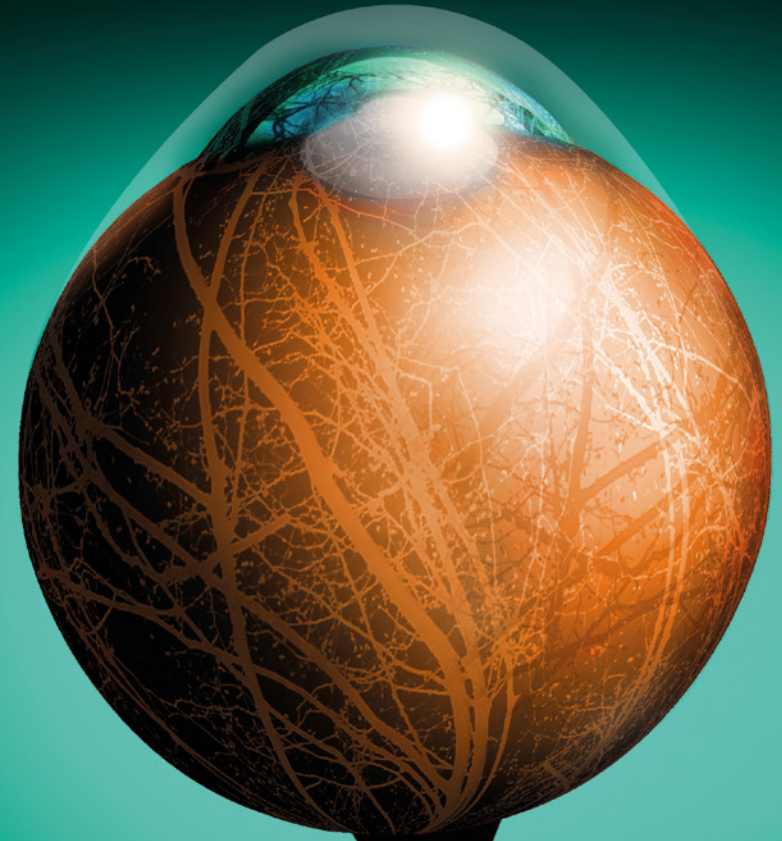


MCPHERSON EYE RESEARCH INSTITUTE
2015 ANNUAL REPORT
2016 CALENDAR



Dear Friends,

When the Eye Research Institute was formally established in 2005 (named the McPherson Eye Research Institute in 2012), it was with the paramount goal of fostering collaboration among researchers in the many disciplines where vision research was being performed at UW-Madison. Ophthalmology, neuroscience, genetics, engineering, pediatrics, psychology, computer science, veterinary medicine, and two dozen other departments and schools all housed investigators who were working, directly or indirectly, on the visual system. For many researchers and clinicians who focused on blinding diseases, there was urgency in this collaboration, and recognition that the cures for devastating eye diseases and injuries would almost certainly come from cross-disciplinary advances. The McPherson ERI was formed to accelerate those collaborations.

Now, ten years later, you can measure our progress by our numerous and noteworthy member-researcher collaborations. A sample of those projects are highlighted on the opposite page, chosen from a broad range of work that addresses cutting-edge issues in diseases such as age-related macular degeneration, retinitis pigmentosa, glaucoma, and ocular cancer – as well as many projects that seek to understand other aspects of vision in both health and disease. We are in full flight toward becoming one of the most forward-thinking vision research centers in the world for current and future discovery. We have our researchers' energy and focus to thank for this, and everyone who reads this report as well. The help that we have received from McPherson ERI supporters has been instrumental in boosting collaborative research, and we believe that you'll be proud to share in the results – now and in years to come.

There is no one who represents the spirit of collaborative work better than our namesake and co-founder, Dr. Alice McPherson. Coincidentally, the 10th year of our Institute has given occasion for us to celebrate Dr. McPherson's achievements in the company of many whom she has inspired. In May 2015, we were pleased to host a reception at the annual Association for Research in Vision and Ophthalmology (ARVO) conference in Denver, attended by a multitude of Dr. McPherson's colleagues (including many former trainees) from around the world. It was a memorable occasion. In October 2015, she was honored by the University of Wisconsin-Madison—her alma mater for both bachelor and MD degrees—with the Distinguished Alumni Award, presented by Chancellor Rebecca Blank at her annual luncheon. That same day, Dr. McPherson met with students at her namesake learning community, McPherson House at the UW-Madison School of Medicine and Public Health. It is that meeting which sums up Dr. McPherson's spirit and influence, in what has been a lifelong drive to foster and support education and research – whether among students, investigators, clinicians, or patients.

The McPherson Eye Research Institute has its roots in that drive and vision – and, as roots will do, they have grown into a network of full-sized collaborations. We anticipate many more to come, along with the groundbreaking results they engender, and we hope that you'll continue with us on that journey.

