Abstract

Meta Cell Technology in Regenerative Medicine: Selecting and Cultivating Autologous PRP, Stem Cells, and Exosomes

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Recent advances in regenerative medicine have highlighted the central role of **exosomes** and **platelet-derived products** in tissue repair. Exosomes are generated through the **endosomal pathway**, where early endosomes mature into **multivesicular bodies (MVBs)**. These MVBs fuse with the plasma membrane to release exosomes into the extracellular space. This release is a **highly regulated process**, involving dynamic **membrane– membrane interactions**. Notably, the **temperature-dependent mobility** of tethered exosomes is a key factor that determines the mode and pattern of exosome secretion, underscoring that exosome release is not a passive process but an active, biophysically controlled mechanism.

In platelet biology, **cold storage protocols** have been shown to enhance platelet functionality. These protocols reduce **VASP phosphorylation**, thereby increasing platelet responsiveness to ADP and collagen-induced aggregation and promoting the expression of platelet activation markers. This provides a strategic foundation for cold-activated platelet storage to enhance therapeutic efficacy.

The use of **polychromatic light sources (PAC, 600–1200 nm)** to stimulate **platelet-rich plasma (PRP)** has been demonstrated to promote **controlled and sustained release** of growth factors. This represents a novel photobiomodulation-based approach for improving regenerative therapies.

Exosomes derived from **human umbilical cord mesenchymal stem cells (hUC-MSCs)** have been identified as key agents in promoting **angiogenesis**. Photoactivation using **blue and red light wavelengths** enhances the angiogenic potential of these exosomes by **upregulating specific miRNAs**, establishing a novel mechanism for enhancing exosome-based vascular regeneration.

Further research has focused on optimizing PRP regenerative efficacy through protocol refinement—including **modulation of anti-angiogenic factor levels**, **cold activation**, and **supplementation with biocompatible scaffolds**. These strategies are anticipated to improve clinical outcomes in **refractory wound healing**, such as **diabetic ulcers**.

Lastly, the interaction between **light wavelengths (600–1200 nm)** and biological chromophores has been elucidated. **Infrared (IR)** and **near-infrared (NIR)** light influence **mitochondrial cytochrome c**, **opsins**, and **TRP channel activation**, with additional effects observed on **nanostructured biomaterial clusters**, offering further insight into light-induced regenerative pathways.