



SPRING 2019

# MORGRIDGE CAMPUS IMPACT REPORT



MORGRIDGE  
INSTITUTE FOR RESEARCH

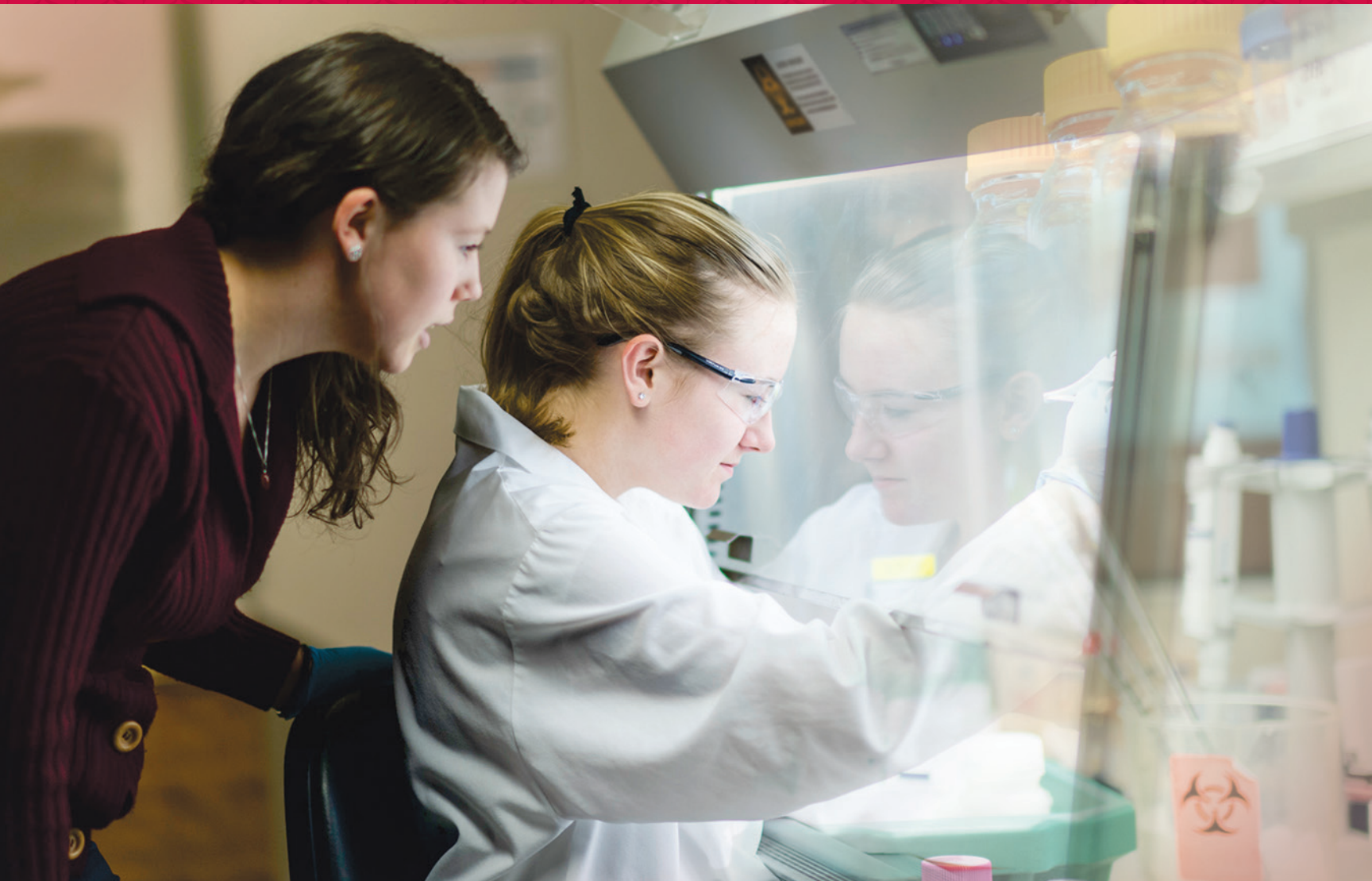


WISCONSIN  
UNIVERSITY OF WISCONSIN-MADISON



**“The Morgridge Institute for Research shares in the great UW–Madison tradition of bringing researchers together from multiple fields to spark new ideas and build collaborations. This culture facilitates quality research and also positions us to compete for world-renowned faculty and staff who want to work on the important questions that are best solved by interdisciplinary teams of researchers.”**

**— CHANCELLOR REBECCA BLANK**





## Meeting society's expectations for scientific discovery

Science holds a privileged place in society. Even amid high-profile skepticism over some research areas, the scientific profession enjoys consistently high levels of confidence and trust from the American people.

