THESIS PROJECT PORTFOLIO

Design of a Uniform and Tunable Light Source for Photolysis-Based Expansion of 3D Cultured Mesenchymal Stem Cells

(Technical Report)

No Longer Suffering in Silence: How Medical Racism Affects Cancer Patients, and How It Can Be Combated

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2022

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It is estimated that there will be 1.9 million new cancer cases diagnosed and 608,570 cancer deaths in the U.S. during 2021. Until a cure is found for this disease, the treatment of cancer patients is the highest standard of care that can be provided. Treatment is a broad term that is often considered in solely a medicinal and physiological capacity. While medicines and therapeutics are undoubtedly vital to their care, the social treatment of patients– specifically minority patients – by their medical professionals is often overlooked but equally imperative to their quality of treatment. As large strides are being made in the technological side of treatment of cancer patients, specifically via the use of mesenchymal stem cells, the social methods of improving the treatment of minority patients must be investigated. The overall medical treatment of cancer patients cannot be considered to be perfected until both the technological and social aspects of the care being provided have been improved upon.

3D mesenchymal stem cells (MSCs) have a variety of applications in developing therapeutic treatments of cardiovascular diseases, immune disorders, and cancer. To grow these MSCs, they must be encapsulated in a 3D hydrogel scaffold which is degraded once the MSCs are harvested. A current common method uses proteolytic enzymes in order to degrade the 3D hydrogel scaffolds, which is also detrimental to the local extracellular matrix (ECM) and cell surface proteins. Dr. Donald Griffin has developed a photosensitive microporous annealed particle (MAP) hydrogel which is degraded when exposed to a specific wavelength and intensity of light. Presently, this light is generated by a very small source that can only cover two wells of a 96-well plate. This is time consuming and can result in varying consistency of the MSCs since conditions may change in the first well by the time the last well is harvested. The goal for this project was to create a larger light source platform to cover the entire 96 well plate. The main structure of the platform was designed using Autodesk Fusion 360, produced via 3D printing,

and the LEDs were assembled via electrical soldering. The device was characterized using a radiometer and tested using the MAP hydrogel. This resulted in a functional platform that is able to degrade MAP hydrogel scaffolding at a larger scale than was previously possible. This will allow for higher efficiency of high-throughput experiments and for more MSCs to be produced. The increase in the scale of the degradation is vital for both research purposes and the production of MSCs for therapeutic treatments.

Currently, in the U.S. access to superior medical care is not equal and many inequities correlate with race. This is especially prominent in the field of cancer treatment; cancer mortality rates among black people in the U.S. are on average nearly 10% higher than among whites. Many advocacy groups and their related organizations are striving to alleviate the cancer health inequalities that minority groups have faced. There are three methods the treatment centers and the groups that support them can utilize: raising awareness of the truth behind minority cancer death rates and the experiences of minority patients, improving minority involvement in cancer research, and creating innovative programs that help to reduce cancer incidence in minorities and improve the treatment of the minority patients. The work to raise awareness has prompted more minority patients to seek cancer screening and has provided them with resources for handling a diagnosis. Improving minority involvement in cancer research has led to increased trust of minority patients in cancer treatments. Programs like the culturally-specific comprehensive cancer control (CCC) have resulted in an increase in cancer screening and earliest stage diagnoses in the communities they target. As these methods have been investigated and proven to be effective, they should be implemented in medical facilities across the country in order to reduce the disparities in the treatments received by minority cancer patients.

My team was able to successfully create the platform that allows for more high-throughput harvesting of 3D MSCs, and this device will remain in the Griffin lab after this semester ends. It is extremely rewarding to know our work will help future researchers conduct more robust experiments that may one day lead to extraordinary treatment possibilities for those with cancer. Recommendations to future research includes the implementation of more intense LEDs that are able to degrade the hydrogel faster. Additionally, the platform should be tested with MSCs to ensure that the light causes no harm. For the social research problem, I believe that my work provided meaningful results. Investigating various methods of reducing cancer treatment disparities in minorities provided concrete evidence of their efficacy and recommendations for how more treatment centers across the country should implement the methods.