McPHERSON
EYE RESEARCH INSTITUTE

2021 ANNUAL REPORT | 2022 CALENDAR

MERI
UW–MADISON

Dear Friends of the McPherson ERI,

The concept of "information overload" often derives its negative connotation from the dizzying array of daily messages we receive from media and advertising outlets. However, rapid advances in computer technology have also led to unprecedented data access for people in nearly every profession, from automotive repair to zoo keeping. As one would expect, science and medicine not only embrace Big Data, but constantly seek to probe its limits. Results thus far have been nothing short of astounding, but like any other tool, its utility is limited by our ability to use it accurately and efficiently.

Think of important data as small nuggets of gold. In the past, researchers "panned" for their information, one handful at a time. This approach took time and a great deal of good fortune (digging in the exact right place), and thus discoveries largely came at a slow clip. Fast-forward to today, when giant information excavators can deposit tons of data in a fraction of the time. That sounds great on the surface, but it also introduces new challenges. How do you capture relevant information without losing some in the wash, or capturing irrelevant or misleading information (fool's gold). In other words, how do we determine what deserves our attention and what is simply "noise"?

We are very fortunate at UW-Madison and the McPherson Eye Research Institute to have an elite group of researchers who are developing and validating the algorithms and artificial intelligence methods necessary for analyzing large data sets. In turn, this information is being used to understand causes of eye disease and to develop treatments and devices that will improve the lives of both normal-sighted and visually impaired individuals.

In the next few pages, we highlight some of these researchers. Their work is a big reason why the pace of scientific discovery has increased dramatically, and is also another indicator that the future of vision research and medicine is bright. We will be at the forefront of that work, and your help and support has made that possible. Thank you, and I wish you a wonderful new year.

David M. Gamm, MD, PhD

RRF Emmett A. Humble Distinguished Director
Sandra Lemke Trout Chair in Eye Research

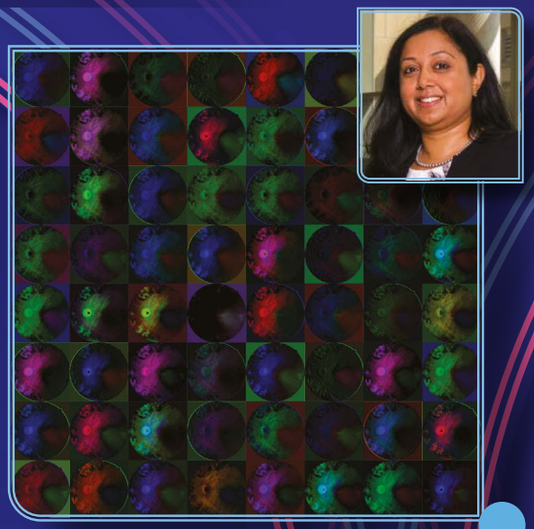
AI and Machine Learning at MERI

In recent years, machine learning methods have transformed the field of computer vision and pattern recognition and have had a profound impact on biomedical applications.

In the McPherson Eye Research Institute, machine learning-based research has become a major area of strength ranging from tool and software development to clinical and basic research applications. These advances promise to be of great importance in saving, restoring, and understanding sight.

Machine learning is an artificial intelligence (AI) technology that can process data, learn from it, and then apply what is learned to make informed decisions. Deep learning is a subtype of machine learning that uses structured algorithm layers to create an "artificial neural network" that can learn and make intelligent decisions on its own. Active research in machine learning is happening in almost every discipline at the University of Wisconsin–Madison. Below we briefly profile five McPherson ERI investigators who are engaged in developing and applying machine learning and computer vision-based technologies. These scientists are representative of a much larger interdisciplinary community at UW–Madison and the McPherson ERI.

Automated detection of diabetic retinopathy using artificial intelligence. The image collection shows activation maps, regions of the retina being analyzed by the AI model, in an eye with severe diabetic retinopathy. Image courtesy of EyePACS.



Amitha Domalpally MD, PHD

❊ Assistant Professor (CHS), Ophthalmology and Visual Sciences ❊ Research Director, Wisconsin Reading Center (formerly the Fundus Photograph Reading Center)

As scientific director of the recently formed A-EYE unit within the Department of Ophthalmology and Visual Sciences, **Amitha Domalpally** leads the department's artificial intelligence (AI) research. Alongside recently hired Senior Scientist Robert Slater, she works to develop and apply AI algorithms that can automate the search for various vision characteristics, such as lesion detection, quantification, disease classification, and identification of prognostic markers. Retinal AI studies also have the potential to provide insight into systemic diseases such as Alzheimer's and cardiovascular diseases.

It was only in 2018 that the FDA approved the use of autonomous AI for the detection of diabetic eye disease—the first use in any field of medicine. Since then, multiple AI algorithms have been deployed in clinical trials for the automated diagnosis of retinal diseases. The A-EYE unit will address the growing needs of AI-related research and will make Wisconsin a leader in this new field.

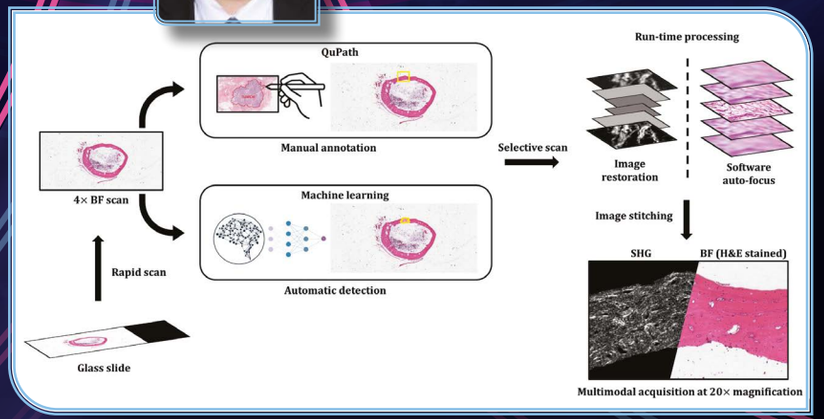
Augmented AI, where automated diagnostics work alongside physician decision-making, is particularly useful in clinical workflow. One example is in wet age-related macular degeneration. Domalpally developed training data to build AI algorithms that identify fluid in the eye and prioritize patients who need repeat injections. Collaborating with the NIH, she validated AI algorithms for the automated detection of fluid using retinal scans with the aim of reducing the burden of monthly clinic visits for the patient. The A-EYE unit will leverage Domalpally's research expertise and Robert Slater's AI development skills to support the revolutionary gains of AI research from code to clinic.

Kevin Eliceiri PHD

❊ Associate Director, McPherson Eye Research Institute
❊ RRF Walter H. Helmerich Professor of Medical Physics, McPherson ERI and Biomedical Engineering
❊ Investigator, Morgridge Institute for Research

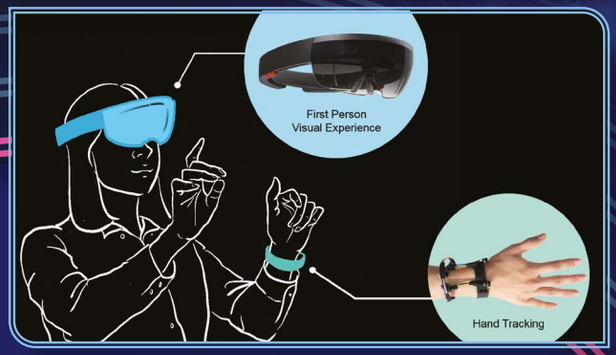
Kevin Eliceiri's research centers on bioimage informatics, the field of study having to do with the many computational techniques used to acquire, analyze, visualize, and disseminate biological images. His current machine learning-powered research is focused on so-called "weakly supervised" deep-learning methods for disease detection in pathology images. This approach requires less supervision or annotation by an expert, allowing the detection model to be trained with a large number of unannotated slides produced in real-world clinical routines. Based on this model, the Eliceiri lab has developed a "smart" multimodal histopathological slide scanning system which can examine healthy or diseased tissue in a variety of ways. Researchers using this system can automatically scan, analyze, and detect malignant regions on a slide and perform optical imaging at different magnifications on the detected areas. The need for user intervention is minimized at the same time as image production becomes more rapid.

Eliceiri has initiated or actively participates in many collaborative computational projects with researchers at UW–Madison and elsewhere. He is a worldwide leader in developing open-source software for deep learning and workflow solutions in bioimaging, and strongly believes in building expertise through networks in computer vision and machine learning. Eliceiri lab initiatives that support this goal include a Chan Zuckerberg Initiative-funded grant to create BioImaging North America (BINA), an imaging expertise network linking Canada, Mexico, and the US; and an NIH P41 grant to create a national Center for Open Bioimage Analysis (COBA). His UW-Madison-based and Morgridge Institute-based projects, such as a current Beckman Foundation-funded grant to build a smart microscope using smart light sheet technology, always aim to disseminate these technological advances more widely.



The overall workflow of a smart microscope for multimodal imaging of tissue sections. A low-magnification rapid scan (left) is annotated manually or detected by machine learning (center), and is then imaged with higher resolution modalities (right). Image courtesy of Kevin Eliceiri.

AI AND MACHINE LEARNING AT MERI



Tracking hand movements, as is done in certain research projects in Yin Li's lab, can shed light on a variety of health conditions. Image courtesy of Yin Li.

Yin Li PHD

❄ Assistant Professor, Biostatistics and Medical Informatics and Computer Sciences

We don't often think about the simplest actions that we perform, yet they produce puzzles for scientists. **Yin Li** works to solve these puzzles. His lab focuses on problems in computer vision and on developing useful healthcare applications, including software and wearable devices. Consider the action of grabbing a coffee mug for a quick sip. Do you look at the handle of the mug before reaching out? How do you grasp the mug? Or imagine that you are talking with a close friend. How often do you make eye contact? Answers to these questions explain how we interact with objects and other people, and can tell us much about our own health. Increased failures in object grasping (that coffee cup!) might be linked to Alzheimer's disease. Reduced eye contact during social interactions could be an early sign of autism. Li's lab builds body-worn cameras and develops AI algorithms to observe subjects' daily activities and understand their links to health.

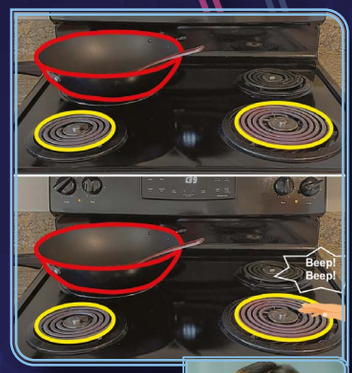
Recently, the Li lab created a smart wristband with pea-sized cameras to track the fingers of a user wearing the device. This novel system uses AI models to convert videos of the hand, recorded at the wrist, into accurate representations of 3D finger posture and location, even when the user's hand is holding an object. In the future, this device could be used to detect early signs of dementia in older people by monitoring how their hands interact with common objects on a daily basis.

Yuhang Zhao PHD

❄ Assistant Professor, Computer Sciences

An envisioned augmented reality system to facilitate safe cooking for people with low vision: (above) adding color-coded contours to indicate the high-temperature objects in the kitchen; (below) providing an audio alert if the user's hand is getting close to a hot area. Image courtesy of Yuhang Zhao.

Technological advances have led to new devices that assist people with low vision in recent years, but much remains to be done. **Yuhang Zhao** designs and builds intelligent interactive systems to enhance human abilities. Zhao does this by combining her research interests in human–computer interaction (HCI), accessibility, and augmented and virtual reality.



In a current major project, Zhao's lab is designing augmented reality (AR) systems that provide direct visual enhancements to people with low vision for various daily tasks, including reading, visual searching, and navigation. Zhao and her students have recently begun the complex task of designing technologies to assist those with low vision with cooking—an important but challenging set of tasks with a large impact on people's health and quality of life. Zhao's group will explore the cooking challenges and needs of people with low vision via observation and interview studies and will then design augmented reality systems with visual and audio enhancements that facilitate safe and efficient cooking. For example, to prevent someone with low vision from burning their hand during cooking, the AR system will automatically detect the surface temperature in the kitchen and highlight high-temperature objects with color-coded contours. A beeping sound will alert the user when their hand approaches a hot area. Adaptive devices and systems such as these are essential and an area of research focus for many McPherson ERI researchers.

Vikas Singh PHD

❄ Professor, Computer Sciences

Machine learning methods mark a dramatic advance in collecting and organizing data, as they allow for the aggregation, pooling, and harmonization of large imaging datasets from multiple data acquisition sites. Computer Sciences Professor **Vikas Singh** develops these methods for use in various areas; for instance, in the context of "fair" machine learning, where one seeks to ensure that the algorithms underlying numerous computer vision systems, from face recognition to image captioning, are not biased in favor of or against race, gender, and other similarly protected attributes. Computer vision systems that incorporate these fairness criteria lead to results that are more explainable, more meaningful, and that align better with human perception.

Singh's work has applications in many areas of medicine, including neurodegenerative diseases—some of which affect vision. With his student Vishnu Lokhande, and in collaboration with Barbara Bendlin, Grace Wahba, and Sterling Johnson here at UW–Madison, and Martin Reuter at the DZNE Bonn, Singh is developing machine learning methods for identifying biomarkers for neurodegenerative diseases. These novel methods will allow us to learn from large amounts of medical imaging data at a scale not currently possible.

