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INTEGRATION OF A PNEUMATICALLY ACTUATED MICROVALVE PUMP WITH IN VITRO CELL CULTURE TO STUDY THE MECHANOBIOLOGICAL RESPONSE OF THE TRABECULAR MESHWORK

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Damaged optic nerves and abnormal pressures in the eye contribute to the development of glaucoma, which is the leading cause of blindness in senior citizens. Increased intraocular eye pressure (IOP) is directly related to a buildup of aqueous humor, the fluid within the eye. Aqueous fluid is regulated by a healthy network of trabecular meshwork cells (TM) cells. TM cells control the drainage of aqueous humor, thereby governing the IOP. The quality and quantity of the TM network declines as humans age, permanently altering vision. Degeneration of the TM network consequence of mechanical, oxidative, etc. stress is currently a topic under investigation. We are interested in the mechanobiological response of the TM cells to shear stress resulting from aqueous flow.

We are developing a pneumatically actuated microvalve pump to precisely control shear stress profiles. The micropump was designed with three lifting-gate microvalves and fabricated using soft lithography techniques and a glass slide. Following a full characterization of the microvalve pump, the entire system will be prepped for an in vitro TM mechanobiological study. TM cells will be cultured on an organ chip and the micropump system will be integrated with the organ chip and placed within an incubator. The micropump will cycle culture media through the organ chip to simulate aqueous flow within the eye. Through the characterization of the micropump, we will be able to both quantify the cellular response of the TM by investigating morphology and various biomarkers throughout the course of the in vitro experiment. We will closely monitor how TM cells respond to a wide range of shear stresses to better understand the mechanobiological phenotype of the trabecular meshwork network.

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