In its 2018 report “Perceptions of Science in America,” the American Academy of Arts and Sciences cites a survey showing that 80 percent of respondents trust that scientific research is serving the best interests of humanity. Another 71 percent expressed strong support for public funding of basic science research, while 86 percent stated it’s important for scientists to engage with the general public.

This trust was hard-earned. For the past century, major advances in scientific knowledge have been a wellspring for improved health, prosperity and quality of life for Americans and the world. Antibiotics and vaccines, advanced computing and the World Wide Web, medical imaging, regenerative medicine and biotechnology all have stemmed from curiosity-driven science — and grown in ways we couldn’t have predicted.

At the Morgridge Institute, we talk a lot about “public trust” and “serving society” because we understand it’s precious and can never be taken for granted. Through our strong partnerships with the University of Wisconsin-Madison and the Wisconsin Alumni Research Foundation (WARF), we want to stay true to the principles of basic research that have made it a great engine of human progress.

We have been able to achieve things together with UW–Madison that would have been highly difficult for either entity to do alone. Our ability to establish fruitful partnerships across numerous departments and disciplines has helped deliver technologies that are transforming biology, such as cryo-electron microscopy and mass spectrometry. The UW-Morgridge alliance also has proven powerful in attracting top scientific talent to Wisconsin and building community within promising and fast-growing fields like metabolism and regenerative biology. In turn, these efforts benefit other research areas on campus, such as cancer and Alzheimer’s research.

This report will focus on specific strides made in 2018 that could not have been made without the contributions of WARF, UW–Madison and John and Tashia Morgridge. We have tremendous gratitude for the trust university partners have placed in our institute to contribute to a new generation of discoveries that will improve the world.

### **Brad Schwartz**

CEO, Morgridge Institute for Research



# INSPIRED COLLABORATIONS WITH UW-MADISON

## Bringing transformative technology to campus

“Pushing the boundaries of collaborative, high-impact science cannot be done alone. Rather, vital partnerships can set the agenda, marshal the resources and bring the vision to proceed, innovate and discover. From my viewpoint as chair of the **Department of Biochemistry** at UW-Madison, the Morgridge Institute for Research provides this vital partnership.

During the past few years, biochemistry and Morgridge have joined forces to achieve goals that neither we nor the UW-Madison campus could achieve by solo efforts. Our decision to act together



to bring cryo-electron microscopy to the campus is the most notable effort to date. Cryo-EM is a rapidly emerging technology that promises to be transformative across nearly all realms of biological research, so much so that all top-tier institutions must include its capabilities. Our shared vision is to establish a world-class facility at UW-Madison for cryo-EM research in order to expand opportunities for biological researchers campus-wide to include structure determination in their studies of important — and increasingly complex — biological problems.

Our vision also endorses the importance of collaborations with other institutions and with industry-sponsored partners, and operation as a research core under a sustainable fiscal plan. Collectively, biochemistry and Morgridge have already made substantial investments in equipment and people to help assure this vision becomes reality. Future opportunities to advance our collective mission will surely emerge and can be moved forward in this same collaborative spirit.”

— BRIAN FOX, CHAIR OF BIOCHEMISTRY

## BerbeeWalsh Prototype Pathway connects students to clinicians

Morgridge celebrated its third year of the BerbeeWalsh Prototype Pathway, a unique program funded by Karen Walsh and Dr. Jim Berbee that connects students, engineers and clinicians to address solutions to pressing biomedical problems.

The pathway promises three critical deliverables: address solutions to biomedical challenges; forge strong, lasting relationships with UW–Madison clinicians; and empower UW–Madison students to pursue their biomedical interests.

What began at the Morgridge Institute Fab Lab has come a long way. Students and clinicians now work together regularly to solve biomedical challenges. Staff engineers guide and train students to think deeply and broadly about these challenges. Alumni say the program has empowered their career interests and encouraged them to pursue medical school, graduate school or industry.

“But perhaps the most profound aspect has been the prevailing sentiment that the interactions between clinician and engineer reshaped our students’ approaches and led to a new way of thinking about the best ways to solve biomedical problems,” says Fab Lab Director Kevin Eliceiri.

