JHU Lab of human retinal organoid biology Value Proposition

1) Research Summary

The Johnston lab studies human retinal organoids to identify fundamental mechanisms controlling the generation of different neuron types in the retina, including cone and rod photoreceptors and retinal ganglion cells (RGCs). These approaches can be used to isolate specific cell types in high quantities and of distinct developmental timing (e.g. precursor stage, mature neuron, etc.). Moreover, these approaches can generate human retinal tissue with designed cell type constituency, with applications for specialized regions of the human retina like the high acuity fovea.

2) The Unmet Need

Degenerative diseases including macular degeneration, retinitis pigmentosa, and glaucoma affects millions of people worldwide. Robust sources of human photoreceptors and RGCs would advance transplant-based therapeutics. Our studies of human retinal organoid biology aim to provide these cell types.

3) Solution

The Johnston lab has developed genetic and pharmacological approaches to manipulate populations of photoreceptors and RGCs in human retinal organoids.

4) Selected IP Portfolio & Key Publications

Peer-reviewed Research Papers and Preprints

1. Eldred, K.C., Hadyniak, S.E., Hussey, K.A., Brenerman, B., Zhang, P., Chamling, X., Sluch, V.M., Welsbie, D.S., Hattar, S., Taylor, J., Wahlin, K., Zack, D.J., and **Johnston, R.J., Jr.** (2018) Thyroid hormone signaling specifies cone subtypes in human retinal organoids.
***Science**, 362,* 6411.
https://www.science.org/doi/10.1126/science.aau6348?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub 0pubmed

Featured in (selected from >140 media outlets from 18 countries):
Articles: TIME, Forbes, Washington Post, Scientific American, Vice, Live Science, Axios
Radio interviews: NPR
Video profile: The Hub JHU

2. Liu, Y.V.*, Santiago, C.P.*, Sogunro, A., Konar, G.J., Hu, M.W., McNally, M.M., Lu, Y.C., Flores-Bellver, M., Aparicio-Domingo, S., Li, K.V., Li, Z. L., Agakishiev, D.,

Hadyniak, S., Hussey, K., Creamer, T.J., Orzolek, L., Teng, D., Canto-Soler, M.V., Qian, J., Jiang, Z., **Johnston, R.J.°**, Blackshaw, S.°, and Singh, M.° (2023). Single-cell transcriptome analysis of xenotransplanted human retinal organoids defines two migratory cell populations of nonretinal origin.
Stem Cell Reports, *18*, 1138-1154. * indicates equal contribution ° indicates co-corresponding authors
https://www.sciencedirect.com/science/article/pii/S2213671123001388?via%3Dihub

3. Hadyniak, S.E., Eldred, K.C., Brenerman, B., Hussey, K.A., McCoy, R.C., Hagen, J.F.D., Sauria, M.E.G., Kuchenbecker, Reh, T., Glass, I., Neitz, M., Neitz, J., Taylor, J., and **Johnston, R.J., Jr.** (2022) Spatiotemporal specification of human green and red cones.
bioRxiv*, 2021.03.30.437763*
PLoS Biol*, in revision*
https://www.biorxiv.org/content/10.1101/2021.03.30.437763v3.full

4. Hussey, K., Eldred, K., Reh, T. A., and **Johnston, R. J.** (2023) Foveolar cone subtype patterning in human retinal organoids.
bioRxiv*, 2023.01.28.526051*
https://www.biorxiv.org/content/10.1101/2023.01.28.526051v1.full

Inventions, Patents, Copyrights

1. Protocol to direct hiPSC to form human retinal tissue in vitro with specific ratios of blue and red/green cone cells No IP filing- tech can be licensed as tangible biological material. Robert Johnston, Kiara Eldred, Karl Wahlin, Donald Zack

2. Cytoplasmic transfer cell (CTC). Pending PCT/US2021/057586. Robert Johnston, Seth Blackshaw, Jiang Qian, Mandeep Singh

3. Optimized photoreceptor cells for retinal and macular repair. Pending PCT/US2022/040853. Robert Johnston, Mandeep Singh

4. Method of purifying cell clusters for photoreceptor transplantation treatment. Pending 63/338,318. Robert Johnston, Seth Blackshaw, Ying Liu, Clayton Santiago, Mandeep Sin

5) Research & Market Trends, Competition, and Potential Corporate Partners of Interest

Our studies provide validated approaches to generate bona fide human photoreceptors and RGCs, benchmarked for cell fate features on studies in human tissue. This resource will improve with additional studies to improve our understanding of the processes and manipulate cell fates more efficiently and expand studies to all the neuron types of the human retina (~100 putative neuronal subtypes). This regenerative biology approach represents a great potential for transplant-based therapy.

6) Faculty and Lab Profile

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