Stem Cells 101: From Stem Cells to Specialized Cells
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Many of you may have heard that stem cells have the potential of growing into an organ. Like many other ambitious young adults, I was sold on this promise and became interested in stem cell research. However, I knew very little about stem cells and how they could do something so extraordinary. I hope to share the knowledge I have learned about them to better inform you of their potential.

We all have stem cells and specialized cells inside us. Stem cells are a group of cells that are able to divide and become different specialized cell types. The process of stem cells becoming specialized cells is called differentiation. These differentiated cell types include skin, muscle and bone cells performing a specific function. While a stem cell differentiates, it also renews itself to maintain a stem cell population shown in Fig 1.

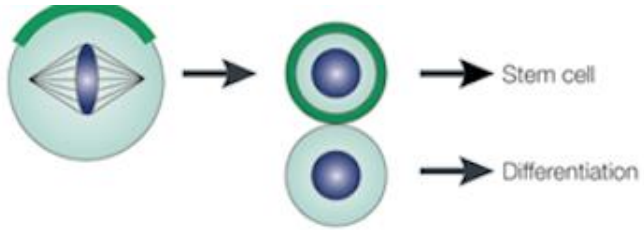

Fig 1. A stem cell dividing into a self-renewal cell and a differentiated cell that will perform a specialized function.

How do stem cells differ from specialized cells on the molecular level? How can stem cells grow into specialized cells?

I learned that both stem cells and specialized cells contain the same set of genes, but they have differential gene expression. Imagine each gene has a light switch that can be turned on/off. Stem cells have more of their genes turned on, while the specialized cells have some turned on and others off. Stem cells are instructed to turn genes on/off with signals, which leads to the creation of specialized cell types. These signals are termed cytokines, which are small proteins important for cell communication in the surrounding cell environment.

Where is stem cell research right now?

Scientists know the signals stem cells need to differentiate into certain specialized cells. They have been supplementing these signals in a petri dish to instruct stem cells to grow into organ tissues. However, we are not close to growing full-size organs yet, because organs have particular architectures. For example, cells need scaffolding to direct their growth and function. This is analogous to building a house on an already constructed foundation.

Although we can't grow a full-size organ at the moment, the scientists can take a patient's stem cells to grow the organ he/she needs. When this organ is transplanted back into the patient who donated the stem cells, there will be no organ-transplant rejection. Organ-transplant rejection is

when the recipient's immune system destroys the donor's organ because the organ is recognized as foreign. This is why it is important for the donor's organ to match the recipient. However, to get a match isn't easy, so the organ-transplant waiting list is long. In the United States, 76,000 patients are currently waiting for an organ transplant, and 22 people die everyday while waiting (https://optn.transplant.hrsa.gov/). Therefore, the idea of the recipient being his/her own organ donor would eliminate the issue of organ-transplant rejection.

We hope to continue to make progress in growing a full-sized, functioning organ from patient's own stem cells to address this organ availability bottleneck.