In 2018, three new students worked on a range of projects, including:

- ▶ BME senior **Gopika Senthilkumar** works on The Halo Project, a collaboration with **surgery Professor Burke Richmond** to develop an acoustic sound-based system that can localize sounds from tinnitus (ringing of the ears). The hope is to better understand the pathology of tinnitus, a common ailment as people age.
- ▶ BME senior **Joe Ulbrich** is developing an ergonomic syringe, in partnership with **biomedical engineering Professor Robert Radwin**. The device attaches to common brands of syringes and allows them to be extended or compressed by one hand in an ergonomic motion. This allows for one-handed injections and blood draws.
- ▶ BME junior **Lisa Xiong**’s project is the DVT Phantom, an effort to develop an anatomically and geometrically correct ‘phantom’ for performing ultrasounds that mimics deep vein thrombosis. Xiong collaborates with **Tim Hacker, director of the cardiovascular physiology core, medical physics Professor Tim Hall and medicine Professor Carol Mitchell**.

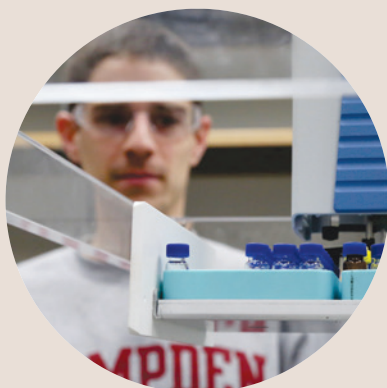


The Halo Project



DVT Phantom Project

## Inspired collaborations with UW–Madison



### Powering up mass spec across campus

The Morgridge investment in mass spectrometry — a vital tool that can determine the precise chemical identity of a substance — continues to pay strong dividends for the university in 2018. Morgridge has made a core technology investment in the mass spec facility, run by **chemistry Professor Josh Coon**, and contributed four full-time staff members and a postdoctoral student to the facility team. The facility is experiencing a wave of productivity, with 58 collaborative projects currently under way across 22 UW–Madison departments. The project also has generated 31 scholarly publications in 2018, on topics ranging from small molecule analysis, tissue imaging and disease biomarker detection. Morgridge investigators have three active projects with the lab.



### Morgridge adds major conferences to campus landscape

Two new conferences sponsored by Morgridge enhanced the international reputation of UW–Madison in biomedical research. In July, the Phil Newmark Lab organized a highly successful *International Planarian Meeting* that attracted more than 140 registrants from 15 states and 13 countries. Planarians are a remarkable model organism uniquely suited to reveal secrets about regeneration and organ development and serve as models for human disease. In September, the Dave Pagliarini Lab hosted the meeting *Frontiers in Metabolism*, bringing together more than 150 researchers who study the basic mechanistic underpinnings of metabolic disorders. The meeting attracted scientists from all over the world including Australia, Finland, Switzerland, United Kingdom, as well as many from all over the United States. The Pagliarini Lab will host the event again in 2019.



### Celebrating stem cell research leadership

Twenty years ago, scientist James Thomson jolted the scientific world by isolating human embryonic stem cells — the building blocks of human life. Today, research is booming worldwide, including hundreds of scientists at UW–Madison and the Morgridge Institute. Wisconsin stem cell research has led to 10 Madison spinoff companies, 70-plus license agreements and more than 700 patents. To recognize this monumental feat, Morgridge partnered with UW–Madison to generate broad recognition of the anniversary. A private gala in spring and two public forums in the fall collectively attracted more than 600 guests. Morgridge partnered with **University Communications** and the Wisconsin State Journal on a Sunday insert mailed to more than 130,000 subscribers. Morgridge’s oral history report on Thomson’s discovery, “Immortal,” generated more than 4,300 reads.



# TRANSLATIONAL OPPORTUNITIES AT MORGRIDGE

## Phil Newmark: Fighting a neglected tropical disease

Wisconsin is far removed from one of the deadliest neglected tropical diseases in the world, yet some of the most groundbreaking work is being conducted here. Schistosomiasis kills an estimated 280,000 people a year, almost all in Africa, Asia, and South America. As many as 250 million people suffer from the disease that also causes anemia, malnutrition, and pervasive learning disabilities.

Morgridge investigator Phil Newmark, **professor of integrative biology at UW-Madison** is making real strides toward improving those numbers. And he is poised to make a big translational impact, thanks to the support of the Wisconsin Alumni Research Foundation, which patented a key Newmark advance in 2018.

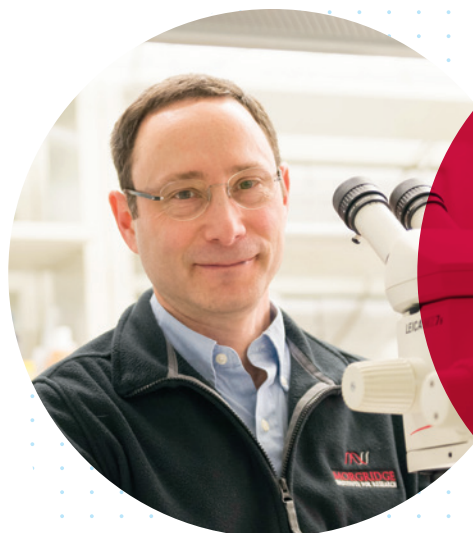
Schistosomiasis is caused by parasitic flatworms called schistosomes that, once inside a human body, travel to blood vessels around the liver or bladder where it causes massive health problems. The drug Praziquantel is currently the primary form of treatment, but it's only able to kill the parasite in its adult form — and not the stage that infects people.

