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Research Interests

The GROW research laboratory was established in 2013 with the goal of performing patient directed, discovery research for application in future diagnostics, drug repurposing and novel therapies. The laboratory focuses on understanding the genetic and molecular signaling mechanisms driving pathogenesis of ocular disorders and cancers. In particular, we are interested in signal cascades that determine the course and severity of the disorders for applications in early clinical diagnosis, identification of biomarkers of disease and novel therapeutic targets. The laboratory research techniques focus on identifying biomarkers from primary patient samples by genetics, transcriptomic analyses, protein biochemistry, mass spectrometry and flow cytometric methods followed by modeling the pathologic conditions in relevant cell culture and *in vivo* animal models. The laboratory is part of a teaching hospital and collaborates continuously with clinicians to develop novel diagnostics and advanced therapeutic applications including drug repurposing for new indications. A database of mutations and genes associated with genetic diseases within the Indian population has been established for future recombinant vector-based gene therapy and cell replacement modalities. The Gene Therapy platform focuses on recombinant Adeno-associated virus (AAV) as the transfer vehicle utilizing multiple pseudotyped capsids for efficient treatment of inherited diseases. We are also developing dual AAV vector technologies for the delivery of large therapeutic transgenes. A clinical grade gene therapy vector production platform has now been developed at GROW lab and various functional genetics studies are being done with the aim of performing human gene therapy clinical trials in India. The lab also trains graduate scholars (for PhD degree), clinical fellows and post doctoral fellows.

List Of Publications

Research Articles

1. Liu H[†], Ghosh S[†], Vaidya T[†], Bammidi S, Huang C, Shang P, Nair AP, Chowdhury O, Stepicheva N, Strizhakova A, Hose S, Mitrousis N, Gopikrishna Gadde S, Thirumalesh MB, Strassburger P, Widmer G, Lad EM, Fort PE, Sahel JA, Zigler JS, Sethu S, Westenskow PD, Proia AD, Sodhi A, **Ghosh A***, Feenstra D*, Sinha D*. Activated cGAS-Sting Signaling elicits endothelial cell senescence in Diabetic Retinopathy. *JCI Insight*. (Accepted 2023)
2. South Asian Medical Cohorts Reveal Strong Founder Effects and High Rates of Homozygosity. Wall J, Sathirapongsasuti J, Gupta R, (GenomeAsia consortium authors), Ramprasad V, Kukkle P, Seshagiri S, Kathiresan S, **Ghosh A**, Mohan V, Saleheen D, Stawiski E, and Peterson A. *Nature Communications*. (Accepted 2023)
3. Gijs M, Arumugam S, van de Sande N, Webers CAB, Sethu S, **Ghosh A**, Shetty R, Vehof J, Nuijts RMMA. Pre-analytical sample handling effects on tear fluid protein levels. *Sci Rep*. 2023 Jan 24;13(1):1317
4. Suresh Babu V, Kizhakeyil A, Dudeja G, Chaurasia SS, Barathi VA, Heymans S, Verma NK, Lakshminarayanan R, and **Ghosh A***. Selective Induction of Intrinsic Apoptosis in Retinoblastoma Cells by Novel Cationic Antimicrobial Dodecapeptides. *Pharmaceutics* 2022 Nov 18;14(11):2507
5. Suresh Babu V, Bisht A, Mallipatna A, Sa D, Dudeja G, Kannan R, Shetty R, Guha N, Heymans S, **Ghosh A***. Enhanced Epithelial-to-Mesenchymal Transition and Chemoresistance in Advanced Retinoblastoma Tumors Is Driven by miR-181a. *Cancers* (Basel). 2022 Oct 19;14(20):5124.
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9. D'Souza S, Vaidya T, Nair AP, Shetty R, Kumar NR, Bisht A, Panigrahi T, J TS, Khamar P, Dickman MM, Agrawal R, Mahajan S, Sengupta S, Nuijts RMMA, Sethu S*, **Ghosh A***. Altered Ocular Surface Health Status and Tear Film Immune Profile Due to Prolonged Daily Mask Wear in Health Care Workers. *Biomedicines*. 2022 May 18;10(5):1160.
10. D'Souza S, Shetty R, Nair AP, Agrawal R, Dickman MM, Khamar P, Nuijts RMMA, **Ghosh A***, Sethu S*. Corneal Confocal Microscopy Features and Tear Molecular Profile in Study Participants with Discordance between Ocular Surface Disease Clinical Signs and Discomfort. *J Clin Med*. 2022 Apr 25;11(9):2407.
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87. Lei B, Zhang K, Yue Y, **Ghosh A**, Duan D. Adeno-associated virus serotype-9 mediated retinal outer plexiform layer transduction is mainly through photoreceptors. *Adv Exp Med Biol*. 2010; 664:671-8.
88. Sharma A, **Ghosh A**, Hansen ET, Newman JM, Mohan RR. Transduction efficiency of AAV 2/6, 2/8 and 2/9 vectors for delivering genes in human corneal fibroblasts. *Brain Res Bulletin*. 2010 Feb 15;81(2-3):273-8.
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97. Lai Y, Yue Y, Liu M, **Ghosh A**, Engelhardt JF, Chamberlain JS, Duan D. Efficient in vivo gene expression by trans-splicing adeno-associated viral vectors. *Nature Biotechnology*. 2005 Nov;23(11):1435-9.

