Tapping Into The Surroundings For Spinal Cord Regeneration
By Hila Swindell

"Before the spinal cord injury (SCI), I was a very independent person, with a very busy social life with a lot of friends, working very hard, travelling a lot, concluding my law course, dating... my life was identical to any other young female, with a lot of desire to live. After the SCI, everything changed and many dreams were interrupted – to live alone, finish the university, start a family." (Claudia)

Have you ever stopped to think about how much your survival relies on your ability to interact with your surroundings?

Experiencing a spinal cord injury (SCI) can tremendously impact one's ability to interact on both the macro-level (basic day to day functions) and the microcellular level (the interactions between molecules that maintain and repair the tissues of our body).

The devastating reality is that in many cases of SCI, life as one knows it changes drastically. The spinal cord is a powerful transmission tower made of millions of nerves. A damaged spinal cord is no longer able to convey information between the brain and every part of the body, and the end result is a complex state of disrepair. Motor and sensory impairment caused by SCI can lead to multiple organ dysfunction, lifelong disability and loss of independence. SCI often strikes out of nowhere. Automobile accidents and falls are the two most common causes (38% and 31% respectively) - none of us are immune from this risk!

While current therapies cannot regenerate spinal function, the advances in the fields of stem cell and regenerative medicine give people living with SCI hope that spinal cord injuries will eventually be repairable.

(Sent an email to Jennifer Pierstorff, the artist who created this beautiful art, and waiting for her permission to use the image)

Stem cells are a type of cell that are famous for their inherent capability to transform (differentiate) into different types of cells and potentially repair and regenerate damaged tissues of the body. Unfortunately, clinical trials have only led to moderate improvement in the use of stem cells for regeneration of damaged tissues. Most often, stem cells do not integrate (engraft) well in the tissues of body and die shortly after being injected or transplanted. The reason is that we have yet to figure out how to create and provide stem cells with their “niche”. The term “stem-cell niche” refers to the unique microenvironment, with a specific architecture and components, that actively instructs stem cells on whether they should either self-renew or differentiate to form new tissues.

We all live in a constant state of interdependency with our surroundings, breathing, eating, communicating with each other, etc. The same is true for all cells of our body; humans, after all, are multicellular organisms. The tens of trillions of cells that form us are interdependent - and just like us, their survival, growth and persistence rely on the microenvironment that surround them.

Whereas cells are the building blocks of tissue, tissues are the basic functional units in the body. To survive, our cells need to communicate and physically connect with their environment—to do so, they form an extracellular matrix (ECM). You can think of the ECM as the equivalent of the world around you that contains all the resources such as air, water, nutrients, etc., and also the physical phenomena such as gravity and transformations of energy between one form to another (e.g. chemical □□ mechanical □□ thermal...). The ECM is a biophysical environment, a suspension of macro- and micro-molecules that support everything from providing nutrition to cells, to the growth of local tissue, and the maintenance of an entire organ.

To restore interactions on the microcellular level and to ultimately repair SCI by enabling regeneration of spinal cord neurons, our team at the Surgical Bioengineering Laboratory at UC Davis is focused on bioengineering several types of scaffolds, which are 3D structures that mimic natural ECMs produced by the body. Our goal is to create bioscaffolds with specific physical properties and then modify them by adding special molecules that provide stem cells and other cells with the ingredients they need for doing their job. These scaffolds can either be injected or surgically introduced into the injured site. Our hope is that our scaffolds will provide a viable and effective treatment option to give SCI patients back their mobility and independence.