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FALL/WINTER 2023

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Letter From the Chair



Donald L. Budenz, MD, MPH
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Professor and Chair
UNC Department of Ophthalmology

12-YEAR GROWTH*
**PATIENT
CARE**

Outpatient Visits

54%

OR Procedures

103%

*2011 – 2023

Dear Friends, Alumni and Patients of UNC Ophthalmology,

Translational research is the term used for research designed to translate basic science findings into clinically useful therapies. The Carolina Eye Research Institute (CERI) is a translational research center designed and devoted to bringing UNC Department of Ophthalmology laboratory discoveries in ocular disease into the clinic to improve patient care.

CERI is focused primarily on gene therapy and stem cell research for a variety of ocular diseases, including corneal disease, retinal disease, glaucoma, ocular inflammation and ocular cancers. Housed in UNC's Neuroscience Research Building, CERI is home to six laboratories where Principal Investigators, postdoctoral fellows, graduate students and technicians conduct their respective ocular disease studies. Concurrent with our laboratory work, our clinical researchers perform epidemiology studies and clinical trials to elucidate the magnitude and risk factors for eye disease and apply translational treatments.

UNC-Chapel Hill is a wonderful cross-disciplinary, collaborative environment for investigators. All research that UNC Ophthalmology investigators pursue is designed to improve patient care, just as our educational and clinical missions do. Our investigators routinely work with research colleagues in other University schools (eg, UNC Gillings School of Global Public Health, UNC Eshelman School of Pharmacy), UNC School of Medicine departments and centers (eg, Departments of Physiology and Cell Biology, Microbiology, Radiology, Lineberger Comprehensive Cancer Center) and other top-tier research universities (eg, North Carolina State University, Duke University, University of Miami). In this issue of UNC Eye, you will learn about new therapies that are working in animal models to prevent corneal transplant rejection and corneal scarring, eradicate ocular tumor cells, treat macular degeneration and novel nanoparticle applications to treat inherited retinal disease.

Although much of our research is grant-funded, many of our grateful patients donate to our research program to accelerate this important research.

Visit the UNC Department of Ophthalmology website and our "Research" pages to learn more about our basic scientists and clinical researchers, as well as our investigative programs and clinical trials.

Donald L. Budenz, MD, MPH
Kittner Family Distinguished Professor
Chair, UNC Department of Ophthalmology

Carolina Eye Research Institute

*Cross-Disciplinary Collaboration,
Ocular Gene Therapy & Drug Development*



**Jean-Claude Mwanza,
MD, MPH, PhD**
Research Professor

It is a pleasure to introduce the Carolina Eye Research Institute (CERI) and highlight its mission to the University community, North Carolinians and others. Founded in 2015, the CERI advances basic and translational research specific to vision. It enables exceptionally skilled researchers to collaborate across UNC School of Medicine centers and complementary research programs to translate fundamental discoveries in vision into treatments. All CERI members vitally contribute to our ongoing success. The CERI's strength may be best reflected, however, by highlighting UNC Ophthalmology faculty scientists who advance its mission.

Dr. Zongchao Han is a biomaterials-mediated ocular gene and drug therapy authority. His cutting-edge, cross-disciplinary studies using innovative therapeutic strategies and nanoparticulate drug delivery systems utilize viral and non-viral vectors to overcome current limitations in ocular gene and drug delivery to host tissues. Dr. Han's lab successes may translate to future treatment of chronic ocular diseases like hereditary retinal diseases, age-related macular degeneration, diabetic retinopathy and ocular tumors.

Stem cell markers and cell/tissue regeneration expert Dr. Hua Mei is dedicated to developing novel drugs for corneal and anterior segment diseases, including limbal stem cell deficiency, corneal neovascularization, corneal scar and dry eye disease. Her promising drug discoveries could reduce corneal scar formation after wounding in

experimental models and achieve the first FDA-approved drug to treat corneal injuries from trauma, surgeries and linked diseases. Dr. Mei's lab is also working toward a therapeutic solution to ease dry eye disease symptoms via stimulating both aqueous tear and tear film secretions.

