Stem Cell Therapy and Biomedical Applications

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Abstract

Stem cells have revolutionized research and applications for biomedical sciences. In combination with gene therapy as well as regenerative medicine, stem cells have led to several breakthrough technologies. Utilizing these advances, coupled with rDNA techniques, adult stem cells can be re-engineered to behave like embryonic stem cells. These induced Pluripotent Stem cells (iPSCs) can be introduced into the body in order to repair and rectify the underlying issues

Introduction

At the same time that researchers are improving the efficacy of stem-cell therapy, gene therapy offers the ability to replace mutated genes with healthy copies, or insert genes that have been designed to boost the production of vital proteins. Brought together, these two technologies have enormous potential to both correct pathological genetic mutations, and incorporate those corrections into new cell populations in the body

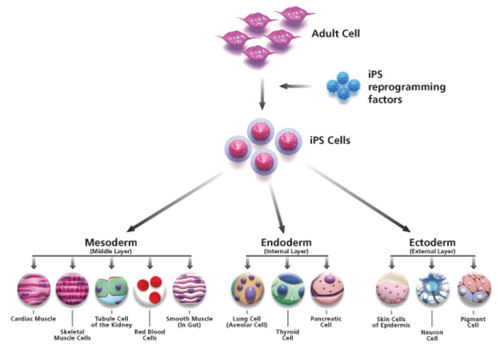
Novelty of Work

What makes this work so unique is by using the natural ability of stem cells to differentiate based on their environment you can have targeted Gene therapies and ensure that at least some of the cells in that area have the correct genetic material

Methodology

The methodology for all of these techniques is very similar. First stem cells are either gathered from the host and created via chemical rDNA induction. Those stem cells are then genetically transformed and selected for uptake of the new genetic change. Once these changes have been made in a petri dish (Ex Vivio) the altered stem cells are inserted or injected into the area where repair is needed. There the stem cells differentiate into the correct form based on signaling from their environment, but because they have the new corrected gene they will survive and propagate the corrected material

Fig 1. Induced pluripotent adult stem cells (iPSCs) and differentiation. https://sites.google.com/site/stemcellresearchdebate/argument/advantages-and-disadvantages-of-adult-stem-cells



Examples

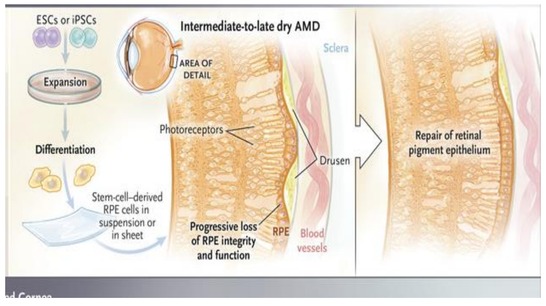
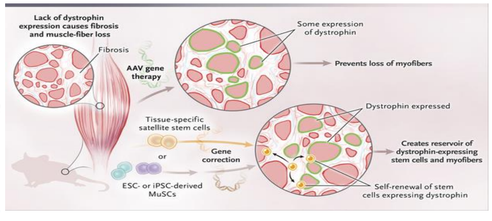


Fig 2. Use of iPSCs for localized delivery and repair of damaged Retinal photoreceptors (RPE) https://www.nejm.org/doi/full/10.1056/nejmra1716145

Fig 3. A Gene correction is inserted into iPSCs. The modified iPSCs are then administered where they fix the improper gene expression https://www.nejm.org/doi/full/10.1056/nejmra1716145



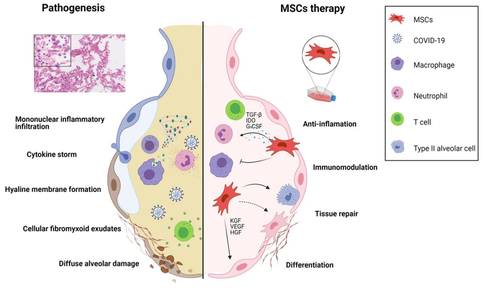


Figure 4. Proposed mechanisms for MSC action in patients with severe COVID-19. https://www.nature.com/articles/s41392-021-00754-6

Discussion

The use of induced pluripotent stem cells with gene therapy has the potential to do what either one would lack the ability to do on its own. While Gene therapies have the potential to fix some of the most debilitating conditions because of their lack of specificity and the possibility of creating an immune response they have limited viability and have had halting research. iPSCs have incredible therapeutic and regenerative qualities, but because they use that patient's own cells any problems that are genetic will just reestablish themselves. By marrying the specificity and immuno-compatible nature of stem cells with the targeted genetic treatments personalized medicine will take a huge leap forward.

Conclusion

Because the gene editing happens outside the patient, there is an opportunity to filter out any aberrant stem cells before they are transplanted back into the patient. But that doesn't guarantee that all of the transplanted cells will be perfect. Though genome editing in human pluripotent stem cells has historically been very difficult due to the inefficiency the development of custom-engineered endonucleases to precisely target DNA DSBs substantially increased the efficiency of HDR-based gene editing in human stem cells

References

Shi, L., Wang, L., Xu, R. et al. Mesenchymal stem cell therapy for severe COVID-19. Sig Transduct Target Ther 6, 339 (2021). https://doi.org/10.1038/s41392-021-00754-6

Blau, H. M., Interview with Dr. Helen Blau on stem cells in the treatment of disease. (09:12), & Author AffiliationsFrom the Baxter Laboratory for Stem Cell Biology. (2019, August 29). *Stem cells in the treatment of disease: Nejm*. New England Journal of Medicine. Retrieved April 15, 2022, from https://www.nejm.org/doi/full/10.1056/nejmra1716145