101 Light-based treatment strategies for blinding eye disease
Sunday, May 07, 2017 8:30 AM–10:30 AM
Ballroom 3 Symposium
Program #/Board # Range: 1–6
Contributing Section(s): Anatomy and Pathology/Oncology, Biochemistry/Molecular Biology, Cornea, Eye Movements/Strabismus/Amблиoopia/Neuro-Ophthalmology, Glaucoma, Immunology/Microbiology, Lens, Low Vision, Multidisciplinary Ophthalmic Imaging, Physiology/Pharmacology, Retina, Retinal Cell Biology, Visual Psychophysics/Physiological Optics
Program Number: 1
Presentation Time: 8:36 AM–8:53 AM
Principles of light-based therapies and emerging strategies in medicine
Brian C. Wilson, University of Toronto, Toronto, ON, Canada.
Presentation Description: Optical spectroscopies and imaging are rapidly emerging and, combined with either light-based or conventional treatments, are enabling a range of theranostics, i.e. guided interventions. In addition, there is strong convergence of these methods and technologies with other fields, including nanotechnologies, radiological imaging, fast computation and robotics. The principles underlying these advances are explained and the applications, both in pre-clinical research and clinical practice, are illustrated by multiple examples. The potential for translation to meet unmet needs in vision research and clinical ophthalmology is considered, together with the technological, translational, commercialization and clinical challenges involved.
Commercial Relationships: Brian C. Wilson, None

Program Number: 2
Presentation Time: 8:53 AM–9:10 AM
Optogenetic Technologies and Beyond: Tools for Mapping and Repairing Complex Biological Systems
Ed Boyden, Massachusetts Institute of Technology, Cambridge, MA.
Presentation Description: To enable the understanding and repair of complex biological systems such as the retina and the brain, we are creating novel optical tools that enable molecular-resolution maps of large scale systems, as well as technologies for observing and controlling high-speed physiological dynamics in such systems. First, we have developed a method for imaging large 3-D specimens with nanoscale precision, by embedding them in a swellable polymer, homogenizing their mechanical properties, and exposing them to water – which causes them to expand isotropically severalfold. This method, which we call expansion microscopy (ExM), enables scalable, inexpensive diffraction-limited microscopes to do large-volume nanoscopy. Second, we have developed a set of genetically-encoded reagents, known as optogenetic tools, that when expressed in specific neurons, enable their electrical activities to be precisely driven or silenced in response to millisecond timescale pulses of light. Finally, we have collaboratively developed strategies to image and record fast physiological processes in 3-D with millisecond precision, and are using them to acquire neural activity maps with single cell resolution in living brain circuits. In this way we aim to enable the systematic mapping, control, and dynamical observation of complex biological systems like the retina and the brain.
Commercial Relationships: Ed Boyden, None
Support: NIH Director's Pioneer Award 1DP1NS087724

Program Number: 3
Presentation Time: 9:10 AM–9:27 AM
Tissue optics in the eye: fundamental considerations for light-based therapies
Randolph Glickman, Dept of Ophthalmology, University of Texas Health Science Center San Antonio, San Antonio, TX.
Presentation Description: The propagation of light through the eye critically depends on the optical properties of the component ocular tissues. The transmission of light through the cornea, lens and ocular media is spectrally defined and determines not only the wavelength limits of vision, but also the amount of light energy that can be deposited in any given tissue, thus determining the wavelengths that can practically be used to achieve an effective phototherapy. Another consideration is the upper limit of optical radiation that can be delivered to the eye before tissue damage occurs. Light damage to ocular tissues occurs through three general mechanisms involving thermal, mechanical, or photochemical effects. The particular mechanism activated depends on the wavelength and exposure duration of the incident light. Energy confinement, i.e. the rate of energy delivery to the tissue, is a key concept in understanding or predicting the type of damage mechanism produced by a given light exposure. In the case of exposure to ultrashort laser pulses, tissue damage or ablation can proceed through several nonlinear mechanisms. In addition to tissue damage caused directly by light absorption, light toxicity can be mediated by the presence of photosensitizing molecules, of both endogenous and exogenous origin. These molecules may be excited to reactive states by light of an appropriate wavelength and produce damage by Type I (free radical) and/or Type II (oxygen dependent) mechanisms. Thus, based on the treatment modality and the intended tissue targets of the phototherapy, factors to be considered include the wavelength, which is a principal determinant of tissue penetration depth, whether the exposure will use continuous or pulsed light, which affects the nature of the light-tissue interaction, and – in the case of photodynamic therapy - the photochemical properties of the photosensitizing agent. Finally, the relevant safety standards relating to ocular light exposure will be briefly reviewed.
Commercial Relationships: Randolph Glickman, None

