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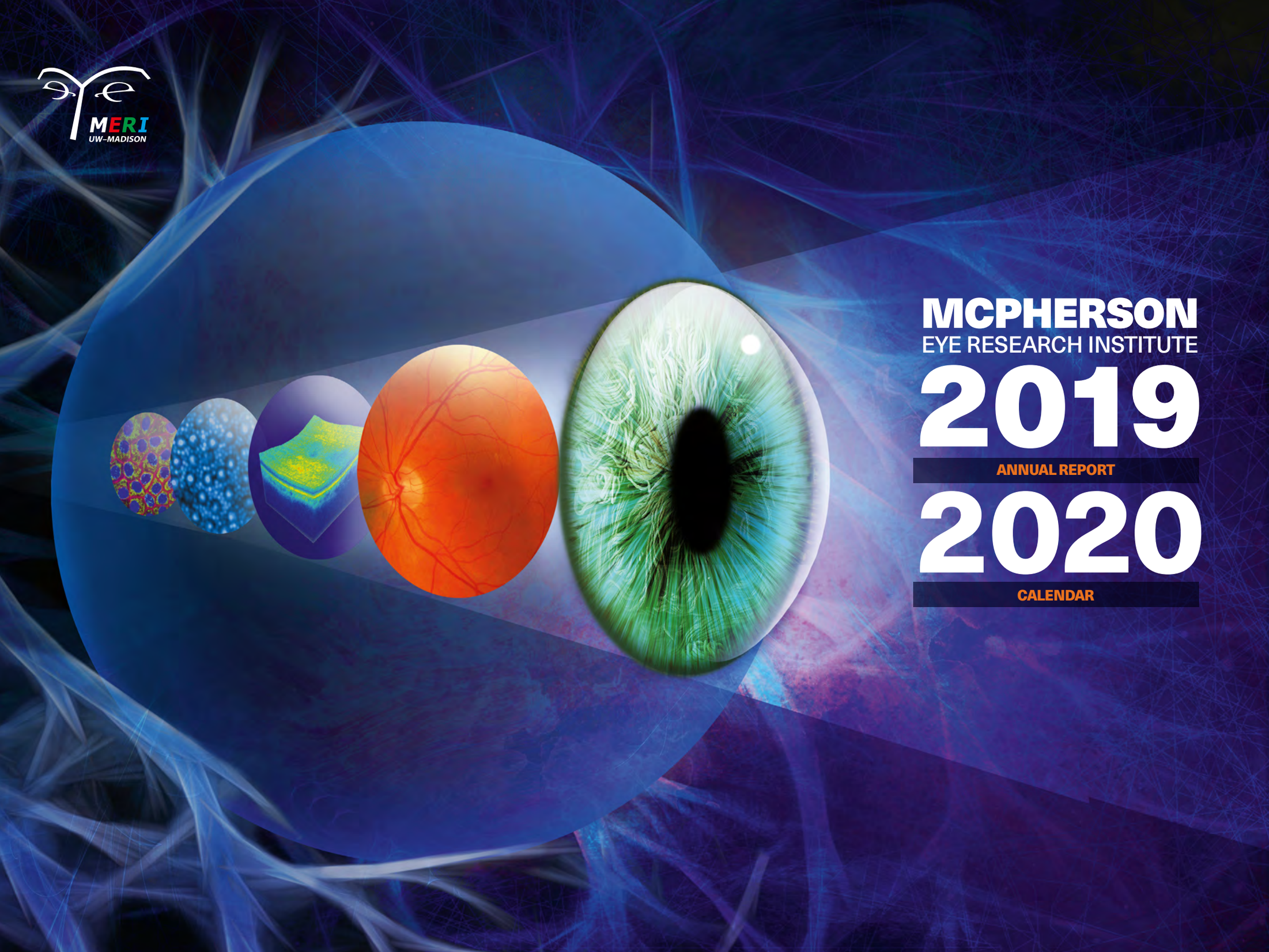
UW–MADISON



MCPHERSON EYE RESEARCH INSTITUTE

2019 ANNUAL REPORT

2020 CALENDAR

FROM THE DIRECTOR

Dear Friends of the McPherson Eye Research Institute,

Vision research at UW–Madison (and at our partner institutions across Wisconsin) made great strides in 2019 across a wide range of areas, from retinal gene editing and stem cell biology to novel drug studies and nanoparticle-based therapeutic delivery systems. These groundbreaking tools and treatment strategies all rely on imaging systems in order to truly see how they interact and perform within the living eye—down to the cellular and genetic levels. With recent improvements in imaging methods, our knowledge of eye structure and function in both sickness and health has never been better. McPherson ERI researchers are at the forefront in the development of the latest state of the art imaging technologies.

We've highlighted the Wisconsin Advanced Imaging of Visual Systems (WAIVS) initiative on these first pages, as well as a collaborative project of WAIVS partners Dr. Melissa Skala and Dr. Joe Carroll. Efforts like these will improve our ability to observe small changes in the intact, living eye. This important interdisciplinary work highlights the McPherson ERI's mission—to bring vision researchers together to solve the most challenging and devastating causes of blindness.

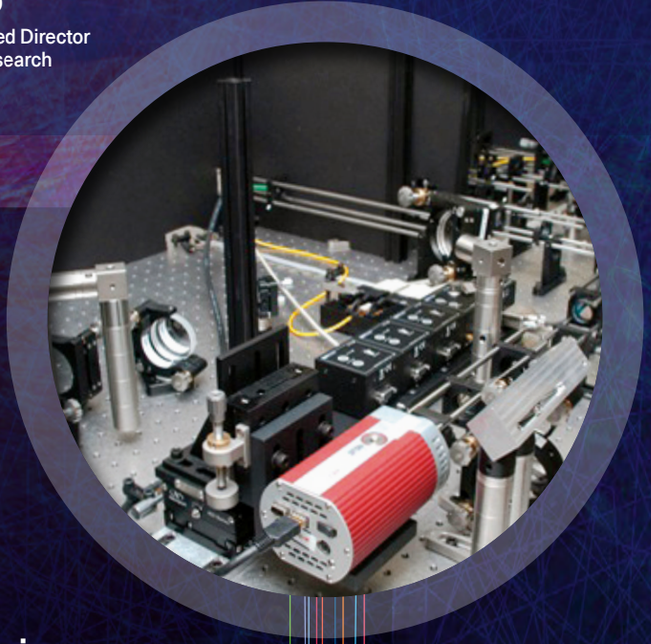
On the other pages of this annual calendar and report, you'll learn more about some of our 160+ McPherson ERI researchers from many UW–Madison departments (including those who hold endowed chairs and professorships through the Institute). I hope that you will be both intrigued and inspired by their diverse interests and skills. Scientific productivity and impact flourish in the type of collaborative network that constitutes the McPherson ERI. We are all very excited about what the next few years will bring.

