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 studying scleral gas permeable contact lens wearers, post-refractive surgery patients and patients with anterior segment pathologies. In addition, we are conducting research in ocular anatomy and pathology at a cellular and subcellular level using light and electron microscopy. In these studies, the research is utilizing human cadaver eyes and corneal buttons from keratoplasty transplant surgery. These specimens will allow the study of normal anatomy, diseases like keratoconus, macular-, granular-, lattice- and Fuchs endothelial- dystrophies, some of which are rare anomalies. 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. 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 emphasize the use of immunofluorescence light microscopy, routine transmission electron microscopy and serial block-face scanning electron microscopy for 3D ultrastructural reconstruction using software that makes use of a virtual reality hardware.

Han Cheng, OD, PhD – This summer’s research project is to evaluate a new contrast sensitivity test in healthy adults. Visual function is typically measured with high contrast chart. However, low-contrast vision is often more predictive of the real-world vision and more sensitive in revealing changes in vision. Current contrast sensitivity tests are expensive, not easily portable, or require supervised testing conditions. The SpotChecks is an inexpensive disposable paper chart designed as a take-home test for patients to self-monitor disease progression. Due to the newness of the test, there is currently no normative values or test-retest variability available. The goal of the study is to establish them in healthy adults. The data will be used to set the normative limits for SpotChecks contrast sensitivity so that abnormal vision can be detected; the test-retest variability will provide guidance in using the test for monitoring disease progression.

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, eye movements, and color vision, as well as the use of computational and statistical techniques for modeling, diagnosis, and prediction. This summer we will continue the development and validation of a novel platform for remote testing of spatial, color, and binocular vision, using custom cellphone and VR-based tools.
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 and stem cells. 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 ocular injury and corneal lymphangiogenesis, 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.

Muna Naash, PhD & Muayyad Al-Ubaidi, PhD - The research interests of the joint labs of Drs. Naash and Al-Ubaidi involve primarily the study of the mechanisms of retinal degeneration in animal models of human blinding disorders. Knockin mouse models for mutations that affect humans are generated and subjected to non-invasive functional and structural techniques to assess the rate of degeneration. Then molecular and biochemical analyses are performed on retinal samples obtained from the mouse models. These mouse models are then used to develop nanoparticle based gene therapy to ameliorate the disease phenotype. The animals models used in the labs are for retinitis pigmentosa and Usher syndrome. Another approach that has been recently introduced is the study, using metabolomics, of the metabolic changes that occur prior and during the retinal degenerative process. A student working on any of these projects would attain hands-on experience in electroretinography, optical coherence tomography, fundus imaging, as well as molecular, biochemical, cell biological and histological techniques.

Lisa Ostrin, OD, PhD – My research interests include environmental and behavioral influences on circadian rhythm, myopia, and the choroid. Light exposure has a close link with numerous aspects of human physiology and has been implicated in several different pathological processes including myopia development, circadian rhythm disturbances, mood disorders, cancer, and metabolic disorders. The intrinsically photosensitive retinal ganglion cells (ipRGCs) are an inner retinal photoreceptor that
respond directly to short wavelength blue light, and are responsible for non-image forming functions including circadian rhythm entrainment and pupil size. Ongoing projects in the lab include 1) measuring and correlating light exposure with ipRGC activity, circadian rhythm patterns, melatonin level, and refractive error, 2) determining the influence of retinal blur on the choroid, and 3) understanding how behaviors are altered during and after the covid pandemic and if these changes might ultimately contribute to increasing myopia prevalence and progression.

**Nimesh Patel, OD, PhD** – The research interest of my lab include the accurate quantification of optic nerve head morphology in normal and disease eyes. We use optical coherence tomography (OCT) to image the eye, and develop custom algorithms for analysis, which are then histologically validated. Current projects in this area include; 1) accounting for retinal curvature for OCT based optic nerve head and macula quantification, and 2) determining the retinal ganglion cell density and axonal characteristics in the peripapillary tissue of healthy and glaucomatous 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.

**Guoting Qin, PhD** – One of my research interests is to identify and determine the functions of the ocular surface microbiome using mass spectrometry-based omics tools. This summer, we will work together to develop ultra-sensitive proteomic methods to identify microbiome species on the ocular surface and determine the interactions between the ocular surface microbiome and the host.

**Vijay Krishna 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 ocular surface inflammation and infection. We hypothesize ocular surface damage stimulates the release of alarmins which activate toll-like receptors (TLR) to perpetuate inflammation through the production of cytokines and conversely protect the ocular surface through the production of antimicrobial peptides. These studies have been investigating using a variety of models including cell culture, animal, and human subjects to
examine molecular changes that occur with disease (e.g. dry eye). Currently, we are examining novel therapeutic options that may modulate the risk of inflammation and infection.

Given the prevalence of dry eye expected to double over the next few decades and the lack of definitive treatment regimes, there is a critical need to development of therapeutic regimen 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. This includes subjecting and objective methods for evaluation of Lid Wiper Epitheliopathy and Meibomian Gland Disease. In the area of refractive error development, my research interest is in contact lens control of myopia progression and the visual performance of these contact lens. Specifically, my interest is in optical profiles of contact lenses, the effect on treatment efficacy, and the quality of life with these devices, with the long-term goal of optimizing myopia control treatments.

**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 along with eye movements.

**Michael Twa, OD, PhD** - I have a longstanding interest in biomedical imaging, image analysis and using machine learning methods to improve clinical decision making. My current research is related to the development of new imaging technology for sensing tissue biomechanics (optical coherence elastography) and I am also working to address adherence behavior in glaucoma.