David M. Gamm, MD, PHD

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



PHOTO: ANDY MANIS

Institute co-founder Dr. Alice McPherson, Founding Director Dr. Daniel Albert, and Director Dr. David Gamm (October 2015)



PHOTO: WILLIAM CRONIN

Dr. McPherson with distinguished speakers Drs. Daniel Albert, Matthew Davis, Alan Bird, Nansi Colley, David Gamm, John Dowling, and Paul Sieving (May 2015)



PHOTO: JAMES GILL

L-R: Chancellor Rebecca Blank, Dr. McPherson, and Wisconsin Alumni Association President Paula Bonner

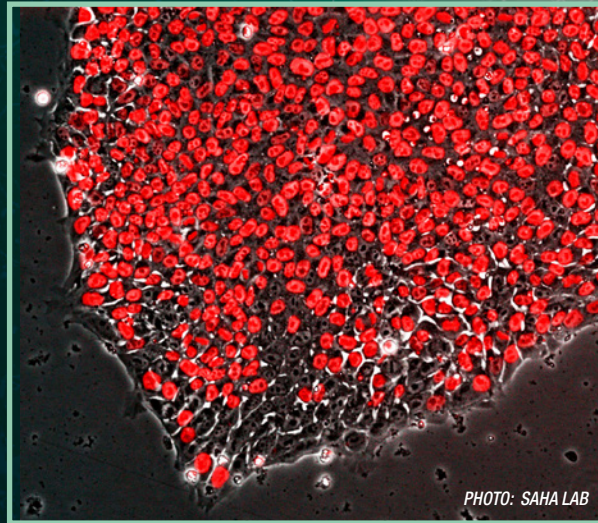
PHOTO: TODD BROWN

Addressing McPherson House medical students

CROSS CAMPUS COLLABORATION

RETINAL REGENERATIVE MEDICINE

The University of Wisconsin-Madison is a world leader in stem cell research, and the McPherson Eye Research Institute has built upon this foundation to establish its own high-powered consortium of investigators in the field of retinal regenerative medicine. Anchored by Dr. James Thomson, who first developed the technology to grow human embryonic stem cells and later pioneered research into induced pluripotent stem cells, we have brought together top researchers to translate discovery to treatment: Dr. Gamm in generation of stem cell-based human retinal cells, including photoreceptors; Drs. Gong and Ma in design of 3-D retinal scaffolds for retinal cell delivery; Dr. Saha in stem cell gene editing and repair techniques; and Dr. Hei in future production of clinical grade retinal cells for patient use. Working together, these researchers are making strides to bring stem cell technology to patients with otherwise untreatable retinal diseases and injuries.



James Thomson, VMD, PhD
Director, Regenerative Biology
Morgridge Institute for Research



Derek Hei, PhD
Director, Biomanufacturing
Waisman Center



Krishanu Saha, PhD
Biomedical Engineering
Wisconsin Institute for Discovery



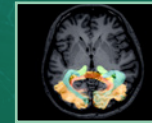
Zhenqiang Ma, PhD
Wisconsin Nano Engineering Device Lab
Electrical and Computer Engineering



David Gamm, MD, PhD
Director, McPherson ERI
Ophthalmology & Visual Sciences



Shaoqin Gong, PhD
Biomedical Engineering
Wisconsin Institute for Discovery



ASSESSING VISUAL PATHWAYS IN AMBLYOPIA

Amblyopia (lazy eye) is a developmental visual disorder caused by poorly coordinated visual input to the two eyes. It disproportionately affects children of low socio-economic status, and if left untreated, leads to a number of visual deficits throughout adulthood. Using state-of-the-art neuroimaging techniques, Assistant Professor Bas Rokers and his graduate student, Brian Allen, recently established that these visual deficits are associated with structural abnormalities in several visual pathways in the human brain. These findings provide key insights into the neural consequences of amblyopia and provide novel avenues for diagnosis and treatment. The Rokers Lab is currently expanding upon this work, in a newly-formed collaboration with pediatric ophthalmologists at UW including Melanie Schmitt and Burton Kushner. To better understand the effects of amblyopia across the developmental trajectory, they are investigating the neuroanatomical consequences of successfully and unsuccessfully treated amblyopia.

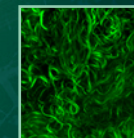
Bas Rokers, PhD
Psychology

**Burton Kushner, MD
& Melanie Schmitt, MD**
Ophthalmology and
Visual Sciences

Gillian McLellan, BVMS, PhD, DACVO

Ophthalmology and
Visual Sciences;
Veterinary Medicine

Jeremy D. Rogers, PhD
Biomedical Engineering



ASSESSING SCLERAL COLLAGEN IN GLAUCOMA

A collaboration between veterinary ophthalmologist Dr. Gillian McLellan and engineer Dr. Jeremy Rogers aims to develop a new screening tool that could lead to improved outcomes in humans and animals with glaucoma. Their work explores the potential to assess risk of blindness due to glaucoma by measuring light scattering from the sclera (tough outer coat that constitutes the white of the eye). Dr. McLellan's studies in dogs and cats with glaucoma suggest that differences in individual susceptibility to high intraocular pressure, which results in optic nerve damage and blindness, may be linked to differences in the makeup of the sclera. It may be possible to use the light scattering properties of the sclera in a quick and simple test to identify those patients at most risk for vision loss from glaucoma, providing clinicians with a basis for more personalized care of individual patients.



