Hello? Messengers of Health? Are You Out There?

By Ethan Nabeta

Did you know that all the cells of our bodies came from one place? Even the blood cells you lost when you stubbed your toe on the corner of the wall? It's true! As a fetus in your mother's womb, you had a special cluster of cells referred to as the Inner Cell Mass (ICM). When the cells of the ICM are isolated in a lab setting, they are referred to as "pluripotent" stem cells because they can regenerate themselves indefinitely or become any type of cell in the developing body. Because of these unique properties of stem cells, many scientists have used them toward treating and/or curing a variety of deadly diseases. More recently, we have discovered that it isn't just the stem cells alone that treat the diseases, but rather the things *inside* them.

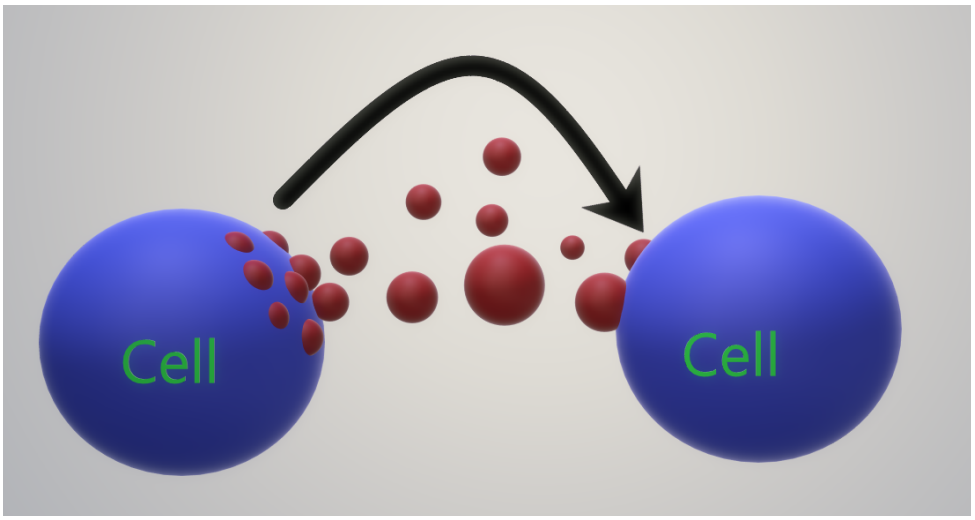

Figure 1 Transit of exosomes (red) from one cell to a neighboring cell

Did you notice the little red orbs in the middle of Figure 1? Those are called exosomes. Many cells make them, including stem cells! In fact, they are partially responsible for cell-to-cell communication. Yes, cells do talk to each other; in fact, our bodies rely on cell-to-cell

communication for essentially every bodily function! Just as phones are used to send text messages via the airways, cells send messages via exosomes for other cells to "read and respond." Looking at Figure 2, you might call exosomes *cell* phones, perhaps?

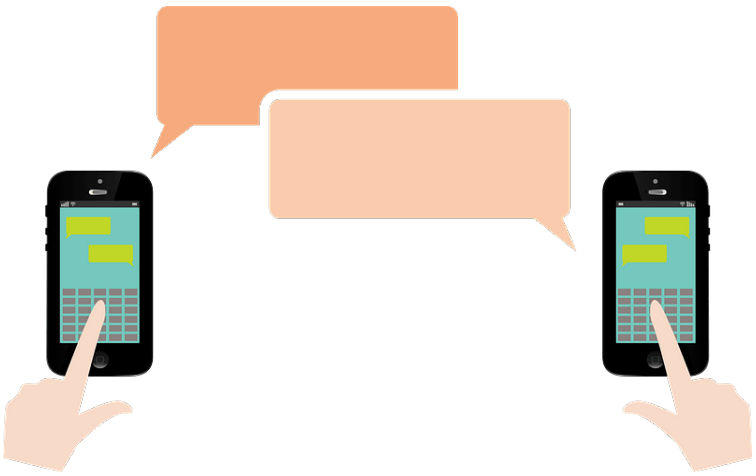

Figure 2 Cellphone-to-cellphone communication representing cell-to-cell communication (CC0 1.0)

Now, can you imagine if we could control the messages that cells send between each other—as easily as we edit Tweets or YouTube comments—as a way to control the body and fight disease? Scientists are pushing hard to turn that idea into reality.

