BIOGRAPHICAL SKETCH

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NAME: **Baranov, Petr**

eRA COMMONS USER NAME (credential, e.g., agency login): **Baranov14**

POSITION TITLE: **Assistant Scientist, Schepens Eye Research Institute; Massachusetts Eye and Ear; Assistant Professor, Department of Ophthalmology, Harvard Medical School**

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Russian State Medical University, Moscow, Russia	MD, MSc	08/2007	Medicine, Histology
The Schepens Eye Research Institute, Boston, MA	N/A	09/2010	Pluripotent stem cell biology, retinal cell biology
Russian State Medical University; Research Institute for Eye Diseases, Russian Academy of Medical Sciences, Moscow, Russia	PhD	03/2011	Cell biology, Ophthalmology
The Schepens Eye Research Institute, Massachusetts Eye and Ear, Boston, MA	N/A	10/2014	Retinal regeneration, Tissue engineering, Neuroprotection

A. Personal Statement

My lab is committed to the development of cell replacement therapies for glaucoma, traumatic optic neuropathies and other age-related sensory disorders. To achieve this audacious goal of functional restoration of vision, we combine the advancements in regenerative medicine, retinal cell biology, deep learning, automation, transplantation, and functional imaging of the retinal neurons on a single-cell level. We have pioneered the automated production of stem-cell derived retinal organoids and their use for drug discovery and cell production for transplantation.

I believe that the successful retinal ganglion cell replacement therapy would require a highly collaborative effort to address multiple aspects of cell integration. My work on RGC production from stem cells, and methods to improve neuron survival and maturation in transplantation setting is supported by the National Eye Institute, BrightFocus and Gilbert Family Foundation. I have extensive experience with small and large animal models of retinal disease, stem cell differentiation, imaging and automation, transplantation, and cell therapy development. To address the significant steps of the bench to bedside translation, I rely on productive collaborations with academia (advanced imaging, bioinformatics, and deep learning, genetic engineering) and industry (scaled up cell manufacture, cell isolation, and characterization).

B. Positions, Scientific Appointments, and Honors

Positions and Employment

2006 - 2007	Research Assistant, Research Institute for Eye Diseases, Russian Academy of Medical Sciences
2007 - 2011	Researcher, Research Institute for Eye Diseases, Russian Academy of Medical Sciences
2011 - 2014	Postdoctoral fellow, The Schepens Eye Research Institute of Massachusetts Eye and Ear
2014 - 2017	Investigator, The Schepens Eye Research Institute of Massachusetts Eye and Ear
2015 - 2017	Instructor, Department of Ophthalmology, Harvard Medical School
2017 – Present	Assistant Scientist, The Schepens Eye Research Institute of Massachusetts Eye and Ear
2017 – Present	Assistant Professor, Department of Ophthalmology, Harvard Medical School

Other Experience and Professional Memberships

2011 - Present	Ad hoc reviewer for Investigative Ophthalmology and Visual Science, Translational Vision Science & Technology, Stem Cells Translational Medicine, Stem Cells, Tissue Engineering, Cell Proliferation, Journal of Ophthalmology, Scientific Reports, PLoS One, Military Medicine, Microvascular Research, Journal of Ocular Pharmacology and Therapeutics, Drug Discovery Today, ACS Applied Materials and Interfaces, Journal of the Royal Society Interface, Frontiers Neuroscience, Cell Stem Cell, Frontiers, BMC Ophthalmology, the FASEB Journal, Molecular and Cellular Neuroscience
2012 - 2019	Safety Review Committee, Schepens Eye Research Institute
2014 - 2019	Co-chair, Ocular Regeneration Focus Group, Schepens Eye Research Institute
2016 - Present	Member, Distinguished Lecture Series Committee, Schepens Eye Research Institute
2017 - Present	Member, Stem Cell Network Canada grant review panel
2018 - Present	Grant Reviewer for Massachusetts Lions Foundation, Moorfields Eye Charity, French National Research Agency, The Dutch Research Council, The Gavin Herbert Eye Institute
2019 - 2022	AMPC ARVO RC member and co-chair
2019	Co-organizer, 2nd Annual Joint Research Symposium, Massachusetts Eye and Ear
2019 - Present	IACUC member, Schepens Eye Research Institute
2020	ECR reviewer, NIH BDCN J 81 Review Committee
2022	ECR reviewer NIH/NCATS CTSA R03 Panel

