Summer Research Opportunities - 2016

Heather Anderson OD, PhD – One aim of my research lab is to investigate the measurement of accommodation in both children and young adults using objective techniques with efforts to better quantify the overall accommodative amplitude of clinical patients and identify age-related changes. A second aim is to investigate the optical limits of visual acuity in patients with Down syndrome and determine whether spectacle prescriptions derived objectively to minimize the negative impact of optical aberrations on retinal image quality will improve visual performance beyond that obtained with standard clinical techniques.

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 – Texas Eye Research and Technology Center offers a number of interesting opportunities. We will be conducting clinical studies involving new contact lens designs and materials and new contact lens care products. We are also studying the tear film in 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. We have an ongoing research program in the area of ultraviolet radiation (UVR), where we are developing new ways to measure transmittance through contact lenses and intraocular implants (IOLs) and the in vitro cornea. Finally, 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.

David Berntsen, OD, PhD – My research interests include both the development and progression of myopia in children, contact lenses, and aberrations of the eye. My research involves using biometric data (measurements of the ocular components) and measures of optical quality to better understand the mechanism responsible for the progression of myopia in children. My research also involves determining the effect of refractive correction (spectacles and contact lenses) on the central and peripheral optics of the eye.

Alan Burns, PhD – The location of the cornea makes it vulnerable to traumatic injury, either accidental or as a result of surgery. Healing of corneal wounds is of vital importance, not only to ensure the integrity of the eye but also to maintain the best possible visual acuity. The mechanisms regulating healing after corneal injury are not fully understood. Migration of inflammatory cells to the site of corneal injury appears to be necessary and beneficial for wound healing. However, dysregulated inflammation delays wound healing and increases the risk of infection. Our experiments are designed to understand mechanisms regulating inflammatory cell migration within injured corneas. In studies of injured cornea, we examine the healing process and inflammatory cell migration in mice that are deficient in certain adhesion molecules or specific cell types. Techniques employed include high resolution immunofluorescence light microscopic imaging (deconvolution), electron microscopy and computerized 3D image reconstruction, morphometric computer-assisted analysis, cell culture and live cell imaging. Information gained from our studies will help to identify molecular and cellular mechanisms responsible for inflammatory cell recruitment into the injured cornea and this may define
new therapeutic targets for regulating inflammation while still preserving the benefits it brings to wound healing.

**Han Cheng, OD, PhD** – Optic disc edema (ODE) is a manifestation of compromised optic nerve health, which may result from various ocular or systemic health problems. Early detection of ODE is crucial as it may save a person’s vision or life. However, even for the most experienced clinician, subtle ODE can be confused with the so-called pseudo-disc edema (PODE). PODE refers to relatively benign optic nerve conditions (e.g., optic disc drusen, optic nerve tilting, crowded hyperopic disc) that mimic a swollen optic disc. In both ODE and PODE, the optic nerve head appear elevated, crowded, and/or have irregular indistinct margins. Some evidence in the literature suggests that optical coherence tomography (OCT) and orbital ultrasound (OUS), two non-invasive objective low-cost techniques, are useful for detection of disc edema. However, the sensitivity and specificity of each technique is unknown. My research interest is to evaluate the utility of OCT and OUS in detecting true disc swelling. Knowledge gained from this research will aid clinicians in correctly diagnosing disc edema especially mild disc edema, which will facilitate early detection/treatment of ocular or systemic health conditions.

**Vallabh Das, PhD** – The focus of research in my laboratory is to investigate disruption of eye movement control in animal models for strabismus. Strabismus is a common visual developmental disorder affecting 2‐5% of all human infants. Though the exact etiology of strabismus is still unknown, it is clear that disruption of binocular visual information in infancy plays a critical role in development of strabismus. Many seminal behavioral, anatomical and physiological studies have revealed various aspects of visual sensory deficits that are associated with the strabismic condition. By the same token, we know relatively little about disruptions in neural oculomotor (eye movement) circuits, though these structures must also be involved in maintaining the steady-state strabismus. The possible involvement of such structures ranges from altered eye muscle lengths to neural mechanisms that alter eye muscle tone or contractility. Our research is therefore directed towards identifying and understanding the roles of specific areas in the brain that may be involved in producing oculomotor properties describing the strabismus state. Our strategy is to utilize a basic science approach with studies in animal models, incorporating concepts, tools and techniques developed via studies of the oculomotor system in normal humans and animals. To this end, we use a multi-pronged strategy involving behavioral studies of eye alignment, eye movements and ocular accommodation, MRI studies evaluating extraocular muscle (EOM) structure and single cell recording studies of information processing in neural oculomotor circuits. Faculty Profile: [http://vdas.opt.uh.edu/](http://vdas.opt.uh.edu/)

