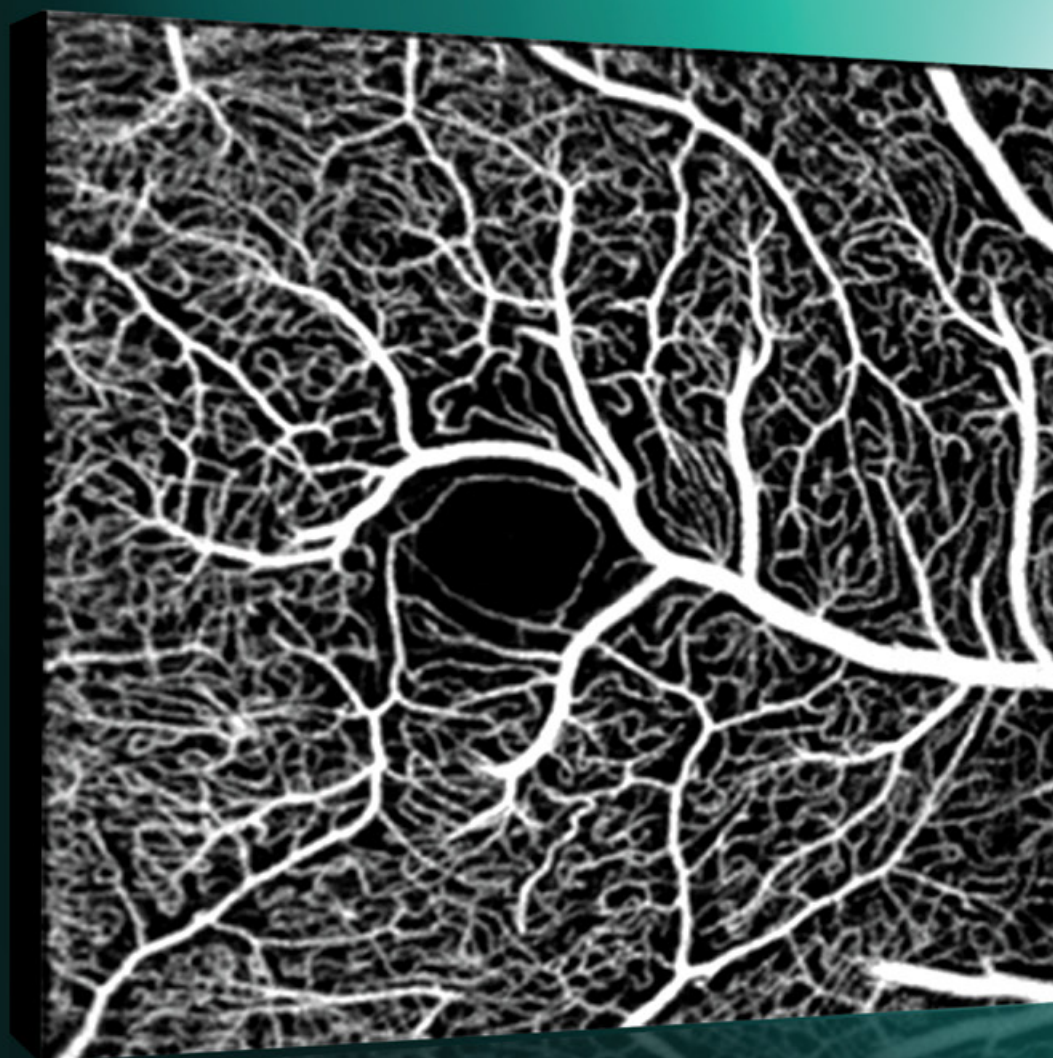


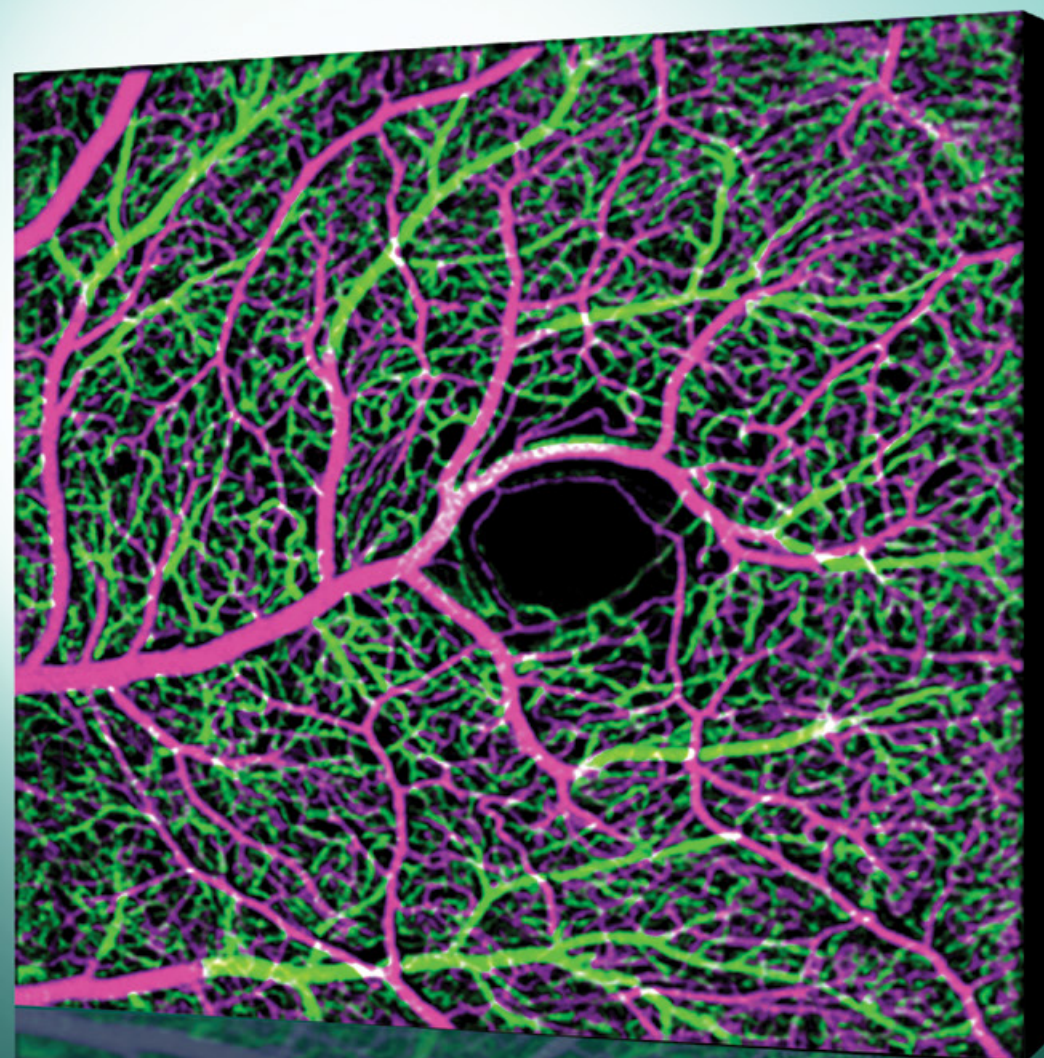
MCPHERSON EYE RESEARCH INSTITUTE
2017 ANNUAL REPORT
2018 CALENDAR





i In these 3D optical coherence tomography angiography (OCTA) images from a patient born with an abnormally large retinal blood vessel, a “macrovessel” can be seen coursing just above the central black area that normally lacks blood vessels (the “foveal avascular zone”).

