Evidence of Learning #5

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Subject: ISM (Independent Study and Mentorship)

MLA citation:

Khorasani, Najme, and Mehdi Sadeghi. “A Computational Model of Stem Cells’ Internal Mechanism to Recapitulate Spatial Patterning and Maintain the Self-organized Pattern in the Homeostasis State.” Scientific Reports, vol. 14, no. 1, Jan. 2024, https://doi.org/10.1038/s41598-024-51386-z.

Assessment: Research Assessment #6

For my evidence of learning assessment, I chose to do a research assessment on a paper titled “A Computational Model of Stem Cells’ Internal Mechanism to Recapitulate Spatial Patterning and Maintain the Self-organized Pattern in the Homeostasis State.” by researchers Najme Khorasani and Mehdi Sadeghi. Reading this research paper taught me a lot about how a practical model of stem cells would be done using computational modeling and bioinformatics. In the last study I researched, I learned a lot about the importance of using computational modeling in stem cell research. Still, I couldn't find any examples of researchers using the technique. However, this paper taught me a lot about the exact processes and methods I would need to know to do a project in this field. Using a computer-based model, the paper aims to demonstrate how Stem cells organize themselves to form patterns. Stem cells differentiate into various cell types, and the researchers aimed to simulate this self-organizing behavior to create patterns in a computational model. This information is relevant because it is precisely the type of project I want to do by the end of the year. I want to model the cells computationally, and this paper does precisely that uniquely and innovatively. This is important to my ISM journey and project because it shows me exactly the steps I need to take to create a similar project.

The whole paper is about self-organizing behavior in stem cells, which is foundational for tissue engineering and regenerative medicine; understanding how stem cells behave and create patterns is necessary to make and modify the stem cells you want. Using this approach, I could design stem cells that use the stem cell's natural tendencies instead of depending on complex processes. Moreover, I could use the information from this study to understand how to set up the conditions in my simulation so that the cells are encouraged to self-organize in the way I want them to.

The paper is evident and systematic, and I saw it broken up into four topics/key elements: stem cell signaling, randomness, cell division, and self-regulation. These are the main topics that the research paper focuses on throughout the paper. The researchers considered all of these elements when creating their model and talked a lot about each of these topics in the results/discussion part of the paper. Because they spoke about all of these topics in an easy-to-understand manner, I could appreciate the results concerning each topic more clearly. This model builds on my previous knowledge that stem cells are versatile and are influenced by many growth factors. I learned that tissue growth does not need a strict environment; sometimes, cells can "self-direct" themselves using simple signals. This changed my viewpoint because I previously thought cell formation needed strict guidance with multiple growth factors. Still, this new information will simplify my project as I try to make my model.

This model has inspired me in many ways; I intend to use much information from this paper in my project. When I create my stem cell model, I can focus on using techniques similar to those in this paper to develop self-organizing cell systems so that they can have minimal intervention. So, instead of adding many signals and growth factors to the simulation, I could program the cells to self-assemble using one signal. This information, combined with my previous knowledge, could help me build hydrogen models that use external signals and the natural organizing behavior delivered in this paper to make my engineering more efficient. This paper also determined whether this self-organizing behavior principle could be applied to other cell types, such as ocular ones.

Overall, this study was beneficial as it created a unique experiment highly relevant to my topic of regenerative medicine. The model the researchers, created achieves its goal by showing that cells can form and make a structured pattern independently without external signals. The discovery that cells can independently create ordered structures was exciting and surprising as it is a new idea that I didn't even know existed before this. It helps my journey because it shows me that there might be more ways to simplify the process when working with stem cell research.