**Laura Frishman, PhD** – The electroretinogram (ERG) is a retinal response to a flash of light or to modulation of the contrast of a patterned stimulus that can be recorded noninvasively from the surface of the cornea. The overall objectives of the work in this laboratory are to analyze the retinal origins (i.e. to identify the specific retinal cell types) that contribute to the flash and multifocal ERG so that we can improve the utility of this noninvasive measure in assessing retinal function in the lab and in the clinic. To this end, we are comparing ERGs recorded from normal humans, monkeys and mice, with ERGs of humans with diseased retinas, and animal models.

**Ruth E Manny, OD, PhD** – My research interests encompass several broad areas that include vision development, refractive error and anomalies of binocular vision. My focus this summer will be on studies to support the development of a screening procedure for preschool children currently funded by a small grant from NIH. In addition Dr. Anderson and I will be working on a project to evaluate
several clinical methods to assess accommodative accuracy and how these methods compare to an objective assessment of accommodative accuracy.

**Jessica Mathew, OD, PhD** - My current research includes investigating the affects of contact lenses on the ocular surface and in particular the tear film. End of day comfort is a common complaint among contact lens wearers and part of my research is to better understand the interaction contact lenses have on the ocular surface and how this plays a role in comfort. I am also interested in repeatability and validation measures of common dry eye diagnostic instruments when used over a contact lens and whether these are acceptable measures.

**Alison McDermott, PhD** – My research is centered around improving our understanding of wound healing and innate immunity at the ocular surface. Currently we are specifically investigating the role of antimicrobial peptides such as defensins in corneal epithelial wound healing and in protecting the ocular surface from infection. Specific projects ongoing in the lab include: the role of cytokines in regulating antimicrobial peptide expression in the cornea; effect of synthetic defensins on the proliferation and migration of corneal cells. A variety of techniques are being used including tissue culture of human corneas, RT-PCR, immunohistochemistry, western blotting, fluorescence based proliferation assays and chemotaxis assays. We also use animal models of microbial keratitis to study the role of antimicrobial peptides in preventing corneal infection. We collaborate with Dr. Cai from the Chemistry department to use nanotechnology to study the mechanism of action of antimicrobial peptides and to develop antimicrobial peptide coated contact lenses.

**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.

**Lisa Ostrin, OD, PhD** – One of the goals in my lab is to understand environmental influences, such as light exposure, on eye growth and circadian rhythms. Light exposure has a close link with numerous aspects of human physiology and has been implicated in several different pathological processes including circadian rhythm disturbances, mood disorders, cancer, and metabolic disorders. The intrinsically photosensitive retinal ganglion cells (ipRGCs) are an inner retinal cell type that respond directly to short wavelength blue light, and are responsible for non-image forming functions including circadian rhythm entrainment and pupil size. Current projects in the lab include 1) measuring and correlating ipRGC function with light exposure, circadian rhythm patterns, melatonin levels and refractive error, 2) determining the effects of short and long wavelength blocking glasses and/or contact lenses on ipRGC function and choroidal thickness, and 3) determining the effects of blue light emitting devices (iPads, iPhones) on ipRGC function and the choroid.
Nimesh Patel, OD PhD – Glaucoma is a group of optic neuropathies that can result in irreversible blindness, especially if not treated. Although there is no cure, early detection and treatment can slow the progression of vision loss. Non-invasive OCT imaging is often used to assess early structural changes within the retina and optic nerve. Current projects in the lab include investigating; 1) methodologies for structural analysis that account for non-neuronal tissue and ocular magnification, 2) structural risk factors for glaucoma progression, and 3) the relationship between ganglion cell layer/inner plexiform layer thickness and visual function.

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.

Daniel Powell, OD, PhD – Dry eye is a commonly encountered condition in the clinical setting and can be associated with a decrease in quality of life if left untreated or undermanaged. A myriad of risk factors have been associated with dry eye ranging from contact lens wear to the external environment. Potential studies include investigating the effects of tobacco smoke and contact lens wear on dry eye status as well as repeatability and validation studies of diagnostic dry eye tests.

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.

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.