The left OCTA image is of the most superficial retinal blood vessels, while the right image incorporates the deeper retinal vessels. By artificially coloring the superficial (pink) and deep (green) blood vessels, one can get a better sense of the complexity of the blood supply to the retina. Joseph Carroll, professor in ophthalmology and Director of the Advanced Ocular Imaging Program at the Medical College of Wisconsin, uses this and other high-resolution imaging tools to study the human retina.



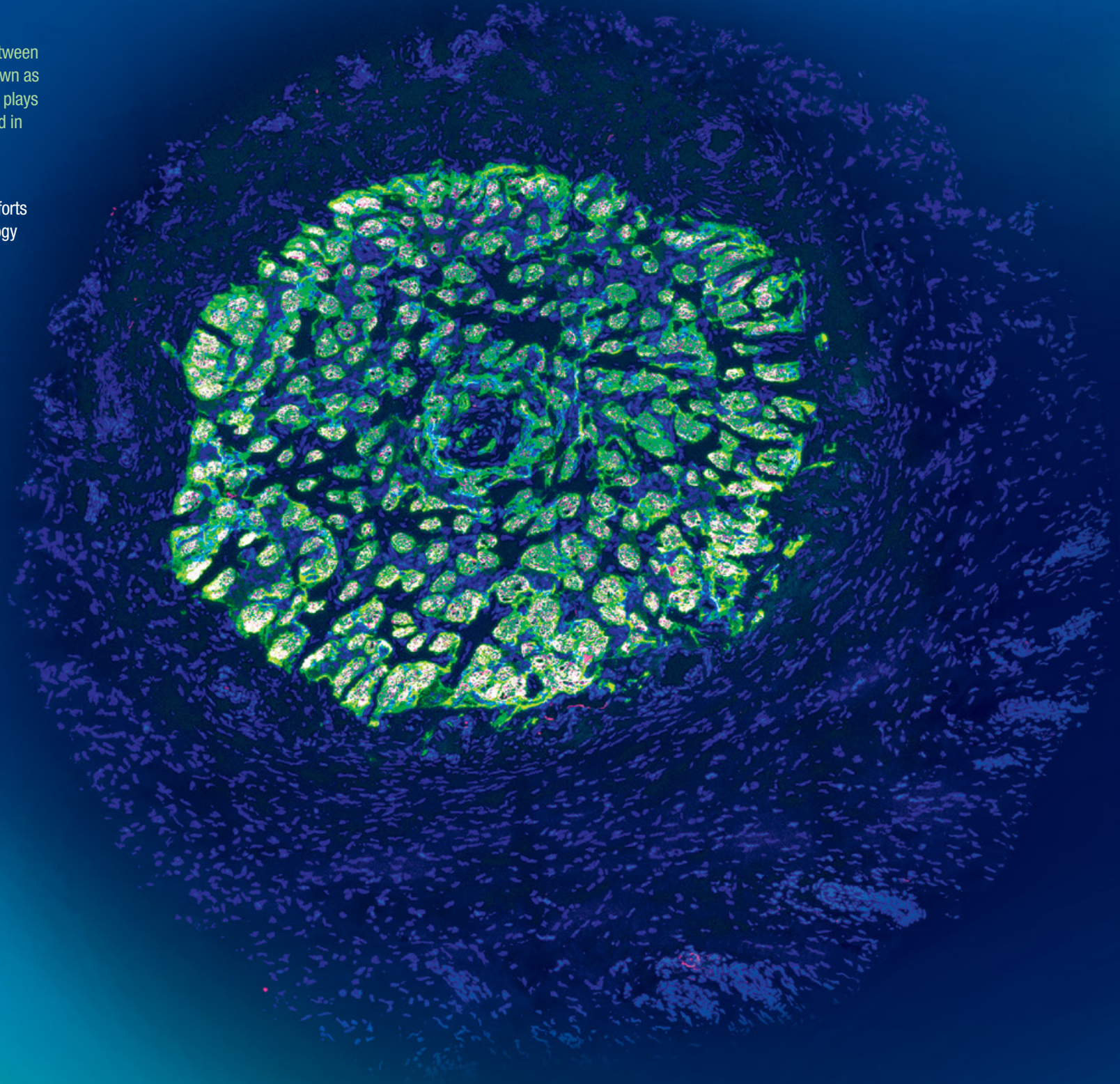
i The CRISPR-Cas9 gene editing

system allows researchers to turn almost any gene on or off or adjust its level of activity, in any organism. It has broad implications for genetically modifying plants and animals, reducing human diseases and cancers, and creating biofuels.