Murray Brilliant, PhD

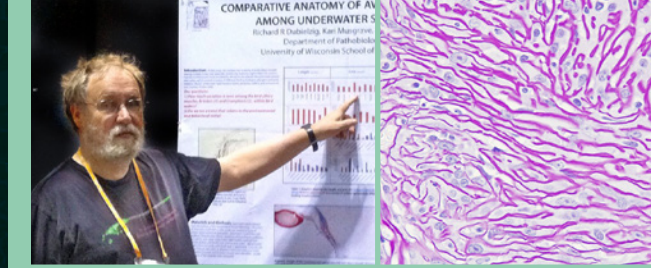
Director, Center for Human Genetics
Marshfield Clinic Research Foundation

Along with environmental exposures, genetic variants contribute to our risk of disease. Dr. Brilliant's research centers on the genetics behind vision disorders such as albinism, age-related macular degeneration (AMD), and glaucoma.

Albinism—although most often associated with the lack of melanin pigment in the iris, skin, and hair known as oculocutaneous albinism—may also be defined by eye conditions including underdevelopment of the central retina, poor visual acuity, nystagmus (repetitive uncontrolled eye movements), strabismus (eye misalignment), and misrouting of the optic nerves. Notably, AMD risk is highly correlated with pigmentation and affects the same tissues that fail to develop properly in albinism. A key factor underlying the visual defects in albinism is DOPA, a chemical intermediate in melanin biosynthesis. In all forms of oculocutaneous albinism, both pigment and DOPA are absent or severely reduced.

Individuals with ocular albinism (which causes the same ocular defects as all other forms of albinism, but is not associated with a severe reduction in visible pigmentation) lack the GPR143 gene, a receptor for DOPA. Under normal conditions, signaling through GPR143 increases pigment epithelia derived factor (PEDF) and decreases vascular endothelial growth factor (VEGF) – thereby slowing down, through two routes, the growth of blood vessels in the eye. In studying a vast cohort of individuals with and without AMD, Dr. Brilliant and his colleagues have found that AMD is delayed or absent in individuals taking L-DOPA. This implies that signaling through GPR143, via L-DOPA, may be used therapeutically to delay or prevent AMD.

Risk for age-related macular degeneration is largely inherited. In other work, Dr. Brilliant has leveraged analysis of over 20,000 DNA samples, combined with long-term medical records of the Marshfield Clinic's Personalized Medicine Research Project, to determine the genetic risk factors for AMD and glaucoma. These data (stored in the genetic and clinical Data Warehouse pictured) have been crucial to advancing several national and international studies on the genetics of these ocular disorders.



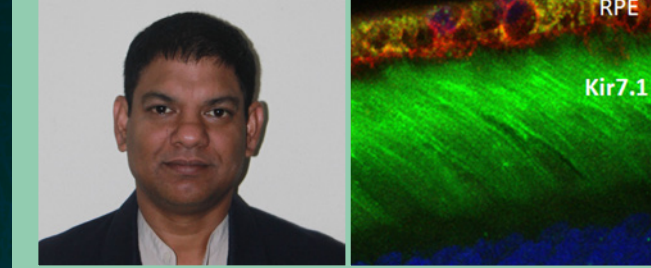
Richard R. Dubielzig, DVM

Department of Pathobiological Sciences
School of Veterinary Medicine

At the Comparative Ocular Pathology Lab of Wisconsin (COPLOW), founded by Dick Dubielzig in 1983, animal eyes are studied as both a clinical priority—to help diagnose and treat animals with eye diseases—and as windows into complex questions of anatomy, morphology and visual function. A still-active emeritus professor in pathobiological sciences, Dr. Dubielzig served as COPLOW's director for more than 30 years, amassing an extraordinary collection of ocular specimens from more than 570 species. In the course of this immersive study, Dubielzig has become one of the world's foremost experts on the pathology and natural history of spontaneous diseases of the eye in animals, and has significantly advanced ocular comparative anatomy. His textbook *Veterinary Ocular Pathology: A Comparative Review* is a standard reference for pathologists and ophthalmologists seeking clarification on the nature of eye disorders.

Dr. Dubielzig recognized early on that COPLOW could serve as an international diagnostic center. Since its inception, more than 48,000 ocular specimens have been collected and archived, sent from dozens of institutions and veterinary ophthalmologists. Specimens are available as a teaching resource and have been used as principal research material by COPLOW trainees and other investigators. Dubielzig himself has authored almost 300 publications, primarily describing the morphologic changes in spontaneous animal diseases of the eye. Comparative study—discerning patterns, parallels or contrasts within and across species and breeds—has led him to first-time recognition of multiple ocular diseases.

Beyond the benefits that COPLOW brings to its home in the School of Veterinary Medicine, the laboratory plays an important role in the mutually informative and richly complementary study of animal and human eyes. Dick Dubielzig was the first veterinary faculty member to join the McPherson Eye Research Institute, and has been a pioneer in fostering collaboration between veterinary scientists and researchers in other schools at UW-Madison. Multiple cross-disciplinary studies have grown from this link, with results advancing understanding of eye health and disease in animals including humans.



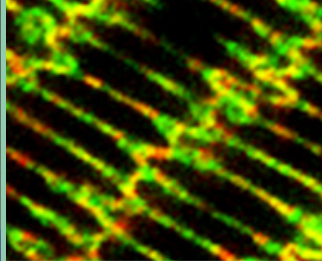
Bikash Pattnaik, PhD

Department of Pediatrics
School of Medicine & Public Health

Helen Keller once commented, “Never bend your head. Always hold it high. Look the world straight in the eye.” Bikash Pattnaik, senior scientist in the Department of Pediatrics, focuses on looking at the world straight through the eyes of children. The prevalence of childhood blindness worldwide ranges from 0.2 to 1.2 per 1000, but – as Dr. Pattnaik notes – for those who are blind, this statistic is 100%. Our ability to visualize the outside world is realized by the photoreceptors in the eye. Loss of photoreceptors and resulting blindness can be due to either developmental or inherited issues. The Pattnaik laboratory has worked to understand both causes of blinding diseases, and has published two important studies this year.

