The use of synthetic 3D polymer scaffolds to create a prostate gland

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Introduction

Prostate diseases such as benign prostatic hyperplasia and prostate cancer are highly prevalent, however research has been hindered by the difficulty in generating and culturing prostate-like organoids (miniature organs grown in culture dish).

Working in partnership with Newcastle University Mechanical & System Department, the team provided 3D-printed Poly ε-caprolactone (PCL) polymer scaffolds for the research.

The scaffolds provide the main structure for prostate cells to proliferate and retain a luminal structure, which could serve as a pre-clinical model to test new drug treatments for prostate cancer.

Aims

1. To determine the survival and proliferation of prostate stromal cells and prostate-induced pluripotent stem cells (pro-iPSCs) on an 3D PCL polymer scaffold uncoated with collagen
2. To differentiate pro-iPSCs towards prostate specific lineage cells, with the aim to create the wall of prostate

Results

After 2 weeks of seeding, the scaffolds were analysed under microscope and immunofluorescence (”Staining the cells with fluorescence dye”) were carried out.

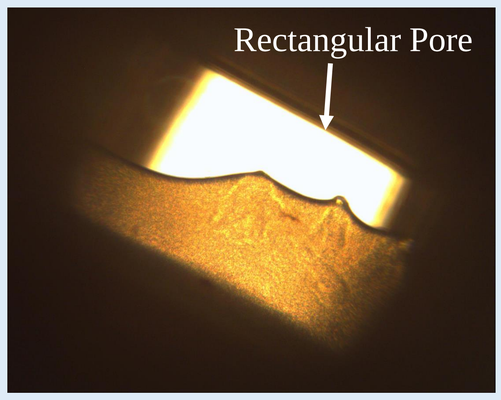

Figure 3. Pro-iPSCs forming a bridging film over the scaffold pores **(NEW DISCOVERY)** with a 30x magnification on microscope. This feature is seen occurring in many scaffolds’ pores.

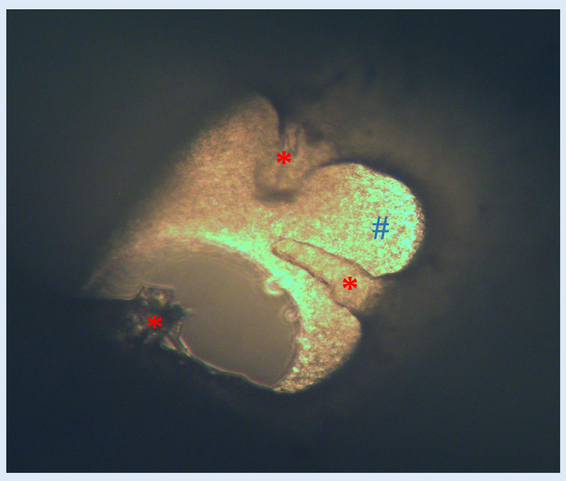

Figure 4. Irradiated stromal cells (*) and pro-iPSCs (#) featured in a scaffold pore with 10x magnification on microscope. This picture is taken on the scaffold with 100,000 cell density.

Microscopic view of all the scaffolds shows that the irradiated stromal cells and pro-iPSCs are able to coexist. The pro-iPSCs are able to survive and differentiate into prostate specific lineage cells inside the scaffold. These findings are significant as this signifies that we will be able to grow an entire prostate gland outside a human body soon.

Furthermore, this is the first time that pro-iPSCs is grown in a 3D structure, and the formation of a bridging film over pores is a serendipitous discovery, making the experiment particularly exciting.

Conclusion

1. Pro-iPSCs is able to adhere to the scaffold and proliferate, further develop into prostate specific lineage cells.
2. Pro-iPSCs outgrown the scaffold rapidly, totally beyond my supervisor’s and my expectation.
3. However, the distribution of both prostate stromal cells and iPSCs are uneven, resulting in certain area of the scaffolds being more populated.

Acknowledgment

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Methods

What are induced pluripotent stem cells (iPSCs)?

iPSCs are mature adult cells that have been genetically reprogrammed to embryonic-like cells in which they are capable of generating any type of cell in the human body.