These advances in vision research are possible because you care along with us. We are immensely grateful and humbled by all levels of your support. This year, the McPherson ERI has received major support for the newly endowed David and Nancy Walsh Family Professorship in Vision Research and the Monroe and Sandra Trout Director's Fund for Vision Research. We are also offering an exciting year-end gift-matching opportunity made possible by Roger and Lynn Van Vreede. And we are grateful to hundreds of riders and donors who support Cycle for Sight each year, or give at other times to fuel the efforts of the Institute. Such outreach activities allow us to build and maintain an open and productive dialogue between our researchers and you, the people we serve. **You** have helped our work move forward. **Thank you,** and I wish you the very best in the new year.

David M. Gamm, MD, PhD
RRF Emmett A. Humble Distinguished Director
Sandra Lemke Trout Chair in Eye Research

RESEARCH NEWS

WAIVS: Creating *the* Future *of* Imaging



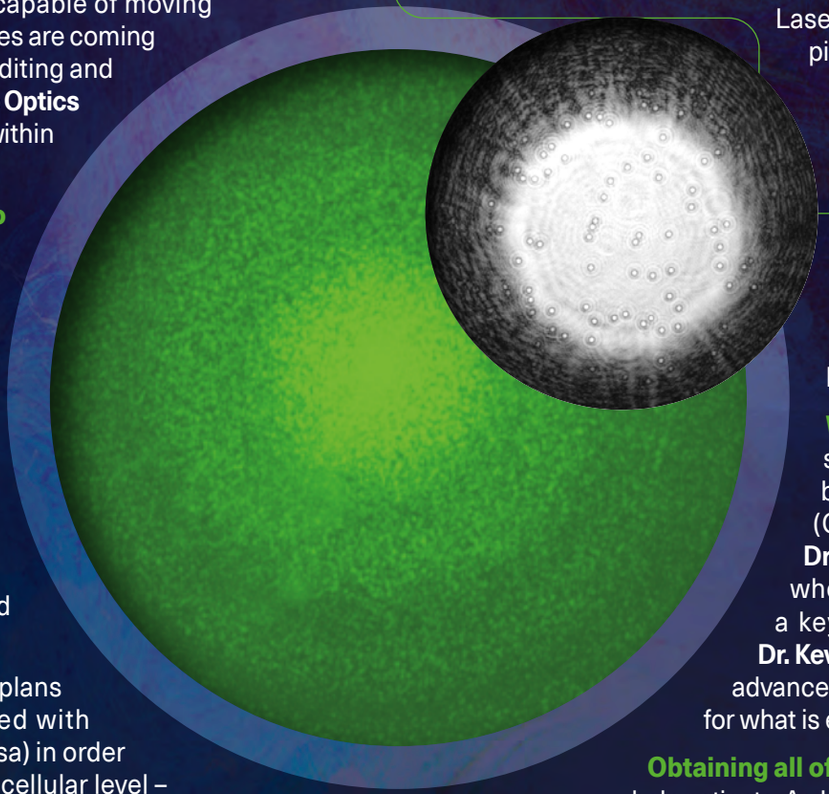
The first phase of our multidisciplinary **WAIVS** (**W**isconsin **A**dvanced **I**maging of **V**isual **S**ystems) initiative will go live in 2020, as we bring a revolutionary imaging method called **Adaptive Optics** to the University of Wisconsin-Madison campus.

The WAIVS initiative seeks to probe more deeply and effectively into the entire visual system, from the front of the eye to the brain's visual cortex, and epitomizes the McPherson ERI's leadership in vision technology. The UW-Madison Department of Ophthalmology and Visual Sciences is a co-lead in this effort that addresses the pressing need to have imaging technology capable of moving promising therapeutics forward. Landmark therapies are coming to clinical trial now and in the near future – gene editing and photoreceptor regeneration among them. **Adaptive Optics** will allow us to "see" retinal cells as they function within the living eye.

WAIVS will improve imaging methods in two ways: by providing a platform to advance research models in the lab, and by directly evaluating therapies that are in human clinical trials now or will be soon. **These two tracks won't run in isolation,** but will give feedback on each other. Advanced imaging methods created in the lab will be adapted for clinical use, while clinical findings will be used to direct new laboratory research endeavors. This synergism between research and clinical activities will be overseen by an interdisciplinary group of McPherson ERI faculty from across the UW-Madison campus and other partner institutions in the state.

From the clinical perspective, Dr. Kim Stepien plans to initiate pilot studies with patients diagnosed with inherited retinal diseases (e.g., retinitis pigmentosa) in order to track the effectiveness of new therapies at the cellular level – a level of imaging detail not previously possible. One example of a future clinical trial that will benefit from Adaptive Optics imaging is **Dr. David Gamm's** photoreceptor cell replacement effort. The UW's Fundus Photograph Reading Center (FPRC), led by **Dr. Barbara Blodi**, will develop new protocols to interpret imaging data from human clinical trials and multiple other projects.

In the lab, Dr. Jeremy Rogers – whose optical engineering group is building both the clinical and lab-based AOLSO (Adaptive Optics Laser Scanning Ophthalmoscope) machines – will pioneer imaging of retinal cell types not currently visible in fine detail *in vivo*, and will develop further capabilities geared towards the needs of WAIVS scientists. Rogers works closely with McPherson ERI members **Dr. Alfredo Dubra** (Stanford) and **Dr. Joseph Carroll** (Medical College of Wisconsin), who jointly developed this type of AOLSO technology. UW-Madison's version of their Adaptive Optics equipment will, at its inception, be the most advanced of its type in the world.



An image of 1.54 micron diameter spheres and their associated scattering pattern for green (525 nm) light, captured with goniometry.

WAIVS will draw on expertise from additional scientific areas as well. **Dr. Melissa Skala** will bring expertise in optical coherence tomography (OCT) and metabolic function imaging, while **Dr. Gillian McLellan**, a veterinary ophthalmologist who studies glaucoma in cats and dogs, will be a key resource for nonhuman model systems. **Dr. Kevin Eliceiri** will advise the entire WAIVS team on advanced data and computational analysis approaches for what is expected to be a flood of new and exciting data.

Obtaining all of this data has a purpose, of course, and it's to help patients. As Jeremy Rogers notes, "What's really exciting is our ability to use this knowledge to advance cutting edge therapies. Adaptive Optics allows us to understand the impact of drug, gene, and cell therapeutics in the living eye, which puts us in a great position to maximize their safety and effectiveness."

