478 Visual functions and processes conserved across species - Minisymposium
Wednesday, May 10, 2017 3:45 PM–5:30 PM
Room 321 Minisymposium
Program #/Board # Range: 4785–4789
Organizing Section: Anatomy and Pathology/Oncology
Contributing Section(s): Cornea, Eye Movements/Strabismus/Amblyopia/Neuro-Ophthalmology, Genetics, Lens, Multidisciplinary Ophthalmic Imaging, Physiology/Pharmacology, Retinal Cell Biology, Visual Neuroscience, Visual Psychophysics/Physiological Optics

Program Number: 4785
Presentation Time: 3:50 PM–4:05 PM
Squid eye development and the evolution of complex visual systems
Kristen Koenig[2, 1]. [1]FAS Center for Systems Biology, Harvard University, Cambridge, MA; [2]Harvard University, Cambridge, MA.
Presentation Description: High functioning visual systems across the animal kingdom have many similarities. Some of these similarities are likely conserved from a common ancestor while others are convergent, resulting from confronting common functional problems. Our interest is to better understand the developmental mechanisms involved in generating high functioning visual systems as way to better understand this mix of conserved and convergent traits and to better understand the emergence of complexity in biological systems. We have established the squid, *Doryteuthis pealeii,* as a lophotrochozoan model for complex eye development. Utilizing histological, transcriptomic and molecular assays we have characterized eye formation in *Doryteuthis pealeii*. Through lineage tracing we have identified the sole source of retinal tissue and functional assays demonstrate that Notch signaling is required for photoreceptor cell differentiation and retina organization. This work highlights some of the common developmental mechanisms found during neurogenesis within visual organs.
Commercial Relationships: Kristen Koenig, None
Support: NIH Grant DP5-OD-023111

Program Number: 4786
Presentation Time: 4:05 PM–4:20 PM
Did the Eye Evolve Once or Multiple times? Evidence From the Effects of Visual Experience on Eye Development in Vertebrates and Non-Vertebrates
Jacob Sivak. Sch of Optometry, University of Waterloo, Waterloo, ON, Canada.
Presentation Description: It is speculated that the unitary eyes of vertebrates and molluscs and the compound eyes of insects and crustaceans evolved separately. However, the common use of rhodopsin as a photoreceptor molecule and the use of Pax 6 as a universal master control gene, suggest that the eye evolved once. Serendipitous discoveries involving form deprivation and positive and negative defocus with young monkeys and chicks demonstrate the importance of visual experience on eye development. The same results have been demonstrated in lower vertebrates (fish, tilapia), although eye anatomy, physiology and optics are very different. Since fish grow through life, these effects can also be demonstrated in adults. The cephalopod eye is an example of convergent evolution, although considerable developmental differences exist when compared to the vertebrate eye. Nevertheless, the visual environment has been shown to similarly affect squid eye refractive development. These common results add to the view that the eye evolved once.
Commercial Relationships: Jacob Sivak, None
Support: Natural Sciences and Engineering Research Council of Canada

Program Number: 4787
Presentation Time: 4:20 PM–4:35 PM
Evolution of lamellar branching in the cornea of vertebrates: An example of convergent evolution?
James Jester. Gavin Herbert Eye Institute, UC Irvine, Irvine, CA.
Presentation Description: Although the cornea is the major refractive element of the eye, the mechanisms controlling corneal shape and hence visual acuity remain unknown. To address this question we have used non-linear optical microscopy of second harmonic generated signals (SHG) from collagen to characterize the evolutionary and developmental changes that occur in corneal stromal lamellar collagen architecture. Our evolutionary studies show that there is a progression in complexity of the stromal lamellae from lower, aquatic to higher terrestrial vertebrates, leading to increasing tissue stiffness that may control shape. In boney and cartilaginous fish, the cornea is composed of orthogonally arranged, rotating collagen sheets that extend from limbus to limbus with little or no interaction between adjacent sheets, analogous to 'ply wood'. In amphibians and reptiles, these sheets are broken down into broader lamellae that begin to show branching and anastomosing with adjacent lamellae, but maintain their orthogonal, rotational organization. This paradigm is most complex in birds, which show the highest degree of lamellar branching and anastomosing, forming a 'chicken wire' like pattern most prominent in the midstroma. Mammals, on the other hand, diverged from the orthogonal, rotational organization and developed a random lamellar pattern with branching and anastomosing appearing highest in the anterior stroma, associated with higher mechanical stiffness compared to the posterior stroma. The stromal organizational pattern in non-mammalian vertebrates has been attributed to the corneal epithelium depositing a primary stroma and establishing a template for the deposition of secondary stroma by the corneal keratocytes. However, recent SHG imaging of developing chick cornea show that the complex rotational, branching and anastomosing pattern present in birds appears only after the full invasion by corneal keratocytes, similar to that observed in mammals. These findings suggest a convergence between avian and mammalian species towards a keratocyte-fabricated, collagen architecture necessary to build a stable refractive corneal structure compatible with higher visual acuity. Understanding the cellular, molecular and mechanical mechanisms controlling the building of this stromal architecture may help guide future efforts to correct refractive errors and design bioengineered corneal constructs.
Commercial Relationships: James Jester, None
Support: NIH Grant EY018665, UK BBSRC BB/M025349/1, unrestricted grant from Research to Prevent Blindness, Inc.

Program Number: 4788
Presentation Time: 4:35 PM–4:50 PM
Evolution of rod photoreceptors from fish to mammals
Belinda Chang. Ecol & Evol/Cell & Systems Biology, University of Toronto, Toronto, ON, Canada.
Presentation Description: The initial step in vision in all vertebrates is triggered via absorption of a photon by a visual pigment located in the photoreceptors of the eye. Variation in the functional properties of visual pigments can therefore have profound consequences on the visual capabilities of an organism. The visual system has a surprisingly large dynamic range, and is highly specialized for the efficient sensing of light in extremely diverse light environments. How is this achieved at the molecular level? My laboratory studies these and other questions such as the mechanisms of spectral tuning,

and the evolution of color vision, using a variety of interdisciplinary approaches, including ancestral reconstruction, computational sequence analysis, site-directed mutagenesis and protein expression.
Commercial Relationships: Belinda Chang, None
Support: NSERC Discovery grant

Program Number: 4789
Presentation Time: 4:50 PM–5:05 PM
How the visual system of primates differs from other mammals
Jon H. Kaas. Vanderbilt University, Nashville, TN.
Presentation Description: The visual system of primates differs from those of other mammals in several ways that might relate to research questions. Thus, retinal projections to the superior colliculus are restricted to those representing the unilateral visual hemifield, 80% of retinal ganglion cells project only to the lateral geniculate nucleus, the pulvinar complex has a unique organization, visual cortex is expansive and includes new visual areas, and an expanded posterior parietal cortex is devoted to primate specific visuomotor networks. My talk will briefly describe these differences and their implications for research.
Commercial Relationships: Jon H. Kaas, None
Support: NEI Grant EY002686-37A1