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Smart and Living Biomaterials Equipped with Active Therapeutics and Stem Cells for Regenerative Nanomedicine

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Regenerative medicine is a branch of translational research in repair and tissue engineering, which deals with the process of replacing, engineering or regenerating human cells, tissues or organs to restore or establish normal function. This field holds the promise of engineering damaged tissues and organs via stimulating the body's own repair mechanisms to functionally heal previously irreparable tissues or organs.

Regenerative medicine refers to a group of biomedical approaches to clinical therapies that may involve the use of stem cells. Examples include the injection of stem cells or progenitor cells obtained through directed differentiation (cell therapies); the induction of regeneration by biologically active molecules administered alone or as a secretion by infused cells (immunomodulation therapy); and transplantation of in vitro grown organs and tissues (tissue engineering).

The emergence of nanotechnology can enable development of entirely new classes of bioactive devices that need precise intracellular delivery for more efficacies and less toxicities. While both organic and inorganic technologies are under development, controlled-release polymer technologies will likely continue to have the greatest clinical impact for the foreseeable future.

Engineering smart materials allow for novel medical therapies such as designing smart implant based drugs that target cells with improved specificity, resulting in decreased side effects for patients. Other advances are being made in sophisticated biomaterials for use in surgical implantations that are less invasive, leading to shorter recovery times and decreased risk of postoperative infections or other complications. Such innovations will improve the quality of life, extend life expectancies, and could reduce the overall cost of healthcare. Biomaterials play central roles in modern strategies in regenerative medicine and tissue engineering as designable biophysical and biochemical milieus that direct cellular behaviour and function.

Regenerative Nanomedicine is an exciting new field of inter disciplinary research that uses nanoscale technology or materials to seek ways to repair, replace, or regenerate cells, tissues, or organs. The work involves teamwork among researchers in the life, physical, and engineering sciences. The goal of this research is to develop clinical approaches to restore, replace, or enhance biological functions that have been lost due to disease, injury, or aging.

Recently, we have reported a "Smart Hybrid Materials Equipped with Nanoreservoirs of Therapeutics and stem cells". This unique nanotechnology strategy is used to entrap, protect, and stabilize therapeutic agents into polymer coatings acting as nanoreservoirs enrobing nanofibers of implantable membranes [1-3]. Upon contact with cells, therapeutic agents become available through enzymatic degradation of the nanoreservoirs. As cells grow, divide, and infiltrate deeper into the porous membrane, they trigger slow and progressive release of therapeutic agents that, in turn, stimulate further cell proliferation. This constitutes the first instance of a smart living nanostructured hybrid membrane for regenerative medicine [1,2,4,5]. The cell contact-dependent bioerodible nanoreservoirs described here will permit sustained release of drugs, genes, growth factors, etc., opening a general route to the design of sophisticated cell-therapy implants capable of robust and durable regeneration of a broad variety of tissues.

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