In the first study (*Investigative Ophthalmology and Visual Sciences*, February 2015), lab members focused on the supporting layer of the retina, the retinal pigment epithelium (RPE), which plays a crucial role in maintaining homeostasis and allows the retina to decode visual information. Their research revealed the molecular mechanism of a signaling pathway between photoreceptors and RPE cells. Specifically, the neuropeptide hormone oxytocin is present in the photoreceptor neurons and its receptor is localized in the RPE cells. This discovery pinpoints a new connection between age-old pathways. Blindness can occur from the failure of oxytocin signaling in this pathway. Just as oxytocin is now being used in clinical trials for autism spectrum disorder, Pattnaik foresees the use of a novel oxytocin-targeted therapeutic to address blindness caused by this condition.

In another study (*Human Mutations*, July 2015), the group located and identified a novel gene mutation responsible for blindness in children due to Leber congenital amaurosis (LCA16). This disease predominantly affects light sensitive photoreceptors or adjacent RPE cells, causing loss of vision. Pattnaik's work has provided insight into the development of this disease using laboratory studies and gene manipulation in mice. In collaboration with David Gamm (Ophthalmology & Visual Sciences), De-Ann Pillers (Pediatrics) and others, his lab is now focusing on patient-derived iPS cells (induced pluripotent stem cells) to reproduce the disease phenotype at a cellular level, so that blindness-reversing candidate drugs can be easily tested through a disease-in-a-dish mechanism.



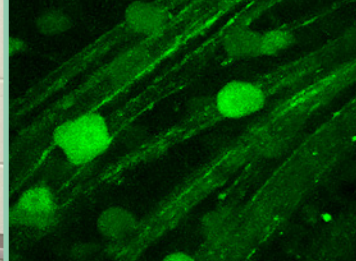
Anne Griep, PhD

Cell and Regenerative Biology
School of Medicine & Public Health

To develop new ways to prevent and treat cataracts, we need to understand the molecular mechanisms that direct lens morphogenesis and maintenance throughout life. Understanding begins with the composition of the lens. The transparency of the ocular lens relies, in part, on the precise hexagonal structure of the individual differentiated cells in the lens, called the fiber cells, and the packing of these cells to form the organized three-dimensional architecture of the lens. Disruption in fiber cell shape and lens structure leads to the loss of transparency and the formation of a cataract—which is the leading cause of blindness in the world today.

The current research objective in the laboratory of Professor Anne Griep, Department of Cell and Regenerative Biology, is to understand the molecular and genetic mechanisms that drive the formation of these unique fiber cells and the overall structure of the lens during embryonic and postnatal development. The lab uses the mouse as their model system because it is possible to generate mice carrying mutations in any gene of interest and then analyze the effects of that mutation on tissue development, structure and function.

Recent studies using genetically engineered mice have shown that in some organs, genes in the Wnt/Planar Cell Polarity (PCP) pathway are involved in dictating cell shape and the organization of cells into higher ordered structures. (PCP refers to polarity, or orientation, across a sheet of cells.) Dr. Griep's lab recently identified the gene *Disks large 1 (Dlg-1)* as a previously unknown PCP gene in the mouse, and also learned that it is a requirement for fiber cell structure and differentiation. Her group found that in the lens, *Dlg-1* interacts in unique ways with other known PCP genes to regulate the hexagonal shape of the fiber cells and signaling pathways that are required for fiber cell differentiation. Knowledge gained from these studies will contribute to the development of new strategies to prevent and treat cataracts and will enhance understanding of development and disease in other tissues and organs where PCP factors play a role.



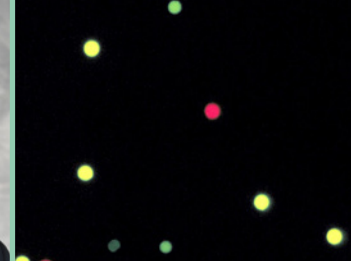
Robert W. Nickells, PhD

Ophthalmology and Visual Sciences
School of Medicine & Public Health

Professor Rob Nickells and his lab study the molecular and cellular events associated with the death of retinal ganglion cells after optic nerve damage. This is the principal feature of diseases like glaucoma, which is rapidly becoming the leading cause of blindness in the world. His group studies the process of ganglion cell death using mouse models, work that they helped pioneer in the field of glaucoma research nearly two decades ago. Because the genome of these animals can be manipulated more easily than any other mammal, involving them in studies means that the functions of a variety of different genes can be directly tested in the cell death process.

The greatest focus of the Nickells group has been on the function of a single gene that regulates a form of cell death called “intrinsic apoptosis.” Deletion of this gene, called *Bax*, allows ganglion cells to survive indefinitely after damage induced both acutely to the nerve using surgery, or in a mouse model of glaucoma. A caveat to this promising strategy is that ganglion cells also undergo certain changes early in the cell death program that leave them in suspended animation, whether or not they have a functional *Bax* gene. The Nickells lab affectionately calls these cells “zombies.” Additional studies have concentrated on understanding the molecular changes the cells undergo to become zombies. Promising results have been obtained by targeting enzymes that modify the genome of dying cells early in the apoptotic process.