Newmark first became interested in flatworms because of their incredible abilities to regenerate entire new animals from tiny fragments of their bodies. But he and others quickly realized that insights from this research also had profound implications for the diseases associated with flatworms like schistosomes.

A large part of their research focuses on the complicated life cycle of these flatworms. Schistosomes begin their life cycle in tainted

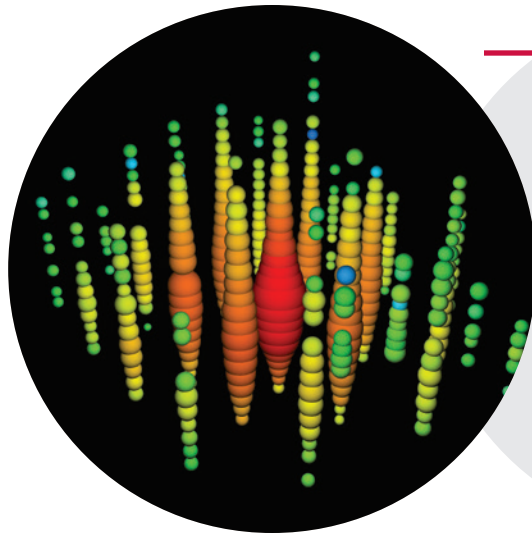
freshwater lakes and ponds, where parasite eggs hatch into tiny creatures whose sole task is to infect a specific type of snail. Within the snail host, the parasite produces massive numbers of offspring called cercariae that, released back into water, can burrow through human skin. That's why children who frequently swim in unhygienic water contract schistosomiasis.

Finding a treatment is like shooting at a moving target because now hybrid schistosomes have emerged, presenting a whole new challenge. But already, one of Newmark's projects has identified a molecule that paralyzes schistosome worms during the life cycle stage that infects people. Newmark's WARF patent may help harness this molecule to create a topical treatment for people to apply to skin before coming in contact with suspect water — preventing people from getting infected in the first place.



Support from WARF is helping scientists like Phil Newmark stay at the top of their fields. Newmark recently learned his status as a Howard Hughes Medical Institute (HHMI) Investigator will be extended another seven years. Morgridge PIs Newmark and Paul Ahlquist are two of only five HHMI investigators at UW-Madison.

# 2018 MILESTONES



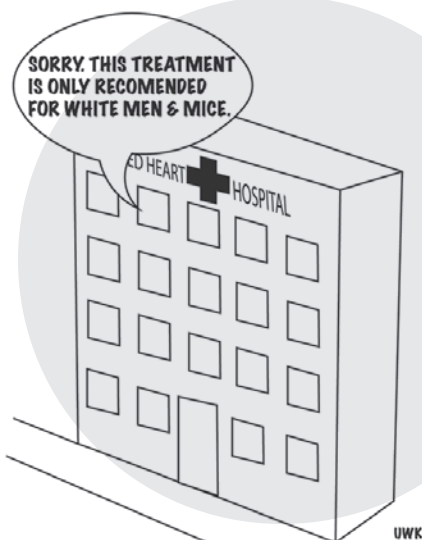
## Powering big science

From particle science to the cosmos, big science is boosted by HTCondor high-throughput computing, pioneered by UW-Madison computer scientist and Morgridge PI Miron Livny. In 2018, scientists lauded its contributions to the UW-Madison IceCube project and its successful detection of cosmic neutrinos. HTCondor powered 300-plus UW-Madison projects in 2018.



## Recruiting cancer assassins

Human T cells are specialized immune system cells designed to seek and destroy disease-causing invaders – and hold great promise for new cancer therapies. A technology by Melissa Skala and Alexandra Walsh to identify and sort the most potent T cells for therapy won a prestigious WARF Innovation Award, chosen from more than 400 entries.



## Illustrating bioethical challenges

Who doesn't love a good cartoon? Morgridge bioethicist in residence Pilar Ossorio applied that premise to her profession. Her Morgridge Bioethics Cartooning Competition was a big hit with UW-Madison students, generating 24 entries and 15 finalists in spring 2018. This fall, entries for the second annual competition more than doubled to 55 submissions.





