2.5 Future Perspectives

Alginate has shown significant utility and promise as a biomaterial for innumerable biomedical applications, specifically related to wound healing, drug delivery, *in vitro* cell culture, and tissue engineering. The exact suitability and match of the properties of alginate for these applications depend on its biocompatibility with negligible toxicity to mammalian tissue, gelation under mild reaction conditions, and the ease of effecting modifications to prepare alginate derivatives with requisite tuned properties. Alginate has a history of safe clinical use in wound healing dressing material and as a pharmaceutical ingredient, and has been implanted in different organ sites, including islet transplantation for treatment of type 1 diabetes [55] and chondrocyte transplantation for treatment of urinary incontinence and vesicoureteral reflux with minimal immunotoxic repercussions [56]. A chemically modified alginate has also been widely used as a carrier for progenitor cells and associated growth factors to heal periodontal damage by replacement. Gels suitable for each application may be generated by a judicious choice of available cross-linking strategies, in conjunction with molecules with favorable chemical structures, molecular weights, and apt cross-linking functionality. Many of the cross-linking and synthetic modification strategies are also employed in cell encapsulation strategies. It is known that covalent cross-linking reactions can be toxic to the cells encapsulated, and a careful use of cell-compatible chemical reagents (e.g., initiator) and complete removal of unreacted reagents and by-products need to be ensured in such cell delivery applications. Looking forward, the use of alginate-based materials in medicine is likely to expand. Alginate gels are much in use clinically in wound-healing sponges, where they act passively absorbing fluid and serving as a basis structure for new cell growth. Next-generation dressings could have greater active function. Single or multiple bioactive drugs and proteins that accelerate wound healing can be embedded into alginate dressings, as these gels support controlled release in the tissue microenvironment sustaining local concentrations of biological factors, such as proteins, for the required time duration. For the purposes of wound healing, and drug delivery, the ability to possess fine control over the delivery of number and dosage of drugs, such as constant or pulsed release in response to the external physiological conditions, is much favored. Active control over delivery can enhance the safety and efficacy of drugs, and can provide new therapeutic solutions. Modification of alginate scaffolds with RGD (arginylglyclaspartic acid) peptide motifs has been widely employed to function as cell adhesion ligand, multiple ligands, and/or a combination of