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Biomaterials Based on Modular Protein Engineering for Skeletal Tissue Engineering

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Description

Tissue engineering, which plays a critical role in skeletal tissue repair, requires biomaterials. However, currently employed biomaterials, such as animal extracts and chemically produced polymers, have poor bioactivity and safety. Due to its lower batch-to-batch variance, avoidance of dangerous infections, and, most crucially, sequence-tenable property, modular protein engineering-based MPE biomaterials made of polypeptides generated via molecular cloning and protein synthesis have greatly expanded in recent years [1]. The features of diverse MPE biomaterials classified by structural domains of polypeptides, as well as strategies to edit the polypeptide sequence and create MPE biomaterials at will, are briefly described in this paper. Then we'll look at how bio-designed MPE biomaterials can be used in skeletal tissue engineering. Polypeptide structural domains are employed alone or in combination [2].

MPE biomaterials' cytocompatibility, impact on cell fate and ECM formation, mechanical characteristics and functions during in vivo skeletal tissue repair would all be determined and guided by their sequence protein modules. We also propose a number of bio-design methodologies and prospective paths for developing MPE biomaterials for improved skeletal tissue engineering and faster skeletal tissue regeneration. The challenges in regenerative medicine could be overcome using a combination of material science and protein engineering. This article presents a thorough review of skeletal tissue engineering using MPE biomaterials and a polypeptide sequence-guided approach. The skeletal system is critical for maintaining our bodies' biomechanical and physiological functioning. Trauma, infection, tumour excision, and other frequent skeletal disorders make this system a prominent target for harm. Though a gradual healing process can be observed in bone fractures, massive bone regrowth is deficient [3].

Cartilage is practically unable of self-repair due to a lack of blood supply, nerve tissues, and low cellularity. This has created considerable obstacles to current treatments for skeletal-related illnesses, necessitating urgent advancements in skeletal-related regenerative medicine. For many years, autologous bone grafting, allogenic bone grafting, and metallic devices have been frequently employed for bone repair. However, it is linked to a variety of clinical outcomes, as well as increased surgical expenditures and postsurgical morbidity at the donor location. Anti-inflammatory medications, bracing, and other non-surgical treatments for cartilage repair are common, whereas operational procedures include micro fracture of the subchondral bone and periosteal transfer. However, while these approaches are effective for short–term pain, long–term effects are frequently elusive. Tissue engineering advances have opened up new possibilities for treating skeletal ailments by simulating native tissue, filling injured tissue, and generating a microenvironment that promotes tissue repair via cell-material and body-material interactions.

In skeletal tissue engineering, biomaterials are crucial. Ceramics and synthetic polymers are the most commonly utilised chemically generated materials for skeletal tissue engineering Ceramics, the most common of which is calcium phosphate are hard but brittle with Young's moduli around and brittleness around whereas polymers like polylactic acid polyethylene glycol, and poly-caprolactone have good mechanical properties but some of their degradation products may be toxic be dangerous. Researchers prefer to manufacture naturally sourced extracellular matrix, such as animal derived collagens, into biomaterials because it is difficult to replicate native tissues using chemically produced materials. However, when employed as biomaterials, animal-derived ECM may offer significant issues. Biomaterials could be diverse, containing pathogenic pathogens or unknown components. By sacrificing a large number of animals, it is difficult to achieve mass manufacturing while avoiding batch-to-batch variation. Importantly, the polypeptide sequence of the ECM obtained from animals cannot be changed [4].

Researchers are able to build modular protein engineering-based biomaterials to match the sequence and structures of native ECM or to generate new protein-based biomaterials that have never existed in nature, thanks to advances in genetic engineering and solid phase peptide synthesis techniques. This innovative approach also enables large-scale manufacturing of MPE biomaterials that are highly pure, chemically defined, and functionalized. As a result, the materials have undergone extensive testing both *in vitro* and *in vivo*. The characteristics of several MPE biomaterials used in skeletal tissue engineering. It is addressed how to create and synthesise a range of MPE biomaterials. Next, we'll look at how MPE biomaterials can be used to help in skeletal tissue engineering. We also make recommendations for future bio-design initiatives and other topics [5].

Conflict of interest

None

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