### **Energizing philanthropy**

In 2018, the Morgridge development team more than doubled the number of donors from the previous year — 118 versus 58 in 2017. Since restarting development efforts in January 2015, the institute has raised a total of \$152.2 million, more than half of which is endowed support. Also in 2018, Morgridge named the John W. & Jeanne M. Rowe Center for Research in Virology, led by investigator Paul Ahlquist, honoring more than \$15 million in support from the Rowe family.

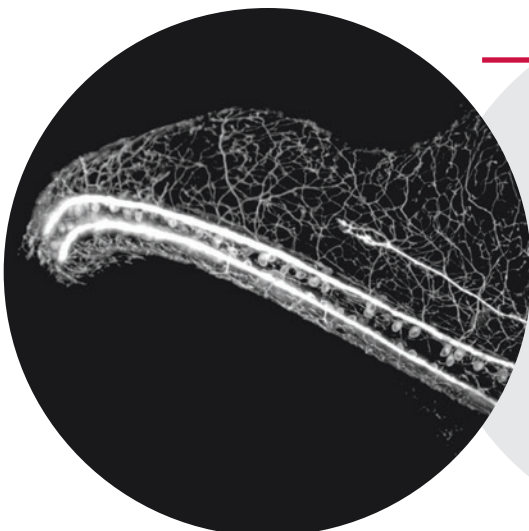
### **Seeding metabolism in new places**

A graduate fellowship launched by Morgridge is bringing fresh eyes to the growing pursuit of UW–Madison metabolism research. Launched by Dave Pagliarini, the fellowship supports students in areas where metabolism is under-researched and might blossom. Its first two fellows are Prasanth Kumar (chemistry) and Bruno Martorelli di Genova (medical microbiology).



### **Jason Cantor joins metabolism**

Morgridge welcomed a new investigator into the fold in 2018, strengthening its metabolism research theme. Jason Cantor, who came from the prestigious Whitehead Institute at MIT, is an expert in creating better synthetic models to understand how environmental factors impact cancer metabolism. He joins the UW-Madison biochemistry faculty.



### **Seeing is believing**

A spectacular time-lapse video of a developing zebrafish nervous system earned first place in the international Nikon Small World in Motion competition. Using Jan Huisken's light-sheet microscope technology, Morgridge researcher Henry He and UW–Madison integrative biologist Liz Haynes created the biological fireworks by condensing 16 hours of embryo growth.



# SELECT ADVANCES IN 2018

## Introducing Flamingo: A microscope for the masses

### FLAMINGO

Modern microscopy has given scientists a front-row seat to living, breathing biology in all its technicolor glory. But access to the best technologies can be spotty.

Morgridge investigator Jan Huisken, the co-founder of light sheet microscopy, has a new project meant to bridge the technology gap. His Morgridge team has developed a portable, shareable light sheet microscope — an engineering feat that shrinks a tabletop-sized technology down to the weight and dimensions of a suitcase liberally packed for a week's vacation. The project can be mailed to a lab anywhere in the world, configured remotely by Morgridge engineers, and run one to three months of experiments.

The microscope then either begins its mail-order journey to the next lab, or back to the Morgridge lab if a tune-up is needed. The first focus will be on sharing with the UW–Madison community. “If we succeed, this project will certainly have a huge impact in the field of fluorescence microscopy and significantly change the way we collaborate,” says Huisken.

The team debuted the tool — nicknamed “Flamingo” for its one-legged stand and vertical profile — at the International Zebrafish Conference meeting at UW–Madison. It's the perfect starting point for this device, since the zebrafish research community wants to use light sheet microscopy. More than 200 scientists signed a form expressing future interest.

**“Our collaboration with the Huisken lab and the use of their light sheet microscope is transforming our research. Not only are the light sheet movies stunningly beautiful, they are also rich with scientific content. The ability to image the whole developing embryo with unprecedented resolution has revealed previously unappreciated dynamics of development.”**

— MARY HALLORAN, PROFESSOR OF INTEGRATIVE BIOLOGY

## Morgridge, Meriter research project targets the persistent risk of preterm birth

Of the approximately 4 million births in the United States each year, at least 400,000 of them still trigger a state of desperation in maternity wards.

Parents, doctors and medical staff feel this way over the challenge of managing high-risk pregnancies. There is a surprising lack of precise science behind diagnosing risk for preterm birth, or intervening at the right time or with the right methodology.

Even worse, U.S. preterm birth rates have actually increased in recent years to almost 10 percent, and along with them a surge of long-term medical and social distress for families.

Against this backdrop, the Morgridge Institute has launched a research project intended to give doctors new tools to improve health outcomes and lower premature birth rates.