This artistic rendering of CRISPR-Cas9 tracks the gene editing process across three images: left, Cas9 protein and its guide RNA; center, Cas9 protein bound to its guide RNA; right, Cas9 protein with guide RNA and target DNA.

i This image highlights the intimate relationship between nerve fibers (pink) and nervous system supporting cells known as astrocytes (green) in the optic nerve. Their close association plays a critical role in maintaining the health of the optic nerve and in its response to blinding diseases such as glaucoma.

Understanding cellular and molecular relationships between these cells in glaucoma is the focus of research efforts by Assistant Professor Gillian McLellan and her Ophthalmology and Visual Sciences lab.





i The research group of **Mikhail Kats**, assistant professor in Electrical & Computer Engineering, is developing optical filters designed to enhance human color vision.

The lenses in this photo are part of an experiment in which pairs of different spectra that appear as the same color (“metamers”) are generated, and then distinguished by using optical filters. The researchers posit that if a set of complementary filters are worn as glasses, one per eye, more spectral information becomes available to the wearer.

A darkfield microscopy image of a mouse retina section. The image shows a large, circular, multi-layered structure with a bright, textured outer ring and a darker, more uniform inner core. The layers are separated by distinct, darker lines, giving it a concentric, onion-like appearance. The background is dark and speckled with small, bright particles.

i Jeremy Rogers, assistant professor

in Biomedical Engineering, develops optical instrumentation and imaging methods for the quantitative study of cells and tissues. This darkfield microscopy view of an oblique section of mouse retina shows retinal layers analogous to the tissue-like layers of an onion when sliced near the very edge.

In darkfield imaging, illumination is from the side and only scattered light is collected by the microscope, so the bright zones correspond to high scattering and dark zones correspond to low scattering. With quantitative measurements of light scattering in the retina, computational models can be used to devise and optimize new imaging contrast mechanisms to assess retinal cell health and improve interpretation of existing clinical imaging modalities.

i Dr. Terri Young's Ophthalmology and Visual Sciences lab utilizes whole genome sequencing technology to identify the novel molecular causes of inherited eye diseases such as high myopia and primary congenital glaucoma. The technology supplies a list of an individual's genome variants – approximately 4.5 million of them! Lab members then set out to discover which one or two of these variants are causing the disease in each patient.

This image, created using Circos software, illustrates an individual's genome variation. Starting from the outside, the rings represent the chromosomes, sequencing coverage, density of small insertions/deletions, density of small sequence changes, ratio of identical or different sites between chromosome pairs, decreases or increases in size of repeat regions, and large structural variants located within genes (translocations, insertions, deletions, duplications, and inversions).





Adam L. Kern, professor in the Department of Asian Languages and Cultures, probes the relationship between word and images in Japan.

His forthcoming *Penguin Book of Haiku* (Penguin Classics), which sports this image as its cover, contains many “haiku pictures” (*haiga*) whose artistry derives not only from the content of haiku poems—but also from how the calligraphic rendering of the written words of those poems interact with images. Elsewhere, Kern argues that visual-verbal storytelling of this sort, more than pure literature or pure art, has actually been central to Japanese cultural production for a millennium, as witnessed by the more recent popularity of Japanese comics (*manga*).



i The colors we perceive are not an objective property of the world. Fixating on the cross on the image on the left (for 15-20 seconds) and then shifting focus to the image on the right will reveal it to be in vivid color.