For example, globally collaborating researchers, including those at the University of California, Davis in Northern California, are working to use exosomes to treat an inherited disease called spina bifida (SB). SB is the result of an underdeveloped fetal spinal column that leaves spinal cord cells vulnerable to injury, which typically causes paralysis (the inability to move), as well as increases mortality in early childhood and throughout adult life (Figure 3) [1, 2]. Sadly, an average of four children are born with the disease every day in the United States alone, and the cost to support their lives is a whopping 13 times greater than unaffected children

[3, 4]. It's no surprise that the push for proof of successful exosome-based treatment has been increasing.

Figure 3 Cartoon (left) and real (right) depiction of spina bifida defect (CC BY-SA 4.0)

In early 2019, a paper was published detailing the healing effects that stem cell-derived exosomes had on damaged spinal cord-related cells [1]. Curious about the results? Figure 4 summarizes the findings: adding exosomes made the cells healthy and happy!

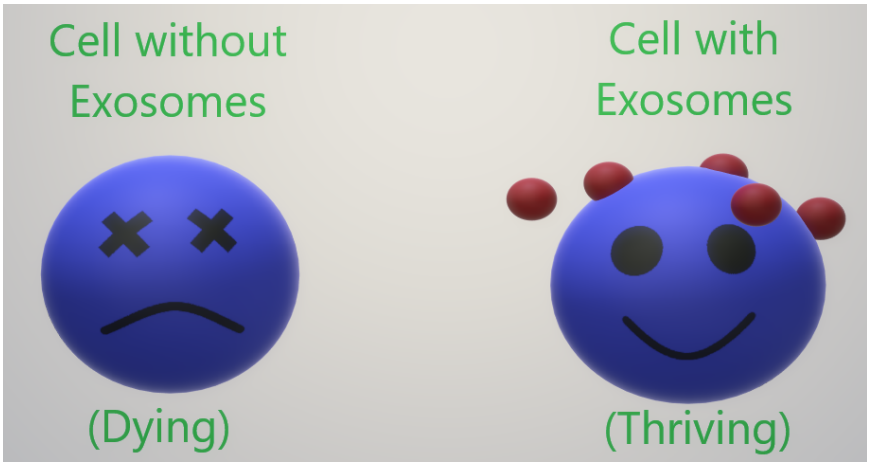

Figure 4 3D depictions of cell not exposed to exosomes (left) vs exposed to exosomes (right). Exosomes are represented by red spheres.

What a nice picture. If exosomes could prevent paralysis by healing the spinal cord cells, then wouldn't it be nice if we could just neatly package exosomes into M&M-sized tablets that could simply be consumed for prevention or treatment of paralysis? Unfortunately, we aren't quite there yet.

A common theme in science that cannot be stressed enough is *specificity*—it isn't just the exosomes alone that treat diseases, but rather the specific molecules *inside* them. All stem-cell-derived exosomes are not created equally—the molecules contained within the exosomes can vary quite a bit. From the stem cells to the exosomes, let's go just a bit deeper to discuss the *molecules*.

Figure 5 Biology has layers/levels of detail from big to small such as in cells to exosomes to molecules.

The same research team that discovered the healing effects of exosomes above also analyzed the effects of a certain molecule on the surface of those exosomes—galectin 1 [1]. After exposing cells to galectin 1, the researchers observed a similar trend: healthy cells [1]! They are currently working to understand exactly *how* galectin enhances cell health. While there is still work to be done, we are living in a time in which there is a foreseeable future with no more spina bifida.

Do you recall the exosomes mentioned earlier? Those came from stem cells harvested from the placenta—an organ routinely disposed of **in the trash** until just a few years ago [5]. Now, we can see that *everything* has a use, even the microscopic galectin 1 protein. What else could lie underneath the microscope at the discretion of a curious mind? Let's find out!

References:

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