The project includes partners at the **UW–Madison Department of Medical Physics**, Intermountain Healthcare in Utah, Columbia University and the Meriter Hospital Birthing Center in Madison.

The project, led by Morgridge postdoctoral researcher Kayvan Samimi, uses samples provided by Meriter Birthing Center medical staff of placental tissue normally discarded after birth from 50 pregnancies from different circumstances, including full-term birth and preterm vaginal and cesarean deliveries. Researchers then use novel imaging tools to examine differences in the structural properties of those tissues to better understand what goes awry during preterm labor.

The catalyst behind the project is Dr. Helen Feltovich, an obstetrician at Intermountain Healthcare in Utah who specializes in high-risk pregnancies and works with hundreds of patients annually.

The preterm birth research project is made possible by the core Morgridge ingredients of collaboration, flexibility and freedom to take well-advised risks.

“The issue for me was going to work every single day to face this problem that no one has solutions for, and no one is getting anywhere with,” Dr. Feltovich says. “It was just starting to grate and grate and grate on me. The point is we flat-out do not understand how spontaneous preterm births happen.”

**“The point is we flat-out do not understand how spontaneous preterm births happen.”**

The Meriter Birth Center staff response to the project has been very enthusiastic, says Melissa Skala, a Morgridge medical engineering investigator and **UW–Madison biomedical engineer** who is overseeing the project. “They’re really excited to learn about what’s happening with their patients, because they’re frustrated,” she says.


Skala says the project is a prime example of how the Morgridge Institute can help seed risk-reward research that may be too early-stage to get funding from the National Institutes of Health.

Samimi was hired under an interdisciplinary postdoc program created by Morgridge to delve into this kind of uncharted territory with UW–Madison partners.

“You need the data before you can get the NIH funding, and you can’t get the data without the person,” Skala says. “We wouldn’t be doing the study without Kayvan.”



POSTDOCTORAL RESEARCHER  
KAYVAN SAMIMI



# REGENERATIVE BIOLOGY LEADERSHIP

## Fighting blindness with the help of stem cells

“As a pediatric ophthalmologist I see a fair number of children with diseases that lead to the degeneration and death of photoreceptors deep inside the retina, causing blindness. There’s nothing you can do today for the vast majority of these patients as the retina has no way to repair itself.

When I first came to Madison, it was two years after Jamie Thomson had discovered human embryonic stem cells. That instilled in me hope: *‘There’s the clay.*



*There’s the promise of making cell types that are lost in the human body because of incurable diseases.’* But it’s a long way to go from that theoretical capacity to actually making what is arguably the most complex cell in the human body, a photoreceptor cell.

As a biochemist I knew little about cell biology, so the stem cell community at Morgridge and UW–Madison took me under their wing. I learned from folks like Jamie, Su-Chun Zhang, Tim Kamp and many others. It was a tremendous collaborative community that helped jump-start my research way more than I could have done on my own. This is the only place in the world that could have accelerated my research and technology at the pace we were fortunate to realize.”

— DR. DAVID GAMM, PROFESSOR OF OPHTHALMOLOGY AND VISUAL SCIENCES AND FOUNDER OF OPSIS, A STEM CELL THERAPEUTIC TO FIGHT BLINDNESS

## Artery banks may transform how we fight heart disease

Cardiovascular disease accounts for one in every three deaths each year in the United States, according to the American Heart Association. In addition, more than 370,000 cardiovascular surgeries were performed last year alone.

These facts have motivated Morgridge investigator James Thomson to make cardiovascular disease the No. 1 focus of his research lab. As one of the world leaders in stem cell science, Thomson quickly saw the potential of stem cell technology to contribute to cardiovascular medicine.

The dream? Just as blood banks are essential to medicine, Thomson's lab hopes to see the advent of artery banks that give surgeons a better, readily available material to replace diseased arteries.

The lab is using pluripotent stem cells to grow the cellular building blocks of the artery — endothelial and smooth muscle cells — and coax them into assembling into arteries that can grow and thrive in a majority of patients.

The National Institutes of Health (NIH) is supporting a seven-year, \$8 million project to help move it toward clinical trials — with potential human therapies a decade away. It's a uniquely Wisconsin project, explained Thomson.

"The campus collaboration highlights what the Morgridge Institute does well because we are able to bring together multiple investigators from different expertise centers around campus," Thomson says. "We have an unusual combination of resources in Madison to pull this off."

