Bio-Spun™ Cell Chamber: An Innovative Electrospun Composite Cell Chamber Designed to Promote Tissue Integration, Minimize Fibrosis, Provide Immunoprotection and Deliver a Targeted Therapeutic

[1]R. Hodroj, [1]L. Fitzgerald, [1]J. Chakravarty, [1]J. Le Do, [1]J. Rangel, [1]N. Long, [1]P. Hayden, [2]M. Contreras, [1]M. Phaneuf

[1]BioSurfaces, LLC, Ashland, MA 01721 USA, [2]Beth Israel Deaconess Medical Center, Boston, MA 02215, USA

Background

The treatment of chronic illnesses such as diabetes, liver disease and many rare and transmittable diseases require corresponding long-term administration of protein drugs or biologics. One approach to maintaining long-term therapy administration is to implant cells that are native to the body (i.e. pancreatic or liver cells), while another is to use genetically engineered cells that can produce therapeutic proteins or antibodies to provide an optimal target biotherapeutic concentration throughout the body. Unfortunately, current implantable devices or cellular coating technologies have failed due to materials that cause scar formation (i.e. fibrosis), which blocks the inflow of vital nutrients to the cells and inhibits outflow of the therapeutic proteins needed to treat the disease. In addition, device failure can also create a dangerous immune response that must be addressed.

BSCC Device

BioSurfaces has developed a cellular immunoprotective device (Bio-Spun™ Cell Chamber or BSCC) to deliver various cell types. The BSCC is produced using BioSurfaces' proprietary electrospinning technology. It is comprised of very small fibers that mimic the structure of the body's own cell scaffold, creating a synthetic extracellular matrix for cells to grow into (Figure 1).

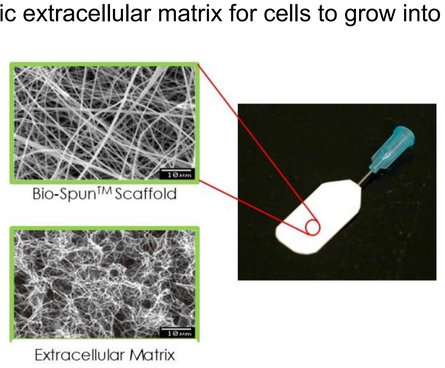

Figure 1. The structure of the fibers (top left) comprising the BSCC (right) resembles the body's natural scaffold known as extracellular matrix (bottom left)

The chamber is designed to hold and shield living cells that release therapeutic proteins or antibodies over an extended period of time, conserving the body's normal functions to provide an environment in which the encapsulated cells can thrive. The BSCC wall is composed of 3 layers (Figure 2).

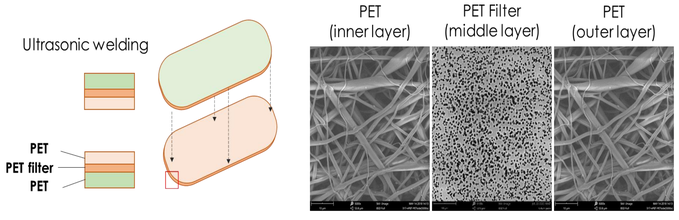

Figure 2. The Bio-Spun™ Cell Chamber is a novel electrospun device that is comprised of 3 distinct layers

The inner layer is made of Bio-Spun™ material that provides ideal support conditions for the encapsulated cells, while the outer layer (also made of Bio-Spun™ material) prevents fibrosis and promotes the ingrowth of living tissue, including capillaries, to the outer surface. Finally, a defined porous membrane between the two Bio-Spun™ layers allows for inflow of nutrients and outflow of therapeutic proteins produced by the cells. This layer prevents both the immune cells from entering the chamber and the encapsulated cells from leaving the chamber. The BSCC can be constructed into various sizes depending on the desired end use (Figure 3).

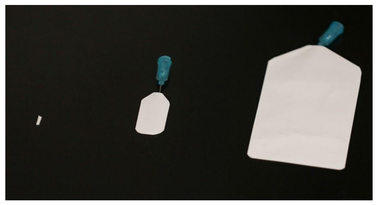

Figure 3. Different sizes of BSCC, demonstrating the flexibility in design.

Targeted Biotherapeutic Delivery

BSCCs have been evaluated in *in vitro* and *in vivo* studies as a delivery vehicle for genetically-modified cells that produce target biotherapeutics such as anti-HIV (3BNC117, Figure 4) and anti-inflammatory (Figure 5) antibodies, respectively. Additionally, the BSCC device has been used to encapsulate human pancreatic islets in efforts to provide long-term glycemic control as a treatment for diabetes. Islet cells in the BSCC have shown response to glucose stimulation *in vitro* and maintained insulin production after implantation *in vivo* (Figure 6).

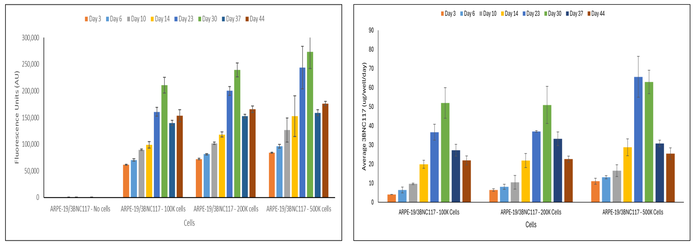

Figure 4. Cell Viability (left) and 3BNC117 production (right) over time using BSCC material.

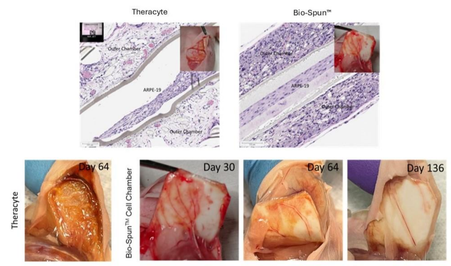

Figure 5. Theracyte control versus BSCC device, both with antibody-producing ARPE-19 cells, after implantation for various time periods.

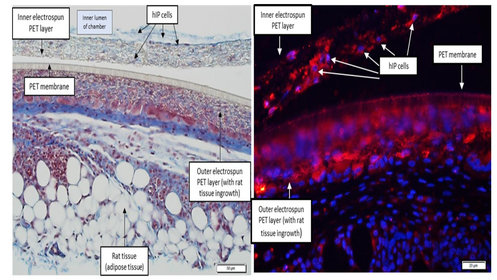

Figure 6. Histological and immunohistochemical assessment of explanted BSCC device with encapsulated human islet cells. Red = insulin. Blue = cell nuclei.

Ongoing Device Development

BioSurfaces is continuing to make improvements on the BSCC device. One advancement is the development of a resealable port (Figure 7). This feature would eliminate the need for an ultrasonic welder in sealing the cell chamber after cell loading. The end-user will be able to simply load the target cells or organoids by puncturing the port with the appropriate gauge needle. Once loaded, the needle is removed and the port area, due to its design, self-seals. This is a major development as it would not only be cost-effective since the cost of a sealing device would be eliminated but may also bring the possibility of reinjecting cells into the chamber once implanted, if needed.

Figure 7. Next generation Bio-Spun™ Cell Chamber with resealable port.

Key Benefits of Bio-Spun™ Technology

- ✓ Induces Tissue Integration = Better Incorporation
- ✓ Reduces Foreign Body Reaction = Fewer Complications
- ✓ Delivers Structural Versatility = Broad Applicability

Conclusions

BSCC exhibits excellent tissue integration, prevents fibrosis, can be produced in various configurations, can be easily implanted and explanted, requires no immunosuppressants and has shown sustained biotherapeutic levels of the target agents.

Acknowledgments

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