Recent work by Gary Lupyan, associate professor of Psychology, has shown that the colors people perceive in such illusions are not—as long thought—solely attributable to retinal adaptation. Rather, they also reflect semantic knowledge. Afterimages are more vivid for landscape scenes like the one above or for objects with diagnostic colors such as a pumpkin compared to arbitrarily colored objects like a pumpkin-colored car.

 Image in public domain, used in Lupyan, G. (2015). Object knowledge changes visual appearance: Semantic effects on color afterimages. *Acta Psychologica*. 161.

A northern leopard frog is partially submerged in murky marshland water, its head and eyes visible above the surface. The water is covered with a dense layer of bright green duckweed, which provides excellent camouflage for the frog. The frog's skin is dark with light-colored spots and blotches, and its large, prominent eyes are clearly visible.

i This image of a rare northern leopard frog, camouflaged in murky marshland water along the Mississippi River in Trempealeau National Wildlife Refuge, was among the winning entries in the annual “Cool Science Images Contest” held by UW Communications and displayed in the McPherson ERI’s Mandelbaum & Albert Family Vision Gallery.

Sighted infrequently, this once-common frog has been in sharp decline in Wisconsin since the 1970s—yet previously it was among the most abundant frog species in the Great Lakes region. Population regression is attributed to loss of wetland habitat, use as fishing bait and in biology classrooms for dissection, and sensitivity to chemical pollutants in air, soil, and water.