The largest current stem cell research project at UW–Madison has the following ingredients:

- ▶ Wisconsin Institute for Discovery **mechanical engineer Tom Turng**, working on the same floor of the Discovery Building as the Thomson Lab, provides synthetic scaffolds, made of polymers or silk, for the human cells to assemble around.
- ▶ **UW biomedical engineer Naomi Chesler** develops the bioreactors that provide the right environment for cells to grow and mature into functional arteries.
- ▶ The **Wisconsin National Primate Research Center**, in a project led by **Igor Slukvin**, is running clinical trials with primates that have a model of human cardiovascular disease.
- ▶ And finally, the **Waisman Center Biomanufacturing Facility** will have the capability to manufacture arterial cells that meet FDA requirements for eventual human clinical trials.

Manufactured arteries may not be just a better choice for patients — they may be the only available choice, Thomson says. Transplant arteries must currently be harvested from another part of the patient, such as the leg. Many patients have advanced arterial disease that can be widespread, making even these secondary arteries unsuitable for transplant.

"We provided valuable proof that we can create a reliable source for cells and make arteries that perform and behave like the real thing," he says.



Morgridge investigator James Thomson is mobilizing stem cell science in the fight against cardiovascular disease, the world's leading cause of death.



# BRINGING SCIENCE TO SOCIETY

## The Morgridge Rural Summer Science Camp: Teachers and Students Respond

“Bringing the big world into our small communities is a huge positive. Some of our areas are so poverty stricken, so traumatized, it’s good for these students to have this opportunity. Where they might not normally branch out and feel secure enough to explore or move away, some of these kids can now say: ‘I can do this.’”

— GEORGI KAPALCZYNSKI, A TEACHER WITH THE WAUSAUKEE SCHOOL DISTRICT



“The most valuable part of the camp was being introduced to research opportunities on campus. Before attending, I wasn’t even aware that doing research as an undergraduate was possible. Meeting the scientists was inspiring to me. I am a first-generation college student, so I was pleasantly surprised to see how easy it was to meet and talk with the successful scientists and researchers.”

— ALEXANDRA KISSEL, 2015 GRADUATE OF DARLINGTON HIGH SCHOOL AND 2014 CAMP ATTENDEE





**Discovery Outreach: 2018 Participation**

**696,719**  
Total door count in 2018



**16,985**  
Event attendees in Discovery Building

**6,430** Saturday Science attendees



**2,697** Field trip participants (1,280 from Madison; 1,417 across state)

**1,821** Offsite programs at areas schools

## Discovery Outreach by the numbers

A partnership with WARF, Morgridge and UW-Madison

**72**  
Communities

**33,545** Attendees

**2018 Wisconsin Science Festival**



**868**  
STEM experts sharing knowledge



**294**  
Total events



**32**  
News outlets coverage



**37**  
Museums & Libraries

Treating macular  
degeneration

+  
Bio-  
manufacturing  
arteries

WAISMAN  
CENTER

Fighting  
pancreatic  
cancer

+  
Virus,  
cancer  
connections

UW CARBONE  
CANCER CENTER

Medical  
device  
innovation

EMERGENCY  
MEDICINE

Health  
records  
for drug  
discovery

VETERANS  
HOSPITAL

New  
arthritis  
insights

SCHOOL OF  
VETERINARY  
MEDICINE

MORGRIDGE  
CONNECTIONS  
ACROSS  
UW-  
MADISON

As a private  
research  
institute, we are  
positioned to  
help accelerate  
biomedical  
discovery across  
the university.