Review articles, book chapters and letters:

98. Panikker P, Roy S, Ghosh A, Poornachandra B, **Ghosh A**. Advancing precision medicines for ocular disorders: Diagnostic genomics to tailored therapies. *Front Med* (Lausanne). 2022 Jul 15;9:906482.
99. Mohan RR, Kempuraj D, D'Souza S, **Ghosh A**. Corneal stromal repair and regeneration. *Prog Retin Eye Res*. 2022 May 29:101090.
100. Jeyabalan N, Ghosh A, Mathias GP, **Ghosh A**. Rare eye diseases in India: A concise review of genes and genetics. *Indian J Ophthalmol*. 2022 Jul;70(7):2232-2238.
101. Das S, D'Souza S, Gorimanipalli B, Shetty R, **Ghosh A***, Deshpande*. Ocular Surface Infection Mediated Molecular Stress Responses: A Review. *Int J Mol Sci* 2022 Mar 14;23(6):3111.
102. Chakrabarty K, Shetty R, Argulwar S, Das D, **Ghosh A**. Induced pluripotent stem cell-based disease modeling and prospective immune therapy for coronavirus disease 2019. *Cytotherapy*. 2021 Sep 14:S1465-3249(21).
103. Gopinath C, Sarkar S and **Ghosh A**. Gene Therapy For Retinal Diseases. *Advances in Vision Research Volume III: Genetic Eye Research*. Springer Nature. (Invited Book Chapter). 2021.
104. Shetty R, D'Souza S, Khamar P, **Ghosh A**, Nuijts RMMA, Sethu S. Biochemical Markers and Alterations in Keratoconus. *Asia Pac J Ophthalmol (Phila)*. 2020 Dec;9(6):533-540.
105. Shetty R, Murugeswari P, Chakrabarty K, Jayadev C, Matalia H, **Ghosh A**, Das D. Stem cell therapy in coronavirus disease 2019: current evidence and future potential. *Cytotherapy*. 2020 Nov 9:S1465-3249(20)30932-4.
106. Shetty R, **Ghosh A**, Honavar SG, Khamar P, Sethu S. Therapeutic opportunities to manage COVID-19/SARS-CoV-2 infection: Present and future. *Indian J Ophthalmol*. 2020 Mar 28.
107. Martin LM, Jeyabalan N, Tripathi R, Panigrahi T, Johnson PJ, **Ghosh A**, Mohan RR. Autophagy in corneal health and disease: A concise review. *Ocul Surf*. 2019 Jan 25.
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109. Sailer MH, Sahu GR, **Ghosh A**. Pharmaco-Gene Therapy. (Invited book chapter) *Gene and Cell therapy: Biology and applications*. Elsevier Press 2018; ISBN 978-981-13-0480-4.
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111. Nishtala K, Pahuja N, Shetty R, Nuijts RM, **Ghosh A**. Tear biomarkers for Keratoconus. (Invited review). *Eye Vis* (Lond). 2016 Aug 4;3:19.
112. **Ghosh A**, Shetty R, Chaurasia SS. Author Response: Causal Management of Keratoconus: Controlling Inflammation. *Invest Ophthalmol Vis Sci*. 2016 Apr 1;57(4):2165
113. Gopinath C, Nathar TJ, **Ghosh A**, Hickstein DD, Nelson EJ. Contemporary Animal Models For Human Gene Therapy Applications. *Curr Gene Ther*. 2015 Sep 29.
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115. Jeyabalan N, Shetty R, Ghosh A, Anandula VR, **Ghosh A**, Kumaramanickavel G. Genetic and genomic perspective to understand the molecular pathogenesis of keratoconus. *Indian Journal of Ophthalmology* 2013 Aug;61(8):384-8.