Seeing into the Eye: Imaging in Action

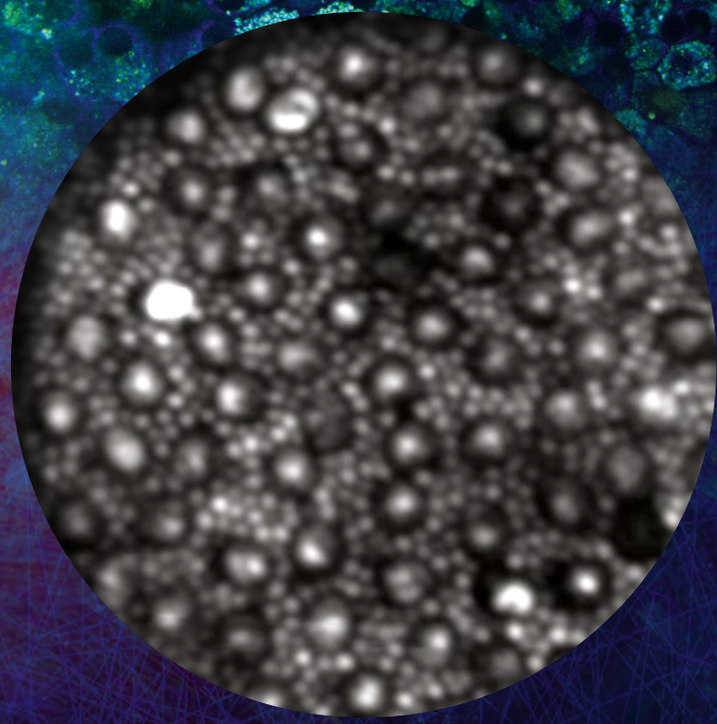
by Brian Mattmiller

An ongoing imaging collaboration between McPherson ERI scientists Melissa Skala and Joseph Carroll was recently highlighted in an article by Tom Still in the *Wisconsin State Journal*. Skala, a Morgridge Institute for Research investigator and UW-Madison professor of biomedical engineering, develops applications in photonics-based imaging that offer many research benefits, most notably that they do not damage living tissue. That has made her technology an ideal candidate for sensitive imaging in many systems of the body, including the visual system.

Several years ago, Skala sought out Joseph Carroll, a researcher and professor of ophthalmology at Medical College of Wisconsin who is a pioneer in adaptive optics retinal imaging (see our WAIVS feature, previous page). Skala was interested in investigating possible research partnerships, and arranged a daylong field trip with students to Carroll's lab. Their subsequent collaboration is helping to inform one of Carroll's core research questions: the role that melanin plays in healthy vision and disease.

Melanin, of course, is best known as the compound that determines skin pigmentation, but it is also essential to vision. "Melanin is responsible for absorbing excess light that comes into our eyes, so it serves a protective role," Skala says. "But we're actually uncertain of all the roles it plays." Together, Skala and Carroll developed an imaging technique that offers 3D, color images of melanin in the eye. It marked the first time a technique called photo-thermal optical coherence tomography (OCT) had been applied to eye research, and was a literal splicing together of two different technologies. Carroll brought his imaging module to the Morgridge Institute in the back of his truck. Skala's medical engineering team then built specialized laser optics into the device, complete with a protective case built by the Morgridge Fab Lab. The equipment has been back to Madison on other occasions for improvements.

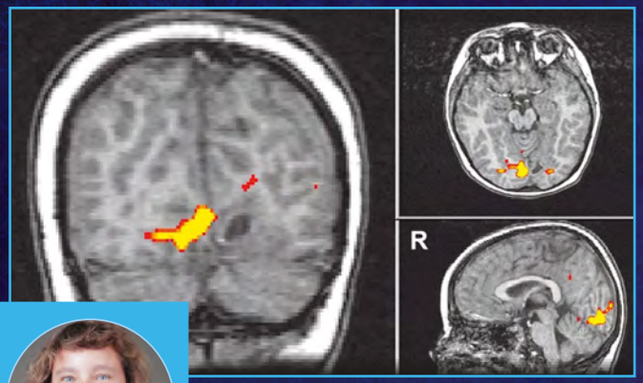
The results have been outstanding. "We found that this is a nice, specific technique to measure not only whether the melanin is there, but how much of it is there," Skala says. "And that's what Joe really needed to answer his questions about how melanin affects the visual system." The work has led to three published papers and a patent disclosure. Both scientists are actively pursuing next steps for potential human clinical applications, and they will continue to collaborate – and to advance more active research partnerships between Wisconsin's two largest urban centers.



Top: (Two-photon excited) autofluorescence image of retinal pigment epithelium cells in culture. Skala lab.

Bottom: Photoreceptor mosaic showing rods & cones, imaged in a human subject via Adaptive Optics. Carroll lab.

MCPHERSON ERI SCIENTISTS



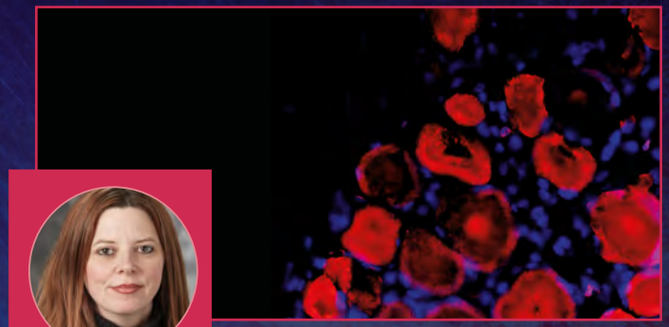
3-axis view of a functional magnetic resonance image showing unilateral brain activation in the visual cortex of a patient.

Beth Meyerand PhD

Medical Physics, School of Medicine and Public Health | Biomedical Engineering, College of Engineering

Dr. Beth Meyerand and her research group focus on the field of magnetic resonance imaging of the human brain. Functional MRI (fMRI) allows them to visualize both the temporal and spatial patterns of brain activity in response to different stimuli. Their goal is the development and application of novel MR methods to visualize brain structure and function and to translate these methods for clinical diagnosis in various patient populations.

In the context of vision research, Dr. Meyerand is working to create methods to map human brain connectivity within the visual cortex using mathematical modeling techniques such as graph theory and dynamic causal modeling. She uses these methods in her collaborations with physicians to improve patient care and to better understand disease progression and treatment.



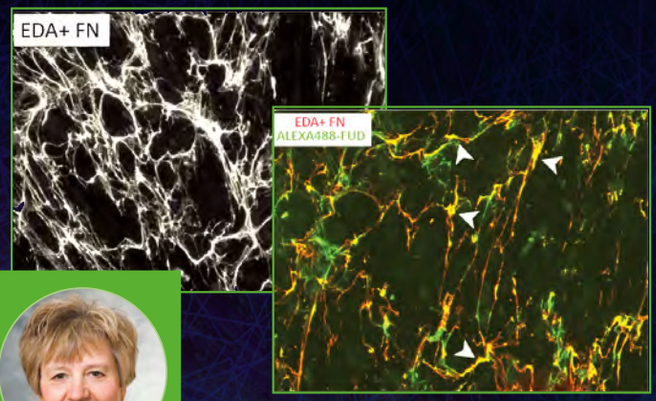
Gene therapy vectors in neurons (red immune)

Donna Neumann PhD

Ophthalmology and Visual Sciences | School of Medicine and Public Health

Herpes Simplex Virus 1 (HSV-1) is a common human virus that can manifest in the cornea and lead to blindness. The virus has two stages of infection, lytic and latent. Lytic infections are characterized by robust viral replication, assembly of infectious viral particles, and transmission to other humans. However, in latency, HSV-1 remains silent within neuronal cells so that it can escape immune detection and clearance, permitting the virus to remain in the infected host for life. Latent virus can reactivate in the eye and can cause severe corneal damage.

Dr. Neumann's research seeks ways to prevent reactivation and the associated corneal damage in patients with HSV-1 infections. Towards this goal, her lab developed a gene therapy technique that allows topical delivery of genetic material to the cornea using a non-infectious part of another virus. This genetic material then moves from the eye to the neurons that contain latent virus. Using this technique, the Neumann group has successfully blocked reactivation of HSV-1 in the eye – providing an innovative and exciting tool for combatting HSV-1 related blindness.