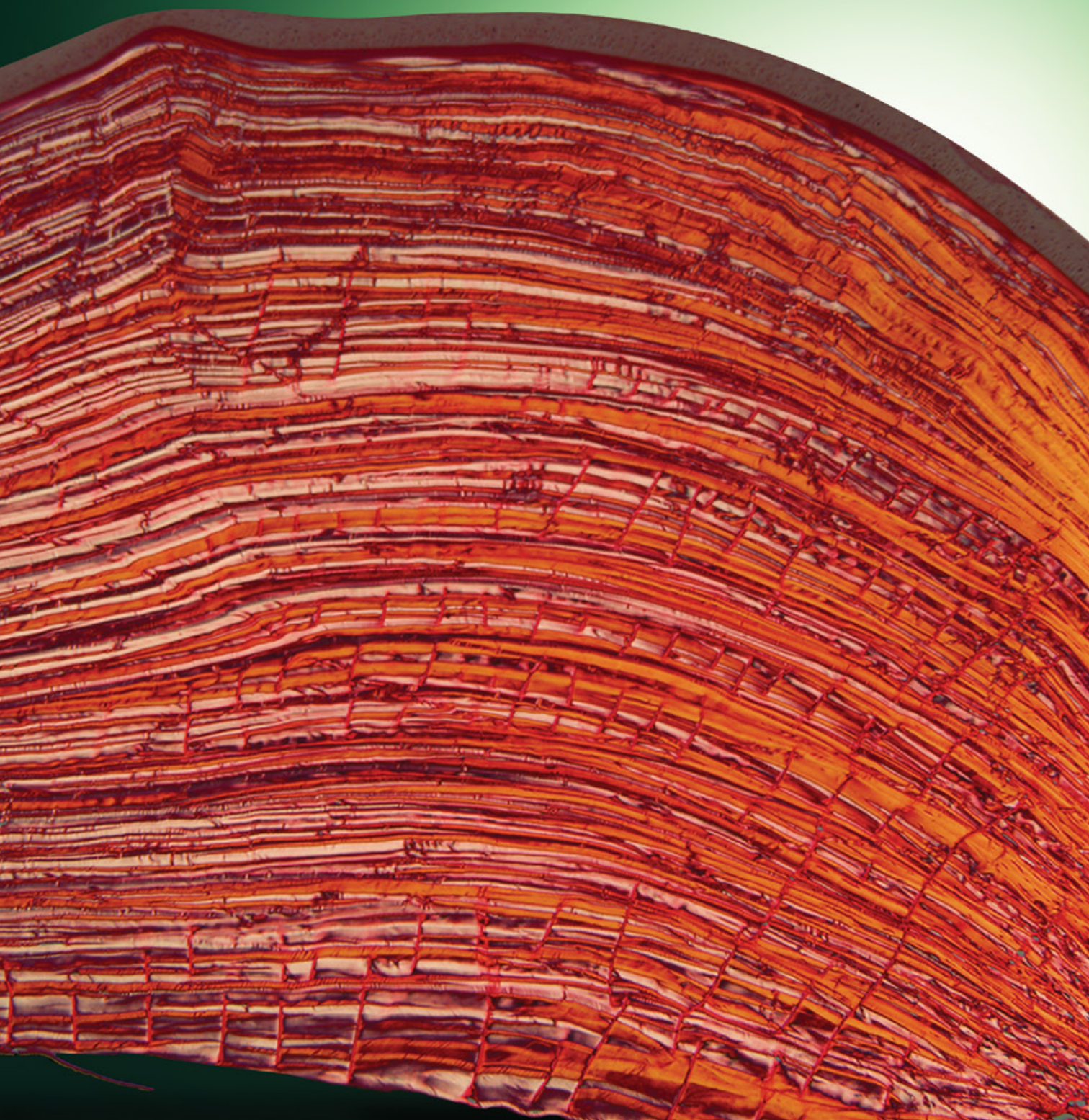
