Summer Research Opportunities - 2015

Heather Anderson OD, PhD – My research interests include objective measurements of accommodation in children and factors limiting visual quality in individuals with Down syndrome. Specifically for this summer I will be evaluating the use of a data logger to accurately track spectacle wear in adults. This project will serve to aid in the development of methods to monitor spectacle compliance in future clinical trials with individuals who have 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 – 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/)

Donald A. Fox, PhD -- The research conducted in my laboratory investigates the cellular and molecular mechanisms underlying normal and abnormal retinal development. This summer, we will be conducting anatomical, biochemical, cell and molecular biological studies to investigate several postulated mechanisms of action for photoreceptor and inner retinal development. Experiments will focus on alterations in signal transduction, transcriptional factors and control of gene expression, calcium metabolism, and cell cycle regulation. A variety of techniques will be employed: Westerns, mRNA expression, real-time PCR, microplate and enzyme assays, tissue culture, electron microscopy, immunohistochemistry and confocal microscopy, and bioinformatics. Only individuals with laboratory research experience in any of these techniques should apply.

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.
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 – My research interests include quantification of optical performance in highly aberrated eyes and development of correction strategies that target both lower order (sphere, cylinder) and higher order (coma, spherical aberration, etc) optical aberration. The laboratory has previously demonstrated the ability to design, manufacture and evaluate both soft and scleral contact lenses that contain lower and higher order optical aberration correction for the keratoconic eye. Future work will 1) continue to evolve and evaluate these individually custom corrections; 2) examine whether the higher order aberration present in the keratoconus population exhibits sufficient commonality to develop corrections that are applicable to groups of keratoconic eyes; and 3) examine whether lower order spectacle corrections can be optimized using objective visual image quality metrics to improve visual performance in this patient population.

Lisa Ostrin, OD, PhD - Myopia has become an epidemic, reaching a prevalence of up to 90% in East Asian countries. Accumulating evidence suggests that more time outdoor light may be protective against the development and progression of myopia. The majority of previous studies in children determine light exposure and activity patterns through the use of parent questionnaires, which are subject to errors in estimation and memory biases. I am conducting a study in which a light weight watch-like activity and light sensor is distributed to school age children in order to objectively quantify light exposure and activity. The device will be worn continuously for 6 two week periods during the fall, spring and summer school sessions over a two year period. Subjects will be given a complete eye exam at UEI with ocular biometry measurements at baseline, 1 year and 2 years. Data will be analyzed to determine the influence of light intensity and activity on eye growth. Seasonal variations in light exposure will be evaluated. Understanding the influence of light levels may help elucidate the etiology of myopia and aid in development of behavioral interventions for prevention and treatment of myopia.

Deborah Otteson, PhD – My lab uses cell and molecular approaches to study the mechanisms that regulate cell-specific patterns of gene expression in the retina and the role of transcriptional regulatory genes in cellular differentiation. Current work focuses on DNA/protein interactions and the role of DNA methylation on regulation of ganglion cell-specific gene expression and analyzing the effects of transcriptional regulatory genes on proliferation and differentiation of retinal cells in culture. There are projects in both of these areas available for summer research. A variety of techniques are being used in this research including bioinformatics-based sequence analysis, promoter activation assays, bisulfite sequencing, cDNA cloning, cell culture, fluorescence-based proliferation assays, immunohistochemistry, fluorescence microscopy.

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.

Judith Perrigin, OD – Projects include microbiological testing to assess risk of contamination and efficacy of cleaning techniques and preservatives of common ocular lubricants, contact lens products, and topical medications. Other projects will evaluate accuracy of calibration of optometric instruments and quality control in production of contemporary contact lenses.

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 (AO) 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 and the optic nerve head over time in eyes with glaucoma, (2) examining changes in the photoreceptor mosaic in patients with retinitis pigmentosa and macular degeneration to better understand genotype-phenotype and structure-function relationships in these diseases, as well as (3) examining how the cone photoreceptor mosaic and foveal pit change during development and differ between eyes with different refractive errors.

Daniel Powell, OD, PhD – The use of thermography to measure ocular surface temperatures dates back nearly 50 years and has been used to evaluate a small number of inflammatory eye conditions. Thermography may serve as a screening tool for dry eye and meibomian gland dysfunction, two conditions commonly encountered in clinical practice. A potential advantage to this procedure relative to other diagnostic procedures for dry eye, like corneal staining and fluorescein tear break-up time, is its noninvasiveness. The aims of this study are 1) to investigate the impact that dry eye potentially has on ocular surface temperatures in high and low humidity environments and 2) to determine if a relationship exists between ocular surface temperatures and dry eye as well as meibomian gland dysfunction.

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.