

WOODHEAD PUBLISHING SERIES IN BIOMATERIALS



# **POLYSACCHARIDE-BASED NANOCOMPOSITES FOR GENE DELIVERY AND TISSUE ENGINEERING**



Edited by  
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# Polysaccharide-Based Nanocomposites for Gene Delivery and Tissue Engineering

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# Chitosan magnetic nanocomposites for gene delivery

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## 14.1 Introduction: Gene therapy

Gene therapy is a treatment or prevention of serious disease by repairing, replacing, or regulating the malfunctioning gene using a therapeutic gene by transferring it into a specifically targeted cell nucleus [1, 2]. Approaches in gene therapy include replacing a mutated gene with a healthy gene, inactivating a malfunctioning gene, and introducing a new gene to assist the treatment of the disease [3]. Nowadays, gene therapy is studied and applied in the treatment of genetic diseases, cancers, acquired immune deficiency syndrome (AIDS), cardiovascular disease [4], and hereditary pathia [5]. In general, the gene therapy process includes the identification of a mutated or defective gene, followed by cloning of an identical healthy gene called a transgene. The next step is loading the therapeutic gene into a vector that delivers the therapeutic gene into the nucleus. The delivered therapeutic gene is integrated into deoxyribonucleic acid (DNA) followed by the correction of the defective or mutated gene [6].

### 14.1.1 Gene delivery systems

There are three main gene delivery systems: viral vector (e.g., adenovirus, herpes simplex virus, retrovirus, lentivirus, and smallpox virus), nonviral vector (e.g., cationic liposome, a cationic polymer, and nanoparticles), and electroporation [7]. The viral vector method is known to have a high transfection efficiency of 80%–90% due to the ability to enter the cells naturally and express their own protein [3]. There are some limiting factors in using viruses as vectors such as the risk of toxicity, safety, acute inflammatory response, cellular immune response, and integration of nucleic acid sequence into the host genome, which leads to inadequate expression of the gene. Other limitations are the number of genes carried by the virus, high cost of production, unsuitability for large-scale production, insertional mutagenesis, and oncogenic effects in *in vivo* application [8].

Gene delivery systems via nonviral vectors have low transfection efficiency of 20%–30%. However, nonviral vectors have good cell viability of 80%–90%, indicating safe transfer of larger DNA molecules [3]. Gene delivery via nonviral vectors