Ophthalmology

Division Photo

First Row: M. Yang, F. Hamada, S. Riazuddin, C. West, N. Brown, T. Cook, M. Bodack

Second Row: S. Lopper, D. Saltarelli, W. Motley, Z. Ahmed, R. Lang, D. Bonsall, R. North

Division Data Summary

Research and Training Details	
Number of Faculty	15
Number of Joint Appointment Faculty	2
Number of Research Fellows	8
Number of Research Students	4
Number of Support Personnel	18
Direct Annual Grant Support	$1,415,780
Peer Reviewed Publications	31

Clinical Activities and Training	
Number of Clinical Staff	15
Number of Clinical Students	12
Number of Other Students	6
Inpatient Encounters	2352
Outpatient Encounters	22690

Significant Publications

Riesenberg, A.N., Z. Liu, R. Kopan and N.L. Brown (2009) Rbpj cell autonomous regulation of retinal ganglion cell and cone photoreceptor fates in the mouse retina. Journal of Neuroscience 29:12865-77.

Featured on Journal Cover and on cover of 40th SFN Anniversary Supplement of invited monographs distributed at annual Society for Neuroscience Meeting. This paper significantly extends mechanistic understanding of Notch signaling regulation of vertebrate retinal neurogenesis.

Lomberk G, Imoto I, Gebelein B, Urrutia R, and Cook TA. Conservation of the TGF[beta]/labial homeobox signaling loop in endoderm-derived cells between Drosophila and mammals. Pancreatology 10:74-84, 2010

HoxA1 mutations are associated wtih autism, as well as Athabaskan brainstem dysgenesis syndrome and Bosley-Salih-Alorainy syndrome, disorders characterized by horizontal gaze palsy, deafness, central hypoventilation, and developmental delay. Up-regulation of HoxA1 is also linked with several cancers. In our study, we demonstrate that HoxA1expression is up-regulated in the pancreas by the TGFb signaling pathway, a pathway intimately linked with

pancreatic cancer. In addition, we map HoxA1's transcriptional regulatory function to the same region that encompasses the autism-linked codon variant. Thus, this paper should provide an important foundation for future studies related to cancer and autism.

Riazuddin S, Anwar S, Janssen A, Ahmed ZM, Khan SY, Belyantseva I, Jochen E, Friedman PL, Riazuddin S, Fahlke C, Friedman TB. Molecular basis of DFNB73: mutations of BSND are associated with nonsyndromic deafness or Bartter syndrome. Am J Hum Genet (2009). 85(2): 273-280.

Featured on Journal Cover page and in Editors' Corner of the American Journal of Human Genetics. This paper represents the first report on the identification of mutant allele of Barttin causing nonsyndromic hearing loss in humans and described a unique gentoype-phenotype correlation, which will be helpful for therapeutic inventions.

Kitajiri SI, Sakamoto T, Belyantseva IA, Goodyear RJ, Stepanyan R, Fujiwara I, Bird JE, Riazuddin S, Riazuddin S, Ahmed ZM, Hinshaw JE, Sellers J, Bartles JR, Hammer JA, Richardson GP, Griffith AJ, Frolenkov GI, Friedman TB. TRIOBP is a Novel Actin-Bundling Protein Required for Rootlet Formation and Rigidity of Hair Cell Stereocilia. Cell (2010). 141:786-798.

Featured on the Cover page of Cell, in Preview as well as in Faculty 1000 website. This paper significantly extends our knowledge about the development of hair cell stereocilia rootlets and function of Triobp as a novel action bundling protein.

Lin Shuei-Liong, Li B, Rao S, Yeo Eun-Jin, Hudson TE, Nowlin BT, Pei H, Chen L, Zheng JJ, Carroll TJ, Pollard JW, McMahon AP, Lang RA, Duffield JS. Macrophage Wnt7b is critical for kidney repair and regeneration. PNAS (2010) Mar 2;107(9):4194-9 PMID: 20160075 PMCID: PMC2840080

In this work, we showed that using the kidney as a model system, the signaling ligand Wnt7b produced by macrophages has an important role in tissue repair.

Division Highlights

Zubair Ahmed, PhD

Dr. Ahmed's research focuses on the identification and characterization of signaling pathways common between vision and sound perceptions. Last year, Dr. Ahmed's lab has contributed in the identification of three new genes that cause inherited hearing loss in the 60 human families and also characterized the novel actin bundling portein, TRIOBP. Dr. Ahmed's work was presented at the Annual meeting of American Society of Human Genetic, Hawaii and 2010 Annual meeting of Association for Research in Otolaryngology, Anaheim, CA. His work on Usher syndrome was recently recognized by Research Horizons.