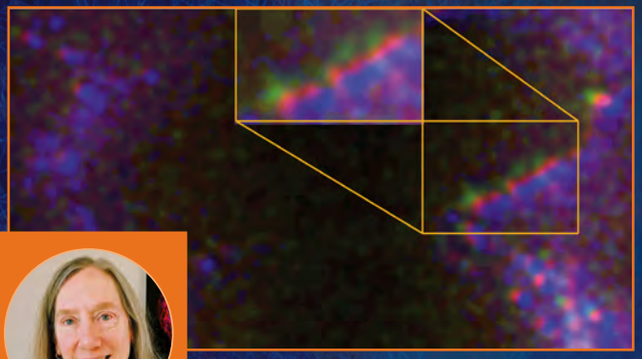
The assembly of fibronectin fibrils by trabecular meshwork cells can be prevented using a small molecule called FUD.

Donna Peters PhD

Pathology and Laboratory Medicine | School of Medicine and Public Health

Dr. Donna Peters studies the signaling pathways that govern the level of intraocular pressure (IOP) during glaucoma— a family of age-related neurodegenerative diseases that result in optic nerve damage, causing irreversible blindness. Two common forms – primary open angle glaucoma and steroid-induced glaucoma – are believed to be caused by chronic elevation in IOP due to restriction in the movement of fluid (aqueous humor) through a tissue called the trabecular meshwork, found in the angle where the sclera and cornea meet. This restriction is believed to be due to the increased deposition of proteins like collagen and fibronectin into insoluble fibrils in the extracellular space in this tissue.

Dr. Peters' group is investigating the signaling pathways responsible for the formation of these fibrils and is trying to develop ways to prevent or remove them. The Peters lab has identified a receptor called αvβ3 integrin that causes the increase in fibronectin fibrils *in vitro* and has shown that inhibiting its expression decreases IOP in mice eyes. They have also identified a molecule that may prevent the unwanted accumulation of fibronectin fibrils and could represent a new therapeutic approach.



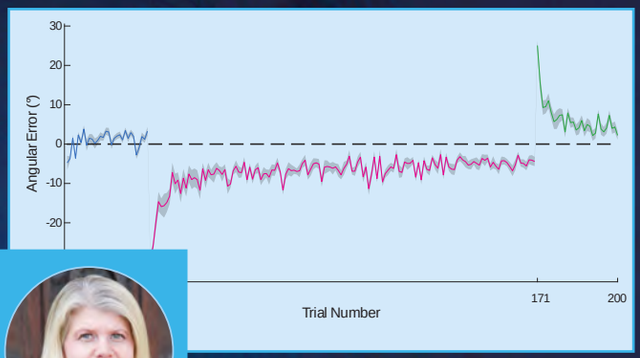
Mouse lens fiber cells stained with antibodies to Discs-large (green), Van Gogh-like 2 (red) and Scribble (blue).

Anne Griep PhD

Cell and Regenerative Biology | School of Medicine and Public Health

Because the role of the lens is to focus light on the retina, allowing us to see, the lens must remain transparent. (Opacities in the lens result in vision-obscuring cataracts.) The transparency of the lens depends on its unique architecture, which relies on the exquisite hexagonal shape of its primary cell type, the fiber cell, and the packing of these cells into highly ordered arrays. Although the unique structure of the fiber cells has been known for decades, researchers have only recently begun to identify the factors responsible for their structure.

Dr. Anne Griep uses genetically engineered mouse models to identify factors and signaling pathways that regulate fiber cell structure. Her lab has recently determined that Discs-large, Scribble and Van Gogh-like 2 – factors that belong to a pathway that regulates tissue polarity – are regulators of fiber cell structure. Understanding how the lens maintains its transparency is essential in finding better ways to delay or prevent cataracts, and may help advance ways to regenerate the lens *in vivo*.



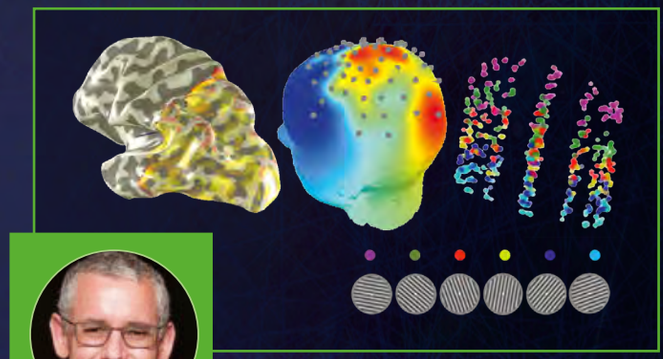
Reach error for a study: for trials represented in pink, visual cues were distorted. With practice, participants changed their movements so visual reach errors were minimized.

Leigh Ann Mrotek PhD

Biomedical Engineering | Marquette University, Milwaukee WI

Hitting a baseball and swatting a fly are intricately complex tasks. People must use visual information quickly to estimate the future location of a moving object in order to intercept it successfully. The brain uses specific information extracted from the visual scene and performs complex calculations to determine when and how to move the hand to capture objects. Because moving and manipulating objects are key goals in many daily tasks, the NeuroMotor Control Laboratory at Marquette University—under the direction of Dr. Leigh Ann Mrotek—seeks to develop technologies, training strategies, and therapeutic interventions for facilitating motor learning in healthy individuals and for promoting rehabilitation in patients with neuromotor injury or neurodevelopmental disorders.

The Mrotek lab is working to better understand the timeline and calculations used during reaching and intercepting tasks that utilize vision. Participants are asked to intercept targets in situations where the visual environment is altered. Researchers then compare participants' performances in different situations to examine the plans they attempt to execute. More importantly, researchers are interested in the errors made during performance and in how these errors are corrected during and between reach attempts.

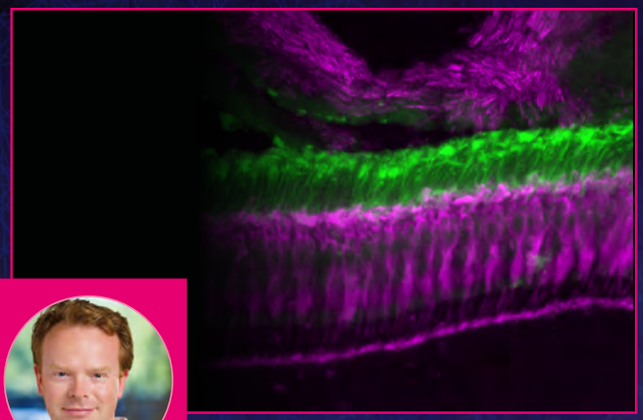


Brad Postle PhD

Psychology, College of Letters and Science | Psychiatry, School of Medicine and Public Health

Cognitive neuroscientist Dr. Brad Postle and his research group share interests in human memory and cognition encompassing the cognitive and neural bases of working memory, attention, control, and consciousness. We all use visual working memory hundreds of times every day—like when we remember where on the grocery store shelf to replace a previously selected item after deciding to buy a different brand, or when we hold in mind an image from the GPS while driving in an unfamiliar neighborhood.