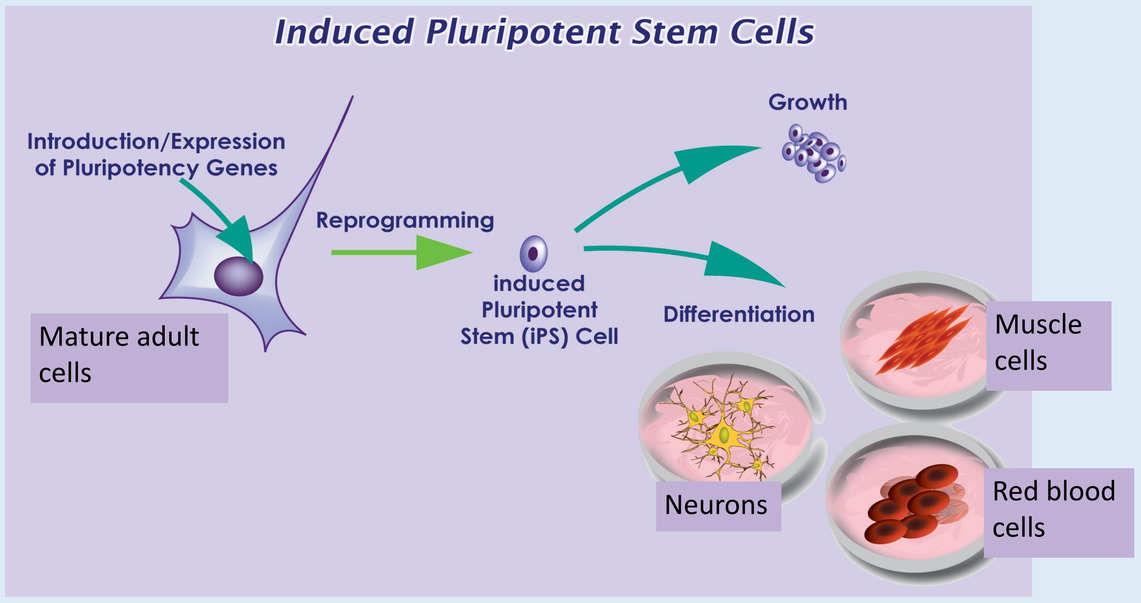

Figure 1. Function of pluripotent stem cells

Seeding of cells into PCL scaffold

Pro-iPSCs were cultured in wells filled with special iPSCs growth medium (DMEM with 5% serum). Prostate stromal cells were grown in normal growth medium (RPMI). After two weeks, the stromal cells were semi-irradiated prior to seeding into the scaffold to prevent over-proliferation which could kill the pro-iPSCs. 1 day later, pro-iPSCs were then split and seeded into the same scaffold. The scaffolds were further grown for 2 weeks in the incubator maintained at 37°C and 5% CO_2 (Figure 2). The prostate-iPSCs were allowed to differentiate with the hormones and growth factors secreted by the semi-irradiated prostate stromal cells.

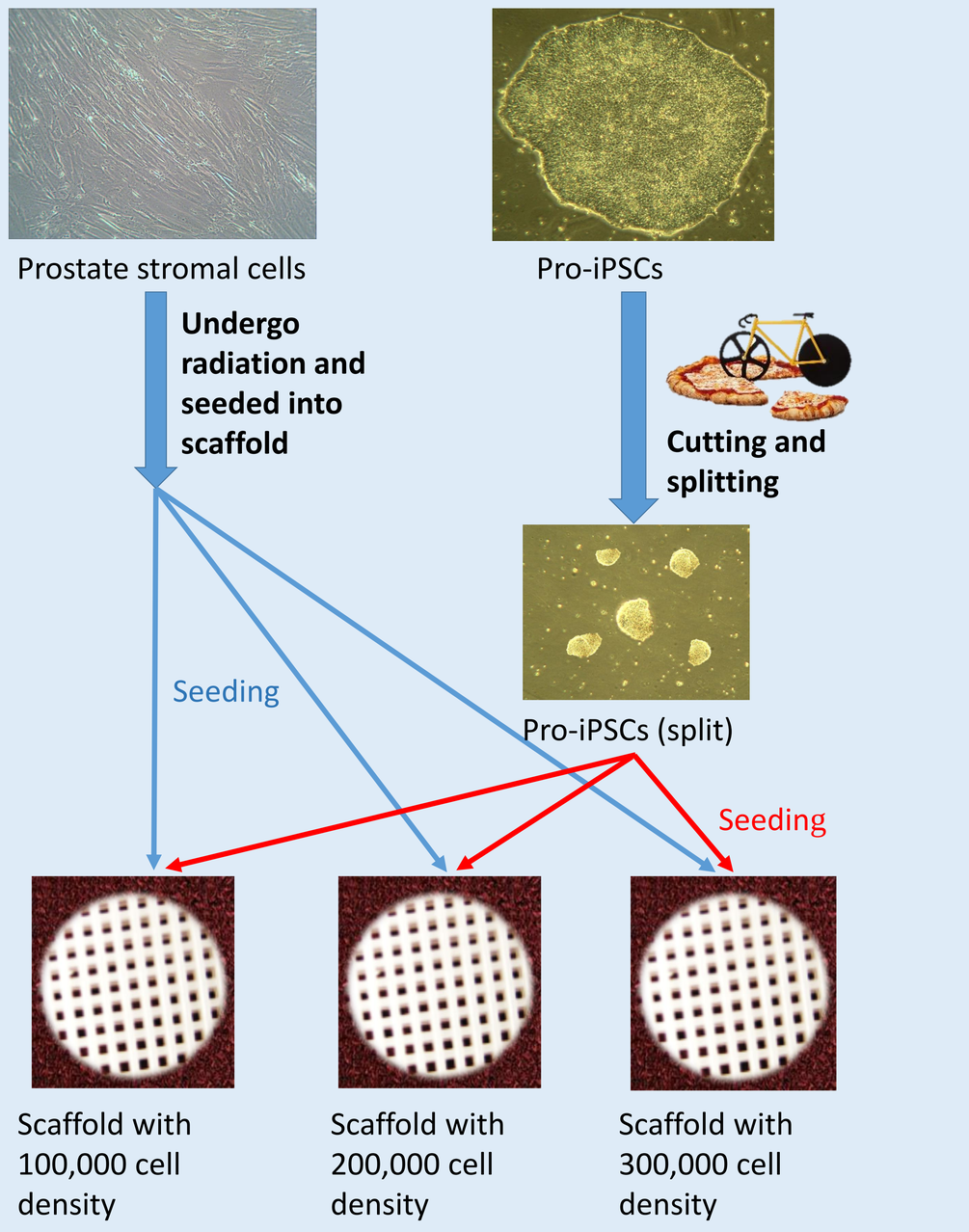

Figure 2. Schematic diagram of the scaffold seeding procedure

Future application

The PCL scaffolds are biologically compatible with human body. With this unique feature, we hope to develop a full prostate gland outside the human body, which can then be implanted into patients who had undergone prostate removal.