Treatments for Neurotrauma

Three Dimensional Bioprinting Offers a Revolutionary Approach to Retinal Regeneration

There has been an increasing incidence of eye injuries, and ocular trauma is ranked as the fourth most common injury in the modern war field (*Ward 2007, Weichel et al. 2008*). Specifically, retinal detachment is among the eye injuries with the worst visual outcomes and is considered one of the main reasons for visual loss following ocular trauma. Research is underway at the University of California, San Diego (La Jolla, California) which aims to regenerate the diseased retina by transplanting a variety of cell types into the vitreous or subretinal space with the expectation that these donor cells would migrate to the site of retinal degeneration, integrate within the host retina, and restore functional vision. Despite promising outcomes, these studies showed that the bolus injection technique gave rise to poorly localized tissue grafts.

The researchers developed a layer-by-layer (LBL) bioprinting process using stem cells for retinal tissue regeneration (Figure 1). As an emerging and disruptive technology, three dimensional (3D) bioprinting offers a revolutionary approach to retinal regeneration. The LBL nature of the bioprinting process complements the native, multilaminar anatomy of the retina. The hypothesis is that through LBL bioprinting with retinal stem cells encapsulated in a biomaterial (e.g., hyaluronic acid), the anatomically correct retina can be regenerated in a biomimetic fashion, thus creating a paradigm shift in retinal tissue engineering.

Successes to date include development of hydrogel biomaterials with comparable mechanical properties that are 3D printable. This process uses human fetal retinal progenitor cells (hfRPC) as the cell resource for retinal tissue differentiation. The researchers have demonstrated that these 3D-printed hydrogel materials are biocompatible for retinal cell growth. The hfRPC can be directed toward a specific cell fate within 3D-printed hydrogel and chemically defined induction medium. Moreover, the hfRPC can be differentiated into photoreceptors within a short period of time.

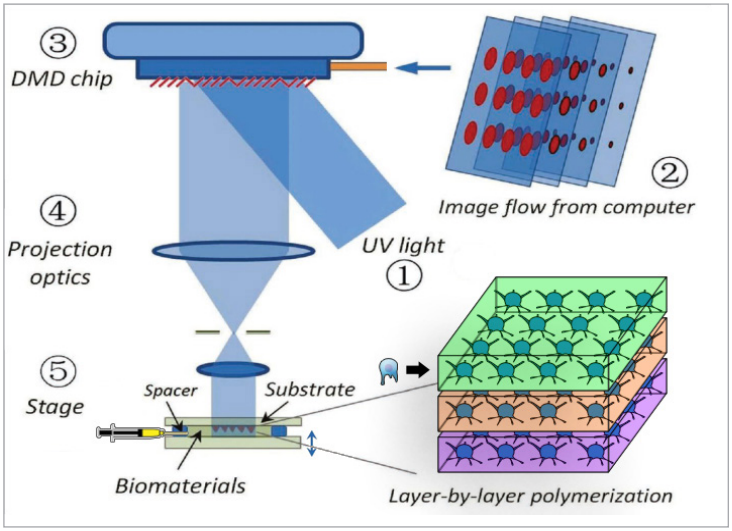

FIGURE 1: Schematic diagram of a layer-by-layer bioprinting method with different cells encapsulated in different layers (Figure used with permission from the authors)

The integration of 3D bioprinting with stem cells represent a disruptive technology platform. This work could lead to patient-specific new strategies for repairing damaged retina tissue of Service members due to ocular trauma or macular degeneration.

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