The overarching goal of Dr. Nickells' research is to develop a way to specifically treat ganglion cells in glaucoma. This is paramount, since the only available treatment for this disease is to lower the intraocular pressure of an affected person. While effective for many, this treatment does not directly target the tissues that succumb to this disease, and for some, it is not enough to prevent continued vision loss. The Nickells lab hopes that combining pressure-lowering therapy with a strategy that directly protects ganglion cells will help preserve sight for all patients who have glaucoma.



T. Michael Nork, MD, MS

Ophthalmology and Visual Sciences
School of Medicine & Public Health

Dr. Michael Nork, a vitreoretinal surgeon also trained in ophthalmic pathology, is interested in how ocular disease affects the retina in terms of both its morphology (form) and its electrophysiology (function). His laboratory focuses on outer retinal changes—specifically alteration in the rods and cones—that occur in glaucoma. Studying observed injury to rods and cones, previously underappreciated in the scientific literature, the Nork laboratory has found cone swelling and electrical changes suggestive of ischemia (lack of oxygen) in an animal model of glaucoma. While interesting from a basic science standpoint, such outer retinal changes per se are not the reason people with glaucoma lose vision. Rather, glaucoma patients go blind because the ganglion cells, whose axons connect the retina with the brain, gradually degenerate over the course of years. Why this occurs is not well understood, and leading theories involve either mechanical deformation of the optic nerve head or poor vascular supply to the optic nerve. However, neither theory explains the outer retinal effects.

As part of the effort to better understand any potential relationship between rod and cone injury in glaucoma and ganglion cell death, Dr. Nork's lab has been studying a possible mechanism for this outer retinal injury—namely, decreased blood flow in the chorioid, the layer of blood vessels supplying the rods and cones. His lab has developed a method to study regional choroidal blood flow with non-recirculating fluorescent microspheres (shown in figure). Using animal models of glaucoma, the Nork group has established that elevated eye pressure greatly decreases choroidal blood flow and could explain the injury seen in the rods and cones. By manipulating choroidal blood flow pharmacologically, Dr. Nork hopes that it will be possible to show a link between choroidal blood flow, outer retinal ischemia, and ganglion cell loss in glaucoma. If this proves to be the case, drugs that increase choroidal blood flow may represent an exciting new approach to saving vision in those who experience this common eye disease.



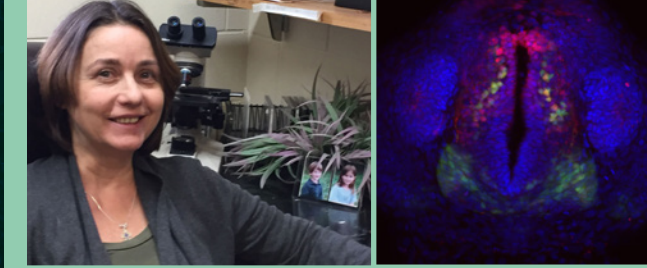
Julie Mares, MSPH, PhD

Ophthalmology and Visual Sciences
School of Medicine & Public Health

Professor Julie Mares and her team conduct research investigating nutrition and lifestyle in relation to risk for age-related cataract, macular degeneration, and diabetic retinopathy—providing evidence needed to develop strategies to prevent or slow these diseases. They have recently observed that people with a genetic predisposition for developing age-related macular degeneration (AMD) significantly reduced their odds of developing intermediate stages of this vision disorder if they smoked less than a pack a day for seven years, consistently ate a diet rich in fruits and vegetables, and exercised. Odds of developing AMD in those predisposed to this disease were also lowered if they maintained adequate blood levels of vitamin D. The overall findings suggest that one's genes, diet, lifestyles, and vitamin D levels all come together in a synergistic way to mediate the disease processes that promote AMD.

In collaboration with Dr. Max Snodderly at the University of Texas, Dr. Mares' primary research focus has been on the potential benefit of the yellowish dietary carotenoids, lutein and zeaxanthin, on eye health throughout the lifespan. In the coming year, in collaboration with Dr. Barbara Blodi (Ophthalmology & Visual Sciences), the Mares group will begin an NIH-funded project to provide the first epidemiological evidence to determine whether a low density of the dietary plant pigments (lutein and zeaxanthin) in the retina of the eye (macular pigment) predicts aging of the retina, development and progression of age-related macular degeneration, and loss of vision more than ten years later. In addition, they will evaluate whether aspects of diet, supplement use, lifestyle, health, and genetics help women maintain high macular pigment levels. This will be the longest-term large study of its type worldwide, and it will provide evidence as to whether a simple test to assess macular pigment identifies those who would benefit most from increasing macular pigment levels via healthy lifestyles or via taking supplements.

The Mares group is also studying whether receiving lutein as early as infancy might enhance its accumulation over our lifetimes, suggesting that dietary standards for levels of lutein and zeaxanthin needed for optimal vision might be set for breastfeeding mothers and individuals of all ages.