Bioreactors  
for tissue  
engineering

+

Student  
medical device  
prototyping

BIOMEDICAL  
ENGINEERING

Expanding mass  
spectrometry  
resources

BIOTECHNOLOGY  
CENTER

New  
metabolism  
partnership

CHEMISTRY

Identifying  
neurotoxic  
chemicals

+

Big data  
to fight  
Alzheimer's

BIostatistics  
AND MEDICAL  
INFORMATICS

Major  
Cryo-EM  
investment

BIOCHEMISTRY

Polymer  
'scaffolds'  
for tissue  
engineering

WISCONSIN  
INSTITUTE FOR  
DISCOVERY

High-throughput  
computing

+

Enhancing  
cybersecurity

COMPUTER  
SCIENCES

Advanced  
imaging  
for  
biologists

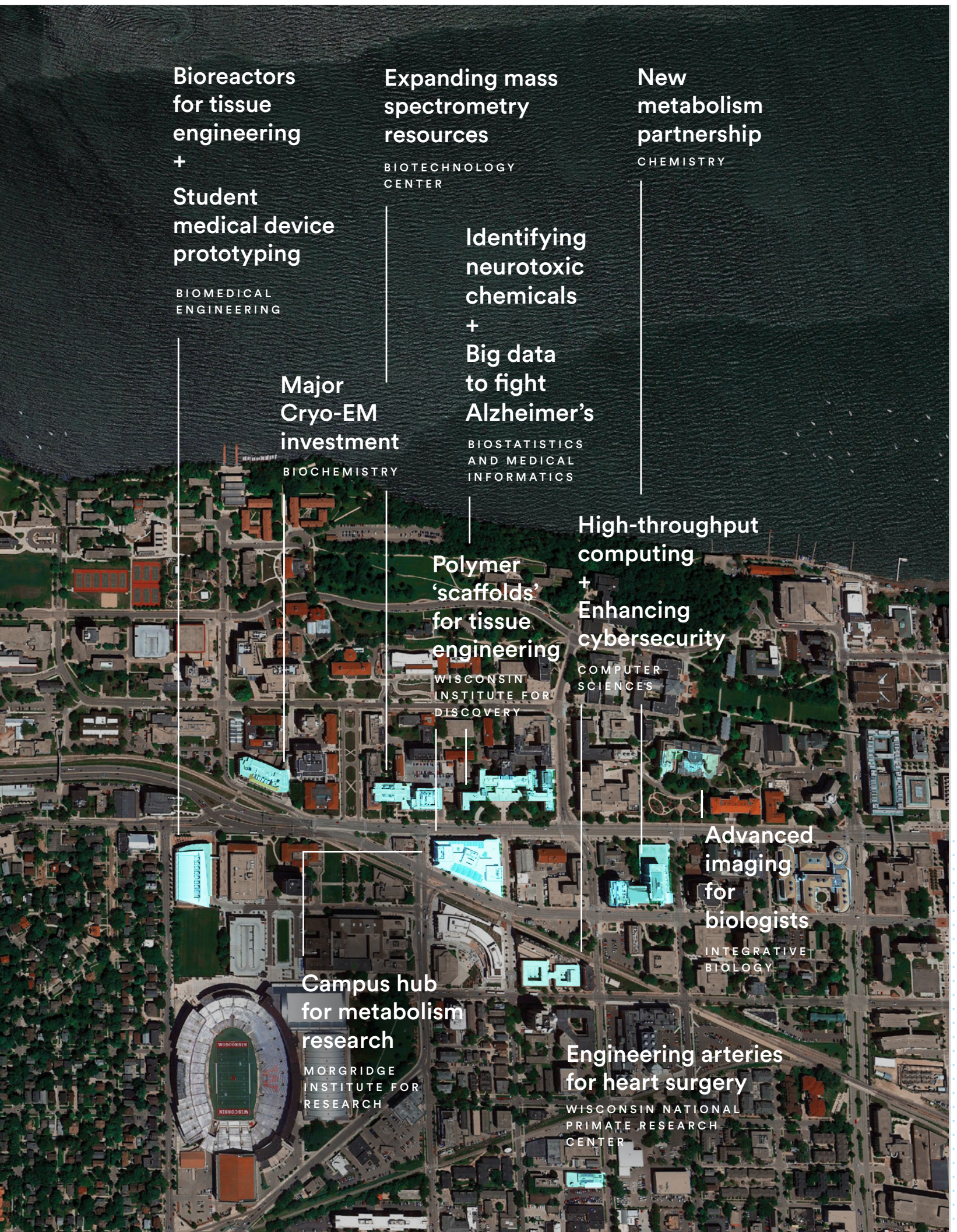
INTEGRATIVE  
BIOLOGY

Campus hub  
for metabolism  
research

MORGRIDGE  
INSTITUTE FOR  
RESEARCH

Engineering arteries  
for heart surgery

WISCONSIN NATIONAL  
PRIMATE RESEARCH  
CENTER





**“The Morgridge Institute is a little island of hope. It’s a little island of friends, of professionals who just thrive by the thought, ‘how can we make things better?’ Not only for themselves but for the community. I think that inquisitive nature accompanied by the goodness in them is what makes it a very special place.”**

— GUELAY BILEN-ROSAS, PROFESSOR OF ANESTHESIOLOGY AND CLIENT OF THE BERBEE WALSH PROTOTYPE PATHWAY



**“Basic research is the foundation of everything. Without it, we get nowhere. The lack of basic research in obstetrics, particularly in the imaging space, explains why we continue to regurgitate century-old technologies and treatments, which in turn explains why the rate of preterm birth is actually increasing. But my optimism has exploded logarithmically since working with Melissa and Kayvan.”**

— HELEN FELTOVICH, OBSTETRICIAN AT INTERMOUNTAIN HEALTHCARE,  
ON THE MORGRIDGE PRETERM BIRTH RESEARCH PROJECT





MORGRIDGE  
INSTITUTE FOR RESEARCH

THE DISCOVERY BUILDING / 330 N. ORCHARD STREET, MADISON WI 53715

608.316.4100 / MORGRIDGE.ORG