McPHERSON EYE RESEARCH INSTITUTE

FEATURED RESEARCHERS

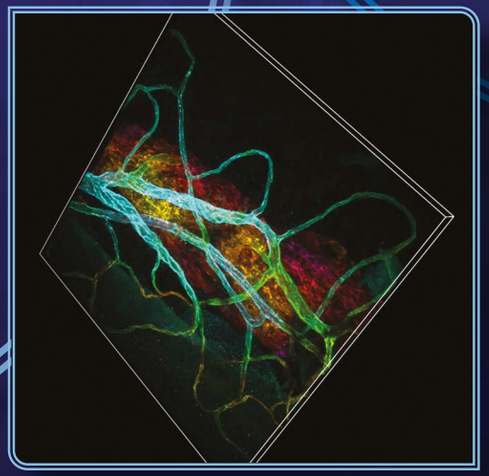
Terri Young MD, MBA

❄ Chair and Peter A. Duehr Endowed Professor
• Ophthalmology and Visual Sciences

Terri Young's group investigates families with primary congenital glaucoma (PCG), a leading cause of childhood blindness worldwide. This disease is primarily due to developmental defects in the fluid outflow structures of the eye; in particular, the trabecular meshwork and Schlemm's canal, which are located where the iris meets the cornea. When these drainage structures are malformed, pressures within the eye rise, causing the child's eye globe to increase in size. As the eye stretches, breaks can form in the innermost membrane of the cornea, allowing fluid to flow in and leading to corneal swelling and cloudiness. If left untreated, the eye can grow abnormally large (buphthalmos or "ox eye"). The high eye pressures also lead to problems at the back of the eye, causing optic nerve damage and loss of retinal ganglion cells which, in turn, result in vision loss and blindness. This severe and developmental form of glaucomatous vision loss affects babies and infants up to 3 years of age, though similar disease mechanisms may also be responsible for later-onset forms of glaucoma.

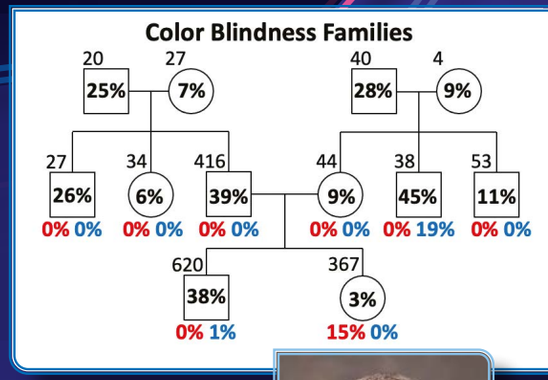
It is known that the major disease gene CYP1B1 accounts for approximately 20% of PCG cases in Western populations. The Young Lab looks for other genetic causes for PCG and recently published findings that mutations in the TEK gene, as well as its associated molecule, ANGPT1, account for a further 4% of the disease. They also demonstrated that signaling by the TEK gene is essential for Schlemm's canal development.

Certain characteristics of TEK-related PCG disease have led the Young Lab to develop a method that may help identify even more genes that cause PCG. This is critical, since three-quarters of all children with PCG still do not have a known genetic cause for their blindness, which significantly reduces the likelihood that a treatment will be found.



This confocal image shows a flat-mounted section of a normal adult mouse eye with the major "drainpipe", Schlemm's canal (the large yellow-red vessel), located behind a network of episcleral veins (blue-green) through which the aqueous humor exits the eye. Image courtesy of the Young Lab.

The most common form of color blindness is "X-lined recessive," meaning males are more likely to be affected than females because they only have one X-chromosome. This figure is a summary of all families in the Marshfield Clinic study diagnosed with color blindness. Above each symbol (□ = males and ○ = females) are the total number of individuals identified. Inside each symbol is the percent affected. Below each symbol is the percent affected that have either an affected father (red) or mother (blue). Image courtesy of Scott Hebbring.



Scott Hebbring PHD

❄ Research Scientist-Genetics • Center for Precision Medicine Research ❄ Marshfield Clinic Research Institute

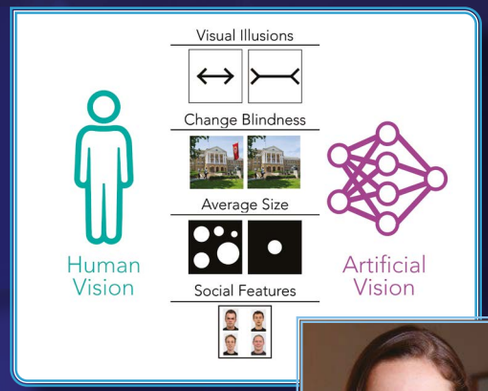
Many diseases are passed along in families, which makes sense given the genetic factors that can cause or make individuals more susceptible to disease. Age-related macular degeneration (AMD) is one such disease. **Scott Hebbring**, a Research Scientist at the Marshfield Clinic Research Institute Center for Human Genetics, traces those family relationships using masses of available data. His lab's primary goal is to leverage electronic health record data to identify diseases with unappreciated genetic influences, to characterize the biology of those diseases, and to translate his findings to the clinic in order to advance patient care.

Hebbring recently led a study that demonstrated that basic demographic data in an electronic health record could be used to assign approximately 600,000 Marshfield Clinic patients to over 170,000 families. Further integration of diagnostic data in the electronic health record allowed his lab to identify diseases that travel in families more easily and with greater accuracy. The Hebbring lab is currently using this family data to automatically extract family history information that one day may be used to better identify—and hopefully prevent—poor outcomes for patients at the highest risk for AMD, cataracts, and many other ocular diseases.

McPHERSON EYE RESEARCH INSTITUTE

FEATURED RESEARCHERS

The Ward lab compares human and artificial perception in several visual domains. Examples include whether deep neural networks show failures of perception, such as with visual illusions or change blindness; and whether they are sensitive to complex visual features, such as average object size and social features like expression. Image courtesy of Emily Ward.



Emily Ward PHD

❄ Assistant Professor, Psychology

Becoming aware of the world seems simple and straightforward—but we frequently see the world in a way that differs from how it actually is. We may fail to see a car turning right in front of our eyes despite the fact that our vision in general is extremely detailed. Why does our perception fail us in the first place, and how do we predict when such failures may occur? How can we experience so much rich awareness given the poverty of the input?

Emily Ward's research focuses on understanding visual awareness. The Ward Visual Cognition Laboratory in the Department of Psychology uses a combination of behavioral and functional neuroimaging methods that utilize novel visual tasks and machine learning to explore both human and artificial visual systems.

The Ward lab is currently pursuing several exciting research directions. First, they are investigating the surprising ways in which conscious experience of the world is dissociated from the actual nature of the world, such as when we see visual illusions or suffer from failures of awareness. Second, they are identifying what visual information we can acquire without our awareness, from simple features like the average size of an array of objects to more complex features like facial expression and identity. Finally, they are trying to understand why these failures (and features) of visual perception occur by comparing the performance of human and artificial visual systems, including deep neural networks.

Nader Sheibani PHD

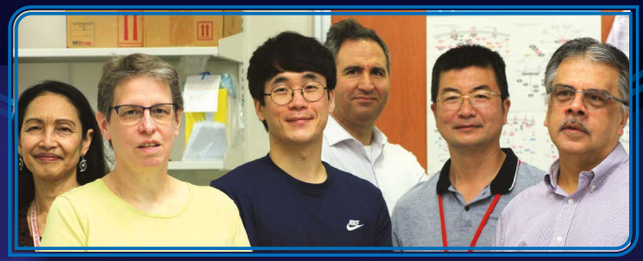
❄ Professor and RRF/Alice R. McPherson Chair, Ophthalmology and Visual Sciences

Many diseases start with tiny, inconspicuous abnormalities in proteins or metabolic pathways within the cells of our bodies. **Nader Sheibani's** lab expertly investigates these changes that lead to a variety of devastating vision disorders, with a current focus on three major areas.

The Sheibani lab has a long-standing interest in diabetic retinopathy (DR), a complication of diabetes and major cause of vision loss in the working-age population. Their DR work focuses on pericytes, which are supporting cells that wrap and aid very small blood vessels called capillaries. One of the earliest changes noted in DR is the loss of these pericytes, which ultimately results in abnormal blood vessel growth ("neovascularization") that often causes vision loss. The lab recently showed that a particular pathway, the hexose biosynthetic pathway, is selectively activated in retinal pericytes under high glucose (i.e., diabetic) conditions. This causes enhanced glucose uptake which then affects many proteins that in turn alter pericyte function. The lab is investigating other pathways as well, in the hope of deriving new drugs to treat diabetic retinopathy.

Age-related macular degeneration (AMD) is a second focus of the Sheibani Lab, with current projects for both wet and dry AMD. For wet AMD, their focus is on the processes that cause or deter the abnormal growth of blood vessels in the eye. They investigate proteins that play a role in this process, as well as peptides (small strings of amino acids) that can slow or stop new blood vessel growth. For dry AMD, the Sheibani lab is actively studying the role of inflammatory processes involving specific cellular pathways (for example, the adenosinergic pathway), which may lead to new therapies for this currently untreatable form of AMD.

A third area of emphasis for the Sheibani lab is **Hypoxic-ischemic encephalopathy (HIE)**, which often has major adverse effects on the vision, cognition, and well-being of newborns and juveniles as a result of pre- or perinatal brain ischemia (loss of blood flow). The detailed cellular targets and mechanisms involved in HIE remain unclear, although it is thought that vision impairment is mainly due to damage to the vision-processing region of the brain. The Sheibani Lab has proposed that HIE-mediated changes in retinal blood vessels contribute significantly to vision impairment. They use a preclinical model of HIE to advance understanding of its root causes and evaluate new therapeutics for this devastating condition.



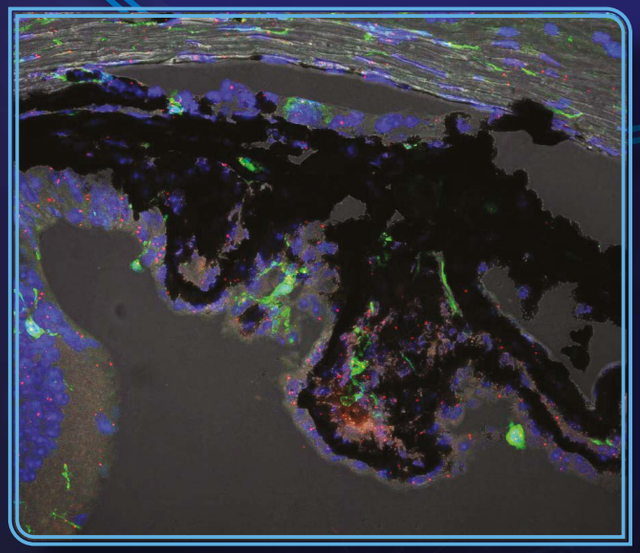
The Sheibani lab group (L-R): Soesiawati Darjatmoko, Christine Sorenson, Yong-Seok Song, Ismail Zaitoun, Shoujian Wang, Nader Sheibani. Image courtesy of the Sheibani Lab.

Colleen McDowell PHD

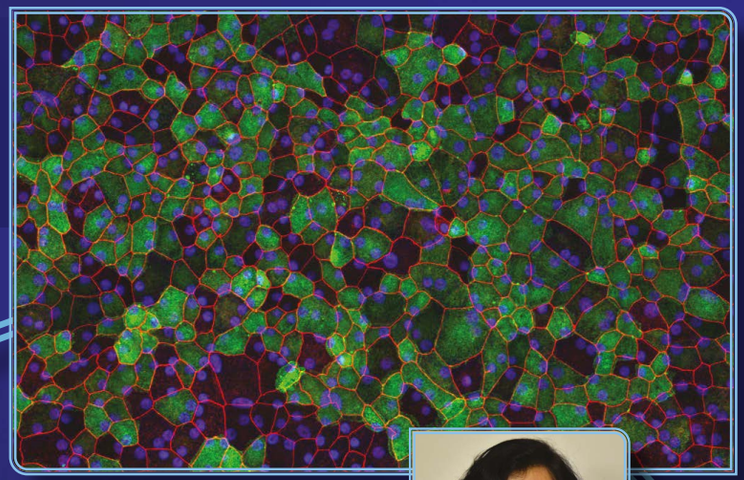
❄ Associate Professor, Ophthalmology and Visual Sciences

Colleen McDowell's work is directed at discovering the molecular underpinnings of glaucoma in order to design effective therapies. Glaucoma is a silent, underdiagnosed, costly, and debilitating disease. All available treatment options for glaucoma are currently aimed at reducing elevated pressure in the eye, which is a major risk factor for the development of the disease. This rise in eye pressure occurs when fluid does not drain properly through specialized structures (the trabecular meshwork and Schlemm's canal) in the front of the eye. The McDowell laboratory seeks to understand mechanisms that regulate the arrangement and construction of the drainage structures and how changes in this makeup prevent their proper function.

Dr. McDowell has developed and characterized several mouse models of glaucoma throughout her career, which she has used to discover the molecular pathways associated with glaucoma. Utilizing these mouse models, her lab discovered a novel pathway involved in the development of damage in the drainage structures of the eye. Modification of this molecular pathway led to the development and characterization of her lab's newest mouse model, which recapitulates many aspects of the human disease. Using this model, she has been able to identify new therapeutic targets for glaucoma.



Cross-section of a mouse eye showing the trabecular meshwork drainage structure. Image courtesy of Colleen McDowell.



Stem cell-derived RPE of an individual affected by mutations in *BESTROPHIN1*, causing Best disease. Viral vectors were used to express functional protein (observed via green fluorescence). Image courtesy of Divya Sinha.

Divya Sinha PHD

❄ Assistant Scientist, Waisman Center

Inherited retinal degenerative diseases are a major cause of progressive vision loss. Most of these conditions lack approved treatment options due in part to the absence of appropriate disease models to test potential therapies. Induced pluripotent stem cell (iPSC) technology provides a promising approach to circumvent this issue by allowing laboratory production of retinal cell types affected by disease. **Divya Sinha**, a scientist in David Gamm's laboratory, uses stem cell-derived photoreceptors and retinal pigment epithelium (RPE) cells harboring disease-causing mutations to model genetically transmitted retinal disorders like retinitis pigmentosa. These models are then used to develop and test therapies.

Recently, in collaboration with Kris Saha's, Bikash Pattnaik's, and Sushmita Roy's labs, Sinha and colleagues in the Gamm lab tested two types of gene therapies to mitigate the effects of BESTROPHIN1 gene mutations in RPE cells. These mutations cause a type of macular degeneration known as Best disease. Sinha and colleagues' research showed that gene therapy aimed at introducing a normal copy of the BESTROPHIN1 gene can overcome problems created by most mutant versions of the gene that cause RPE cells to malfunction. Furthermore, in cases where this approach is not useful, gene editing can be used to specifically target and silence the defective copy of the gene. Sinha is using this and other stem cell-based retinal disease models to test a wide range of novel therapies for inherited blinding disorders.