In the experiment represented by the image above, the Postle lab asked people to remember two of the six oriented grating images shown at bottom right (color-coded), then had them turn a response dial to indicate the orientation of the first image, followed by the second. This requires the brain to juggle priority between the two images at different times. Brain regions engaged by this task are shown with the yellow "activation map" (upper left), and the brain's electrical activity is measured at the scalp with EEG (top center). The plot at the top right provides a snapshot of the brain's representation of the six stimuli during this task.



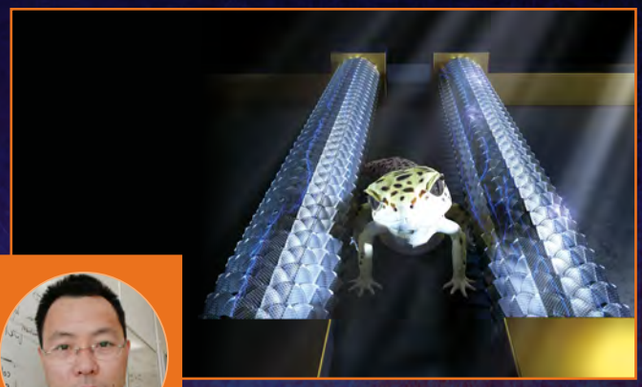
Zebrafish retinal pigment epithelium (green) and photoreceptors (magenta)

Ross Collery PhD

Ophthalmology and Visual Sciences | Cell Biology, Neurobiology and Anatomy | Medical College of Wisconsin, Milwaukee WI

The Collery Lab uses zebrafish to model human eye disease. Unlike many animal models, zebrafish have eyes rich in cones – the photoreceptors used by humans for daytime vision, and to perceive colors. Dr. Collery is particularly interested in retinoids – relatives of vitamin A that are vital for photoreceptor health and function – and his lab uses cutting-edge Crispr-Cas9 methods to edit genes associated with human eye diseases where retinoid transport is compromised.

Dr. Collery's research program has also developed methods to calculate the refractive state of the zebrafish eye (a measurement of whether the eye is nearsighted or farsighted). By inactivating genes thought to be associated with refractive error and eye size control, he seeks to better understand how genetic factors interact to bring our vision into focus. By combining gene editing, transgenic techniques, and live imaging of individual cells within the retina, the Collery lab seeks to understand mechanisms behind eye disease to further vision research and help in the fight to prevent vision loss.



Inspired by the directional hearing of geckos, this light sensor consists of two nanowires that can detect the incident angle of light waves – by working as the "eardrum" for optical waves.

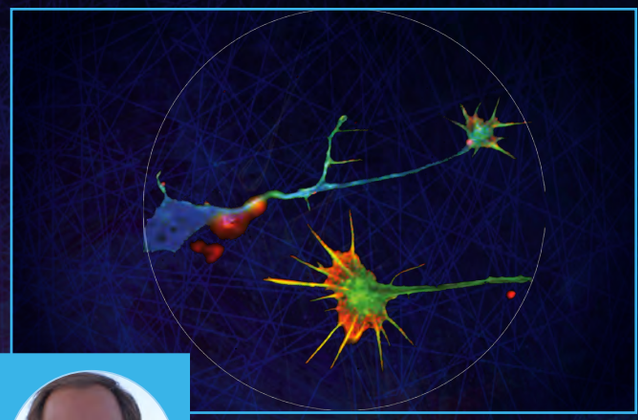
Zongfu Yu PhD

Electrical and Computer Engineering | College of Engineering

Dr. Yu's research group works on devices that help machines see better. Today's machines rely on the same type of cameras that we find in cell phones. They use imaging sensors consisting of arrays of light-sensitive pixels, each of which measures the intensity of the light falling on it. The issue with such pixels is that they are incapable of acquiring other important aspects of multimodal information of light, such as its incident angle, wavelength, and phase.

While the intensity information is enough for conventional applications such as photography, its limitations become apparent in advanced visual tasks. For example, it is impaired by fog and rain. As a result, expensive optical instruments, such as the LIDAR systems used for distance measurement in autonomous cars, are often used to assist vision.

Researchers in Yu's group work on identifying the pathway that could overcome these fundamental issues in traditional visual hardware. In addition to helping machines to see, they also develop devices to help machines to understand a scene – for example, using a structured glass to recognize an object without any computer chip.



In culture, developing human photoreceptors (blue, above) and retinal ganglion cells (below) from iPSCs display distinct structures.

Tim Gomez PhD

Neuroscience | School of Medicine and Public Health

Research in the Gomez laboratory is directed toward understanding the molecular mechanisms that govern the assembly of neuronal circuits, such as connections within the retina, during emergent development. As circuits develop, neurons must elaborate processes that connect to the correct downstream target cells. Understanding how complex neuronal circuits normally assemble will inform therapeutic interventions to correct mis-wiring due to neuro-developmental disease and to repair circuits after degenerative loss or injury.

Photoreceptors (PR) are our primary visual sensory cells, and their loss through damage or disease leads to incurable blindness. While PR transplant research is ongoing in animal models, success is limited by our poor understanding of how PRs normally generate axons and form synapses. Using human PRs derived from pluripotent stem cells, the Gomez lab is studying the natural, structural development of these cells ***in vitro*** and within retinal organoids--with a goal to optimize conditions for cell regeneration and future cell replacement therapy.

MCPHERSON ERI ENDOWED CHAIRS & PROFESSORSHIPS

RESEARCH UPDATES 2019

Akihiro Ikeda DVM, PhD

Timothy William Trout Professorship in Eye Research

"Our overall research goal is **to identify mechanisms underlying aging and age-related diseases** in the retina. Using mouse models, we have successfully discovered several key molecules associated with aging of the retina. For example, one major finding was the identification that a mutation in a gene called ***Tmem135***, which is associated with mitochondrial functions, is responsible for accelerated aging and age-related macular degeneration (AMD)-like disease phenotypes in the mouse retina.

We have noted other interesting observations as well, including metabolomic changes (i.e., changes in the overall metabolic signature) in ***Tmem135*** mutant mice, which suggested new therapeutic targets for age-related disease phenotypes. We have also observed that multiple genes interact with the disease-causing mutation to determine the severity of aging and age-related disease symptoms (these genes are called "modifier genes"). We have been able to develop and refine techniques and tools to visualize cells in the retinal pigment epithelium (RPE) of mice, to quantify morphological changes in these cells with age, and to perform imaging of mitochondria in live cells. Our goal, which is greatly helped by support from the **Timothy William Trout Professorship in Eye Research,** is to dive further into these molecular mechanisms and test potential therapeutic strategies for age-related retinal diseases."