116. Thiruvengadathan R, Korampally V, **Ghosh A**, Chanda N, Gangopadhyay K and Gangopadhyay S. Nanomaterial Processing using Self Assembly - Bottom-Up Chemical and Biological Approaches and Top-Down Patterning Processes. *Reports on Progress in Physics. (Invited article)*. 2013 Jun; 76(6):066501.
117. **Ghosh A***, Tergaonkar V. Extra-telomeric roles of telomeric proteins. *Reviews on Selected Topics of Telomere Biology* 2012. ISBN 978-953-51-0849-8 *Intech. (Invited book chapter). (* Corresponding author)*.
118. **Ghosh A**, Tergaonkar V. Telomeres and Inflammation: Rap1 joins the ends? *Cell Cycle* 2010 Oct 1;9(19):3834-3835. (Invited "Extra View" article).
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PATENTS

- Adeno associated virus (AAV) mediated Lysyl Oxidase gene therapy for Keratoconus and the constructs thereof. Subhradeep Sarkar, Pooja Khamar, Rohit Shetty and Arkasubhra Ghosh (Application no. 202341034428)
- A hybrid dual AAV vector system with splice enhancer elements for expression of large genes. Chitra Gopinath and Arkasubhra Ghosh. (Application no. 202341034269)
- Truncated Dystrophin sequences for Gene Therapy of Duchenne Muscular Dystrophy. Ruchita Selot and Arkasubhra Ghosh. (Application no. 202341028208)
- A topical formulation for alleviating inflammatory and ectatic signs and symptoms for ocular conditions. Rohit Shetty, Swaminathan Sethu, **Arkasubhra Ghosh** (Application no: 6182/2019-CHE)
- Biomarkers for diagnosis of ocular diseases and the method thereof. **Arkasubhra Ghosh**, Rohit Shetty, Narendra Pindipapanahalli, Swaminathan Sethu (Application no: PCT/IB2019/054472)
- Angiogenin as a diagnostic or prognostic biomarker and drug target in age-related macular degeneration. Priyanka Chevour, Narendra P, K. Bhujang Shetty, Swaminathan Sethu, **Arkasubhra Ghosh** (Application no: PCT/IB2017/051998).
- Set of biomarkers to identify early diabetic retinopathy, retinal angiogenic diseases and resistance to ocular anti-VEGF therapy. **Arkasubhra Ghosh**, Santosh Gopi Krishna, Naresh Yadav, Priyanka Chevour, Narendra P, K. Bhujang Shetty. (Application no: 2251/CHE/2016)
- A quantitative testing of vitamins in tears and topical ophthalmic composition for treatment of ocular diseases. Rohit Shetty, Swaminathan Sethu, **Arkasubhra Ghosh** (Application no: 3818/CHE/2015)
- A process for identification of biomarkers for Keratoconus progression. 2013. Roger Bueurman, **Arkasubhra Ghosh**, Rohit Shetty, Zhou Lei and Debashish Das (provisional patent 110/CHE/2013)
- A Transgene-independent Hybrid Vector System Expands Adeno-associated Viral Vector Packaging Capacity. 2009. Dongsheng Duan, **Arkasubhra Ghosh** and Yongping Yue. (US 2010/0003218 A1)
- Dual vector technology for AAV mediated gene transfer. 2005. Dongsheng Duan, **Arkasubhra Ghosh** and Yongping Yue.