Nadean Brown, PhD

In the past fiscal year, Nadean Brown was awarded a four year renewal of an NIH R01 grant on retinal neurogenesis. Dr. Brown gave invited research presentations at Washington University, Medical College of Wisconsin and Oxford University (England). She also was the principal organizer of the Midwest Society for Developmental Biology, held at Cincinnati Children's in May 2010. This conference had record attendance with participants from 25 research universities and institutes, located in 10 different states.

Tiffany Cook, PhD

Dr. Cook's research examines the processes underlying retina and lens formation. Last year, Dr. Cook's work was presented at the University of Idaho, Indiana, and Dayton, the Great Lakes Vision Research Conference, and the Gordon Research Conference on Visual Systems Development in Barga, Italy. Her retina work has led to several collaborative research projects, and was recognized for its applicability to better understanding genetically-based retinal degenerative disorders by Research Horizons and two families afflicted with this disease.

Fumika Hamada, PhD

The long-term goal of our research is to understand the molecular mechanisms of thermo- and pain sensation. In FY2010, we carried out a genetic screen using Drosophila, and identified a G-protein coupled receptor, whose mutants show defective temperature preference behavior. We hypothesize that the GPCR is required for temperature processing and may modulate activity of the warmth- or cold-sensitive neural circuits. The mammalian homologue of this GPCR is known to be involved in pain sensation. Therefore, an assessment of the GPCR function in the fly is likely to provide the basis for understanding pain in humans.

Richard Lang, PhD

Dr. Lang's laboratory continued making significant scientific contributions during FY2010. His lab has made important advances in our understanding of epithelial morphogenesis mechanisms and has shown that Cdc42-dependent filopodia are critical during the epithelial invagination that results in eye formation. Dr. Lang has also shown that during tissue repair, macrophages produce Wnt pathway ligands to re-capitulate the developmental programs that can re-build a damaged organ. Dr. Lang's research has wide-ranging implications for tissue repair therapies. In this past year, Dr. Lang has presented his work at the World Conference of Regenerative Medicine in Leipzig, Germany, at the Van Andel Research Institute in Grand Rapids, MI and the National Eye Institute at the National Institutes of Health.

Saima Riazuddin, PhD

Dr. Riazuddin's research focuses on the identification of genetic factors contributing to inherited hearing impairment in the human population. Last year, Dr. Riazuddin's lab identified two new genetic loci associated with recessive deafness and identified three new genes essential for normal hearing. Dr. Riazuddin's work was presented at the Annual meeting of American Society of Human Genetics in Hawaii and at the 2010 Annual meeting of Association for Research in Otolaryngology, Anaheim, CA. Her work on inherited hearing loss was recognized by Research Horizons and Deafness Research Foundation

Division Collaboration

Collaboration with Developmental Biology

Collaborating Faculty: Jim Wells
Wntless in Pancreas Development with Richard Lang
Collaboration with Developmental Biology

Collaborating Faculty: Aaron Zorn; Rashmi Hegde; Matt Kofron
CRIM1 Function with Richard Lang
Collaboration with Developmental Biology

Collaborating Faculty: Yutaka Yoshida
Wntless in Neurogenesis with Richard Lang
Collaboration with Developmental Biology

Collaborating Faculty: Geraldine Guasch
Sox2 and Wnt in Transitional Zone Formation with Richard Lang
Collaboration with Developmental Biology

Collaborating Faculty: Yi Zheng
GTPase Function in Morphogenesis with Richard Lang
Collaboration with Developmental Biology

Collaborating Faculty: Noah Shroyer
Wnts in Gut Regeneration with Richard Lang
Collaboration with Developmental Biology

Collaborating Faculty: Xinhua Liu
Wintless Funtion with Richard Lang
Collaboration with Immunobiology

Collaborating Faculty: Marsha Wills-Karp
Microglial Function in Vascular Patterning with Richard Lang
Collaboration with Developmental Biology

Collaborating Faculty: Brian Gebelein
Molecular control of Drosophila nervous system development with Tiffany Cook
Collaboration with Developmental Biology

Collaborating Faculty: Rashmi Hegde
Molecular modeling of USH1 protein to identify the affect on the structure with Zubair Ahmed
Collaboration with Developmental Biology