Yevgenya Grinblat, PhD

Department of Zoology
College of Letters and Science

Neural retina, the “heart” of the eye, begins life as an integral part of the brain. Soon after fertilization, the brain undergoes a remarkable transformation from a flat sheet of cells to a tube-like structure, termed the neural tube. At the same time, the two retinal primordia emerge from the front end of the neural tube, coming to lie on either side of it. These future retinæ remain connected to their place of origin via thin bridges called the optic stalks, precursors to the optic nerves that carry information from the eye back to the brain. The primordial retinæ and optic stalk cells then engage in complex interactions with the surrounding tissues; it is through these interactions that the intricate visual apparatus (the eye) and its essential supporting tissues (muscles, blood vessels, cartilage and bones) emerge. The details of these cellular “conversations,” essential to the correct formation of the visual system, are largely unknown.

Professor Grinblat and her research group aim to identify genes that control these interactions and to explain how these genes act at the cellular level to bring about normal eye development. Their studies are focused on an early key step in retinal development, formation of the choroid fissure at the border of the retina closest to the optic stalk. Failure of choroid fissure formation leads to retinal coloboma, a birth defect that causes significant visual impairment. Importantly, the choroid fissure develops in close contact with a unique cellular milieu that includes cells fated to become facial skeleton and vasculature, and cross-lineage interactions contribute to choroid fissure formation in ways that are very poorly understood. This gap in our knowledge is largely due to a paucity of animal models in which to dissect the process.

To address the gap, the Grinblat lab is using cutting-edge genome engineering techniques to establish the zebrafish *Zic2* mutant line as a genetic model of retinal coloboma. They will make full use of the extensive zebrafish researcher toolkit that includes genetics (*i.e.*, mutagenesis and transgenesis), high-resolution live microscopy, and small molecule discovery tools. This work will identify novel genetic mechanisms involved in eye morphogenesis, paving the way for pharmaceutical strategies to alleviate retinal coloboma.



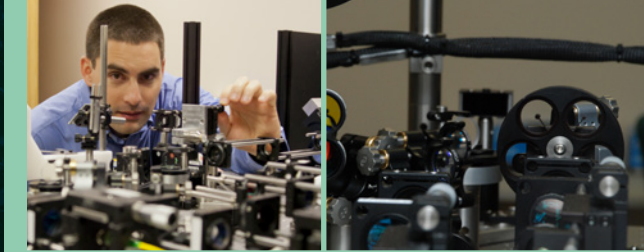
Kevin Ponto, PhD

Design Studies, School of Human Ecology; Living Environments Laboratory, Wisconsin Institute for Discovery

We often see examples of augmented reality (the not-really-there yardage lines on televised football games), and we know of virtual reality through gaming and media such as *Star Trek*. Assistant Professor Kevin Ponto works with both forms of simulated environments, with the aim of developing methods to better the experience through new devices, interfaces, and techniques. Potential real-world applications for these methods are vast: training first responders and military personnel; enhancing the work of surgeons and physicians; advancing criminal justice; augmenting physical rehabilitation; or studying human behavior.

The Living Environments Laboratory in the Wisconsin Institute for Discovery is the center of Dr. Ponto's research. Its six-sided virtual reality (VR) setting, the CAVE, allows for startlingly realistic representations of real or created environments. Here Ponto has compared and contrasted user performances in physical and virtual environments, finding numerous differences. Most notably, users do not react to virtual reality or the VR environment in the same way. Ponto has theorized that some of these discrepancies come from the one-size-fits-all design of virtual reality systems. His research aims to tailor virtual reality to individuals and significantly improve its effectiveness – first by creating methods for external observers to study experiences of VR-immersed individuals, then by designing methods of interaction calibrated to individual users, and finally by tailoring the entire virtual environment to those users' perceptions.

An important part of optimizing the virtual reality experience for all is to simplify user interfaces. Ponto's lab aims to create more natural methods of interface than the often-awkward controllers and VR wands currently available. More intuitive controls using speech or kinesthetic motion could allow for more effective interactions, increasing the range of tasks that could be undertaken and experiences that could be shared. Dr. Ponto's work represents the beginnings for a new immersive interactive medium such as TV, radio, and film were to prior generations—enabling new methods of storytelling and providing the framework for users to have previously inaccessible experiences, such as being in the middle of a sporting event, under the ocean, deep in space, or even back in time.



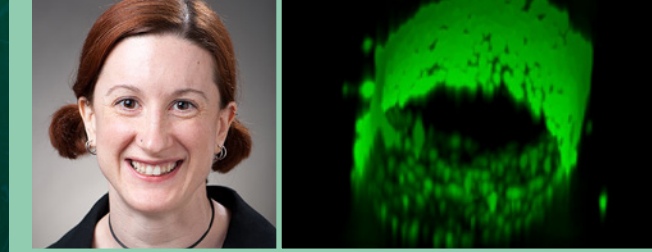
Alfredo Dubra, PhD

Ophthalmology; Biophysics; Cell Biology, Neurobiology & Anatomy
Medical College of Wisconsin

Within the Advanced Ocular Imaging Program at the Medical College of Wisconsin, co-directors and professors Alfredo Dubra and Joe Carroll focus on the development of novel technologies for ophthalmic imaging for advancing the understanding of eye disease, as well as accelerating and improving the evaluation of novel therapies. This requires using a highly interdisciplinary team with expertise in optical engineering, vision science, adaptive optics, computer science and computer engineering among other disciplines. Dr. Dubra's work on ophthalmic adaptive optics instrumentation led to the non-invasive visualization of various microscopic retinal structures in the living eye, including the rod photoreceptor outer segment mosaic and the inner segment cone photoreceptor mosaic, capillary structure and perfusion and numerous pathological hyper-reflective structures.

