program, led by Nobel laureate Saul Perlmutter, which is searching for supernova explosions in some of my distant clusters.

In related research, I'm preparing for a Euclid Consortium meeting this summer in Lausanne, Switzerland. Euclid is a new space telescope being built for launch in 2020, which will probe dark energy in several independent and complementary ways.

What is one thing you wish everyone knew about the study of astronomy?

The thing I'd want people to know is that, as the study of the whole universe and everything in it, it is at once the most fundamental science and, in my opinion, the most inspiring on a personal level. Everybody who has ever really looked at the night sky from a dark site is overwhelmed by the sheer immensity of it all, and by how small we seem in comparison. Truly understanding our place in comparison is mind-blowing and deeply moving.

When you are not conducting research, what do you do in your free time?

These days I spend my time playing with my 2-year-old daughter, who is an absolute joy. I also enjoy playing guitar, cooking and, of course, trying to keep up with hockey — I'm Canadian.

— Alex Dapp

explore online

READ BRODWIN'S FULL EXCERPT AT INFO.UMKC.EDU/RESEARCH.

Mark Brodwin, Ph.D.
Assistant Professor of Physics and Astronomy, College of Arts and Sciences

RESEARCH INTERESTS: Formation and evolution of galaxy clusters; effect of environment on galaxy evolution and observational cosmology

JOINED UMKC: 2011

Photograph by: Janet Rogers

data points

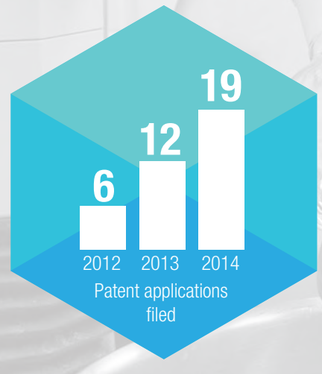
As a research university on the move, UMKC plays a major role in the Kansas City metropolitan area as an educator, employer and research leader. Our research programs span numerous disciplines, and our findings are creating opportunities and driving growth.

224
Number of extramural awards received by UMKC faculty in FY2014

436
Number of proposals submitted

$35.5 million
Dollars awarded to UMKC research and related projects in FY2014

$34.8 million
Total research expenditures for 2014



Patent applications filed

$152 million
Total proposed dollars

23.3%
Our yield on proposed projects

65%
Percentage of total dollars coming from the Federal Government

Illustration by: Gentry Mullen

JANET ROGERS

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