Dr. Jaquelyn Bower's use of Adeno-Associated Virus (AAV) vectors in gene delivery bolsters hopes for novel translational solutions that one day treat uveal melanoma, an aggressive type of ocular cancer. Through exploiting unique molecular and cellular defects in uveal melanoma, Dr. Bower has produced a lead candidate and a highly promising breakthrough therapeutic drug currently in pre-clinical testing.

Ocular gene therapy expert Dr. Matt Hirsch has brought fundamental change to developing single-dose treatments for genetic and acquired ocular diseases. His lab elucidated the biology and optimized delivery parameters for identifying the most promising ocular gene delivery vehicle to date—AAV-based vectors. Dr. Hirsch's lab has applied AAV-based therapeutics to genetic corneal diseases in animal models. He also leads development of an immune modulation approach to prevent corneal transplant rejection and is developing intra-ocular AAV-based therapeutics for equine and human uveitis.

Well-executed, innovative studies demonstrate the CERI's capacity for attracting private and federal/nonprofit foundation funding. Patents and licensing ensure our investigators can exclusively test methods and therapeutic applications. The generous UNC Ophthalmology donors who support the CERI's work and mission are perhaps the clearest indication that our work will continue to develop innovative therapies to fill unmet needs worldwide for a wide range of eye diseases.

Hua Mei:

Stem Cell Drug Discovery in Treating Corneal and Anterior Segment Disease



Carolina Eye Research Institute (CERI) Mei Lab: Mei (L) and lab member (R)

Over five+ years at UNC, Ophthalmology Assistant Professor of Research Hua Mei, PhD, has brought wet lab capacity a step closer to fostering translational treatment of corneal and anterior segment diseases. Her laboratory’s translational framework is leading the way in developing the first FDA-approved, anti-fibrotic drug therapy to treat and prevent injury-induced corneal scarring, a leading cause of blindness that affects five+ million people worldwide.

Dr. Mei noted: “Eye specialists can only mitigate damage to eyesight from corneal wounding through removing foreign bodies, providing eye patches, controlling root-cause diseases and treating infections with topical antibiotics and analgesics. An on-market, anti-fibrotic drug therapy would enable those affected

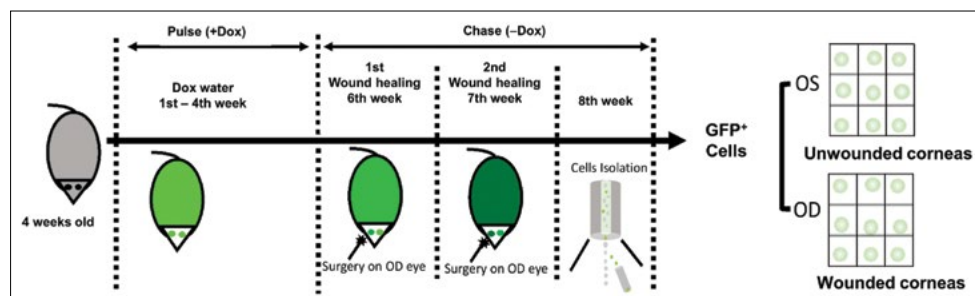
to prevent or reduce corneal scar formation through boosting re-epithelialization in a wounded cornea.”

Dr. Mei’s investigative path in corneal scarring drug discovery began by using single-cell RNA sequencing to identify two distinctive populations of limbal stem cells (corneal epithelial stem cells). Each limbal stem cell type secretes different signaling molecules. Combined in drug therapy, however, both may facilitate corneal epithelial regeneration and re-establish barrier functions that are the first line of cellular defense against chemical, biological and physical threats in fighting corneal pathological conditions.

Mei lab discovery of protein coding gene NBL1 (a BMP antagonist) to inhibit of corneal fibrosis and scar formation after wounding in mice and cultured human corneas has led to study of its potential to develop limbal stem cell therapies to treat several cornea-related conditions. Both secured patents and others in writing are advancing her lab’s exclusive investigative rights in applying corneal epithelial stem cell discoveries to novel application of self-administered eye drops to treat corneal limbal stem cell deficiency, corneal scar, corneal neovascularization and dry eye disease.