Education

Ph.D.	09/2007	Gene therapy/Virology	Department of Molecular Microbiology and Immunology, School of Medicine, Univ. of Missouri - Columbia, MO, USA. (Life Science Fellow)
M.S.	07/2000	Microbiology	Dept. of Microbiology, Nagpur University, Nagpur, India (First Division, Rank 2 nd).
B.S.	07/1998	Chem., Microbio., Zoology	Dharampeth Science College, Nagpur University, Nagpur, India (First Division, Rank 2 nd).

Other Experience and Professional Memberships

2012-present	ARVO (The Association for Research in Vision and Ophthalmology)
2014-present	IERG (Indian Eye Research Group)
2015-Present	ISER (International Society for Eye Research)
2003-2010	ASGCT (American Society of Gene and Stem Cell Therapy)
2012-2014	AIOS (All India Ophthalmological society)

Editorial board member:

eLife
 Translational vision science and technology (ARVO journal)
 Indian Journal of Ophthalmology

Academic appointments, awards and invitations

- 2022 5 ARVO International travel awards. (2 students, 3 clinical fellows) ARVO Annual conference, Denver.
- 2021 ARVO Minisymposium talk "Corneal wound healing: basic mechanisms and therapeutic approaches"
- 2020 1 ARVO International travel awards. (1 student) ARVO Annual conference, Baltimore (Canceled).
- 2019 Organiser of ARVO SIG session; 1 ARVO International travel awards. (1 student) ARVO Annual conference, Vancouver.
- 2018 Invited faculty talk at ISER (International Society for Eye Research), Belfast, Ireland.
- 2018 4 ARVO International travel awards. (2 students, 2 clinical fellows) ARVO Annual conference, Hawaii.
- 2018 ARVO paper "Retinoblastoma regulates cellular energetics through hexokinase dependent AMPK activation." ARVO Annual Conference. Honolulu, USA.
- 2017 3 ARVO International travel awards. (1 student, 2 clinical fellow) ARVO Annual conference, Baltimore.
- 2017 Invited faculty talk at IERG (Indian Eye Research Group) Madurai.
- 2017 ARVO paper "Elevated Angiogenin levels associated with both forms of age-related macular degeneration is regulated by hypoxia and telomerase". ARVO Annual conference Baltimore.
- 2016 2 ARVO International travel awards. (1 PI, 1 clinical fellow). ARVO Annual conference, Seattle.
- 2016 Invited faculty talk at ISER (International Society for Eye Research) Japan.
- 2015 ARVO International travel award. Discovery of novel cell cycle regulatory and signal transduction modules driving Retinoblastoma using a correlative multi-omics approach. ARVO Annual conference Denver.
- 2015 2 ARVO International travel awards. (Self and student) Discovery of novel cell cycle regulatory and signal transduction modules driving Retinoblastoma using a correlative multi-omics approach. ARVO Annual conference Denver.
- 2015 Recognised as PhD Guide at VIT (Vellore Institute of Technology), School of BioSciences and BioTechnology, Vellore, India
- 2015 Appointed as Adjunct Scientist, Mazumdar Shaw Center for Translational Research, Bangalore, India.
- 2014 Appointed Adjunct Faculty at the Singapore Eye Research Institute, Singapore
- 2014 Invited Faculty at IERG (Indian Eye Research Group) Biennial meeting, India
- 2013 Invited Faculty lectures (Gene Therapy, Nanomedicine) at Asia-ARVO, India
- 2013 Invited Faculty lecture at Asia-Pacific Academy of Ophthalmology Congress, India
- 2013 Chair, Disease mechanisms and Instructor, Genetics of orbit and anterior segment. Asia-Pacific Academy of Ophthalmology Congress.
- 2013 Recognised as PhD Guide under RGUHS (Rajiv Gandhi University of Health Sciences), Faculty of medicine, Department of Microbiology, Bangalore, India
- 2010-2012 Panel judge for the Annual Singapore Science and Education Fair, Singapore Science Center.
- 2008 Excellence in Research award - The American Society of Gene Therapy.
- 2008 The American Society of Gene Therapy Travel award. Systemic AAV-9 delivery in normal dog leads to high-level persistent transduction in whole body skeletal muscle. ASGT annual conference, Boston.
- 2008 Panel judge for the Life Science Week poster competition, 2008 (University of Missouri-Columbia)
- 2008 Dysferlin (Jain) Foundation award for best contributor to the dysferlin scientific forum.
- 2006 The American Society of Gene Therapy Travel award. A Novel Hybrid System Efficiently Expands AAV Packaging Capacity. ASGT annual conference, Baltimore.
- 2005 1st Place at the Missouri Life Sciences Week poster competition, Columbia, USA. Title: Packing in Portions in the right bags: Expanding the Capacity of AAV-Mediated Gene Therapy.
- 2003 2nd Place at the Missouri Life Sciences Week poster competition, Columbia, USA. Title: Membrane protein P43 (EntS) participates in enterobactin release from *Escherichia coli*.
- 2002-2006 Life Science predoctoral fellowship at the University of Missouri-Columbia, USA.
- 2002 2nd Place at the National Symposium on "Perspectives in Integrated Plant Disease Management", Nagpur, India Poster competition. Title: Management of bacterial blight of cotton with the use of plant leaf extracts.
- 2001 Qualified the NET (National Eligibility Test, conducted by the University Grants Commission, India)
- 2001 All India rank 75th in GATE (Graduate Aptitude Test in Engineering and Biomedical Sciences, conducted by the Indian Institutes of Technology and Indian Institute of Science).
- 1999 VSRP Fellowship (visiting scholar) at Tata Institute of Fundamental Research (TIFR), Mumbai, India.

