Seeing Progress

The investigative fight for sight

Studying the intricate mechanics of sight is something that Andrew Goldberg, Ph.D., does with impassioned curiosity and drive, within the inspirational environment of Oakland University's Eye Research Institute (ERI).

Andrew Goldberg, Ph.D.

Founded nearly 50 years ago, the internationally recognized ERI promotes the University's teaching goals and research on the underlying causes of eye diseases that result in loss of vision and blindness. The ERI promotes collaboration between Oakland faculty, research associates, post-doctoral fellows, affiliated clinical faculty and students.

Eye detectives

The "wide-eyed apprentices" most encourage Dr. Goldberg, a researcher, teacher, mentor and author.

"It's rewarding to work with these incredible OU students who bring unbridled excitement to the research," said Dr. Goldberg, associate professor of Biomedical Sciences and principal investigator of the ERI's Goldberg Laboratory.

"To bring scientific knowledge back to our communities, students must learn by doing," he continued. "The ERI labs are the perfect environment for this. The training prepares them for placement in nationally competitive graduate and professional programs and for successful careers in science and medicine."

Millions need the efforts of these dedicated eye detectives. About 50,000 Americans lose their eyesight every year.

Retinal 'repair manuals'

"There's often a gap between science and medicine," Dr. Goldberg said. "For physicians encountering complex eye conditions in their practices, it's a bit like me landing on another planet and encountering a machine that needs to be fixed. Without a thorough understanding of how the machine works or a repair manual, it requires a lot of guesswork. Researchers continually work on developing those much-needed retinal 'repair manuals.' "

Dr. Goldberg's specialty is defining the eye's tiniest structures and how they work together.

"The retina is like the light-sensitive chip in a digital camera," he explained. "It contains a layer of photoreceptor cells that convert photons into electric impulses interpreted as images by the brain. When they're functioning well, the images are clear. When they're not, vision becomes fuzzy. Unfortunately, photoreceptors are easily damaged by disease and not easily repaired."

Protein stabilizing shell

For 15 years, Dr. Goldberg has been tackling questions related to dysfunction in the eye's retinal photoreceptor cells, studying the outer segment structure of these photoreceptors. He hones in on how the "pancake-like" stack of disks within the outer segments is created — and how genetic diseases sometimes disrupt it.

Dr. Goldberg's research focuses on peripherin/rds, an eye protein essential for organizing the disk membrane structure.

"We've discovered that the peripherin/rds protein forms a stabilizing shell around the periphery of the photoreceptor disk membranes," Dr. Goldberg said. "Membranes like being flat, so a specialized protein like peripherin/rds is needed to shape them for their biological function. We've discovered that large aggregates of this protein interact with lipids to mold and hold the membranes in place to create the flattened pancake structures."

Significant NIH grants

He recently distilled more than two decades of experience into a book chapter, "Molecular basis for photoreceptor outer segment architecture," in *Progress in Retinal and Eye Research*.

"It's not about just one discovery or research paper," Dr. Goldberg said. "It's about the combined contributions of multiple labs and multiple lab contributors around the world to reach a point of critical mass. That's what moves human understanding forward."

External grants are vital for accomplishing this goal. To further his current research, Dr. Goldberg was recently awarded a $1.5 million, four-year grant from the National Institutes of Health's (NIH) National Eye Institute, one of five grants he has received from the NIH since 1999.

His next step of research will be to investigate how inherited defects in peripherin/rds cause disease. Dr. Goldberg suspects that these defects prevent the protein from creating and/or maintaining the stack of disk membranes needed for vision, perhaps by impairing the protein's ability to bend membranes.

By Mary Gunderson-Switzer, a freelance writer from Kathleen, Georgia.

"Every now and then, you are privy to one of nature's hidden secrets — something that nobody else on the entire planet knows. Those are privileged moments, and it's so rewarding to share them with our students."

Dr. Goldberg with undergraduate student Adam Seidel and Lab Manager/Research Assistant Breyanna Cavanaugh, M.S.

Andrew Goldberg, Ph.D., associate professor, Biomedical Sciences

Dr. Goldberg is an expert in the area of vertebrate photoreceptor structure. His laboratory studies the elaborate cellular architecture of retinal photoreceptors — the rods and cones — to understand their fundamental biology, and the cellular and molecular underpinnings for several forms of clinically significant inherited and acquired eye diseases. His research has been funded by the National Science Foundation, The Grass Foundation, National Eye Institute, E. Matilda Zeigler Foundation, Research Excellence Fund (OU) and Mid-West Eyebanks (now Eversight). His scientific collaborations extend coast-to-coast and internationally. Dr. Goldberg frequently serves as a manuscript and grant reviewer, including as a member of NIH study sections. On campus, his research-related activities include having served on and chaired the OU Institutional Biosafety Committee.

"Molecular basis for photoreceptor outer segment architecture." Goldberg AFX, Moritz OL, Williams DS. Prog. *Retina*. Eye Res. 2016, in press DOI: 10.1016/j.preteyeres.2016.05.003