McPHERSON ERI/ TROUT FAMILY ENDOWMENT CHAIRS

To support the search for better therapies and, ideally, a cure for age-related macular degeneration, Monroe and Sandra Trout have endowed three research chairs at the McPherson Eye Research Institute. These Trout Chair holders are each following exciting new pathways toward better understanding and treatment of AMD. We are grateful to the Trout family for leading the way in the effort to treat this often debilitating, and all too common, disease.

L-R, Michael Altaweel, MD (Monroe E. Trout Chair in Eye Research); David Gamm, MD, PhD (Sandra Lemke Trout Chair in Eye Research); Sandra Trout; Dr. Monroe E. Trout; Akihiro Ikeda, DVM, PhD (Timothy William Trout Chair in Eye Research)

David Gamm MD, PHD

- Director, McPherson Eye Research Institute
- Sandra Lemke Trout Chair in Eye Research

"The Sandra Lemke Trout Chair in Eye Research provides essential funds to **advance the use of human pluripotent stem cells (hPSCs) to treat age-related macular degeneration (AMD)**. My lab uses concepts and protocols developed and refined over the past 15 years to devise next-generation cell-replacement therapies for AMD and other retinal diseases and injuries. AMD causes the death of two critical retinal cell types—retinal pigmented epithelium (RPE) cells and photoreceptor cells (most importantly, cone photoreceptors)—both of which we can generate in unlimited supply in our lab. Recently, we have engaged multiple industry sponsors in a global consortium dedicated to bringing this technology to patients in the foreseeable future. To aid these efforts, we collaborate with McPherson ERI researchers Shaoqin Gong and Zhenqiang Ma to microfabricate scaffolds designed to replace both RPE and photoreceptors. We also work with retina surgeons Dr. Michael Altaweel and Dr. Michael Nork, who are optimizing methods to implant the cells and scaffolds in humans."

Michael Altaweel

MD

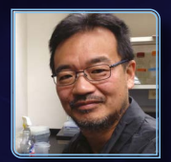
- Monroe E. Trout Chair in Vision Research

"In order to bring photoreceptor replacement therapies to the clinic, it is critical to develop a reproducible process that minimizes any potential complications of surgery and allows maximal integration of the stem cells. In my first year as the **Monroe E. Trout Chair in Vision Research,** I have been developing a system for the surgical delivery of stem cell-derived photoreceptors to the subretinal space.

Currently, I'm conducting a series of surgeries in an animal model with Dr. David Gamm's team that will allow us to move on to a Phase 1 human clinical trial in the near future. We will soon be working on surgeries using an absorbable scaffold with stem cell-generated retinal pigment epithelium and retinal photoreceptors. Once we proceed to Phase 2 human clinical trials, I'll be teaching this surgical technique to other surgeons. We have been fortunate to collaborate and operate with colleagues from the translational stem cell program at the National Eye Institute, and we continue to share our learning as we advance our program. **I am quite excited about the opportunity the Monroe E. Trout Chair has created for advancing this therapy**. Our potential to help patients with macular degeneration, retinitis pigmentosa, and other inherited retinal disorders is groundbreaking."

Akihiro Ikeda

DVM, PHD



- Timothy William Trout Chair in Eye Research

"Our research goal is to identify mechanisms underlying aging and age-related diseases in the retina. Using mouse models, we have discovered several key molecules associated with aging of the retina. One of these mutant mouse models showed symptoms similar to those observed in AMD patients. In this model, we were able to identify a mutation in the gene *Tmem135* that is responsible for accelerated aging and those AMD-like symptoms in the mouse retina.

More recently, we discovered that changes that take place in gene expression in retinal pigment epithelium (RPE) cells of *Tmem135* mutant mice overlap with those in the same tissue (the RPE) of human AMD patients. The overlapping gene expression changes are largely associated with lipid metabolism, an essential part of how cells power themselves. We were able to further unravel the interlinked chain of cause-and-effect that may cause these age-related symptoms. These findings will allow us to test potential therapeutic means to counteract the disease-causing mechanism. I am honored to hold the **Timothy William Trout Chair in Eye Research**, which allows us to generate innovative approaches toward our goal."

- Retina Research Foundation Emmett A. Humble Distinguished Directorship

"The RRF Emmett A. Humble Distinguished Directorship supports my lab's efforts to create and study human pluripotent stem cell (hPSC)-derived models of inherited retinal degenerative diseases. In the late 2000s, my lab developed and patented technology to create "mini-retinas" from hPSCs. These lab-grown retinas are a close approximation of real retinas. They possess a highly organized layer of photoreceptors (rods and cones) that can detect light and transmit chemical and electrical signals much like our own retinas. Because of this, we can use them to study how specific diseases cause blindness and how to prevent, stop, or reverse these processes. Current efforts are directed at multiple types of retinitis pigmentosa, as well as related diseases such as Usher syndrome. We are also advancing efforts to treat inherited macular diseases like Best disease and Stargardt disease. Importantly, this work is aided by collaborations with many other McPherson ERI investigators."

Melissa Skala PHD

- Retina Research Foundation Daniel M. Albert Chair

"The Retina Research Foundation Daniel M. Albert Chair supports my research on retinal imaging technologies. Optical coherence tomography is a powerful 3D imaging tool that is routinely used for clinical retinal imaging. My lab has used the support of this chair to develop a new technique, photothermal optical coherence tomography, which enables molecular imaging in the retina to detect early changes in melanin that may precede age-related macular degeneration. These technologies have also been used with contrast agents such as indocyanine green to guide retinal surgery and have recently achieved non-significant risk designation from the FDA so that first-in-human studies can begin. We have also used this support to develop new imaging techniques to assess visual cycle function in retinal cells as part of a consortium to evaluate off-target effects of gene editing in the retina. Finally, this chair also supports my role in the Wisconsin Advanced Imaging of Visual Systems (WAIVS) initiative to develop and use novel imaging systems to assess the visual pathway."

McPHERSON ERI/RETINA RESEARCH FOUNDATION CHAIRS AND PROFESSORSHIPS

The Houston-based Retina Research Foundation (RRF), one of the world's premier organizations for supporting vision research, is linked to the McPherson ERI through Dr. Alice McPherson, a UW–Madison graduate, founder of the RRF, and namesake of the McPherson Eye Research Institute. The RRF has generously supported research chairs and professorships at the McPherson ERI at UW–Madison since the Institute's founding. We are thankful for the RRF's support of McPherson ERI research and for their research support of colleagues worldwide.

Olachi J. Mezu-Ndubuisi

MD, OD

- Retina Research Foundation Edwin and Dorothy Gamewell Professor

"My research focus is retinopathy of prematurity (ROP), a condition of abnormal retinal blood vessel formation in premature infants exposed to postnatal excess oxygen (hyperoxia). Current ROP therapies are limited; drugs that can be effective in adults may be systemically toxic in infants. My laboratory works with a mouse model with oxygen-induced retinopathy (OIR) and has established *in vivo* retinal imaging techniques in these mice that have identified unique vascular, structural, and functional characteristics of ROP. We have correlated these phenotypes with dysfunction in neuroglia, the cells that support neurons.

Our research has also suggested that there is a transitional phase as oxygen-induced retinopathy proceeds that could be a critical window for early ROP treatment. Key to this is the activity level of vascular endothelial growth factor (Vegf) that, depending on the type of isoform, can either increase or slow vascular growth (are pro-angiogenic or anti-angiogenic). We are currently investigating the effectiveness and safety of innovative pro- and anti-angiogenic treatments that could potentially prevent the severity and progression of ROP while avoiding systemic toxicity. I am grateful for the support from the McPherson Eye Research Institute **Retina Research Foundation Edwin and Dorothy Gamewell Professorship**, which is enabling me to advance work in these studies."

Kevin Eliceiri PHD

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

"The Retina Research Foundation Walter H. Helmerich Research Chair has allowed me to advance my current research on computational optics and to develop new imaging and computational approaches for characterizing changes in the ocular cellular microenvironment. This has involved a number of novel computational imaging instrumentation projects for biomedical applications including ocular use. With McPherson ERI members Amitha Domalpally and Barb Blodi, we've continued our successful collaboration on automated image analysis and machine learning at the Wisconsin Reading Center. McPherson ERI member Vikas Singh and I continue to collaborate on new machine learning approaches for automated cellular pattern recognition. McPherson ERI members Mohit Gupta, Andreas Velten, and I have developed a new technique for widefield label-free monitoring of cellular metabolism in intact tissues that has great potential for clinical application. Overall, we continue to develop and expand our open source imaging platform, including improved approaches for automated analysis and pattern recognition."

Bikash Pattnaik PHD

- Retina Research Foundation M. D. Matthews Professorship

"Within the retina, retinal pigment epithelium (RPE) cells nurture the photoreceptors so that they can sense light. This process relies on the proper functioning of various channel types either in the RPE or in the photoreceptors. We are interested in the clinical development of novel therapies that target defective ion channels that cause blindness.

Ion channels are proteins present in the cell membranes that control the flux of specific ions. This facilitates cellular communication. It is increasingly recognized that mutations in the channel genes that affect the function of these cells underlie many inherited blinding diseases, including Leber Congenital Amaurosis, Congenital Stationary Night Blindness, and Cone–Rod dystrophies. We are studying approaches that target RPE and photoreceptor ion channels, such as gene augmentation, gene editing, developing specific activators to boost gene transcription, targeted delivery of therapeutics, and combination regimen therapies. Our aim is to correct or compensate for these mutations and translate our laboratory findings to the clinic using various disease models and delivery methods."

Mrinalini Hoon PHD

- Retina Research Foundation Rebecca Meyer Brown Professorship

"Chemical messengers called neurotransmitters are released at specialized junctions called 'synapses' and are essential to regulate neuronal activity. GABA is a neurotransmitter that binds to receptors on nerve cells and functions as an inhibitor to restrict neuronal activity. Our recent research has revealed new insights into how GABA signaling pathways are established in visual circuits. We discovered that early-stage GABA receptors play a role in the organization and function of inhibitory circuits in the mammalian retina. Inhibitory synapses on the axon terminals of retinal bipolar cells switch GABA receptor types before eye-opening, transitioning from early expressed slower receptors to faster GABA receptors as the circuit matures.

Expression of the early expressed receptors is critical to recruit mature components of inhibitory synapses across the axon terminals of retinal bipolar cells and is hence essential for sculpting signal processing through the retina. The **RRF Rebecca Meyer Brown Professorship** has been crucial in enabling us to complete this study. We are now investigating the underlying mechanisms that regulate this transition of GABA receptor types in the inner retina during development and its functional implications for vision and visual behavior."

Krishanu Saha PHD

- Retina Research Foundation Kathryn and Latimer Murfee Chair

"Millions of people currently battle inherited vision disorders armed with very few therapeutic options, but a single-shot gene-editing cure using the CRISPR technique holds much potential for treating and preventing these disorders. With outstanding support from the **Retina Research Foundation Kathryn and Latimer Murfee Chair**, I focus on developing gene-editing therapies that would correct the genome within the cells of the retina and restore sight or prevent its loss.

In the eye, genome editors are capable of affecting many cell types, including rod and cone photoreceptors and nerves. We apply genome editors to mini retinal tissues in a dish to investigate the beneficial and adverse effects from such treatments. Together with the Gamm lab (which developed these mini retinas) and other McPherson ERI investigators, we identify changes in the genetic sequence of these photoreceptor cells after we deliver the genome editors. We look for changes that indicate adverse events in preclinical studies so that only safe genome editors are moved into clinical trials. This work is part of a national consortium (NIH SCGE) to accelerate the development of safe and effective methods to edit the genomes of disease-relevant somatic cells and tissues in patients."

DAVID AND NANCY WALSH FAMILY PROFESSORSHIP IN VISION RESEARCH

Raunak Sinha PHD

"Our lab focuses on understanding how visual signals are transduced in the photoreceptors and how they are subsequently read out by the downstream neural circuitry in the vertebrate retina. The **David & Nancy Walsh Family Professorship** supports our lab's efforts to understand photoreceptor function in the fovea, a unique retinal specialization in diurnal primates, and to understand the diversity of photoreceptor signaling across the visual field.

We leverage this basic understanding of photoreceptor biology in primates to evaluate photoreceptor function in human stem cell-derived retinal organoids, which replicate many of the anatomical and genetic features of the human retina. In the past year, we have made significant progress on one of the biggest issues with regard to these retinal organoids. It has been challenging to demonstrate function (i.e. light-evoked electrical activity and its transmission to downstream neural circuitry) in retinal organoid photoreceptors; however we have been able to show, for the first time, robust intrinsic light-evoked function in retinal organoid cone photoreceptors. Our manuscript summarizing these findings has been submitted for publication."

McPHERSON EYE RESEARCH INSTITUTE

GRANTS AND AWARDS

2021

Kenzi Valentyn Vision Research Grants

The McPherson ERI added funds to the **Kenzi Valentyn Vision Research Grant** program in 2021, increasing both the number of awards and the amounts awarded. **Kenzi Valentyn Vision Research Awards** were established in 2017 and are named in honor and memory of Kenzi's courage and positive attitude throughout her long battle with Kearns–Sayre syndrome. **The McPherson ERI is grateful for the Valentyn family's dedication to vision research and participation in Cycle for Sight.**

Four trainee researchers were awarded $5,000 each for their highly promising work:

Allison Ludwig, a dual Veterinary Medicine and PhD student and researcher mentored by **David Gamm** (Ophthalmology & Visual Sciences) for *Development of a photoreceptor enrichment protocol to advance cell replacement therapies*.

Kushin Mukherjee, a graduate student in Psychology mentored by **Tim Rogers** and **Karen Schloss**, for *Understanding how visual communication shapes the structure of visual concept representations*.

