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Opinion Article

Applications of Nano Biomaterials in Tissue Engineering

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DESCRIPTION

Nanotechnology's recent advancements have benefited a wide range of biological sciences, particularly in the fields of tissue engineering and wound healing. Nanotechnology facilitates the development of Nano carrier based biomaterials for tissue engineering applications. Natural medicinal substances have distinct clinical effects that can be combined into nanobiomaterials to improve tissue engineering applications. The use of natural substances in tissue engineering improves therapeutic options and mitigates the side effects that synthetic medications can cause. The varieties of biomaterials, the possible role of nanocarriers, and the diverse impacts of naturally accessible medicinal substances incorporating structures in tissue engineering. It is to develop successful therapeutic modalities and address the problems associated with illness diagnosis, prevention, and therapy. It's widely used in drug delivery ,detection (nano-based sensors) *in vivo* imaging (targeting imaging nanoprobes) therapy techniques (metal-based nanoparticles in hypothermia or antimicrobial agent) biomaterials (biocompatible medical implants) and tissue engineering Recent breakthroughs in nanotechnology have made it simple to create nanocarrier-based scaffolds for tissue engineering applications such as the long-term transport of medicines, bioactive compounds, and antigenic factors. Tissue engineering is an interdisciplinary field that maintains tissue function using principles from life sciences and engineering.

To improve cell diffusion and (3D) tissue creation tissue engineering scaffolds must meet certain parameters, including physical, chemical, and mechanical qualities. Scaffolds' biocompatibility, biodegradability, and mechanical qualities are critical for tissue regeneration and suitable support for cells. Biocompatible scaffolds improve the cells' surface adhesion and migratory capabilities allowing them to function normally. To preserve their integrity during implantation the scaffolding material must eventually have good mechanical qualities such as tensile strength and compressive stiffness. Collagen, silk, gelatin, keratin, chitosan, starch, cellulose, alginate, and chondroitin are some of the most extensively utilized natural polymer-based biomaterials.

Collagen is a biological substance that has been approved by the Food and Drug Administration Collagen generated from animals retains the danger of immunological responses although the use of other natural biomaterials (e.g., silk fibroin) can mitigate the negative effects of these collagens. It can be used as a biomaterial in tissue engineering in two ways as a version of collagen or as a scaffold formed by combining collagen with other biomolecules. For cardiac repair and regeneration, collagen-based biomaterials are a good carrier for delivering cellular components and bioactive compounds. Antibodies specific to stem cells such as anti-Sca-1 loaded collagen scaffold were successfully produced to target Sca-1-positive cells in a mouse model to enhance cardiac regeneration.

Gelatin is a biocompatible and biodegradable natural polymer generated from collagen hydrolysis that has a wide range of applications as a scaffold in tissue engineering and as a drug carrier molecule. Although gelatin has several drawbacks in tissue engineering applications such as poor mechanical and thermal properties. In nerve, tissue engineering and regenerative medicine, nanocomposite fibers based on gelatin and cerium oxide nanoparticles have demonstrated to be beneficial. The porous structure of gelatin scaffolds facilitates osteoblast cell adhesion, migration, and proliferation. Because of its surface hydrophilicity, biocompatibility, biodegradability, and substantial biochemical characteristics chitosan has been widely explored in tissue engineering applications. Cross-linking with a hydrophilic substance like polyethylene glycol improves mechanical characteristics significantly. An electrostatically immobilized heparin-containing chitosan scaffold stimulates osteoblast proliferation and shows improved cell survival and differentiation in MC3T3-E1 for bone tissue engineering applications. An immobilized heparin containing chitosan scaffold improved the stability and loading efficiency of the nerve growth factor and supported morphological development with enhanced cell attachment and cell proliferation of Schwann cells suggesting that it could be used in peripheral nerve regeneration. The electrical conductivity, mechanical, and thermal properties of the scaffolds were all greatly improved by electro active biomaterial.

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In PC12 cells, the produced electro active biomaterial showed improved biocompatibility, cell adhesion, proliferation, gene expression, and protein levels in an *in vitro* cell culture research. The addition of chitosan to the biomimetic genipin cross-linked collagen and chitosan-based porous scaffolds improved cross-linking efficiency, and the degradation revealed that the addition of genipin improves the material's biostability.