Summer Research Opportunities by Mentor - 2019

Heather Anderson OD, PhD – One possible project this summer is to conduct a study to evaluate the use of a newly developed contrast sensitivity test, CamBlobs, in children. The study design may include comparing the test to other pediatric contrast tests, as well as determining the repeatability of the test administered twice in the same subject. A second opportunity is to determine predicted visual acuity outcomes for individuals with Down syndrome by conducting chart reading experiments of typical observers viewing acuity charts representing the image quality of individuals with Down syndrome. In addition to conducting these studies, the student may also observe and assist with study visits for an on-going spectacle lens trial for adult subjects with Down syndrome.

Raymond Applegate, OD, PhD – My research centers on understanding the visual impact of the optical aberrations of the normal and clinical eye and optimizing the visual outcomes of therapy designed to optically improve the visual performance of the normal and clinical eye.

Jan P G Bergmanson, OD, PhD, D.Sc. – Texas Eye Research and Technology Center offers a number of interesting opportunities. We are often conducting clinical studies involving new contact lens designs and materials and new contact lens care products. We are studying the tear film in scleral gas permeable contact lens wearers, post-refractive surgery patients and patients with anterior segment pathologies. In addition, we also routinely receive corneal buttons from keratoplasty transplant surgery to be evaluated histopathologically. These specimens will allow the study of diseases like keratoconus and macular-, granular-, lattice- and Fuchs endothelial dystrophies, some of which are rare anomalies. Keratoconus is a disease that distorts the cornea of the young person with a profound effect on vision and quality of life. TERTC is conducting clinical and basic research to uncover its etiology, histopathology and to improve our clinical management of this disorder. You could be part of this team effort.

Alan Burns, PhD – Over the past few years, the Burns laboratory has defined new aspects of the inflammatory cascade induced by epithelial injury to the cornea in a mouse model. This cascade includes proinflammatory components as well as modulatory components, and this balance is necessary for healing. If the proinflammatory components are deficient, healing is reduced, and if modulatory components are deficient, the resulting excessive inflammation causes corneal injury and poor healing. Our current studies focus on corneal complications of obesity. This is a basic research study to analyze the earliest changes induced by an obesogenic diet. We are attempting to understand the pathogenesis of an important corneal condition before it reaches the far advanced stages of the metabolic syndrome. We will use diet-induced obesity and full thickness corneal epithelial abrasion in C57BL/6J mice for studies *in vivo*. The pathogenic effect of a diet is not simply determined by the nutritive content or quantity of the food source, but includes the timing of food intake as shown by recent investigations. Our studies will incorporate this expanded understanding of dietary influence to provide a database necessary for specific investigations into mechanisms by which an obesogenic diet compromises corneal function. We specialize in immunofluorescence light microscopy, routine transmission electron microscopy and serial block-face scanning electron microscopy for 3D ultrastructural reconstruction.

Han Cheng, OD, PhD – My general research interest is to improve diagnosis and management of optic nerve diseases. As the cerebrospinal fluid pressure (CSFP) plays an important role in the pathogenesis of optic nerve diseases, summer research this year will be focused on understanding how optic nerve sheath diameter (ONSD), a surrogate for CSFP, changes with posture in normal subjects. ONSD expands with increased CSFP, and B-scan ultrasound will be used to measure the

ONSD for normal subjects under seated and supine positions. Previous research has shown that CSFP is ~10 mmHg greater in the supine position.

Daniel Coates, PhD – The broad research focus of my laboratory is visual perception in normal subjects and in the presence of disease, including peripheral vision and reading, binocular vision, and color vision, as well as the use of computational and statistical techniques for modeling, diagnosis, and prediction. This summer there will be opportunities to carry out psychophysical experiments with normal subjects using state-of-the-art tools for investigating binocular rivalry and/or simulated central vision loss.

Vivien Coulson-Thomas, PhD – The research interests of my lab involve primarily the study of glycosaminoglycans and proteoglycans in the fields of cornea, wound healing, stem cells and brain injury. Current projects include (1) understanding how the hyaluronan rich limbal stem cell niche maintains limbal stem cells in their "stem cell state", (2) investigating the anti-inflammatory role of the hyaluronan matrix in the glial scar and the therapeutic potential of targeting this matrix after brain, retina and optic nerve injury, and (3) understanding the pathology of meibomian gland dysfunction and develop prevention strategies. A student working on either of these projects would attain hands-on experience in a vast array of cell biology techniques including primary and established cell line culture, histology, immunofluorescence, protein purification, Western Blotting and high pressure liquid chromatography.

Wendy Harrison, OD, PhD – The goal of our research lab is to better understand what happens in the eye in patients with diabetes. Diabetes is the leading cause of preventable vision loss in working aged Americans. It affects both blood vessels and nerves in the retina as well as the front of the eye. We evaluate retinal nerve function with a multifocal electroretinogram and nerve and vascular structural changes with an OCT and retinal photographs. We hope to understand the timeline of changes to structure and function as the disease progresses. We also hope to learn how gender, diet, and health differences play into vision loss in these patients.

