CHAPTER 12

Targeted Drug Delivery: Advancements, Applications, and Challenges

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1. INTRODUCTION

Specialized and controlled delivery of the drugs to the body is one of the most important issues in the treatment of various diseases such as cancer. In classical drug delivery methods, the drug is distributed throughout the body due to the nonspecific targeting ability of drugs, which affects both healthy and diseased sites of the body. Actually, in most cases, the drug-injected site is far from the diseased area, which results in widespread drug distribution throughout the body. Therefore they cause many side effects and unwanted effects. Although in classical drug delivery methods, a high dose of a drug is entered into the body, there is less therapeutic effect than the taken dose. This challenge in the treatment of cancer with chemotherapy also causes severe side effects, damage to normal cells and tissues around the cancer cells, and weakening the body. The main goals in drug delivery are efficient and specific drug delivery from the administered site to the diseased site, minimizing side effects, reducing costs and affecting on diseased cells without the least damage to adjacent normal cells. Given the challenges in the conventional drug delivery methods, new techniques need to be developed for specific and targeted delivery of drugs to the diseased area in the body. The advent of medical nanotechnology and targeted drug delivery techniques has revolutionized in drug delivery and treatment of various diseases. Nanotechnology-based drug carriers have received a great deal of attention in recent years due to the unique properties of nanoparticles in the treatment of various diseases. A variety of nanoparticles (gold nanoparticles, iron oxide nanoparticles, protein nanoparticles, polymeric nanoparticles, nanogels, and liposomes) are used as drug carriers in targeted drug delivery [1]. Targeted drug delivery methods have many advantages against classical drug delivery methods, including specific and targeted delivery of the drug to the diseased site without any effect on normal cells, which in nontargeted methods, normal cells also affected by administrated drugs. A further advantage of targeted drug delivery is the need for a lower dose of the drug, which uses a much lower dose than the nontargeted methods with a greater therapeutic effect. Nanoparticles provide a longer treatment effect. Nanoparticles can also release the drug in a controlled manner, for example, under sensitive conditions to specific stimuli such as pH, temperature, or other conditions [1, 2]. Generally, active targeting and passive targeting are the main targeting strategies for targeted drug delivery. In active targeting the drug can be specifically delivered into target cells by binding ligands (which have overexpressed receptors on the surface of the target cells) on the drug formulations surface. In passive targeting, drug-containing nanoparticles accumulate in the surrounding area of the diseased site due to enhanced permeability and retention (EPR) because of the different characteristics of the tumor tissue environment than normal areas [3].

This chapter is organized into four main sections. The first section is an introductory to the classical drug delivery methods, their challenges, the emergence of targeted drug delivery methods and its importance, as well as the role in the development of various therapeutic modalities. The second section introduces active targeting strategy; we learn how to deliver a drug formulation specifically to the target area. Also, focus on targeting mediated highly expressed receptors on the surface of defined cells. The second section reviews targeting strategies by peptide ligands, folic acid (FA), and aptamers. Section 3 discusses passive targeting and a number of studies on passive targeting. Section 4 provides a

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