Dr. Mei concluded: “My team’s pre-clinical strides will one day provide the general public and those in higher-risk occupations access to a drug therapy to treat an all-too-common type of ocular trauma. Military personnel and construction workers have higher rates of corneal damage. Domestically, corneal scrapes and store-shelf products with damaging chemicals spilled into eyes affect many adults and children. Without anti-fibrotic therapies on the market to aid healing of corneal injuries, scar tissue that can worsen an individual’s eyesight will almost inevitably form.”

Limbal stem cell and progenitor cell type discovery from animal model single-cell RNA sequencing could produce the first FDA-approved, anti-scarring drug therapy for corneal wound healing.



Jackie Bower: Targeted Gene Therapy to Treat Ocular Melanoma

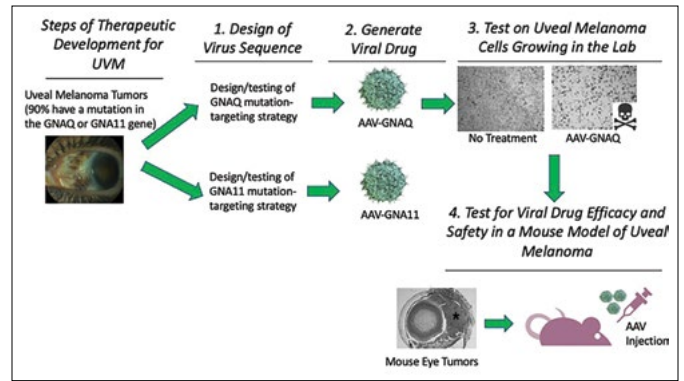


Carolina Eye Research Institute (CERI) Bower Lab: lab member (L) and Bower (R)

Ophthalmologists face a practitioner’s uphill battle in controlling the most common, yet very rare type of eye cancer — uveal melanoma. This very aggressive cancer type responds neither to chemotherapy nor radiotherapy, leaving an estimated five to six per one million sufferers (mostly adults) to endure a 50-50 chance of liver metastasis and almost-assured fatality. Multi-disciplinary treatment teams racing the clock invest their hopes that ocular tumorigenesis experts like UNC Ophthalmology Assistant Professor Jacquelyn (Jackie) Bower, PhD, can achieve pre-clinical success in applying targeted gene therapy to humans to stop early-stage uveal melanoma from spreading to the liver.

As a UNC Lineberger Comprehensive Cancer Center (LCCC) Associate Scientist (2014–2019), Dr. Bower studied molecular mechanisms of DNA repair and cell cycle control in ocular and breast cancers. Launching her Carolina Eye Research Institute lab in 2020, she narrowed her focus to studying mechanisms of ocular tumorigenesis and DNA-damage related ocular pathogenesis. Drawing from adeno-associated virus (AAV) gene delivery methods pioneered by fellow CERI lab leader Dr. Matt Hirsch, Dr. Bower developed targeted gene delivery strategies for promoting uveal melanoma tumor cell death and reducing the number of uveal pigment-producing ocular tumor cells.

She noted: “My background in pathology and pharmaceutical sciences focused on studying tumor



AAV gene therapy approaches for uveal melanoma (American Journal of Ophthalmology (2022) v. 234 / Clin Cancer Res (2019) 25 (7): 2206–2218)

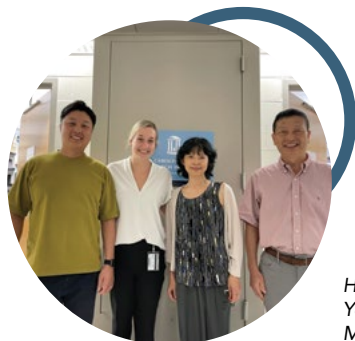
suppressor mutations and regulatory RNA molecules. Our collaborations with experts in AAV-based gene therapy here at CERI has led to developing a complementary approach for targeting genetic defects in ocular melanoma. When we began this project, those translational building blocks for developing an AAV-based drug therapy to treat the eye were established. No one, however, had applied them to uveal melanoma.