Collaborating Faculty: Saulius Sumanus
Analysis of functional variants causing USH1 using zebrafish as a model system with Zubair Ahmed
Collaboration with Ophthalmology

Collaborating Faculty: Robert Sisk
Genetic studies of retinal disorders, particularly, Blue Cone Monochromat syndrome with Zubair Ahmed
Collaboration with Molecular Cardiology

Collaborating Faculty: Katherine Yutzey
Jag1 and Rbpj regulations of lens, heart and liver development with Nadean Brown
Collaboration with Developmental Biology

Collaborating Faculty: Xinhua Lin
Characterization of a novel Drosophila BTB domain gene with Nadean Brown
Collaboration with Otolaryngology

Collaborating Faculty: David Brown
Universal newborn hearing screen with Saima Riazuddin
Collaboration with Otolaryngology

Collaborating Faculty: Ravi Samy
Geentics of hearing loss with Saima Riazuddin
Collaboration with Developmental Biology

Collaborating Faculty: Saulius Sumanas
Analysis of DFNB26 mutation usingZebrafish as a model system with Saima Riazuddin

Faculty Members

Constance E. West, MD, Associate Professor ; *Division Director*

James J. Augsburger, MD, FACS, Professor ; *Chairperson, Department of Ophthalmology*

Richard A. Lang, PhD, Professor ; *Emma & Irving Goldman Scholar ; Head, Visual Systems Group*

Zubair Ahmed, PhD, Assistant Professor

Marie I. Bodack, OD, FAAO, FCOVD, Instructor Clinical

Dean J. Bonsall, MD, MS, FACS, Associate Professor

Tiffany Cook, PhD, Assistant Professor

Fumika Hamada, PhD, Assistant Professor

Adam H. Kaufman, MD, FACS, Associate Professor

Sarah Lopper, OD, Instructor Clinical

William Walker Motley, MD, MS, Assistant Professor

Robert B. North, DO, MBA, FACS, Assistant Professor

Daniele Saltarelli, OD, Instructor Clinical

Robert Sisk, MD, Assistant Professor

Michael B. Yang, MD, Associate Professor

Joint Appointment Faculty Members

Nadean Brown, PhD, Associate Professor
Department of Developmental Biology

Saima Riazuddin, PhD, Assistant Professor
Department of Otolaryngology

Clinical Staff Members

- **Laurie Hahn-Parrott, CO, COT, MBA**
- **Corey Bowman, COT, LDO, ABOC**
- **Brandy Dearwater, COA**
- **Adrienne Distler, COA**
- **Jennifer Duncan, COA**
- **Lisa Fite, COA**
- **Ashley Jackson, COA**
- **Debbie Lipps, COA**
- **Patty Lucas, COA**
- **Melody Klayer,**
- **Judy Masters, COT**
- **Nicole McLeod, COA**
- **Debbie Meister, COA**
- **Jill Simmons, COA**
- **Kelli Vieson, COT**

Trainees

- **Hope Brown, ,** Undergraduate Student, Georgia Institute of Technology, Atlanta, GA
- **Manpreet Chhabra, MD,** Ophthalmology Resident, University of Cincinnati, Cincinnati, OH
- **Ian Conner, MD,** Ophthalmology Resident, University of Cincinnati, Cincinnati, OH
- **April Carpenter-Elrod, PhD,** Research Fellow, Hospital for Special Surgery, New York, NY
- **Bharesh Chauhan, PhD,** Research Associate, Oxford University, Oxford England
- **Abigail Evans, ,** Undergraduate Student, The Ohio State Unversity, Columbus, OH
- **Jieqing Fan, ,** Graduate Student, Tsinghua University, Beijing, China
- **Raja Goli, MD,** Ophthalmology Resident, University of Cincinnati, Cincinnati, OH
- **M. Victoria Gomez, ,** Undergraduate Student, Xavier University, Cincinnati, OH
- **Michael Gray, MD,** Ophthalmology Resident, University of Cincinnati, Cincinnati, OH
- **Faiz Khaja, MD,** Ophthalmology Resident, University of Cincinnati, Cincinnati, OH
- **Haruna Kaneko, PhD,** Research Fellow, Tokyo Medical and Dental University, Japan
- **Rachel Kominsky, ,** Undergraduate Student, Xavier University, Cincinnati, OH
- **Manna Li, PhD,** Research Fellow, Peking University Health Science Center, Beijing, China
- **Tianyi Lu, ,** Summer Student, Duke University, Durhan, NC
- **Amina Malik, MD,** Ophthalmology Resident, University of Cincinnati, Cincinnati, OH
- **Kate Maurer, ,** Graduate Student, Susquehanna University, Sellinsgrove, PA
- **Elizabeth McDonald, ,** Graduate Student, Hartwick College, Oneonta, NY
- **Mehta Mitul, MD,** Ophthalmology Resident, University of Cincinnati, Cincinnati, OH
- **Myung-Soon Moon, PhD,** Research Fellow, University of Wisconsin, Madison, WI
- **Jamey Osher, MD,** Ophthalmology Resident, University of Cincinnati, Cincinnati, OH
- **Timothy Plageman, PhD,** Research Fellow, University of Cincinnati, Cincinnati, OH
- **Virgilio Ponferrada, PhD,** Research Associate, Wright State University, Dayton, OH
- **Sujata Rao, PhD,** Research Associate, Cornell University, Ithaca, New York