Jason Marsack, PhD – The research interests of our laboratory center on the development of new optical correction strategies (glasses, contact lenses) for individuals with ocular diseases that cause distorted corneal optics and poor retinal image formation (e.g.: keratoconus). We are interested in three aspects of this problem. 1) Design, manufacture and evaluation of custom contact lenses that contain patient-specific optical corrections: We are currently building and evaluating these 'wavefront-guided' lenses in-house. 2) Evaluation of pseudo-custom corrections: This study is evaluating whether the types of refractive error present in keratoconus have enough commonality across patients to develop corrections that are applicable to not just one keratoconus patient, but to groups of patients, making delivery of these corrections cheaper for the patient, and easier for the clinician. 3) Simulation of the impact of refractive error on visual performance: These experiments focus on developing computer models that simulate real-world optical conditions and neural constraints. These three areas have as a common goal increasing clinical access to care and improving quality of life for individuals that suffer from abnormally high levels of corneal distortion.

Nimesh Patel, OD, PhD – Optic neuropathies can result in irreversible blindness, especially if not treated. For early detection and determination of progression, non-invasive optical coherence tomography imaging is often used to assess structural changes within the retina and optic nerve, and standard automated perimetry is used to assess visual function. Our lab is interested in factors that influence retinal and optic nerve head measures, and how clinically assessed structural measures relate to visual function. Current projects in the lab involve careful analysis of optic nerve head optical

coherence tomography scans, establishing normal inter and intra individual variability in healthy and disease eyes.

Jason Porter, PhD – The main goals of our laboratory are to learn more about the causes of retinal and optic nerve head diseases and how the retina develops in normal eyes. In conjunction with the use of conventional clinical tests (such as fundus photography and optical coherence tomography [OCT]), we use a technology called adaptive optics to correct the blur imposed by the eye's optics and examine the structure of single cells in normal and diseased eyes. Current projects in the lab include (1) measuring changes in the lamina cribrosa, optic nerve head and retinal vasculature over time in eyes with glaucoma, 2) examining changes in the photoreceptor mosaic in patients with retinal degenerations (such as retinitis pigmentosa) to better understand genotype-phenotype and structure-function relationships in these diseases, as well as 3) examining how the cone photoreceptor mosaic, foveal pit and optic nerve head change during normal development and differ between normal eyes with different refractive errors. Occasionally, the lab also has projects that examine retinal structure and function in patients following a concussion and/or traumatic brain injury.

Vijaykrishna Raghunathan, PhD – Primary open angle glaucoma (POAG) is a retinal disease that is manifested by ocular hypertension due to increased resistance to aqueous humor outflow. Most of the resistance to the outflow is thought to be through the extracellular matrix (ECM) of the trabecular meshwork (TM). My lab is interested in investigating the bidirectional relationship between TM cells and the ECM that they deposit in order to better understand the molecular principles underlying TM dysfunction. Current projects include (1) controlling cell shape and adhesion area to modulate actin dynamics and response to pro-fibrotic cytokines, (2) evaluating the impact of substrate stiffness on cellular response to cyclical stretch, and (3) characterization of ECM deposited by TM cells from segmental flow regions.

Rachel Redfern, OD, PhD – My laboratory is investigating toll-like receptors (TLRs) involvement in dry eye inflammation and the risk for ocular surface infection. We hypothesize that endogenous TLR ligands are increased on the ocular surface in dry eye and can activate TLRs to inflammation, while also reducing the risk for infection through the production of antimicrobial peptides. Currently, we are determining 1) the involvement of TLR endogenous ligands in dry eye and dry eye-associated conditions, 2) the impact of TLRs on the secretion of proinflammatory cytokines and proteases in mice with experimental dry eye and in human ocular surface cells, and 3) the involvement of TLRs in modulating the risk for microbial infection in mice with dry eye. With the prevalence of dry eye expected to double over the next few decades and lack of definitive treatment regimes, there is a critical need to better understand the pathophysiology of dry eye to aid in the development of therapeutic regimes that reduce inflammation while not increasing the risk for infection.

Kathryn Richdale, OD, PhD – My research interests are primarily in cornea/anterior segment and contact lenses. Some of my current research proposals include understanding contact lens complications in children and young adults, developing better ways of treating and managing patients with multifocal and orthokeratology contact lenses, and exploring changes in the anterior segment of the eye with obesity and metabolic disease.

Eric Ritchey, OD, PhD – My research interests are in the area of 1) contact lenses and 2) refractive error development. While contact lenses are the preferred method of vision correction for many patients, we know that dropout from contact lens wear remains a significant issue in clinical practice. My research examines factors related to contact lens comfort and dropout, with a goal of predicting

which contact lens product matches the need of the patient. I also have an interest in myopia development, with my interest in contact lens control of myopia progression and contact lens performance.

Scott Stevenson, PhD – Eye movements are controlled through a combination of voluntary and reflexive responses to visual input. Research in my laboratory examines the visual processes that support each of these aspects, and the way in which they are combined in the final motor response. For comparison to eye movement responses, we also study visual processing of motion and depth information with psychophysical methods, and we study visual tracking behavior using hand and head movements instead of eye movements.