David M. Gamm MD, PhD

Director, McPherson Eye Research Institute | Retina Research Foundation Emmett A. Humble Distinguished Directorship | Sandra Lemke Trout Chair in Eye Research

"The **RRF Emmett A. Humble Distinguished Directorship** supports my lab's efforts to **generate human "disease-in-a-dish" models of inherited retinal disease** (for example, retinitis pigmentosa) using human pluripotent stem cell (hPSC) technology that we patented at UW-Madison. These models are created from blood samples donated by patients with blinding disorders, and we use them as a platform to understand how the disease occurs and to develop new therapies – including drug and gene therapies – to preserve or restore vision in affected patients. An example of an eye disease that we study in this manner is Best disease, one of the most common causes of inherited macular degeneration. In a collaboration with other McPherson ERI researchers (Bikash Pattnaik, Krishanu Saha, Sushmita Roy), we grew retinal cells from hPSCs generated from patients with Best disease and tested them to determine which ones would be good candidates for future gene therapies."

"The **Sandra Lemke Trout Chair in Eye Research** provides critical funds to **advance our pioneering retinal stem cell technology toward the clinic** to treat patients with devastating degenerative diseases of the retina such as age-related macular degeneration. Over the years, support from this chair has facilitated studies that improved our ability to generate photoreceptors (rods and cones) and retinal pigment epithelium (RPE) in a dish and test their effects in diseased retinas. As a result, we are now in a public-private partnership to generate the cells needed to begin a clinical trial for both age-related macular degeneration (AMD) and retinitis pigmentosa (RP) in the foreseeable future. More recently, we have teamed with McPherson ERI researchers Shaoqin Gong and Zhenqiang Ma to create micro-engineered "patches" of retina geared towards replacing photoreceptors and RPE cells lost in these diseases."

Kevin Eliceiri PhD

Associate Director, McPherson Eye Research Institute | Retina Research Foundation Walter H. Helmerich Research Chair

"The **RRF Walter H. Helmerich Research Chair** has provided important support for **new computational imaging directions** in my research program. These include new artificial intelligence-based approaches for revealing image-based biomarkers and novel optical approaches for improved characterization of intact cellular microenvironments. We have been able to develop a machine learning-based software pipeline that can detect disease-associated fibrosis in unlabeled clinical samples. We have also extended our ImageJ image analysis tools for new applications in eye research. The support from the Helmerich Chair has been invaluable in helping generate key preliminary data for grant proposals and initiating new collaborations in vision research."

Mrinalini Hoon PhD

Retina Research Foundation Rebecca Meyer Brown Professorship

"Our research is focused on elucidating the cellular and activity-dependent mechanisms that enable formation of correct **neuronal connections (synapses) in the developing retina** and that damage retinal organization and function during disease and degeneration. The support of the **Retina Research Foundation Rebecca Meyer Brown Professorship** is crucial in enabling us to ask questions about the plasticity of retinal synapses, by allowing us to combine interdisciplinary techniques such as high-resolution light and electron microscopy, single-cell electrophysiology, and gene-sequencing approaches. Using transgenic mouse model systems that mimic developmental deficits or disease configurations, our research will determine which retinal synaptic and circuit modifications and deficits are in need of therapeutic attention."

Krishanu Saha Ph.D

Retina Research Foundation Kathryn and Latimer Murfee Chair

"My lab works towards the development of **precise genome editors for the treatment of various visual disorders.** There have been exciting recent UW-Madison developments in this work, including collaborations with McPherson ERI members David Gamm, Bikash Pattnaik, Sarah Gong, Melissa Skala and others to develop new viral vectors and nanoparticles containing genome editing machinery. These viruses and nanoparticles can be injected into the eye to directly edit the genome of cells within the retina. We exploit the modular CRISPR-Cas9 system, a technique that is undergoing rapid worldwide growth, to easily target these genome editors to disrupt or fix the various mutant alleles found within patients. Support from the **Retina Research Foundation Kathryn and Latimer Murfee Chair** augments this work and is especially timely because it helps us leverage current investments at the federal level in genome editing (for example, the National Institutes of Health's Somatic Cell Genome Editing Consortium)."

Bikash Pattnaik PhD

Retina Research Foundation M. D. Matthews Professorship

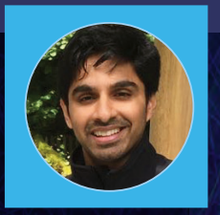
"Our research focus is on **inherited and acquired pediatric blindness**, including Lebers Congenital Amaurosis (LCA), a type of early-onset blindness. A gene defect in one type of LCA causes dysfunctional inwardly rectifying potassium channels in retinal pigment epithelium (RPE) cells. Using patient-derived induced pluripotent stem cells (iPSC-RPE cells), we have tested the effectiveness of gene augmentation therapy in this disease. Gene therapy was also effective in rescuing degenerating RPE cells in a mouse model of LCA. Lastly, we are also testing several other molecular medicines that target a particular type of mutation that introduces a premature "stop" in the production of critical proteins. **The Retina Research Foundation M.D. Matthews Professorship** has provided funds to develop these novel therapies, which will advance the use of cutting edge genome editing tools in the search for cures for pediatric blindness."

Jeremy Rogers PhD

Retina Research Foundation Edwin and Dorothy Gamewell Professorship

"**The Retina Research Foundation Edwin and Dorothy Gamewell Professorship** enables my lab to investigate fundamental methods to **improve imaging of retinal cells in patients**. We are studying how light is scattered and reflected by the retina and use this information in computational models as we optimize and advance cutting edge imaging capabilities, including Adaptive Optics instrumentation. These developments in imaging technology will ultimately allow us to image cell function to aid diagnosis, optimize therapies, and improve our understanding of the visual system."

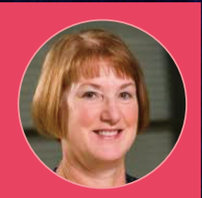
The Walsh Professorship is our newest endowed faculty position, added in 2019. We are grateful to the Walsh family, to Dr. Alice McPherson, and to John & Tashia Morgridge for support for this position.



Raunak Sinha PhD

David and Nancy Walsh Family Professorship in Vision Research

"Research in our lab is focused on understanding **how visual signals are transduced (converted) in the photoreceptors** and how they are subsequently processed by the downstream neural circuitry in the vertebrate retina. We pose this question in species that have varied retinal specializations and rely on vision to different degrees. One such retinal specialization that is unique to diurnal primates like humans is the fovea, which mediates our high definition central vision and thus dominates our everyday visual experience. **The David & Nancy Walsh Family Professorship** will support our lab's efforts to understand the functional specialization of photoreceptors in the fovea at an unprecedented resolution from molecules to cellular function. We will use this ***in vivo*** information as a baseline for testing photoreceptor function in human stem cell-derived retina to facilitate more effective stem cell replacement therapies in diseases such as retinitis pigmentosa and Usher syndrome."



Barbara A. Blodi MD

Retina Research Foundation Daniel M. Albert Chair

"The **Daniel M. Albert Chair** has been invaluable in helping me and the interdisciplinary team at the University of Wisconsin **bring Adaptive Optics into clinical medicine**. Adaptive Optics is a novel imaging system that allows us to see retinal photoreceptors (rods and cones) at the back of the eye. With the Daniel M. Albert Chair, we have built a research team that is ready to acquire Adaptive Optics images in patients with healthy and diseased photoreceptors. My work is focused on standardization of Adaptive Optics in order to make this tool a useful one in clinical trials and ultimately in clinical practice."