By targeting the mutant proteins that drive uveal melanoma cell growth in preliminary animal models, we are attempting to destroy the melanoma cells without harming surrounding healthy ocular tissues. If successful, we can move towards rigorous mechanistic studies that can be applied to human uveal melanoma tumors.”

Dr. Bower’s portfolio of gene therapy awards is supported by institutional, state and expertise-focused sources, among them: 1) 2023 American Society for Gene Therapy Career Development Award (\$100K); 2) 2022–2024 North Carolina Collaboratory (\$350K); 3) 2022–2023 North Carolina Biotech Center (\$20K); and 4) 2021 UNC Chapel Hill Office of the Provost’s IBM Junior Faculty Career Development (\$10K).

Dr. Bower concluded: “The overall goal is to develop a potential therapeutic that can specifically target the uveal melanoma tumor cells for an extended period of time. The use of AAV as a delivery vehicle will enable a faster translation to patients, as it is currently FDA-approved for at least five different rare disease therapeutics. Ultimately, the aim is to reduce the metastatic spread of uveal melanoma and even potentially preserve vision.”

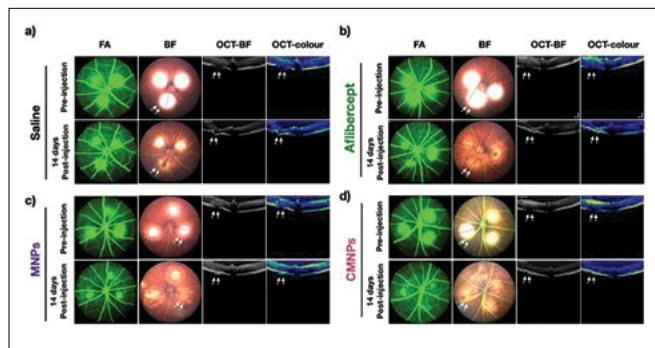
Zongchao Han: Nanoparticle Drug Delivery to Counter Inherited Retinal Disorders



Han lab team (L to R):
Yong-Su Kwon, Mary Kaufmann,
Min Zheng, Zongchao Han

Over 10 years at UNC, retinal drug and gene delivery expert Zongchao Han, MD, PhD, has led widely respected, studies from drug formulation to genomics research aimed at treating retinal disease. Dr. Han's laboratory has recently demonstrated that bio-nanoparticles (NPs) can effectively serve as vehicles or substitutes for treating prevalent retinal disorders associated with vision loss—age-related macular degeneration (AMD) and retinitis pigmentosa (RP). These successes provide a translational framework for further investigative use of nanoparticulate drug delivery systems to treat wider range of retinal disorders linked to chronic diseases.

In March 2023, *Gene Therapy* featured a study led by Dr. Han demonstrating how degenerative effects of mutated rhodopsin DNA in autosomal dominant RP could be mitigated via corrective genomic NP delivery. In October 2022 and June 2023, *American Chemical Society Nano* and *Nano Today* published two Han lab studies, respectively, demonstrating melanin-like nanoparticles (MNPs) could serve as viable, therapeutic substitutes for natural melanin in retinal pigment epithelium (RPE) cells and reduce oxidative stress in patients with AMD. Dr. Han's lab team now aims to develop surrogate NP delivery systems that could mediate not only the degenerative effects of inherited retinal disorders, but



Dr. Han's lab studies whether bio-NPs like melanin-like nanoparticles could potentially treat chronic disease-linked retinal disorders (eg, AMD) via therapeutic gene and drug delivery to targeted cell populations.

also the detriments inherent to reactive oxygen species (ROS)-related ocular diseases beyond AMD.

Dr. Han noted: "Using nano-biomaterial drug delivery systems to treat retinal disease has leveraged multiple nanoparticulate studies in my laboratory. We're currently developing a multi-functional [NP] carrier system capable of therapeutically targeting AMD cell populations and [RP] patients for whom standard treatment options will not work or are not available. My lab is also studying injectable hydrogels to treat retinal disorders such as dry eye, diabetic retinopathy and eye tumors, all of which demonstrate favorable response to various therapeutic agents delivered via sustained release. Lastly, we're working on novel biomedical applications of nano-antioxidants like melanin and nanoceria to treat AMD.