Aindrila Saha, a graduate student in Neuroscience mentored by **Raunak Sinha**, for *Understanding cone signaling in the primate fovea and the characterization of light responses in hPSC-derived organoid cones.*

Kara Vogel, a postdoctoral researcher in Ophthalmology & Visual Sciences mentored by **Gillian McLellan**, for *LTBP2: The mechanistic underpinnings of glaucoma*.




David G. Walsh Graduate Student Support Initiative (GSSI) Awards

The first annual **David G. Walsh Graduate Student Support Initiative** awards were announced early in 2021. Two one-year grants of $12,000, financed by the David G. Walsh Research Fellowship Endowment Fund, were awarded to **Ari Rosenberg** (Neuroscience), in support of PhD candidate **Lowell W. Thomson** and his work on hierarchical neural circuitry supporting 3D object motion processing, and **Nader Sheibani** (Ophthalmology and Visual Sciences), in support of PhD candidate **Yong-Seok Song** and his work on cellular and molecular interactions in retinal vasculature.

Grant Summit Award News


Grant Summit Awards support promising research that needs a small additional boost in funding in order to complete further work needed to successfully reapply for NIH funding. In 2021, **Ismail Zaitoun** (Ophthalmology and Visual Sciences) resubmitted his proposal, *Neural Retina-Specific Bim Expression and Hyperoxia Sensitivity of the Developing Retinal Vasculature*, to NIH following a 2020 Grant Summit Award of $10,000. Midyear, Zaitoun received an NIH R01 grant for $2,129,940 to advance this study of retinopathy of prematurity, more than 200x the amount of his original Grant Summit Award. Also this year, **Raunak Sinha (Neuroscience)** received a new $10,000 Grant Summit Program award for his project, ***Sensory adaptation at early stages of the primate visual system***, which will greatly add to our understanding of high- acuity vision in the fovea.

Student and Trainee Awards

The McPherson ERI distributed a variety of student and trainee awards in 2021, including:

The **Dan & Ellie Albert Student Vision Research Award,** supporting a summer vision research project for an SMPH student through the Shapiro Summer Internship Program, to **Johnson Hoang**, working with Yao Liu, MD, to advance teleophthalmology.

Two Hilldale Undergraduate Awards for $4000 each were sponsored by the Institute in 2021, for research on the formation of retinal synaptic connections (**Tae Ji Li**, working in the Hoon lab) and the visual design of election maps (**Lily Houtman**, working with Associate Professor Robert Roth).

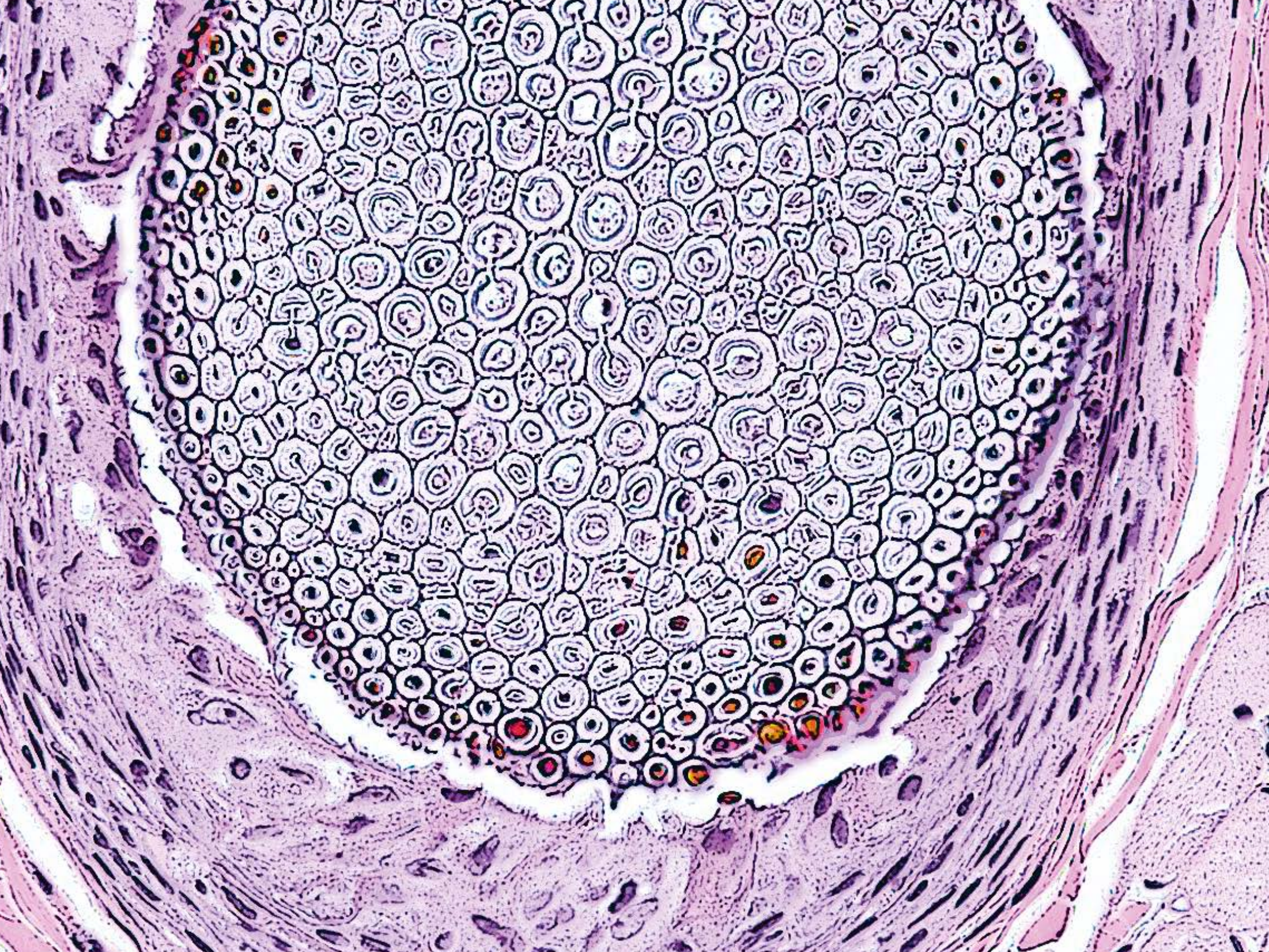
Six McPherson ERI trainees received **Story Form Science Course Awards,** underwriting their participation in the Story Form Science workshop developed by Holly Kerby and Adam Steinberg.

Expanding Our Vision Award

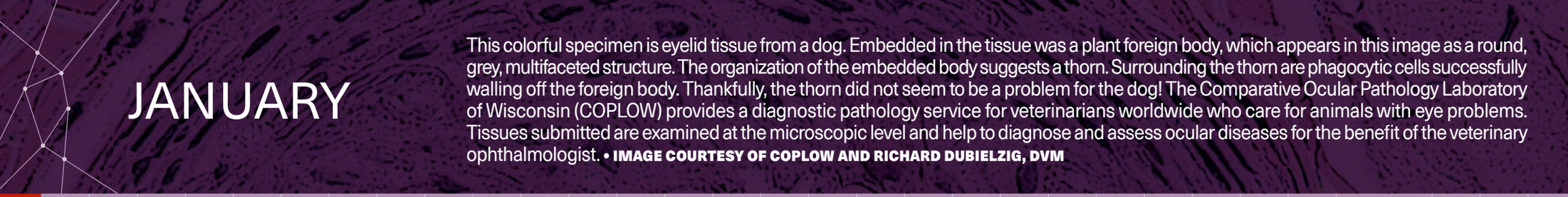
Yuhang Zhao (Computer Sciences) was awarded the 2021 Expanding Our Vision Award ($10,000), for research in visual communication, cognition, perception, computer science, data visualization, or imaging advances. Zhao will collaborate with **Bilge Mutlu** (Computer Sciences) and **Sanbrita Mondal** (Ophthalmology and Visual Sciences) on *Designing Augmented Reality Systems to Facilitate Safe Cooking for People with Low Vision*.

COVID Support

Throughout 2021, McPherson ERI members and trainees were able to apply for and receive modest **COVID Member/Trainee Support Awards**. These awards—for equipment, software, online conference fees, and various other small but helpful purposes—were aimed at making work life during COVID easier for our researchers.



JANUARY



This colorful specimen is eyelid tissue from a dog. Embedded in the tissue was a plant foreign body, which appears in this image as a round, grey, multifaceted structure. The organization of the embedded body suggests a thorn. Surrounding the thorn are phagocytic cells successfully walling off the foreign body. Thankfully, the thorn did not seem to be a problem for the dog! The Comparative Ocular Pathology Laboratory of Wisconsin (COPLOW) provides a diagnostic pathology service for veterinarians worldwide who care for animals with eye problems. Tissues submitted are examined at the microscopic level and help to diagnose and assess ocular diseases for the benefit of the veterinary ophthalmologist. • **IMAGE COURTESY OF COPLOW AND RICHARD DUBIELZIG, DVM**

DEC

WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI
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SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
26	27	28	29	30	31 NEW YEAR'S EVE	1 NEW YEAR'S DAY
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17 MARTIN LUTHER KING, JR. DAY	18	19	20	21	22
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30	31					

FEB

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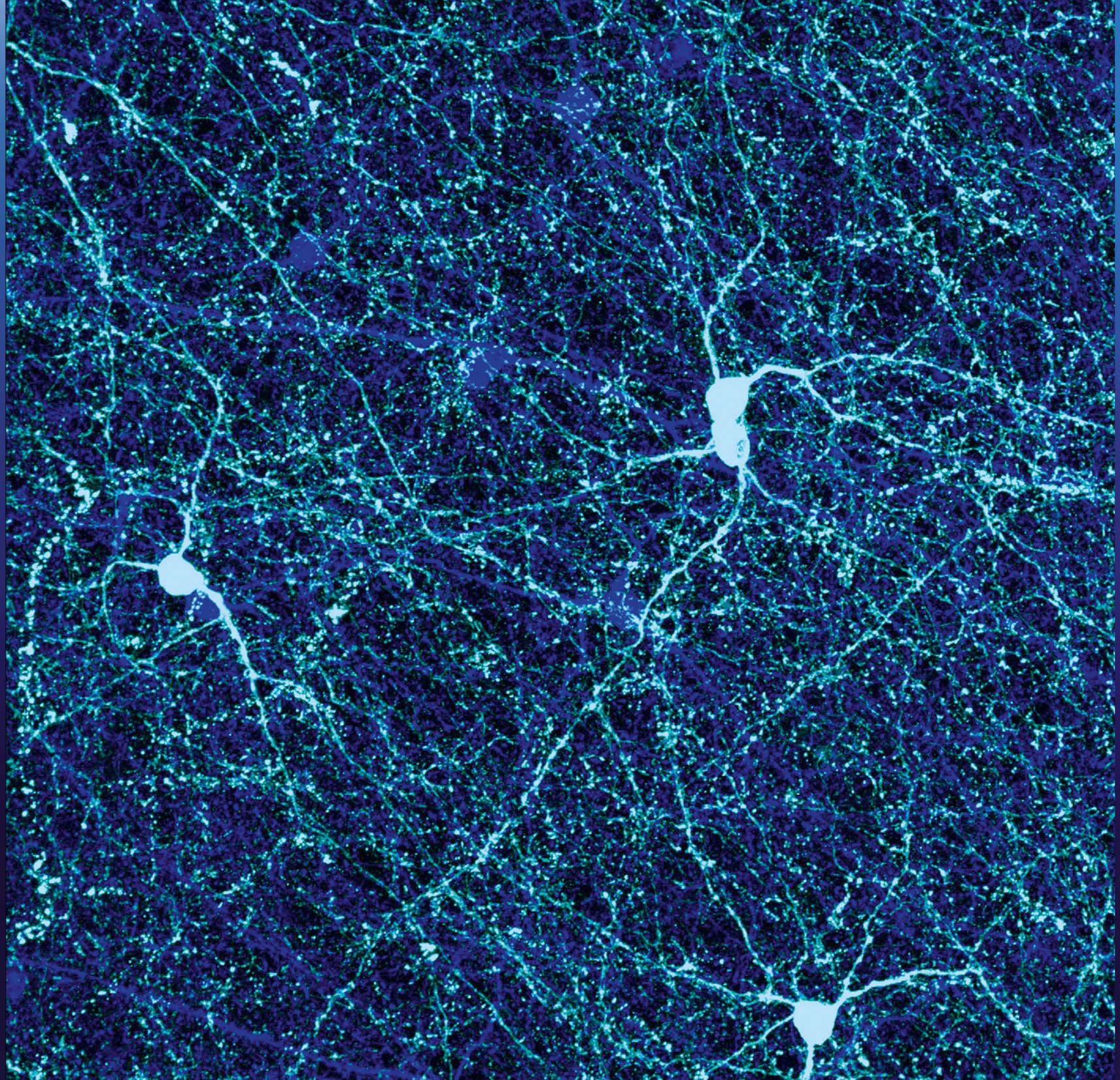

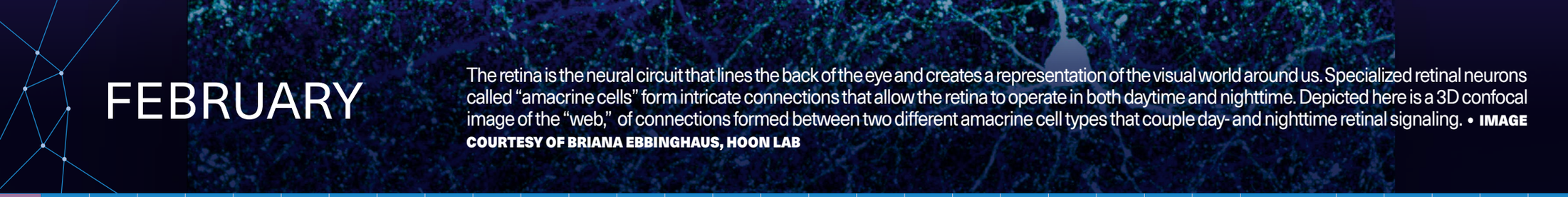

FEBRUARY

The retina is the neural circuit that lines the back of the eye and creates a representation of the visual world around us. Specialized retinal neurons called "amacrine cells" form intricate connections that allow the retina to operate in both daytime and nighttime. Depicted here is a 3D confocal image of the "web," of connections formed between two different amacrine cell types that couple day- and nighttime retinal signaling. • **IMAGE COURTESY OF BRIANA EBBINGHAUS, HOON LAB**