Teaching and mentoring

- 2012-present Training PhD students, clinicians and postdocs. Currently training 8 PhD students (7 basic science stream, 1 clinician) and 4 post-docs.
- 2009-2012 Training and supervising GAP program/NUS students and technicians at IMCB, Singapore.
- 2004-2008 Mentoring undergraduate students and training them in various molecular biology and biochemistry techniques.

2004-2008 Mentoring graduate, rotation students and postdocs or technicians in vector design, recombinant pseudotyped AAV production, quality assessment and biochemical analyses.
2003-2004 Teaching assistant for Microbiology, problem-based-learning at the University of Missouri-Columbia, School of Medicine.

Research and professional experience

04/09-07/12 **Post-doctoral research fellow, Institute of Molecular and Cell Biology, Singapore.**
Role of telomeric proteins in cancer, inflammation and DNA damage repair signalling.
10/07-03/09 **Post-doctoral fellow, Molecular Microbiology & Immunology, School of Medicine, University of Missouri-Columbia, MO, USA**
Rational design of split gene Adeno-associated viral vectors for gene therapy of cystic fibrosis and Duchenne muscular dystrophy.
08/02-09/07 **PhD Scholar, Molecular Microbiology & Immunology, School of Medicine, University of Missouri-Columbia, MO, USA**
Development of novel molecular strategies to expand packaging capacity of adeno-associated virus for delivering large therapeutic genes throughout the body to treat lethal genetic disorders.
10/00-06/02 **Research Associate, Central Institute for Cotton Research, Nagpur, India.**
Molecular diagnostic tools for rapid detection and differentiation of different races of *Xanthomonas axonopodis* pv. *malvacearum* (bacterial blight of cotton plants).
05/99-07/99 **VSRP Fellow, Tata Institute of Fundamental Research, Molecular Biology Unit, Mumbai, India.**
Cloning of extragenic suppressors of *pdc2* (pyruvate decarboxylase mutants) in *S. cereviceae*.

Research Funding:

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Indian Council for Medical Research (Govt. of India),

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Department of Biotechnology (DBT, Govt. of India),

Vision Group in Science and Technology (Govt. of Karnataka),

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Uditi Foundation (New Delhi); WWGM (GNE Myopathy), New Delhi, PPMD (Parent Project on Muscular Dystrophy), Mumbai;

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Research Collaborations:

University of Pittsburgh (USA), Singapore Eye Research Institute (Singapore), Univ. of Missouri-Columbia (USA), Univ. of Minnesota (USA), Maastricht University Medical Center (Netherlands), New York University (USA), Univ. of Basel (Switzerland), Indian Institute of Technology –Kanpur (India), IGIB, New Delhi (India), Vellore Institute of Technology (India), Tezpur University (India), etc.