Our success in developing nanoparticulate drug delivery systems to treat [AMD and RP] is largely due to effective investigative designs. As we explore translational [NP] application in novel therapeutic approaches to other retinal disorders characterized by degeneration, we're hopeful our studies will produce a translational blueprint to develop novel drug therapies to treat broader range of retinal disorders."

Matt Hirsch:

Ocular Gene Therapy Pioneer



Hirsch (L) with UNC Ophthalmology Chair Dr. Don Budenz

In summer 2022, UNC Ophthalmology Research Associate Professor Matt Hirsch, PhD, was one of four early-career genetic engineers to receive the American Society of Gene & Cell Therapy (ASGCT)'s 2022 Outstanding New Investigator Award. Renowned for his breakthrough studies using Adeno-Associated Virus (AAV)-based vectors as a therapeutic gene delivery vehicle, Dr. Hirsch has created a framework for peer gene delivery strategists to develop DNA gene repair approaches to mitigate, prevent and restore vision loss from corneal blindness, retinal disease and other ocular disorders linked to rare degenerative hereditary diseases.

In his earliest University years at UNC's Genetic Therapy Center, Dr. Hirsch applied targeted genetic therapy to treat muscular dystrophies and evaluated AAV large gene delivery contexts in disease models of dysferlinopathy and hemophilia. When UNC Ophthalmology Chair Dr. Don Budenz observed Dr. Hirsch's expertise in using AAV vectors to treat inherited degenerative diseases, cross-disciplinary opportunities arose to collaborate in ocular drug development.

Founded in 2015, the Hirsch Lab played a pivotal role in transforming the Carolina Eye Research Institute (CERI) into a world-renowned cell and gene therapy center for collaborative, cross-disciplinary translational studies. Over Dr. Hirsch's eight years on UNC Ophthalmology faculty, his lab has produced five patented technologies related to treating ocular diseases in human and equine patients. Most of these potential

therapies are licensed to various companies that are funding their FDA-directed toxicological studies required for investigational new drug designations and Phase I human trials.

Backed by \$1M+ in federal awards and private investment, heading into 2024 Dr. Hirsch's lab is focused on a single gene drug that demonstrates the potential to treat several ocular diseases in animal models, using a novel molecule that inhibits inflammation and ocular neovascularization. Applied to treating donor tissue prior to surgery, this technology may prevent corneal transplant rejection. If successful in the cornea, this approach will be evaluated for organ protection in other transplant models, including heart and kidney.

With clear signs that federal, foundation and industry funding will chart upward and his lab will draw more inter-disciplinary collaborators, Dr. Hirsch reflected:

"I'm fortunate I was trained by great mentors and have a wealth of AAV gene therapy knowledge in my colleagues and collaborators, a situation that is unique to UNC. With this support, along with that from UNC Department of Ophthalmology and CERI, we have been fortunate. We're completely surprised by the therapeutic potential of technologies developed in the lab. We remain cautiously optimistic that if one or some of these therapies are approved by the FDA for human application, they will have a positive impact on improving human health."



Single dose AAV vector corneal administration to restore and maintain animal model corneal clarity is a promising therapeutic gene delivery mechanism to treat inherited degenerative disease.

Residency Class of 2027: Training in a Translational Medicine Era

On Match Day 2023, four high-achieving candidates became the newest members of UNC Ophthalmology's residency family. These 2023–2024 1st-year residents were asked: *"What do you observe of UNC Ophthalmology's research strength, from your initial impressions when introduced to the department, to participating in ophthalmology-related research?"*



Dipen Kumar, MD – Wayne State University School of Medicine

"During a research year pre-residency, I was exposed to UNC Ophthalmology's pioneering work in such areas as retinal diseases, glaucoma, and corneal diseases. I saw how clinical and research faculty seamlessly bridge the gap between basic science and clinical practice in a collaborative environment that employs cutting-edge technology and resources.