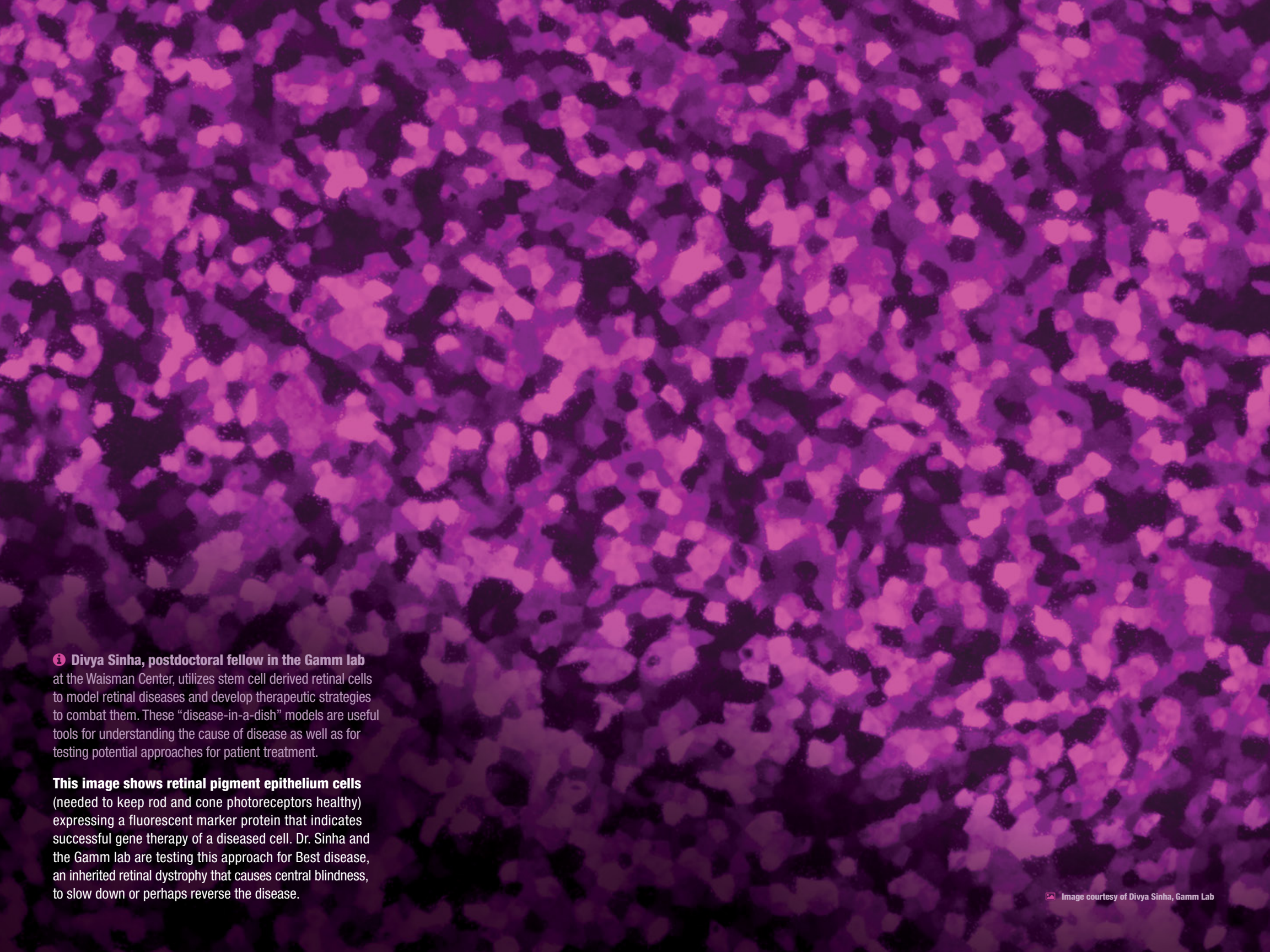