JAN																													
	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN
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SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
30	31	1 CHINESE NEW YEAR	2 GROUNDHOG DAY	3	4	5
6	7	8	9	10	11	12
13	14 VALENTINE'S DAY	15	16	17	18	19
20	21 PRESIDENTS' DAY	22	23	24	25	26
27	28	1	2	3	4	5

MAR																													
	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU
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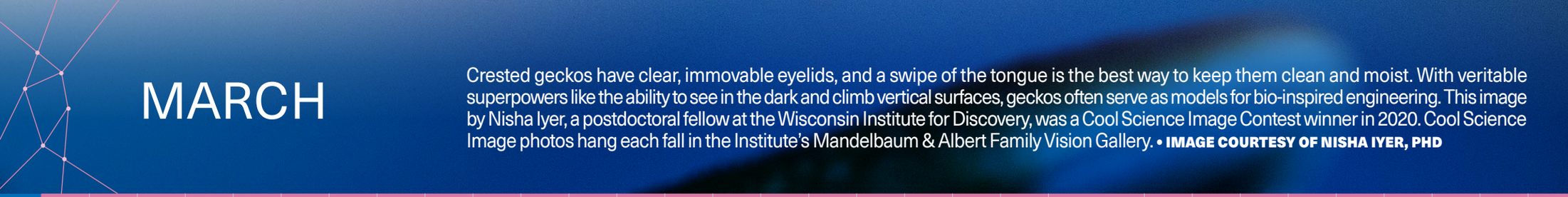
MARCH



Crested geckos have clear, immovable eyelids, and a swipe of the tongue is the best way to keep them clean and moist. With veritable superpowers like the ability to see in the dark and climb vertical surfaces, geckos often serve as models for bio-inspired engineering. This image by Nisha Iyer, a postdoctoral fellow at the Wisconsin Institute for Discovery, was a Cool Science Image Contest winner in 2020. Cool Science Image photos hang each fall in the Institute's Mandelbaum & Albert Family Vision Gallery. • **IMAGE COURTESY OF NISHA IYER, PHD**

FEB	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON
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SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
27	28	1 MARDI GRAS	2 ASH WEDNESDAY	3	4	5
6	7	8	9	10	11	12
13 DAYLIGHT SAVING TIME BEGINS	14	15	16	17 ST. PATRICK'S DAY	18	19
20 FIRST DAY OF SPRING	21	22	23	24	25	26
27	28	29	30	31	1	2

APR	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
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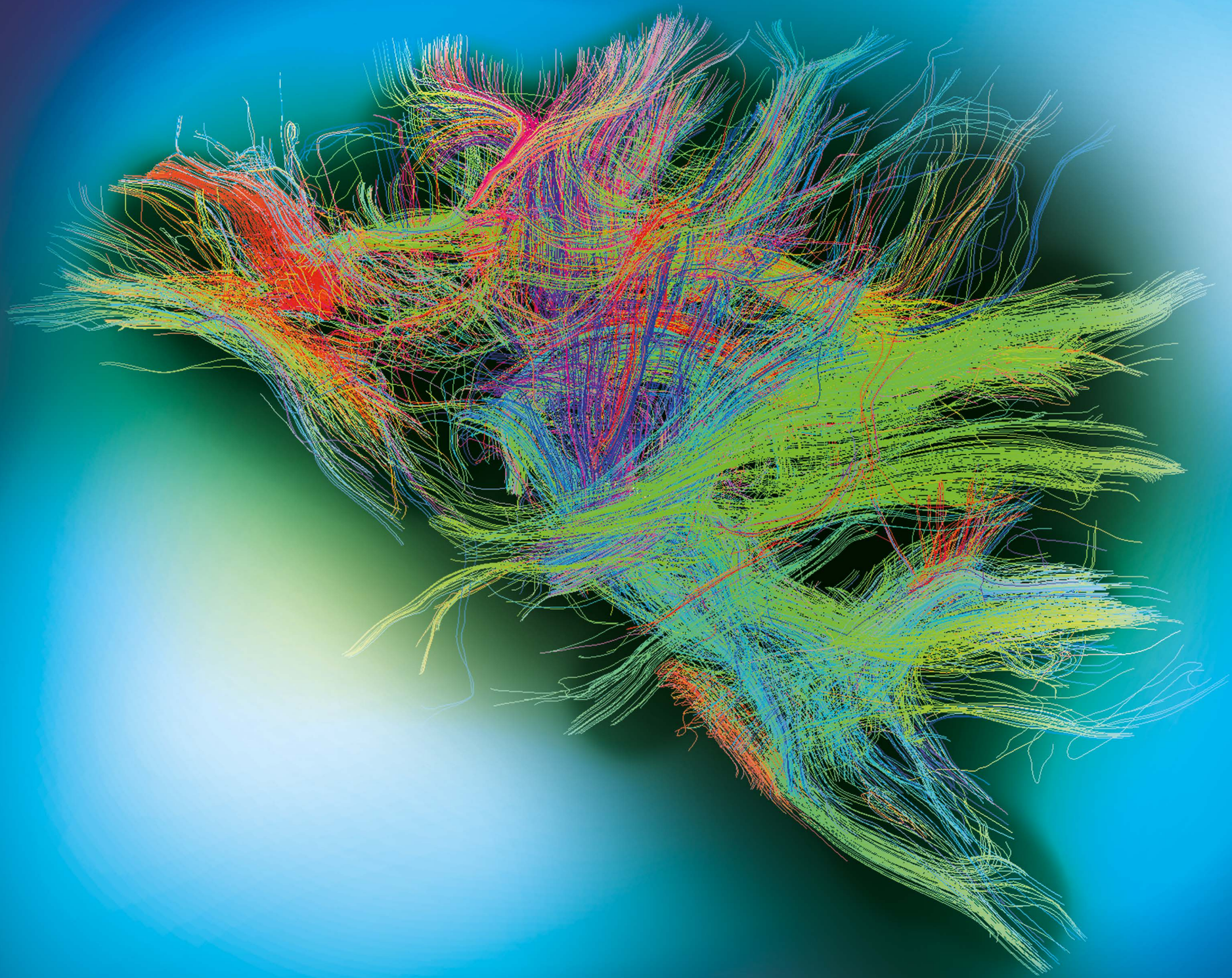

APRIL

Ari Rosenberg's lab investigates how the visual system progressively transforms 2D retinal images into 3D object representations. Determining how different brain regions contribute to this essential visual transformation requires an understanding of their hierarchical and parallel connections. To assess that connectivity, the lab relies on neuroimaging methods to estimate the region-to-region axonal projections of cortical and subcortical visual areas. This image shows estimated axonal projections throughout the entire brain. • **IMAGE COURTESY OF RAYMOND DOUDLAH**

MAR	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU
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SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
27	28	29	30	31	1 APRIL FOOLS' DAY	2 RAMADAN BEGINS
3	4	5	6	7	8	9
10 PALM SUNDAY	11	12	13	14	15 PASSOVER BEGINS GOOD FRIDAY	16
17 EASTER	18	19	20	21	22 EARTH DAY	23
24 ORTHODOX EASTER	25	26	27	28	29	30

MAY	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE
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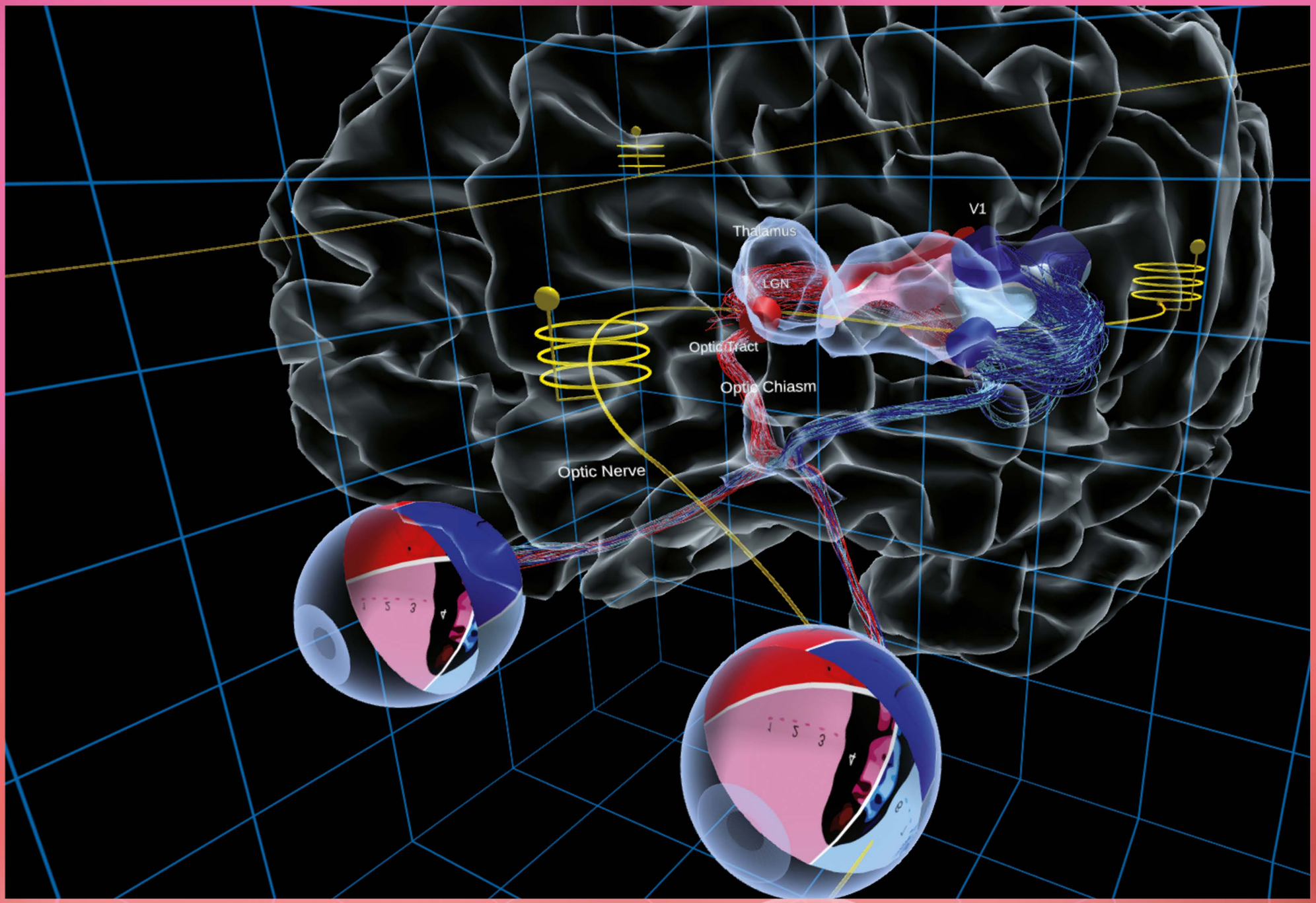

V1
Thalamus
LGN
Optic Tract
Optic Chiasm
Optic Nerve

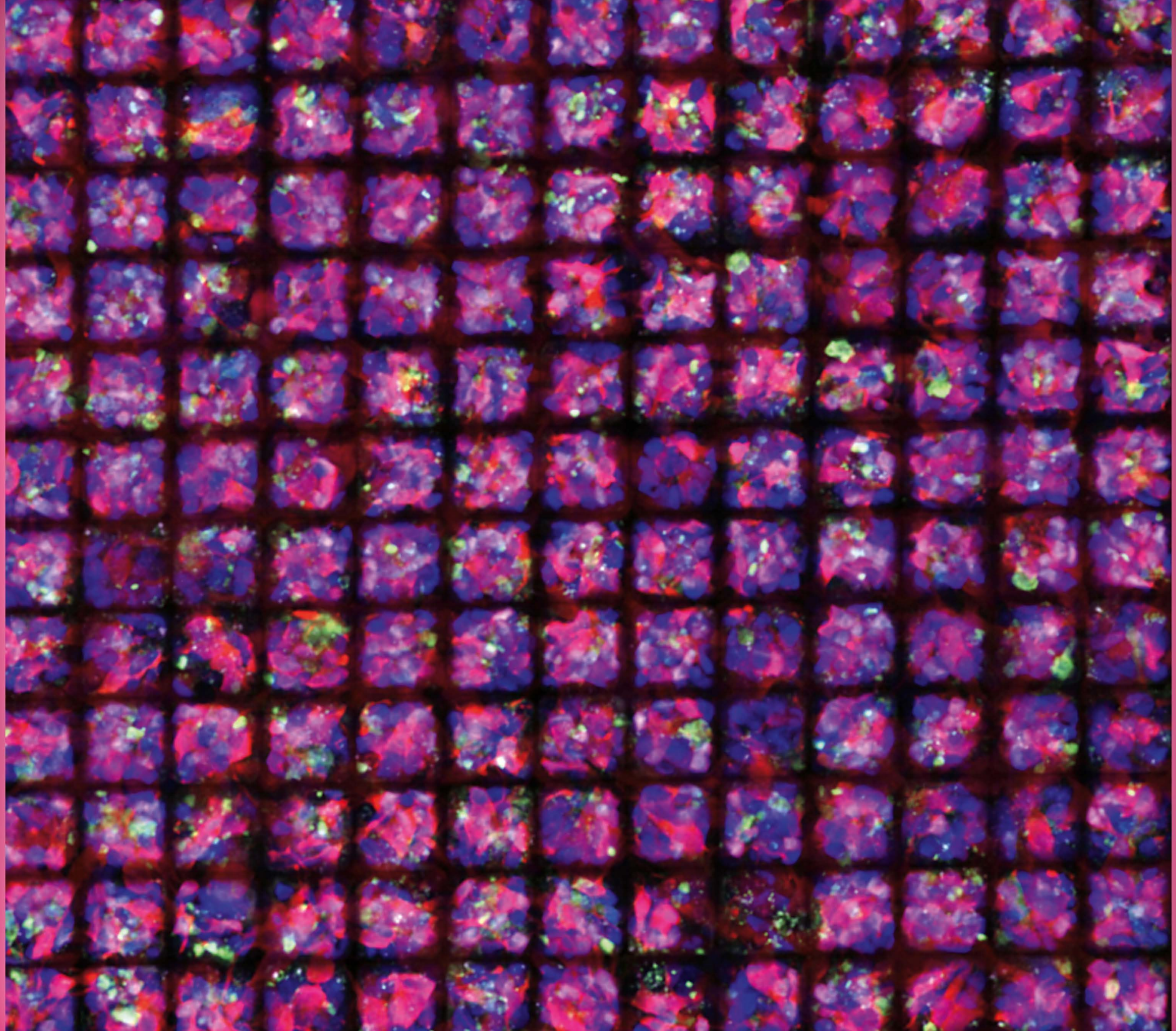
MAY

This image depicts a three-dimensional representation of the visual system in the human brain. The image is taken from the Virtual Visual System lesson, developed by the UW Virtual Brain Project team, which creates interactive 3D narrated diagrams to teach functional neuroanatomy. Learners travel along the yellow tract, into the brain, stopping at stations along the way that describe key topics at each stage of neural processing. The UW Virtual Brain Project lessons are transforming the way students engage with functional neuroanatomy, providing fun, interactive experiences that promote active learning. • **IMAGE COURTESY OF THE UW VIRTUAL BRAIN PROJECT TEAM**