Awards and Honors

2006	The distinguished translational research project, “Frontiers in research and technology,” Moscow
2009	The Russian President’ fellowship for education abroad
2013	Brazilian Council of Ophthalmology Award (with Caio Regatieri, Michael Young and Sarah Tao)
2015	Alice J. Adler Fellowship of the Schepens Eye Research Institute/Eleanor and Miles Shore 50th Anniversary Fellowships for Scholars in Medicine
2016	ARVO/Genentech AMD Fellowship
2020	Iraty Award

C. Contributions to Science

1. *Retinal ganglion cell replacement for glaucoma and other optic neuropathies.*

   Glaucoma and other optic neuropathies lead to permanent damage of the optic nerve and retinal ganglion cells (RGCs). There are no therapies currently available to mitigate the irreversible vision loss that results from the reduced number of these cells. We and others have demonstrated the feasibility of cell replacement therapy with RGCs isolated from a developing retina and stem cell-derived RGCs. Our grafts survived in healthy and damaged retinas following xeno- and allo-transplantation and sent projections into the optic nerve. My lab was the first to demonstrate that donor stem cells derived RGCs survive better in damaged retinas, including animal models of glaucoma. We also pioneered the use of slow-release environment modulators to create “development-like” pro-survival and pro-integratory environment, that allowed for donor RGCs to structurally integrate into the retina and send their neurite into the optic nerve.

I believe that the successful retinal ganglion cell replacement therapy would require a highly collaborative effort to address multiple aspects of cell integration. I feel privileged to collaborate with experts in the field. One of these collaborations is exploring allotransplantation approach in tree shrew model of glaucoma. My group has enabled the differentiation of tree shrew RGCs from tree shrew induced pluripotent cells. We are currently studying the transplantation outcomes.

a. Oswald J, Kegeles E. Minelli T., Volchkov P., **Baranov P.** Transplantation of miPSC/mESC-derived retinal ganglion cells into healthy and glaucomatous retinas. Mol Therapy Meth and Clin Dev., 2021 doi: 10.1016/j.omtm.2021.03.004.
b. Eriksen AZ, Eliasen R, Oswald J, Kempen PJ, Melander F, Andresen TL, Young M, **Baranov P*** and Urquhart AJ* Multifarious Biologic Loaded Liposomes that Stimulate the Mammalian Target of Rapamycin Signaling Pathway Show Retina Neuroprotection after Retina Damage. ACS Nano. 2018 Aug. doi: 10.1021/acsnano.8b00596.

2. *Human retinal progenitor cells for photoreceptor replacement*

Retinal degenerative disorders, including age-related macular degeneration and retinitis pigmentosa, resulting in irreversible loss of photoreceptors. It has been shown that photoreceptor precursors isolated from the developing retina or differentiated from pluripotent cells, integrate, and rescue function in the degenerative retina. We have explored the use of mitotically active retinal progenitor cells (RPC) – committed tissue-specific progenitors, which are isolated from the retina during earlier stages of development. It has been shown that they can form photoreceptor-like cells in vitro and in vivo, and my challenge was to overcome the limited proliferative capacity of RPC in vitro to enable pre-clinical development.

I have described the role of hypoxia-inducible factors in RPC self-renewal and established several cell lines, capable of differentiation into photoreceptor-like cells. Using these cell lines as a tool, we have explored multiple aspects of transplantation and cell replacement in small and large animal models of retinal disorders. In collaboration with the University of Goias, we performed extensive animal studies to identify optimal immunosuppression and cell dosage. We have shown that immune suppression is not required for subretinal allotransplantation in healthy recipients. Another achievement of this project was the development of several hybrid and synthetic tissue-engineered scaffolds to use for cell differentiation and delivery. This project led to a Phase I/IIa clinical trial of a cell therapy for retinitis pigmentosa (PI: Comander J).