 Photo courtesy of Dick Dubielzig

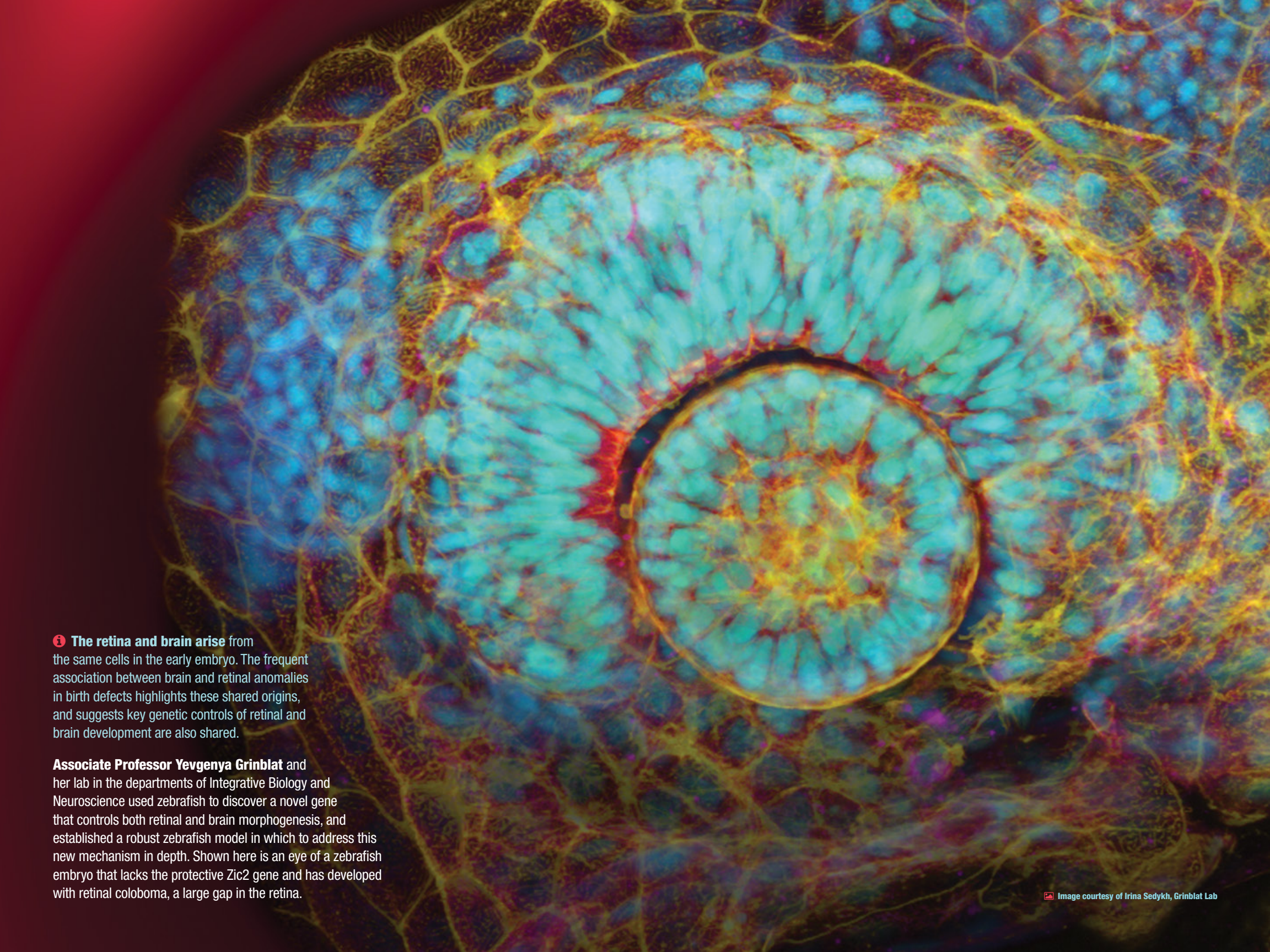
i Stained with **picosirius red** and viewed with polarized light—a technique that facilitates study of collagen networks in different tissues—this image of a whale cornea makes collagen, the main protein of the cornea, appear as if it were fluorescent. Typical of any cornea, it is formed of distinct layers, a feature that is important in both transparency and maintenance of shape.