I am excited to be part of a dynamic training program that heavily emphasizes driving innovation and improving patient lives through translational research that contributes to the global ophthalmology community."



Gulrukh ("Gul") Shaheen, MD – University of Mississippi School of Medicine

"Pre-residency and now in training, I've seen [UNC Ophthalmology]'s dedication to translational research firsthand through clinical research trials and faculty-led projects linked to patient outcomes that bridge the gap between basic science and clinical practice. Department faculty stay up to date with innovative treatment strategies and are dedicated to advancing [residents'] understanding of eye diseases.

In a field with rapidly developing technologies and advancements, I'm so happy to train in a department that invests collaborative research efforts within the institution and on a broader scale in the field. I feel fortunate our residency program provides an intern year block to pursue our research endeavors."



Karen Lee, MD – Medical College of Wisconsin

"As a PGY1, I've observed UNC Ophthalmology's strengths in translational research through its interdisciplinary approach to important clinical questions. Our faculty are renowned experts in their field with extensive publications and clinical and surgical experience. They come from multidisciplinary and diverse backgrounds and are always supportive of the residents."



Grace Reilly, MD – Drexel University College of Medicine

"UNC Ophthalmology's strength in translational research and emphasis on applying novel findings to improve patient care drew me to the residency program. I'm very excited to apply my skills in translational research as a PGY-1 at UNC. I fell in love with clinical and A.I. research during my research year at the Wilmer Eye Institute, and I am honored to begin training and researching under the guidance of UNC Ophthalmology faculty who are each renowned in their fields."

UNC Eye Symposium 2023

Patient care providers rely on translational science to produce drug delivery discoveries, novel therapeutic approaches, improve patient outcomes and overall population health. Ophthalmology is no exception among medical specialties that use breakthrough discoveries in translational research to inform evidence-based practice and enhance patient care.

In April 2023, the UNC Eye Symposium drew eye care practitioners from across North Carolina and nearby

states (its largest audience to date) to hear the latest in evidence-based diagnostic and medical/surgical approaches to comprehensive eye care and treating ocular disorders and disease. Hosted annually by UNC Ophthalmology, this day-long symposium featured distinguished guest experts and UNC Ophthalmology faculty subspecialists sharing their expertise in all major areas of eye care.



TOP (L to R): Almost 200 eye care practitioners from across the Southeast attended the 2023 UNC Eye Symposium. UNC Professor of Ophthalmology and Retina/Vitreoretinal Surgery expert **J. Niklas Ulrich, MD**. **BOTTOM (L to R):** Vanderbilt Eye Institute Director & Vanderbilt University Medical Center Chief Medical Officer **Paul Sternberg, MD**. UNC Ophthalmology Assistant Professor Retina/Vitreoretinal Surgery expert **Keirnan Willett, MD**.

SAVE
the DATE
2024

UNC EYE SYMPOSIUM

with Technician Continuing Education Session

Saturday, April 13, 2024 at
The William and Ida Friday Center
for Continuing Education



New Faculty

UNC Ophthalmology welcomed three new clinical faculty members between Summer 2022 and Spring 2023.



Jon Brisley, MD
Comprehensive Eye Care
August 2022



Sinthu Ranjan, MD
Corneal Disease & Transplantation
September 2022



Marc Booth, MD
Comprehensive Eye Care
March 2023

Friends of UNC Ophthalmology



“It’s who you are, what you do, what you believe in and the wide range of people that are impacted. And it’s UNC! Proud to be a contributor.”

– Harriett Kittner



“We feel UNC Ophthalmology is at the leading edge of research in so many battles to fight eye disease and blindness. Each time we visit the clinic, we realize we are surrounded by patients from many walks of life with different backgrounds; some who have traveled many miles to receive treatment. We are confident these diverse individuals will be treated without bias by highly qualified staff, technicians, and physicians using the latest technology. This is why we support UNC Ophthalmology.”

– Steven & Laura Bergman



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