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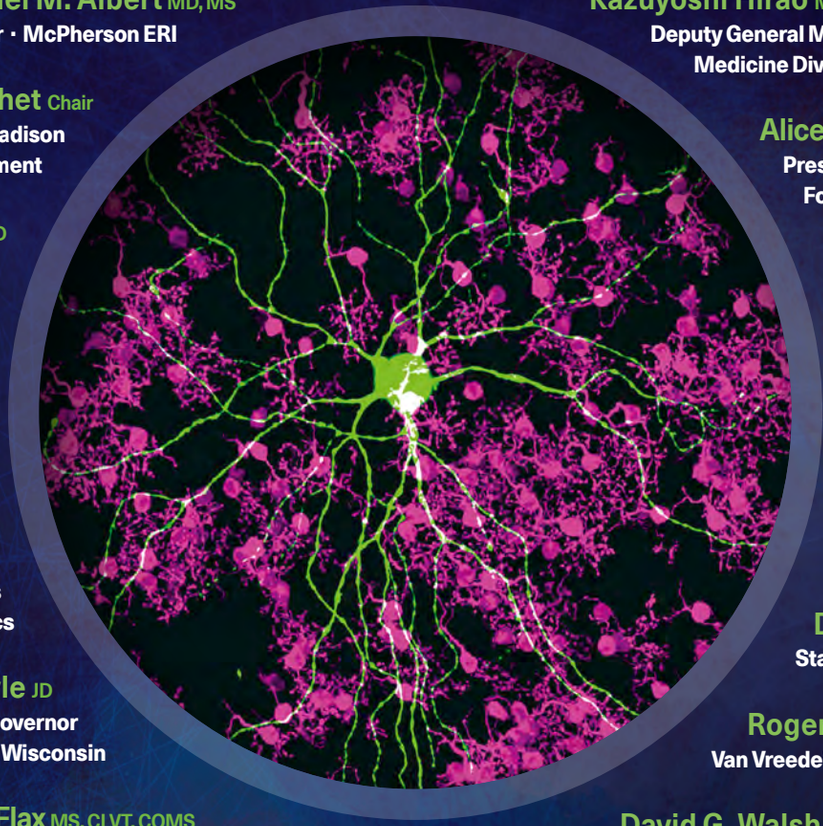

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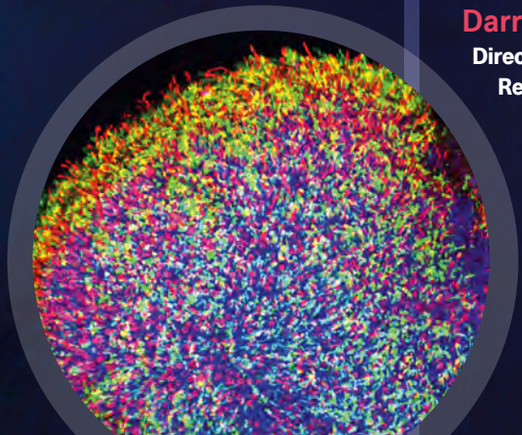

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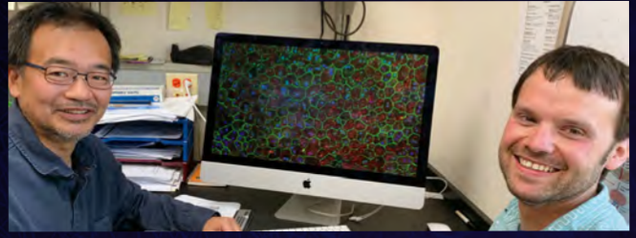
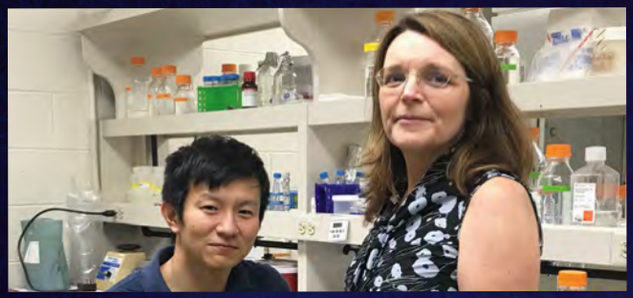


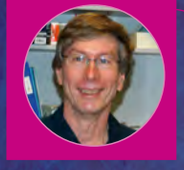


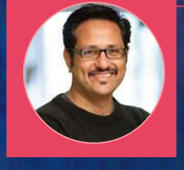
Kenzi Valentyn Vision Research Trainee Grants Commemorate a Brave Spirit

Two one-year grants of $4000 each were awarded to trainees selected by Research and Leadership Committee members in the 2019 competition. Named to commemorate Kenzi Valentyn, whose valiant battle with neurodegenerative disease ended in 2017, these grants were made possible through the Valentyn family's dedication to vision research.

Michael Landowski, PhD, a postdoctoral researcher working with Professor Aki Ikeda's lab group in the Department of Medical Genetics, will pursue a project exploring a protein that may be important in maintaining mitochondrial dynamics, "A role of TMEM135 in retinal glucose and lipid metabolism." His work will also explore age-dependent retinal pathology development in a mouse model.

Kazuya Oikawa, BVSc, a graduate student in the Comparative Biomedical Science Program in the School of Veterinary Medicine who is mentored by Dr. Gillian McLellan (Department of Ophthalmology and Visual Sciences; Department of Surgical Sciences), will be advancing understanding of "Optic nerve head neuroinflammation in a spontaneous large animal model of glaucoma," correlating inflammation with disease severity over different stages of feline glaucoma.





Visiting Scholar Program 2019

The Visiting Scholar Program (VSP) brings researchers from other institutions to UW-Madison for a few days of concentrated research focus. Such immersive experiences facilitate in-depth interactions and exchanges of ideas, which in turn seed or solidify collaborations. This year, owing to the continued success of Cycle for Sight, the Institute funded four VSP awards.

Assistant Professor Raunak Sinha (Neuroscience) hosted **Maxwell Turner, PhD** (Neurobiology, Stanford University) from May 13-17, 2019. Dr. Turner assisted with building an experimental rig that can integrate patterned visual stimulation with electrophysiology and optical imaging. Such a system will be useful to researchers across the UW campus studying visual function.

Assistant Professor Ari Rosenberg (Neuroscience) hosted **Curtis Baker, PhD** (Ophthalmology and Visual Sciences, McGill University, Montreal, Canada) from June 2-8, 2019. Together they worked to develop a new human psychophysical test of retinal ganglion cells, which will aid in assessing ophthalmic conditions such as glaucoma.

Professor Joseph Carroll (Ophthalmology and Visual Sciences, Medical College of Wisconsin) hosted **Deepak Lamba, PhD** (Ophthalmology, University of California-San Francisco) from September 22-27, 2019. Dr. Lamba contributed know-how from his retinal stem cell work to Dr. Carroll's retinal imaging group using the cone-dominant 13-line ground squirrel. Together, they hope to accelerate efforts to employ stem cell technology to replace photoreceptors in patients with inherited retinal degenerations.