APR																												
FRI 1	SAT 2	SUN 3	MON 4	TUE 5	WED 6	THU 7	FRI 8	SAT 9	SUN 10	MON 11	TUE 12	WED 13	THU 14	FRI 15	SAT 16	SUN 17	MON 18	TUE 19	WED 20	THU 21	FRI 22	SAT 23	SUN 24	MON 25	TUE 26	WED 27	THU 28	FRI 29	SAT 30

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2 EID AL-FITR BEGINS	3	4	5 CINCO DE MAYO	6	7
8 MOTHER'S DAY	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30 MEMORIAL DAY	31	1	2	3	4

JUN																												
WED 1	THU 2	FRI 3	SAT 4	SUN 5	MON 6	TUE 7	WED 8	THU 9	FRI 10	SAT 11	SUN 12	MON 13	TUE 14	WED 15	THU 16	FRI 17	SAT 18	SUN 19	MON 20	TUE 21	WED 22	THU 23	FRI 24	SAT 25	SUN 26	MON 27	TUE 28	WED 29	THU 30



JUNE

Human pluripotent stem cell-derived photoreceptors (cell bodies in red, nuclei in blue) grown on a biodegradable scaffold designed to replace cells lost to retinal degenerative diseases. This image has been magnified 20x with a confocal microscope to visualize rod (lavender) and cone (green) photoreceptors. The scaffolds are thinner than a sheet of office paper and can fit on a fingertip.

• **IMAGE COURTESY OF ALLISON LUDWIG, GAMM LAB**

MAY	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE
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SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
29	30	31	1	2	3	4 SHAVUOT BEGINS
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19 FATHER'S DAY JUNETEENTH	20 JUNETEENTH, FEDERAL HOLIDAY	21 FIRST DAY OF SUMMER	22	23	24	25
26	27	28	29	30	1	2

JUL	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN
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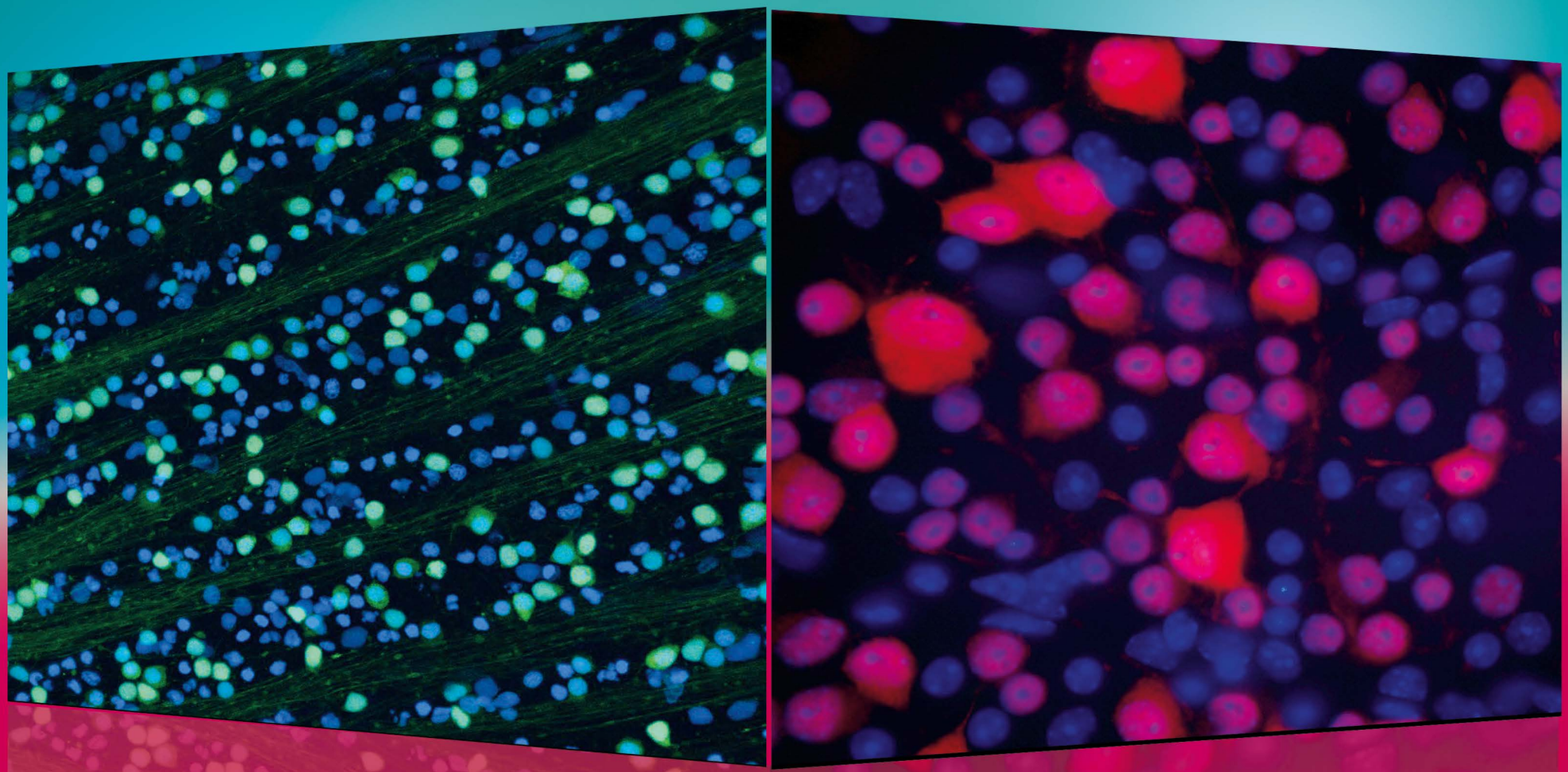

JULY

Keeping critical cells alive is the focus in two McPherson ERI labs. **Left:** Matthew Veldman's lab at MCW uses zebrafish to model the loss of cells connecting the eye to the brain in diseases such as glaucoma. This image shows both healthy cells (in green with round uniformly stained nuclei in blue) and unhealthy/dying cells (with loss of green and non-uniformly stained cell nuclei in blue). Green axonal projections traverse the image diagonally toward the optic nerve head. **Right:** In Rob Nickells' UW-Madison lab, a microscopic image shows the mouse retinal ganglion cell layer after delivery of the BCL-X gene. The viral vector used to deliver the gene targets the ganglion cells; the gene then produces a protein, engineered to glow red, which combats ganglion cell death. Retinal cell nuclei are shown in blue. Images courtesy of Robert Newland, Veldman Lab, and of the Nickells Lab. • **IMAGES COURTESY OF ROBERT NEWLAND IN THE VELDMAN LAB (LEFT), AND THE NICKELLS LAB (RIGHT)**

JUN	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU
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SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
26	27	28	29	30	1	2
3	4 INDEPENDENCE DAY	5	6	7	8	9 EID AL-ADHA BEGINS
10	11	12	13	14	15	16
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24 31	25	26	27	28	29	30

AUG	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED
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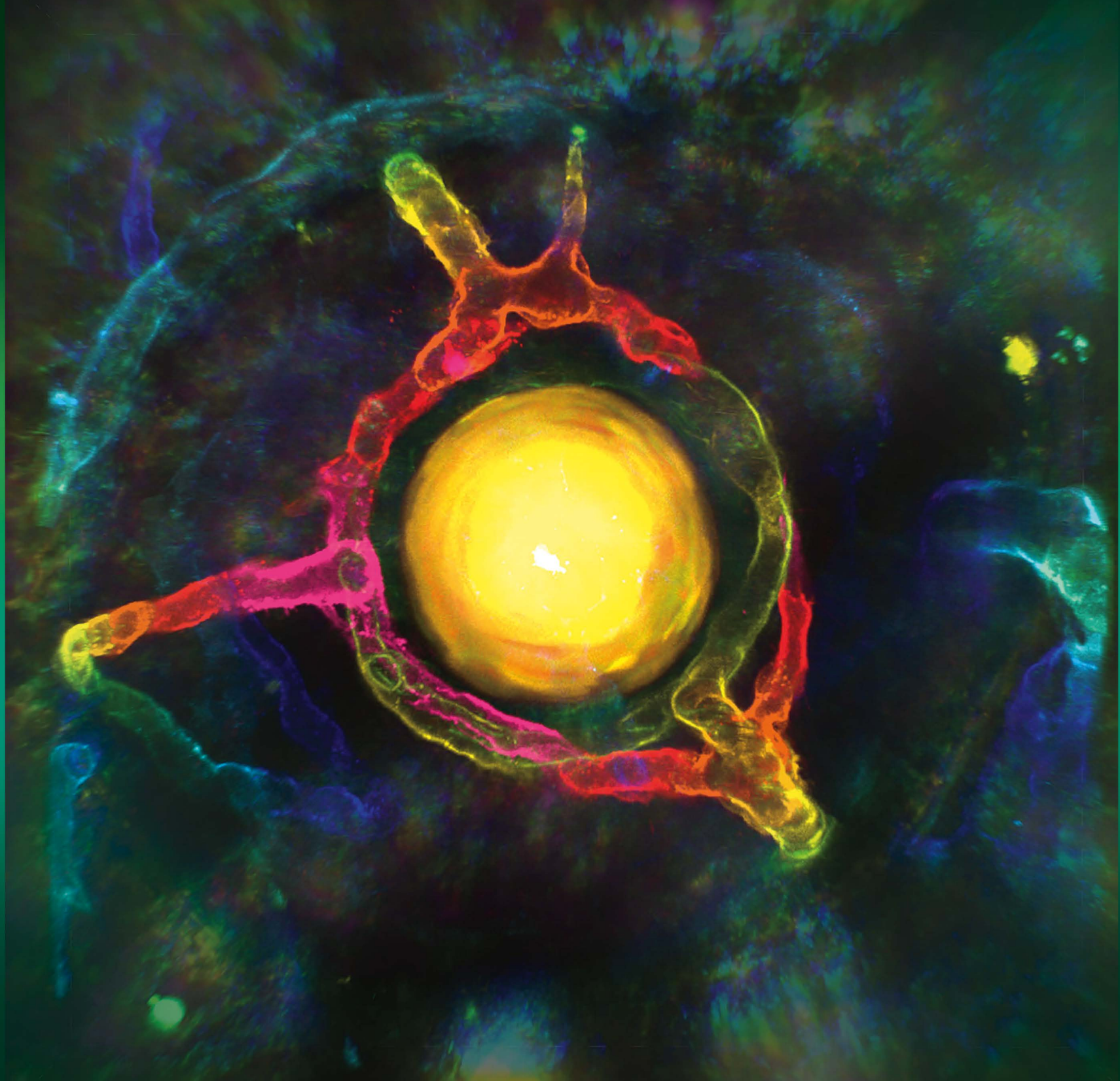
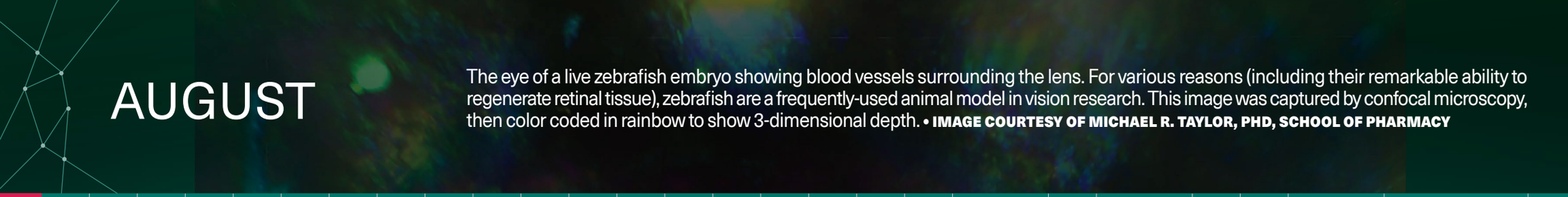


AUGUST



The eye of a live zebrafish embryo showing blood vessels surrounding the lens. For various reasons (including their remarkable ability to regenerate retinal tissue), zebrafish are a frequently-used animal model in vision research. This image was captured by confocal microscopy, then color coded in rainbow to show 3-dimensional depth. • **IMAGE COURTESY OF MICHAEL R. TAYLOR, PHD, SCHOOL OF PHARMACY**

JUL																														
	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
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7	8	9	10	11	12	13
14	15	16	17	18	19	20
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28	29	30	31	1	2	3

