Miniature packets of goodness; cell-derived drug delivery systems

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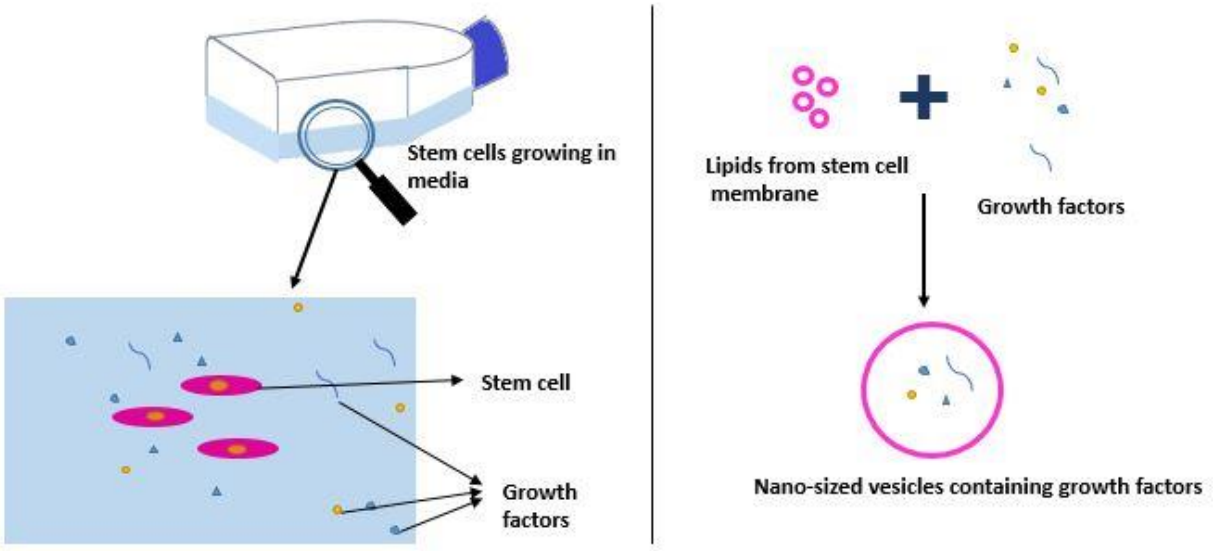
Imagine you had packets of goodness containing drugs that could reduce the symptoms of incurable diseases. A few years ago, this would have felt like an improbable dream. However, with the pace at which regenerative medicine is growing, this will be possible in the near future; scientists are indeed trying to create these packets of goodness from stem cells.

Stem cells are the hot topic of the modern era, but how do these stem cells work?

Stem cells are present in many regions of the body and are actively involved in replacing damaged cells. In an event of cellular damage, stem cells within that region undergo division to replenish not only the dead cells, but also themselves. They achieve this by secreting growth factors that can either help in their survival or induce the cells in neighboring regions to grow [1]. This quality of stem cells is utilized in studies involving cell therapy; treatment options for various diseases using stem cells. Often times though, the stem cells do not reach the target area or lose their way and may lead to tumors. That's terrible!

You must be wondering, if the growth factors help in repair and regeneration, why not use just the growth factors? You are right! Studies have shown that growth factors (produced by the stem cells) are potent and aid in recovery. Unfortunately, the isolated growth factors are sensitive and are degraded easily. Thus, an effective way to overcome this is to package these growth factors in some sort of a stable container. The easiest way to do this would be to use synthetic materials like polymers to package these



Overview of methods involved in the synthesis of nano-sized vesicles from stem cells

growth factors. But, these packets need to be used in our bodies, so we don't want our immune system to attack and destroy them because of their synthetic packaging.

Hmm. Is there a way to collect and package them so that they remain stable, effective and are not destroyed when injected into the body?

Yes, there is. In fact, stem cells are doing the job for us by producing cellular containers called **vesicles** that are packed with growth factors. The immune system fails to recognize vesicles as foreign because they are produced by our own cells. Scientists have been studying the benefits of these vesicles and have noticed that they provide promising results [1].

In order to obtain a substantial amount of vesicles containing growth factors, scientists need to perform numerous filtration steps. Since these vesicles are produced in small quantities from cells and a lot is lost during the collection and filtration steps, scientists don't end up with much using this traditional method [2].

But, now that we know about how these vesicles are formed, scientists are working synthesize our own stable, vesicle-like structure with all the goodness packed in, instead of relying on cells to produce them naturally. As long as we don't use synthetic materials, these vesicles will not be rejected by our immune system. The best part, of course, is that we can potentially make A LOT of vesicles using the new methods!

One such method is to use the cellular components of stem cells, including the lipids present in the cell membrane surrounding the cell. The lipids from the cell membrane are flexible and can reorganize to form nano-sized vesicles that can carry the growth factors. Despite their miniature size, the nano-vesicles are stable carriers and can travel to places where even normal cells cannot reach. The much dreaded immune system is tricked into thinking that the nano-vesicles are cells, and voilà no rejections.

Thanks to the nano-vesicles, soon enough we may be able to have a mere injection that can replace elaborate surgeries.

References

1. Baraniak, P.R. and T.C. McDevitt, *Stem cell paracrine actions and tissue regeneration.* Regenerative medicine, 2010. **5**(1): p. 121-143.

2. Jo, W., et al., *Large-scale generation of cell-derived nanovesicles.* Nanoscale, 2014. **6**(20): p. 12056-64.