- **Ashley Riesenberg, ,** Undergraduate Student, University of Cincinnati, Cincinnati, OH
- **Tomohito Sato, MD,** Visiting Research Scientist, National Medical College, Japan
- **Scott Schoenberger, MD,** Ophthalmology Resident, University of Cincinnati, Cincinnati, OH
- **Adeel Shaikh, MD,** Ophthalmology Resident, University of Cincinnati, Cincinnati, OH
- **Eric Speckner, MD,** Ophthalmology Resident, University of Cincinnati, Cincinnati, OH
- **James A. Stefater, ,** Graduate Student, Centre College, Danville, KY
- **Larry Tenkman, MD,** Ophthalmology Resident, University of Cincinnati, Cincinnati, OH
- **David Terrell, ,** Graduate Student, Texas State University - San Marcos, San Marcos, TX
- **Baotong Xie, PhD,** Research Fellow, Chinese Academy of Sciences, Beijing, China
- **Eun-Jin Yeo, PhD,** Research Fellow, Seoul National University, Seoul, South Korea
- **Rizwan Yousaf, ,** Graduate Student, Center for Excellence in Molecular Biology, Pakistan
- **Yoshiaki Ueda, MD,** Visiting Research Scientist, National Defense Medical College, Japan

Significant Accomplishments

Visual Systems Group

The Visual Systems Group, part of the Division of Ophthalmology, welcomed a new faculty member to our team this year. Fumika Hamada, PhD, from Brandeis University, studies the molecular mechanisms of heat and pain sensation in drosophila. Her recruitment continues to fulfill the mission of Constance West, MD, and Richard Lang, PhD, to develop a successful visual systems basic science research initiative at Cincinnati Children's. As we enter the coming year, our focus remains dedicated to studying the development and disease processes of visual systems.