In order to maximize the benefit of the technology and expertise generated in the group, the adaptive optics team is engaged in various long-term dissemination efforts with national and international research institutions. One of these efforts was recently recognized through one of the first Audacious Goals Initiative grants from the National Eye Institute. This project will advance major technological strides on adaptive optics ophthalmoscopes built at research institutions including the Medical College of Wisconsin, the University of Pennsylvania, University College London & Moorfields Eye Hospital, the New York Eye and Ear Infirmary, and Stanford University. One of the most exciting aspects of this team project is that all of the proposed technologies—such as advanced eye motion compensation and chromatic aberration correction—will be put to immediate use in photoreceptor gene therapy and neuroprotective clinical trials.

Dr. Dubra is also part of the Catalyst for a Cure Biomarkers Team supported by the Glaucoma Research Foundation, a collaborative group aiming to identify novel glaucoma biomarkers for early diagnosis and treatment monitoring.



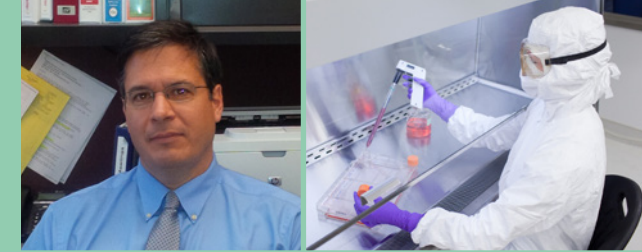
Kristyn S. Masters, PhD

Biomedical Engineering
College of Engineering

The research group of Kristyn S. Masters in the Department of Biomedical Engineering is interested in creating 3-dimensional in vitro models of various diseases (*i.e.*, “disease-in-a-dish”). In contrast to the usual goal of tissue engineering, which is to generate healthy tissues that may be used to repair or replace diseased tissues in a patient, Dr. Masters aims to generate engineered tissues that intentionally display disease characteristics. In creating such disease models, Dr. Masters has three goals: to elucidate the causes of various diseases; to understand why some patients are responsive to current treatments while others are not; and to identify new cellular and molecular events that may be targeted to prevent disease progression.

Research in the Masters Lab has generally focused upon cardiovascular diseases, specifically heart valve calcification. However, in recent years, Dr. Masters has been extending her tissue engineering-based disease research approach to investigate conditions related to abnormal growth of new blood vessels, or “pathological angiogenesis.” Pathological angiogenesis plays a significant role in numerous eye diseases, including age-related macular degeneration (AMD), which affects more than 30 million people worldwide. In late-stage, or ‘wet,’ AMD, new vessels sprout from the existing microvasculature in the choroid layer of the retina, and these abnormal vessels leak fluid that damages the retina and causes acute vision loss.

Currently the Masters group is creating 3-D tissue-engineered models of the retinal environment in order to understand how different cells in the retina communicate with each other to regulate angiogenesis and to investigate how other microenvironmental features (*e.g.*, the composition of the extracellular matrix that surrounds the cells) affect this process. In collaboration with Aparna Lakkaraju (Ophthalmology) and Pamela Kreeger (Biomedical Engineering), the ultimate goal of this work is to merge both experimental and computational approaches not only to better understand the process of AMD, but also to identify new therapeutic targets for improved AMD treatment.



Derek J. Hei, PhD

Director, Waisman Biomanufacturing
Waisman Center

Dr. Derek Hei is the Director of Waisman Biomanufacturing (WB), a specialized facility designed to manufacture cell and gene therapeutics for early-stage human clinical trials in compliance with the FDA's current Good Manufacturing Practice (cGMP) guidelines. This state-of-the-art cleanroom facility is located at the Waisman Center. WB works with academic investigators to develop manufacturing processes and quality control methods and to provide overall product development and regulatory support that is critical to advancing novel biotherapeutics into human clinical trials. Waisman Biomanufacturing is capable of supporting the development of a wide range of biotherapeutics including gene therapeutics, cell therapeutics, vaccines, and recombinant proteins. This range of capabilities allows the facility to support research groups that are involved in developing complex, multi-component projects such as engineered stem cells.

WB recently initiated a collaborative project with Dr. David Gamm to develop a new cell therapy that may be used to treat retinal degenerative diseases. Using a differentiation process that was developed by the Gamm Lab, WB has produced cGMP-compliant induced pluripotent stem cells (iPSCs) that are differentiated into neural retinal progenitor cells and photoreceptor precursors. The team is currently working to optimize a manufacturing process and Quality Control test methods for iPSC-photoreceptor manufacturing to support future human clinical trials.

As principal investigator for the NIH-funded PACT (Product Assistance for Cellular Therapy) Program, Dr. Hei leads a team that provides comprehensive support for cell therapy development including therapeutics derived from human embryonic/pluripotent stem cells and adult mesenchymal stem cells. Waisman Biomanufacturing coordinates efforts with select researchers and clinicians to advance the use of these cGMP cell banks for clinical applications, with a focus on the use of stem cells for treating heart, lung, and blood conditions or diseases.