I continue to use the skillset and collaborations, established during this large project in my current efforts to achieve functional RGC replacement in Glaucoma.

a. Abud M*, **Baranov P*,** Caroline H, Lieppman B, Sinden J, Avila M, Young M. The effect of transient local anti-inflammatory treatment on the survival of pig retinal progenitor cell allotransplants, TVST. 2015 Sep 22;4(5):6.
b. **Baranov P**, Tucker B, Young MJ. Low-oxygen culture conditions extend the multipotent properties of human retinal progenitor cells. Tissue Eng Part A. 2014 May;20(9-10):1465-75
c. **Baranov P**, Michaelson A, Kundu J, Carrier R. & Young MJ. Interphotoreceptor matrix-poly(ε-caprolactone) composite scaffolds for human photoreceptor differentiation. J Tissue Eng, 2014; 5: 2041731414554139.
d. Luo J, **Baranov P**, Patel Sh, Ouyang H, Lu J, Quach J, Wu F, Hicks C, Zeng J, Zhu J, Sfeir N, Wen C, Reade V, Patel S, Sinden J, Shaw P, Young M, Zhang K. Human retinal progenitor cell transplantation preserves vision. J Biol Chem. 2014 Mar 7;289(10):6362-71.

3. *Deep learning and automation for the production of retinal neurons from pluripotent stem cells*

The three-dimensional, “organoid” approach for the differentiation of pluripotent stem cells into retinal tissues has become a major in vitro strategy to recapitulate development. The resulting retina mimics the in-vivo retina and thus can be utilized as a promising source of high-quality retinal neurons for regenerative therapies. My lab has developed tools to automate the production of stem cell-derived retinal organoids and quantify retinal differentiation. Several media and protocol improvements allowed us to achieve the robustness necessary to automate and scale up the differentiation, which in turn enabled the “big data” approach.

We have developed a deep learning-based computer algorithm to distinguish features specific for well-performing stem cell-derived retinal organoids based only on standard brightfield microscopy at a very early stage of their development. Overall, we have demonstrated that the computer algorithm can successfully recognize and predict retinal differentiation, and the program significantly outperforms human experts on selecting retinal organoids.

We continue to develop methods for a universal, non-invasive, scalable, and rapid approach to assess the state of the organoids and individual cells and forecast its fate. We believe that the same approach can be applied to brain, inner ear, intestinal and other stem cell-derived organoids.

a. **Baranov P,** Lin H, McCabe K, Gale D, Cai S, Lieppman B, Morrow D, Lei P, Liao J, Young M. A novel neuroprotective small molecule for GDNF induction and photoreceptor rescue, J Ocul Pharmacol Ther. 2017 Jun;33(5):412-422. doi: 10.1089/jop.2016.0121.
b. Perepelkina T, Kegeles E, **Baranov P.** Optimizing the conditions and use of synthetic matrix for three-dimensional in vitro retinal differentiation from mouse pluripotent cells. Tissue Eng Part C Methods. 2019 Jul;25(7):433-445. doi: 10.1089/ten.TEC.2019.0053. PubMed PMID: 31195897.
c. Kegeles E., Naumov A., Karpulevich E., Volchkov P., **Baranov P**. Convolutional neural networks can predict retinal differentiation in retinal organoids. Front. Cell. Neurosci., 2020. doi: 10.3389/fncel.2020.00171.
d. Kegeles., Perepelkina T., **Baranov P**. Semi-automated approach for retinal tissue differentiation. TVST, 2020 accepted for publication.

Complete List of Published Work in MyBibliography:
https://www.ncbi.nlm.nih.gov/myncbi/petr.baranov.1/bibliography/public/