Division Publications

1. Kehat R, Bonsall DJ, North R, Connors B. Ocular findings of oral sildenafil use in term and near-term neonates. *J AAPOS.* 2010; 14: 159-62.
2. Lomberk GA, Imoto I, Gebelein B, Urrutia R, Cook TA. Conservation of the TGFbeta/Labial homeobox signaling loop in endoderm-derived cells between Drosophila and mammals. *Pancreatology.* 2010; 10: 74-84.
3. Hufnagel RB, Le TT, Riesenberg AL, Brown NL. Neurog2 controls the leading edge of neurogenesis in the mammalian retina. *Dev Biol.* 2010; 340: 490-503.
4. Plageman TF, Jr., Chung MI, Lou M, Smith AN, Hildebrand JD, Wallingford JB, Lang RA. Pax6-dependent Shroom3 expression regulates apical constriction during lens placode invagination. *Development.* 2010; 137: 405-15.
5. Odeh H, Hunker KL, Belyantseva IA, Azaiez H, Avenarius MR, Zheng L, Peters LM, Gagnon LH, Hagiwara N, Skynner MJ, Brilliant MH, Allen ND, Riazuddin S, Johnson KR, Raphael Y, Najmabadi H, Friedman TB, Bartles JR, Smith RJ, Kohrman DC. Mutations in Grxcr1 are the basis for inner ear dysfunction in the pirouette mouse. *Am J Hum Genet.* 2010; 86: 148-60.
6. Motley WW, 3rd, Vanderveen DK, West CE. Surgical management of infantile cataracts in dystrophic epidermolysis bullosa. *J AAPOS.* 2010; 14: 283-284.
7. Pandey RN, Rani R, Yeo EJ, Spencer M, Hu S, Lang RA, Hegde RS. The Eyes Absent phosphatase-transactivator proteins promote proliferation, transformation, migration, and invasion of tumor cells. *Oncogene.* 2010; 29: 3715-22.
8. Lin SL, Li B, Rao S, Yeo EJ, Hudson TE, Nowlin BT, Pei H, Chen L, Zheng JJ, Carroll TJ, Pollard JW, McMahon AP, Lang RA, Duffield JS. Macrophage Wnt7b is critical for kidney repair and regeneration. *Proc Natl Acad Sci U S A.* 2010; 107: 4194-9.
9. Sousa KM, Villaescusa JC, Cajanek L, Ondr JK, Castelo-Branco G, Hofstra W, Bryja V, Palmberg C, Bergman T, Wainwright B, Lang RA, Arenas E. Wnt2 regulates progenitor proliferation in the developing ventral midbrain. *J Biol Chem.* 2010; 285: 7246-53.
10. Rehman AU, Morell RJ, Belyantseva IA, Khan SY, Boger ET, Shahzad M, Ahmed ZM, Riazuddin S, Khan SN, Friedman TB. Targeted capture and next-generation sequencing identifies C9orf75, encoding taperin, as the mutated gene in nonsyndromic deafness DFNB79. *Am J Hum Genet.* 2010; 86: 378-88.
11. Rutstein RP, Quinn GE, Lazar EL, Beck RW, Bonsall DJ, Cotter SA, Crouch ER, Holmes JM, Hoover DL, Leske DA, Lorenzana IJ, Repka MX, Suh DW. A randomized trial comparing Bangerter filters and patching for the treatment of moderate amblyopia in children. *Ophthalmology.* 2010; 117: 998-1004 e6.
12. Kitajiri S, Sakamoto T, Belyantseva IA, Goodyear RJ, Stepanyan R, Fujiwara I, Bird JE, Riazuddin S, Ahmed ZM, Hinshaw JE, Sellers J, Bartles JR, Hammer JA, 3rd, Richardson GP, Griffith AJ, Frolenkov GI, Friedman TB. Actin-bundling protein TRIOBP forms resilient rootlets of hair cell stereocilia essential for hearing. *Cell.* 2010; 141: 786-98.
13. Smith AN, Radice G, Lang RA. Which FGF ligands are involved in lens induction? *Dev Biol.* 2010; 337: 195-8.
14. Yang MB. Extrusion of non-absorbable suture from a supereior oblique tuck without loss of surgical effect. *Binocul Vis Strabismus Q.* 2009; 24: 99-102.