Professor Paul Kaufman, MD (Ophthalmology and Visual Sciences) hosted **Professor Ernst Tamm, MD** (Institute of Human Anatomy & Embryology, University of Regensburg, Germany) from October 26-November 2, 2019. Dr. Tamm shared insights into the control of eye fluid and internal pressure to help the Kaufman lab advance projects aimed at understanding and treating glaucoma.

7th Annual McPherson ERI **Endowed Lecture**

"From Receptors to Behavior"

Held May 6, 2019

Charles Zuker PhD

Biochemistry & Molecular Biophysics / Neuroscience · Columbia University College of Physicians and Surgeons | Investigator · Howard Hughes Medical Institute

11th Annual **Vision Science Lecture**

"What Art Can Tell Us About the Brain"

Held October 24, 2019

Margaret S. Livingstone PhD

Neurobiology · Harvard Medical School

Mandelbaum & Albert Family Vision Gallery

Your Brain on Abstract Art

January – May 2019

How does your brain interpret what you see? How does abstract art affect your perception, memory, and emotions? Viewers responded to abstract art in a range of styles.

Artists: Chuck Bauer, Brian Besch, Pamela Callahan, Sue Jachimiec, Sue Johnson, Trent Miller, Judith Mjaanes, Ben Orozco, Sandra Peterson, Rick Ross

Photography Mimics Vision

June – September 2019

In our sense of vision, light is focused onto a light-sensitive surface, generating signals that are sent to and interpreted by the brain. The process of photography involves many analogous steps. This exhibit featured the work of five artists whose photographs highlight some of these steps in the visual process.

Artists: Eric Baillies, John Kalson, Michael Brown, Steven Agard, Cameron Gillie

2019 Cool Science Image Contest Exhibition

September – December 2019

The striking images in this annual exhibition illustrate oft-hidden features of the natural world key to research and studies undertaken on the UW-Madison campus.

Cycle for Sight 2019

Cycle for Sight, which took place on March 9th this year, raised almost **$55,000** for vision research – an outstanding total. And once again, the sky-high spirit at our three venues was as noteworthy as the funds raised. It's a great pleasure to see individuals and teams participating year after year. **Take a look at the smiling faces on this page…and join us in 2020!**

Funds from Cycle for Sight support a range of research awards and vision research programs. This year, our top fundraising team was once again Kenzi's Team, with $13,080 raised. Their gifts, with other Cycle for Sight gifts, will help support the Kenzi Valentyn Vision Research Trainee Awards in this and future years. In second place once again was the Blind Take Off team, with a new team record of $7,535. Both teams won two tickets to a UW-Madison athletic event of their choice. Many other teams did well, including Sightly Crazy, a new team (with $3370!), Team Tiradani ($2185), Out of Sight ($1900), The MAD City Cyclones ($1545), 44 Sight ($885), Affiliated Engineers ($830), Sight O Paths ($665), Isthmus Eye Care Cares!!! ($650), COPLOW ($640), and the Madison Central Lions ($610). We are also very grateful for an anonymous $5000 donor match, which spurred us over the $50,000 mark.

We would like to thank our great venues, the Princeton Club, Cap Fitness, and the UW Natatorium, as well as our generous sponsors: the MGE Foundation, Opsis Therapeutics, and the Shopko Foundation.

And thank YOU for supporting vision research with your generosity, not to mention your lungs and your legs!

Cycle for Sight
2020

Save the Date
March 7th
2020

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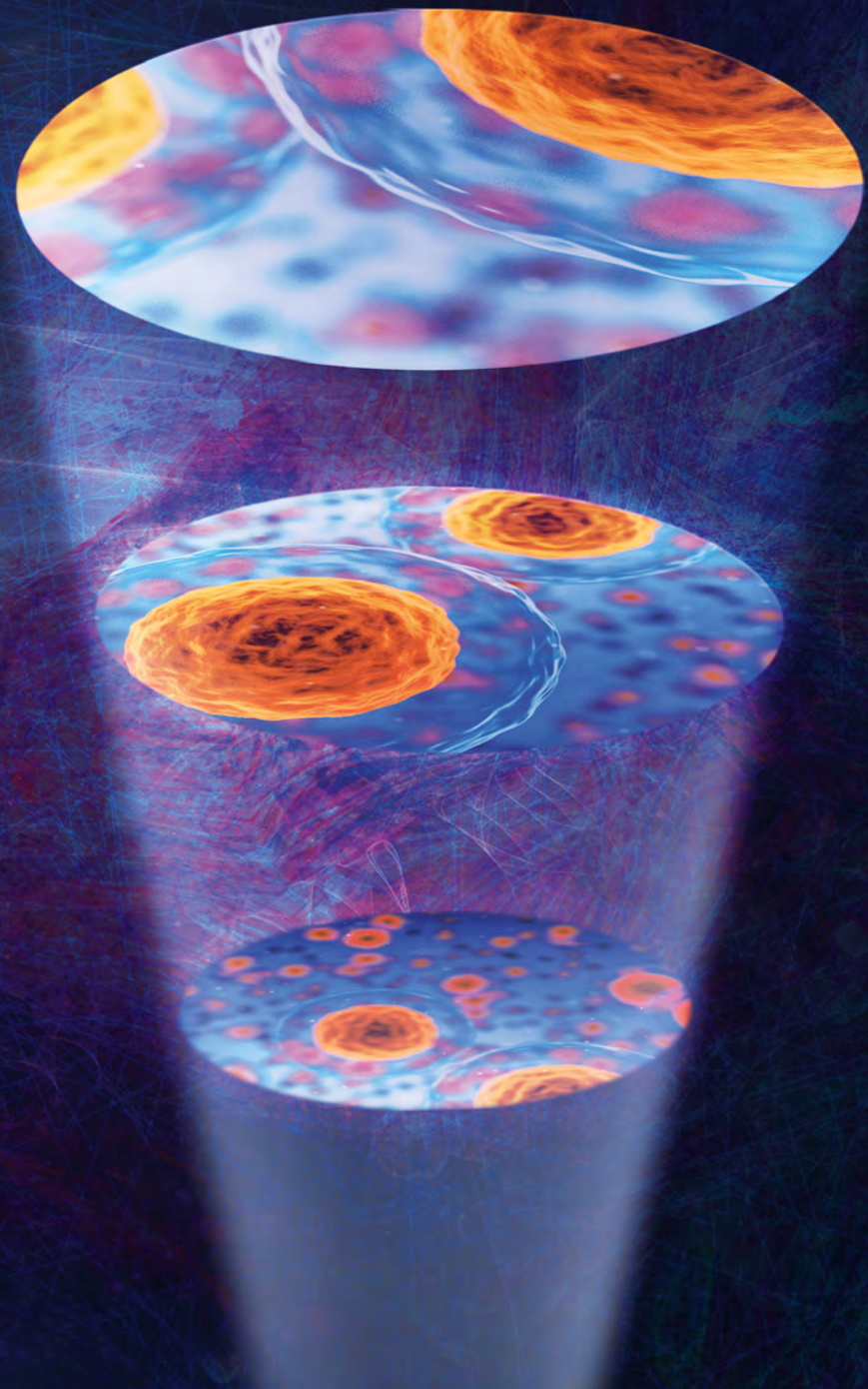

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