Program Number: 4
Presentation Time: 9:27 AM–9:44 AM
Biophotonic Treatment of Corneal Diseases
Dimitriz Azar, Univ of Illinois at Chicago, Chicago, IL.
Presentation Description: In this presentation, we will discuss several applications of biophotonic treatments and the ways in which light can be used for the treatment of corneal diseases. ArF excimer laser, emitting ultraviolet pulses at 193 nm provides precise and accurate removal of corneal tissues without damaging the surrounding tissues. A clear boundary is present between the treated and untreated area, with minimal damage to the stromal lamellae. Operating in the infrared region (wavelength 1053 nm) with pulses duration of 100 fs, femtosecond laser has revolutionized anterior segment refractive surgeries. It has several clinical applications including LASIK flap creation, lamellar and penetrating keratoplasty, corneal tunneling for intrastromal ring implantation, phacoemulsification, nucleus fragmentation, and capsulorhexis for cataract surgery, arcuate incisions for astigmatism, and corneal lenticule removal for presbyopia, myopia, natural as well post-corneal implant astigmatism. We will discuss the indications, contraindications, outcomes and complications of these lasers and focus on ArF excimer laser photorefractive keratectomy (PRK) and phototherapeutic keratectomy (PTK) in addition to the femtosecond laser assisted LASIK, astigmatic keratectomy (AK) and cataract
surgery. Other novel uses of biophotonics for corneal diseases include laser welding, ophthalmic light sensitive nanocarrier systems for the cornea and bacterial biofilm destruction on the contact lens. Laser welding provides immediate and stable watertight closure of wound edges, with reduction in the total/partial number of stitches after surgery, thus offering protection from external inflammation and foreign body sensation, along with optimal results in terms of postoperative induced astigmatism after cataract. We will discuss the applications of laser welding in corneal surgeries, corneal light sensitive nanocarrier systems, and disruption of bacterial biofilms on contact lenses.

**Commercial Relationships:** Dimitri Azar, Novartis (S), Novartis (I), Verily (Google) (S), Verb Surgical (S), Novartis (R), Verily (Google) (C)

**Program Number:** 5
**Presentation Time:** 9:44 AM–10:01 AM

**Light-based strategies to treat glaucoma**

_Tony Realini_. Ophthalmology, West Virginia University, Morgantown, WV.

**Presentation Description:** Laser energy can be utilized to achieve numerous beneficial effects in glaucomatous eyes. Numerous laser procedures are available for myriad clinical scenarios. It is useful to consider them in two groups based on whether their indication is primary or secondary. Primary procedures are those performed primarily in response to the disease state. Trabeculoplasty effectively lowers intraocular pressure (IOP) in eyes with open-angle forms of glaucoma. Iridotomy and iridoplasty are mainstays of therapy for primary pupillary-block and nonpupillary-block angle closure glaucoma, respectively. Cilioablative procedures, both ab interno and ab externo, can reduce IOP across the severity spectrum of open-angle glaucoma. Retinal ablation effectively reduces the production of stimuli of angiogenesis in neovascular glaucoma. Secondary procedures are those performed in response to, or necessitated by, prior interventions. Examples include lysis of scleral sutures or tube ligatures following filtration procedures, lysis of vitreous or iris tissue occluding outflow ostea, surface remodeling for overfiltering or dysesthetic blebs, capsulotomy for aqueous misdirection syndrome, and goniotractotomy after deep sclerectomy. Appropriate selection and application of laser therapy can provide effective alternatives to medical or incisional interventions and can enhance the outcomes of prior procedures.

**Commercial Relationships:** Tony Realini, Inotek (C), Smith and Nephew (C), Alcon (F), Bausch & Lomb (C), Alcon (C)

**Support:** NIH Grant R01EY023620

**Program Number:** 6
**Presentation Time:** 10:01 AM–10:18 AM

**Biophotonic treatment of tumors inside and around the eye**

_Arun D. Singh_. Ophthalmic Oncology, Cole Eye Institute, Cleveland Clinic Foundation, Cleveland, OH.

**Presentation Description:** Biophotonic treatment has broad applications in treatment of ocular tumors. Laser photocoagulation, thermotherapy, and photodynamic therapy can be delivered with low rates of complications and with ease in the outpatient setting. Review of the current literature suggests excellent results when these treatments are applied for benign tumors, particularly for vascular tumors such as circumscribed choroidal hemangioma. For primary malignant tumors, such as choroidal melanoma, thermotherapy and photodynamic therapy do not offer local tumor control rates that are equivalent or higher than those achieved with plaque or proton radiation therapy. However for secondary malignant tumors (choroidal metastases), thermotherapy and photodynamic therapy can be applied as a palliative treatment. Greater experience is necessary to fully comprehend risks, comparative benefits, and complication of ocular phototherapy of ocular tumors.

**Commercial Relationships:** Arun D. Singh, None