Veterinary ocular pathologist Dick Dubielzig, emeritus professor in Pathobiological Sciences, has amassed a unique collection of ocular specimens and images that provides an unmatched resource for the study of comparative ophthalmology.



i Divya Sinha, postdoctoral fellow in the Gamm lab at the Waisman Center, utilizes stem cell derived retinal cells to model retinal diseases and develop therapeutic strategies to combat them. These “disease-in-a-dish” models are useful tools for understanding the cause of disease as well as for testing potential approaches for patient treatment.

This image shows retinal pigment epithelium cells (needed to keep rod and cone photoreceptors healthy) expressing a fluorescent marker protein that indicates successful gene therapy of a diseased cell. Dr. Sinha and the Gamm lab are testing this approach for Best disease, an inherited retinal dystrophy that causes central blindness, to slow down or perhaps reverse the disease.

A fluorescence micrograph of a zebrafish eye. The image shows a complex network of cells and fibers. A large, circular gap in the retina is visible, which is the retinal coloboma. The surrounding tissue is stained with various fluorescent dyes, showing a mix of blue, green, and red colors. The gap is a dark, irregular shape in the center of the eye.

i The retina and brain arise from the same cells in the early embryo. The frequent association between brain and retinal anomalies in birth defects highlights these shared origins, and suggests key genetic controls of retinal and brain development are also shared.

Associate Professor Yevgenya Grinblat and her lab in the departments of Integrative Biology and Neuroscience used zebrafish to discover a novel gene that controls both retinal and brain morphogenesis, and established a robust zebrafish model in which to address this new mechanism in depth. Shown here is an eye of a zebrafish embryo that lacks the protective *Zic2* gene and has developed with retinal coloboma, a large gap in the retina.

MISSION STATEMENT:

The McPherson Eye Research Institute is a multidisciplinary community of scholars working to gain critical knowledge about the science and art of vision and apply it to the prevention of blindness.

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.

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