SEP																														
	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI
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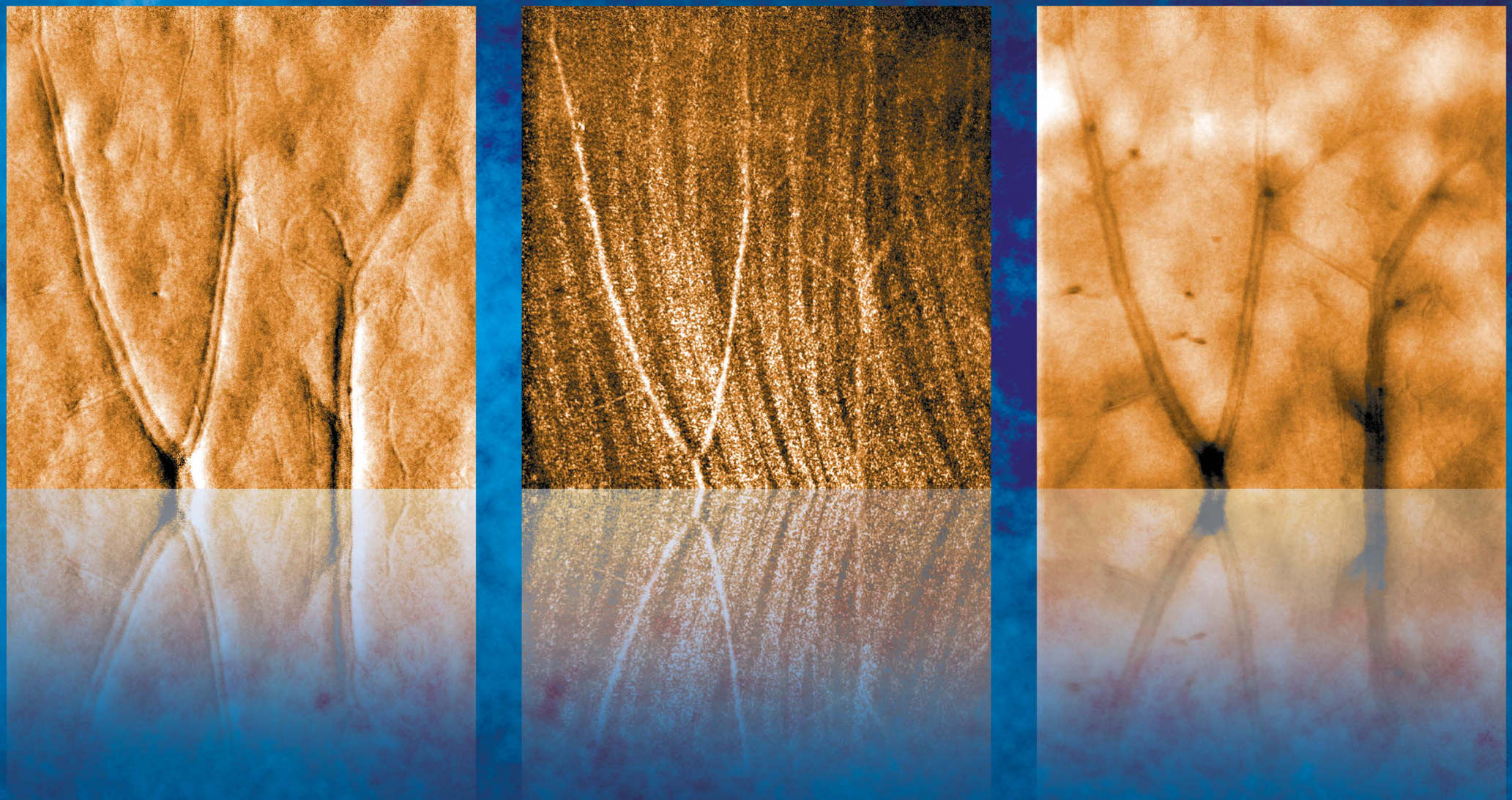


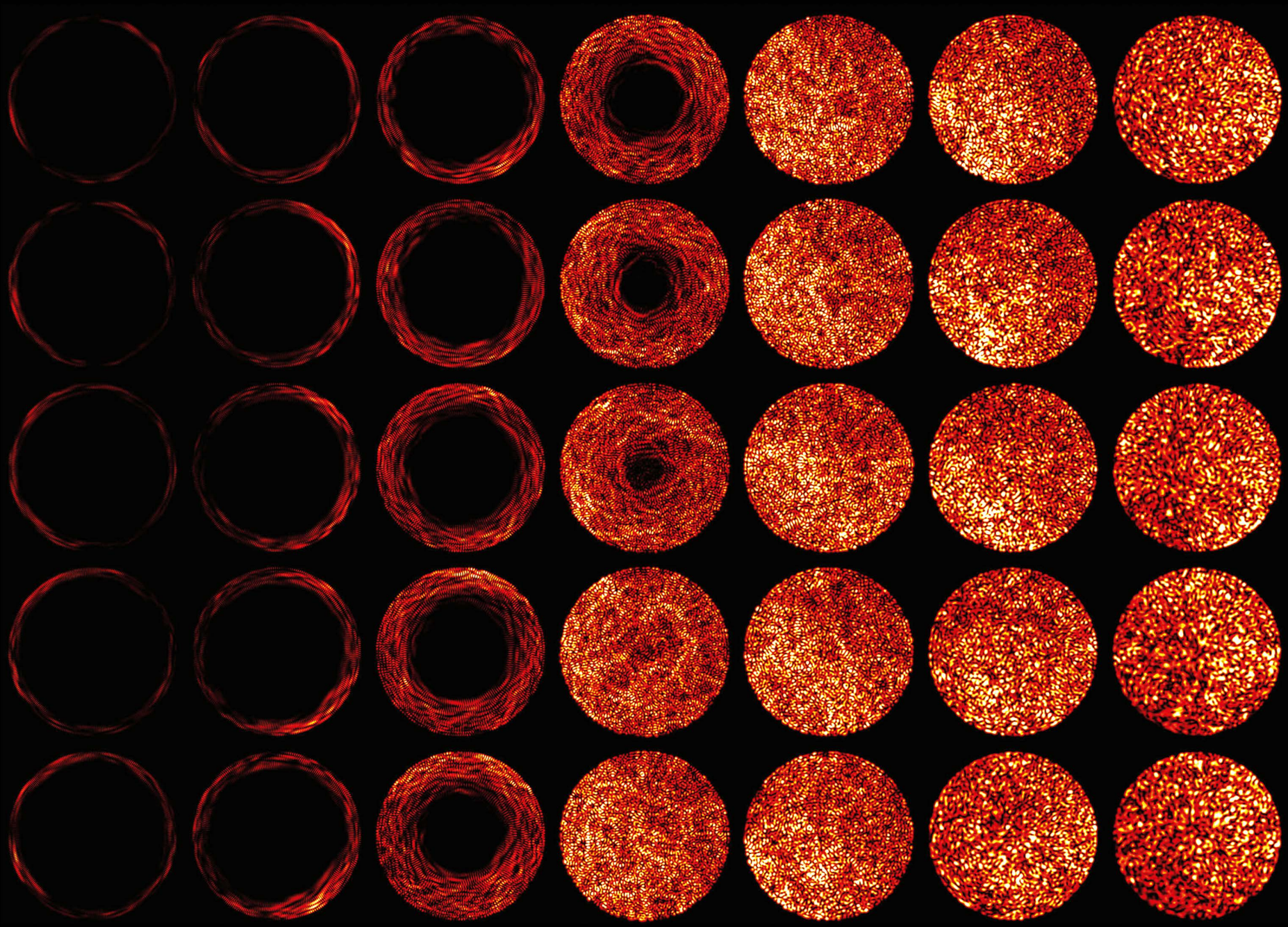
SEPTEMBER

Adaptive Optics technology uses deformable membrane mirrors to correct distortions of light that otherwise prevent sharp focus of retinal cells. By simultaneously capturing scattered light with multiple detectors, contrast from different cells and structures can be distilled from the same image. The identical base image is shown above processed with three different modalities: split detection (left), highlighting vascular walls and capillaries; confocal detection (center), highlighting nerve fibers; and darkfield detection (right), highlighting diving blood vessels. Adaptive Optics imaging is a major focus of the Wisconsin Advanced Imaging of Visual Systems (WAIVS) Lab. **• IMAGE COURTESY OF J.D. ROGERS & BEN SAJDAK, PHDS.**

AUG																														
	MON 1	TUE 2	WED 3	THU 4	FRI 5	SAT 6	SUN 7	MON 8	TUE 9	WED 10	THU 11	FRI 12	SAT 13	SUN 14	MON 15	TUE 16	WED 17	THU 18	FRI 19	SAT 20	SUN 21	MON 22	TUE 23	WED 24	THU 25	FRI 26	SAT 27	SUN 28	MON 29	TUE 30	WED 31

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
28	29	30	31	1	2	3
4	5 LABOR DAY	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22 FIRST DAY OF FALL	23	24
25 ROSH HASHANAH BEGINS	26	27	28	29	30	1

OCT																														
	SAT 1	SUN 2	MON 3	TUE 4	WED 5	THU 6	FRI 7	SAT 8	SUN 9	MON 10	TUE 11	WED 12	THU 13	FRI 14	SAT 15	SUN 16	MON 17	TUE 18	WED 19	THU 20	FRI 21	SAT 22	SUN 23	MON 24	TUE 25	WED 26	THU 27	FRI 28	SAT 29	SUN 30	MON 31



OCTOBER

Like ripples on a pond or the rough chop of a windy day on a lake, light waves can be steady and well organized or can be chaotic patterns of interference called speckle, which can be extremely sensitive to motion. Here, a microscopic view of laser light exiting an optical fiber shows speckle patterns that change top to bottom and left to right as the angle of incidence of the laser onto the fiber decreases. Speckle is studied to develop new imaging methods that are sensitive to motion like blood flow or cellular activity and may provide new sources of contrast for imaging cell function in the retina. • **IMAGE COURTESY OF J.D. ROGERS, PHD**

SEP

THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI
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SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
25	26	27	28	29	30	1
2	3	4 YOM KIPPUR BEGINS	5 YOM KIPPUR	6	7	8
9 SUKKOT BEGINS	10 COLUMBUS DAY INDIGENOUS PEOPLE'S DAY	11	12	13 WORLD SIGHT DAY	14	15 WHITE CANE SAFETY DAY
16	17	18	19	20	21	22
23 30	24 HALLOWEEN 31	25	26	27	28	29

NOV

TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED
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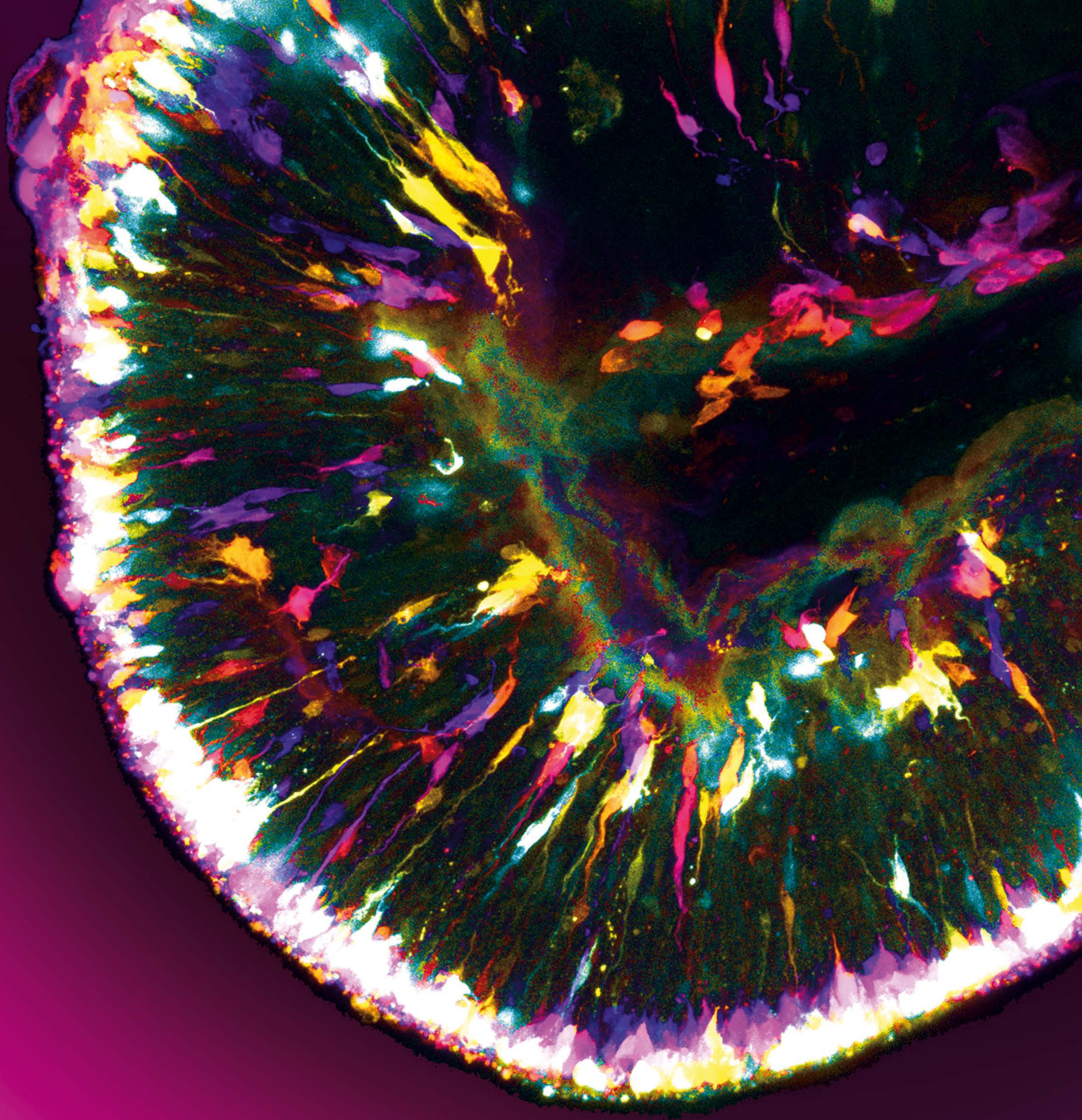