ENDOWED PROFESSORSHIPS AND CHAIRS AT THE MCPHERSON EYE RESEARCH INSTITUTE



David M. Gamm, MD, PhD

Director, McPherson Eye Research Institute

Retina Research Foundation Emmett A. Humble Distinguished Directorship

Modeling and Treating Retinal Disease with Human Induced Pluripotent Stem Cells (hiPSCs)

Sandra Lemke Trout Chair in Eye Research

Applications of stem cell technology to the study and treatment of age-related macular degeneration



Akihiro Ikeda, DVM, PhD

Associate Director, McPherson Eye Research Institute

Retina Research Foundation Walter H. Helmerich Research Chair

Identification of Genetic Factors Affecting Aging of the Retina



Christine M. Sorenson, PhD

Retina Research Foundation Daniel M. Albert Chair

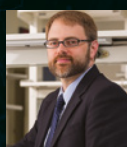
Apoptosis in Retinal Vascular Development and Disease



Arthur S. Polans, PhD

Retina Research Foundation Kathryn and Latimer Murfee Chair

New Agents for the Treatment of Ocular Tumors and Neovascular Diseases of the Eye



Jeremy Rogers, PhD

Retina Research Foundation Edwin and Dorothy Gamewell Professor

Optical Instrumentation and Technology Platforms for the Study and Screening of Retinal Disease



Nansi J. Colley, PhD

Retina Research Foundation M. D. Matthews Research Professor

Molecular Genetic Studies of Retinal Degeneration in Drosophila



Aparna Lakkaraju, PhD

Retina Research Foundation Rebecca Meyer Brown Professor

Insight into the Cellular Basis of Retinal Degenerative Diseases

WITH GRATITUDE TO ...



Alice R. McPherson, MD

Founder, President, and Scientific Director

Retina Research Foundation



Dr. Monroe Trout and Sandra Trout

McPherson ERI Visionaries

Sandra Lemke Trout Chair in Eye Research

Monroe & Sandra Trout Director's Fund for Vision Research

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MANDELBAUM & ALBERT FAMILY VISION GALLERY

— SHOWCASING CONNECTIONS BETWEEN ART AND VISION



Opening reception



Harvey A. Stevens International Collection, Waisman Center



Retina Research Foundation Board

SEEING BEYOND DISABILITIES: UNIQUE INSIGHTS

January - May 2015

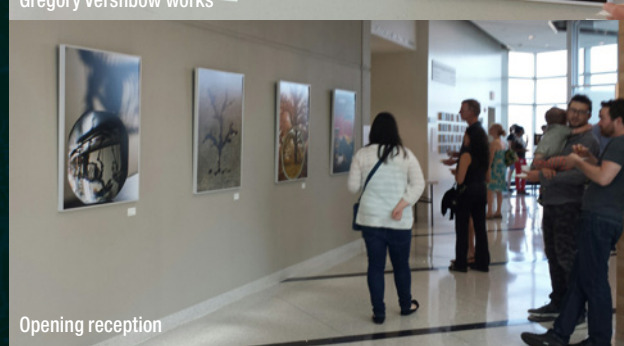
In partnership with the UW Waisman Center, VSA Wisconsin, and ArtWorking



Angela Johnson with students



Gregory Vershbow works



Opening reception

BETWEEN THE IMAGINED & THE OBSERVED

June - August 2015

Paired photographic perspectives by UW Art Department artists — Gregory Vershbow: *Strange Specimens*; Angela Johnson: *Translation*



2015 COOL SCIENCE IMAGE COMPETITION

September - December 2015

In partnership with UW Communications' *The Why Files*



SIGN UP NOW FOR CYCLE FOR SIGHT 2016
SATURDAY, MARCH 12TH, 2016!



CYCLE FOR SIGHT

Our annual indoor cycling fundraiser took place in March 2015 at three locations – two Rec Sports facilities on the UW-Madison campus (the Nat and the SERF), and Madison's west side Princeton Club. (For an added bonus, friends of the McPherson ERI hopped on some bikes in Kuala Lumpur!) Almost 200 riders had a great workout while raising funds for vision research at the Institute. Sincere thanks to all of our participants and supporters and to our major donors – Cellular Dynamics International, the Shopko Foundation, and the Princeton Club.

Visit cycleforsight.wisc.edu for further information.



3RD ANNUAL MCPHERSON ERI ENDOWED LECTURE

held MAY 18, 2015



DR. SHEILA NIRENBERG

Weill Medical College, Cornell University

Professor Nirenberg shared her ground breaking work in her lecture – *Talking to the Brain in Its Own Language: Developing New Kinds of Prosthetic Devices*. A MacArthur Foundation “Genius” Fellow, Nirenberg has discerned the neural code by which visual information captured by photoreceptor cells is converted to a pattern of electrical impulses in the brain, allowing us to “see.” She is developing a computerized eyeglass prosthetic that transmits coded information via the retinal ganglion cells to the brain, bypassing damaged photoreceptors. In early phases of clinical trials, this new strategy holds remarkable promise for treating blindness.

NEXT SPRING - 4TH ANNUAL LECTURE
APRIL 28, 2016 - DR. PAWAN SINHA

JULY 1, 2014 – NOVEMBER 1, 2015

- | | | | |
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For more information on how to partner with the McPherson Eye Research Institute in support of research, education and treatment advances in the visual sciences, please contact us.

T (608) 265-4023

E info@vision.wisc.edu

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