15. Anandajeya WV, Correa ZM, Augsburger JJ. Primary acquired melanosis with atypia treated with mitomycin C. *Int Ophthalmol.* 2009; 29: 285-8.
16. Qian B, Deng Y, Im JH, Muschel RJ, Zou Y, Li J, Lang RA, Pollard JW. A distinct macrophage population mediates metastatic breast cancer cell extravasation, establishment and growth. *PLoS One.* 2009; 4: e6562.
17. Riazuddin S, Anwar S, Fischer M, Ahmed ZM, Khan SY, Janssen AG, Zafar AU, Scholl U, Husnain T, Belyantseva IA, Friedman PL, Friedman TB, Fahlke C. Molecular basis of DFNB73: mutations of BSND can cause nonsyndromic deafness or Bartter syndrome. *Am J Hum Genet.* 2009; 85: 273-80.
18. Shaham O, Smith AN, Robinson ML, Taketo MM, Lang RA, Ashery-Padan R. Pax6 is essential for lens fiber cell differentiation. *Development.* 2009; 136: 2567-78.
19. Kehat R, Bonsall DJ. Recurrent corneal metallic foreign bodies in children with autism spectrum disorders. *J AAPOS.* 2009; 13: 621-2.
20. Maksimovic S, Cook TA, Buschbeck EK. Spatial distribution of opsin-encoding mRNAs in the tiered larval retinas of the sunburst diving beetle Thermonectus marmoratus (Coleoptera: Dytiscidae). *J Exp Biol.* 2009; 212: 3781-94.
21. Tompkins DH, Besnard V, Lange AW, Wert SE, Keiser AR, Smith AN, Lang R, Whitsett JA. Sox2 is required for maintenance and differentiation of bronchiolar Clara, ciliated, and goblet cells. *PLoS One.* 2009; 4: e8248.
22. Yang MB, Donovan EF. Risk analysis and an alternative protocol for reduction of screening for retinopathy of prematurity. *J AAPOS.* 2009; 13: 539-45.
23. Augsburger JJ, Correa ZM, Shaikh AH. Effectiveness of treatments for metastatic uveal melanoma. *Am J Ophthalmol.* 2009; 148: 119-27.
24. Bodack MI. Ptosis and cranial nerve IV palsy reveal juvenile myasthenia gravis. *Optometry.* 2009; 80: 342-9.
25. Schultz JM, Khan SN, Ahmed ZM, Riazuddin S, Waryah AM, Chhatre D, Starost MF, Ploplis B, Buckley S, Velasquez D, Kabra M, Lee K, Hassan MJ, Ali G, Ansar M, Ghosh M, Wilcox ER, Ahmad W, Merlino G, Leal SM, Friedman TB, Morell RJ. Noncoding mutations of HGF are associated with nonsyndromic hearing loss, DFNB39. *Am J Hum Genet.* 2009; 85: 25-39.
26. Chauhan BK, Disanza A, Choi SY, Faber SC, Lou M, Beggs HE, Scita G, Zheng Y, Lang RA. Cdc42- and IRSp53-dependent contractile filopodia tether presumptive lens and retina to coordinate epithelial invagination. *Development.* 2009; 136: 3657-67.
27. Riesenberg AN, Liu Z, Kopan R, Brown NL. Rbpj cell autonomous regulation of retinal ganglion cell and cone photoreceptor fates in the mouse retina. *J Neurosci.* 2009; 29: 12865-77.
28. Makarenkova HP, Hoffman MP, Beenken A, Eliseenkova AV, Meech R, Tsau C, Patel VN, Lang RA, Mohammadi M. Differential interactions of FGFs with heparan sulfate control gradient formation and branching morphogenesis. *Sci Signal.* 2009; 2: ra55.
29. Smith AN, Miller LA, Radice G, Ashery-Padan R, Lang RA. Stage-dependent modes of Pax6-Sox2 epistasis regulate lens development and eye morphogenesis. *Development.* 2009; 136: 2977-85.
30. Waryah AM, Rehman A, Ahmed ZM, Bashir ZH, Khan SY, Zafar AU, Riazuddin S, Friedman TB. DFNB74, a novel autosomal recessive nonsyndromic hearing impairment locus on chromosome 12q14.2-q15. *Clin Genet.* 2009; 76: 270-5.
31. Laham A, Correa ZM, Augsburger JJ, Heur M. Complete ring cyst of iris pigment epithelium documented by ultrasound biomicroscopy. *Ophthalmic Surg Lasers Imaging.* 2009; 40: 495-7.

Grants, Contracts, and Industry Agreements

Grant and Contract Awards — Annual Direct / Project Period Direct

Ahmed, Z

Molecular Genetics of Usher Syndrome Type I
National Institutes of Health
R00 DC 009287 — 08/01/09 - 07/31/12 — $182,423 / $520,486

Cook, T

Pros/Prox1 and Lens Development in Drosophila
National Institutes of Health
R01 EY 017907 — 09/15/07 - 07/31/12 — $225,000 / $1,125,000

Lang, R

Developing Vision: Cadherin Function in Lens Morphogenes
National Institutes of Health
R01 EY 016241 — 09/09/05 - 08/31/10 — $242,758 / $1,217,544

Targeting Survival Factors for Ocular NV
The Johns Hopkins University (National Institutes of Health)
R01 EY 012609 — 04/01/08 - 03/31/12 — $20,400 / $81,600

Macrophages and Tumor Angiogenesis
Albert Einstein College of Medicine (National Institutes of Health)
R01 CA 131270 12/01/07 - 11/30/12 $104,000 / $479,000

RhoGTPases in Early Eye Development
National Institutes of Health
R01 EY 017848 04/06/07 - 03/31/12 $222,750 / $843,750

The Roles of Sox2 in Lens and Retinal Development
US-Israel Binational Science Foundation
02/01/09 - 01/31/13 $13,000 / $59,956

CRIM1-b-Catenin-Cadherin Interactions in Eye Development
National Institutes of Health
R01 EY 019377 06/01/09 - 05/31/11 $248,963 / $498,963

Eyes Absent Phosphatase Inhibitors in Eye Disease
National Institutes of Health
R21 EY 019125 08/01/09 - 07/31/11 $150,000 / $150,000

West, C

Save Our Sight Ohio Amblyope Registry
The Research Institute at Nationwide Hosp (Ohio Department of Health)
02530011AR0109 07/01/08 - 06/30/10 $6,486 / $12,783

Current Year Direct **$1,415,780**

Total $1,415,780