NOVEMBER

This image shows photoreceptor cells within a retinal organoid, a sphere of retina cells made from stem cells in a dish that mimic early human development. By understanding how human photoreceptor cells develop, the Gomez Lab (in collaboration with the Gamm Lab) hopes to unlock strategies to allow regeneration or transplant therapies to restore vision for patients who have gone blind due to photoreceptor loss. The picture has been color-coded based on where the photoreceptor cells are in the Z dimension (perpendicular to the page) so that we can convey 3D information in this 2D image. • **IMAGE COURTESY OF SARAH REMPEL, GOMEZ LABORATORY**

OCT																														
SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON
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SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
30	31	1	2	3	4	5
6 DAYLIGHT SAVING TIME ENDS	7	8 ELECTION DAY	9	10	11 VETERANS DAY	12
13	14	15	16	17	18	19
20	21	22	23	24 THANKSGIVING	25	26
27	28	29	30	1	2	3

DEC																														
THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
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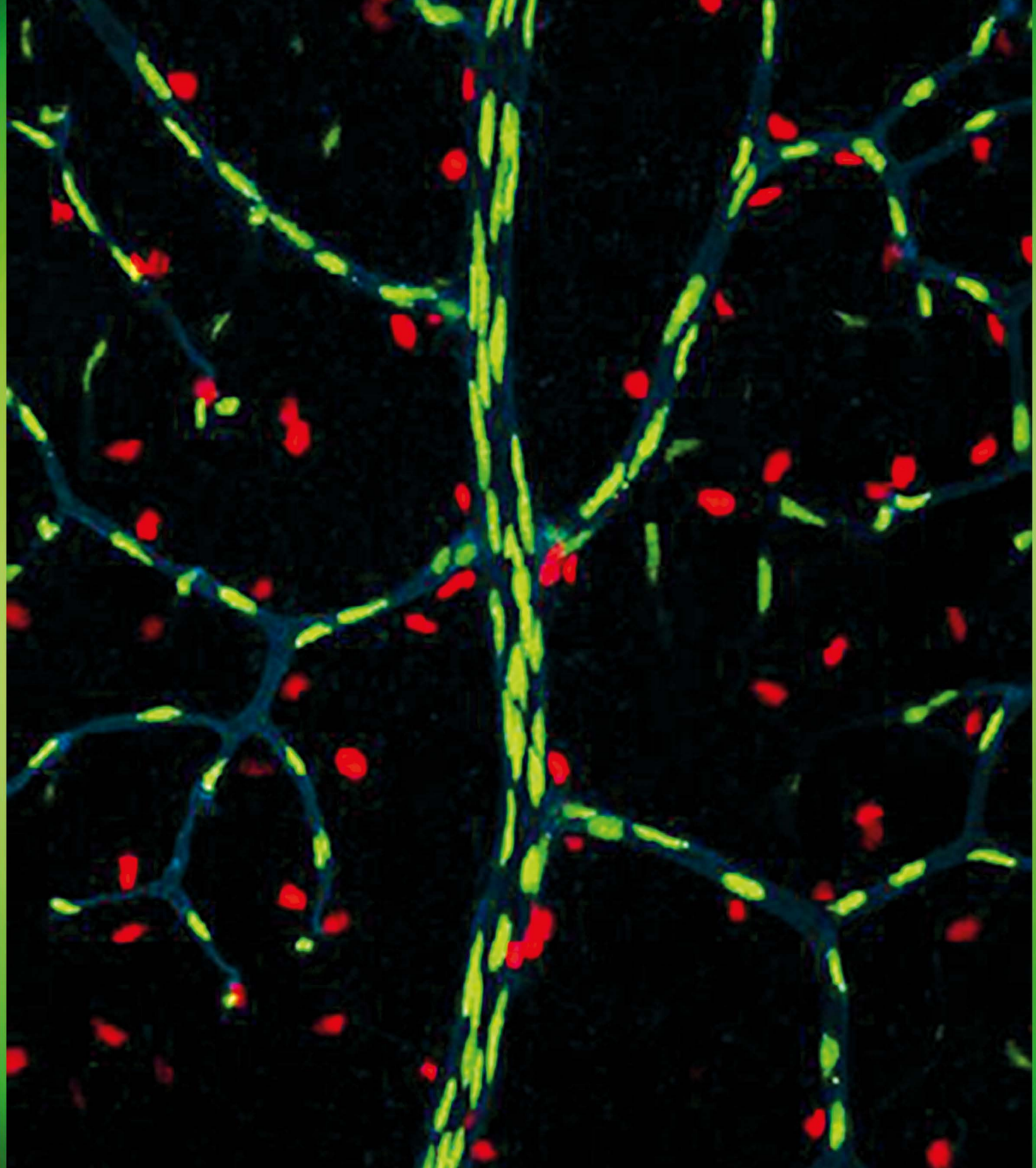
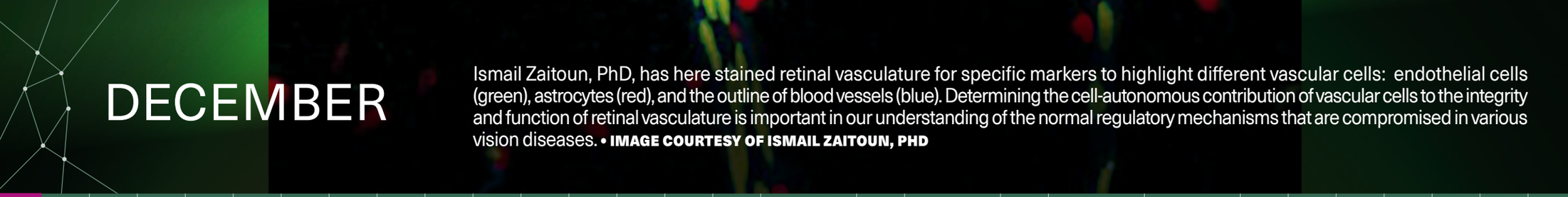


DECEMBER



Ismail Zaitoun, PhD, has here stained retinal vasculature for specific markers to highlight different vascular cells: endothelial cells (green), astrocytes (red), and the outline of blood vessels (blue). Determining the cell-autonomous contribution of vascular cells to the integrity and function of retinal vasculature is important in our understanding of the normal regulatory mechanisms that are compromised in various vision diseases. • **IMAGE COURTESY OF ISMAIL ZAITOUN, PHD**

NOV																													
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27	28	29	30	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18 HANUKKAH BEGINS	19	20	21 FIRST DAY OF WINTER	22	23	24 CHRISTMAS EVE
25 CHRISTMAS DAY	26 KWANZAA BEGINS	27	28	29	30	31 NEW YEAR'S EVE

JAN																													
	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE
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2020
2021

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IN MEMORIAM

Marv Conney

McPherson ERI Advisory Board member Marv Conney passed away in March, 2021, at 94 years of age. The McPherson ERI was one of many research, educational, and cultural nonprofits that was fortunate to draw the interest and support of Marv and his late wife, Mildred "Babe" Conney (also an Advisory Board member before her death in late 2016). After his time in the US Navy and at UW-Madison (where he graduated with an economics degree), Marv had a long career as the founder and owner of Conney Safety Products of Madison. Both before and after their 1998 retirement, the Conneys had a "second career" in philanthropy, and were known as one of the most insightful, intelligent, and generous couples in Madison. They supported a number of outstanding scientists, including McPherson ERI member and pioneering stem cell researcher James Thomson. The Conneys were generous supporters of other UW-Madison endeavors as well, including cardiology and Jewish Studies (endowing the Conney Project on Jewish Arts). Marv and Babe were a delight to know and to talk with, often over Marv's favorite Chinese food lunches, and we will miss them.

The Mandelbaum & Albert Family Vision Gallery

The Mandelbaum & Albert Family Vision Gallery on the 9th floor of WIMR II is one of the McPherson ERI's jewels, featuring changing exhibits of vision-related art and scientific illustration. Through much of the pandemic, the exhibit ***Demystify: Seeing the Unseeable*** continued to hang in the gallery. In Fall 2021, the Vision Gallery hosted the annual ***Cool Science Image Contest*** exhibition, which displayed the spectacular winning images from this campus-wide competition from both 2020 and 2021.

TOP: A thin section of troctolite, an igneous rock; polarized light accentuates the vivid colors. Photo by Natalie Betz and Anya Wolterman

MIDDLE: Hiking to the South Pole home of IceCube, a UW-Madison-led neutrino telescope, during an Antarctic winter. Photo by Yuya Makino.

BOTTOM: A carnivorous sundew plant rolls up its leaves around a meal to facilitate digestion. Photo by Nisha Iyer.

Cycle for Sight Plus 2021

In 2021, Teams Chose their Own Venues and Raised $55,000!

Cycle for Sight Plus 2021, held in late April, changed its format from previous years, with teams cycling, walking, or running on their own. Instituted in response to COVID-19, the new format was a big success with many teams, allowing outdoor walks and rides, not only in Madison, but from Baraboo and Eau Claire to the Colorado Rockies and Alaska. Teams raised approximately $55,000 for a variety of vision research grant programs. Kenzi's Team, which hosted a walk around the Wisconsin State Capitol, once again took the lead.

We're grateful for all of our teams. In 2021, they showed that their dedication and drive to raise funds for vision research overcomes all obstacles! In 2022, we'll continue Cycle for Sight in a hybrid format, indoors and outside. We're looking forward to a great event, so stay tuned. **And thank you to all who participated and donated!**

Thank you to our terrific sponsors!

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Your gifts allow us to begin new research initiatives and research grants. In 2022, we will sponsor a new pilot grant for age-related macular degeneration (AMD) thanks to generous gifts from **Roger and Lynn Van Vreede** and the **Robert A. Brandt Macular Degeneration Fund**. The Van Vreedes will also support a similar pilot grant for retinitis pigmentosa research. Coming months will also see the establishment of a major new endowment for accelerating AMD research. Your gifts, too, support near-term research opportunities with future clinical applications.

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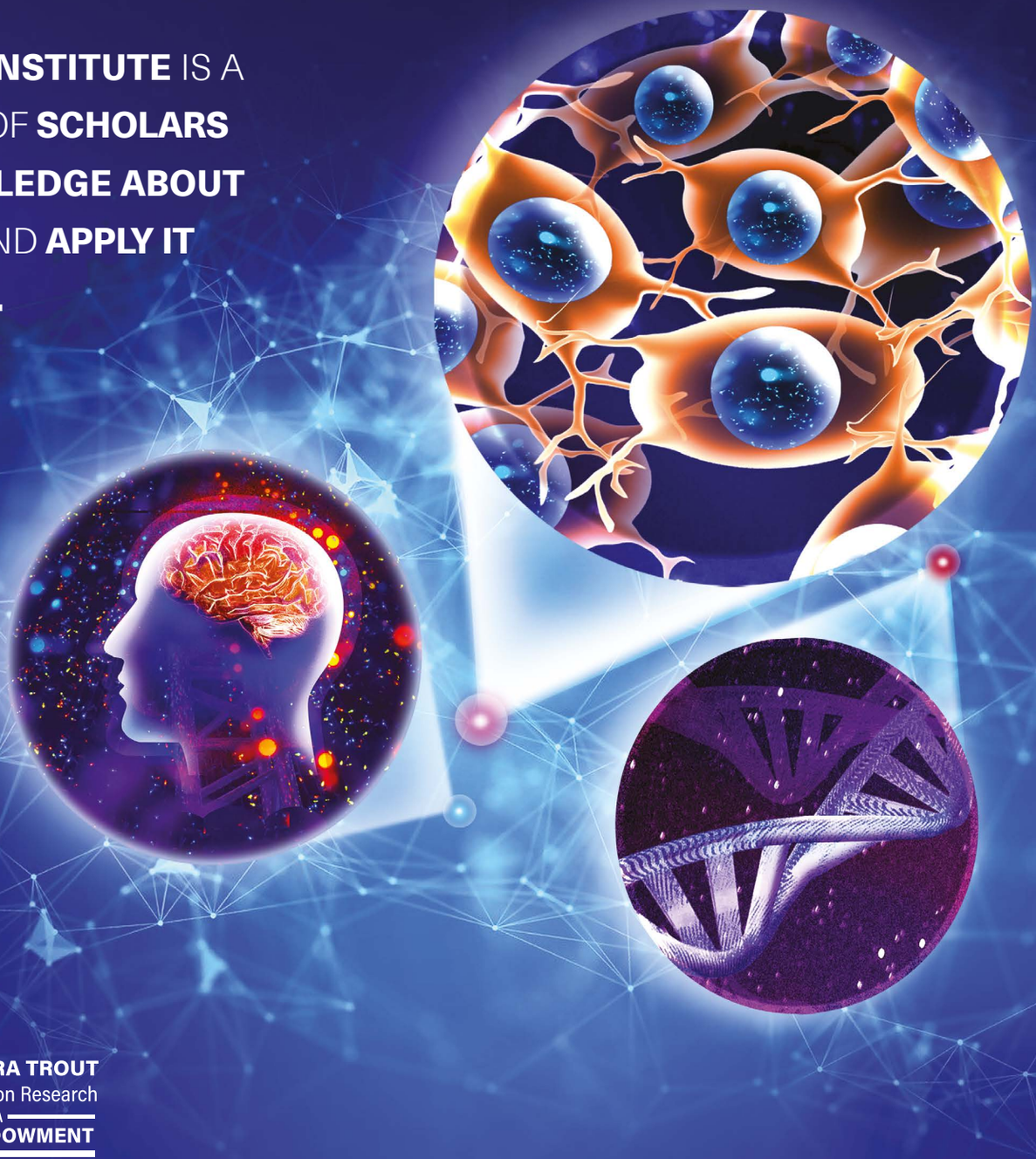

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