Conjugated nanomaterials for drug delivery purposes

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Abstract

Different types of nanomaterials including polymeric nanoparticles, metallic nanoparticles, inorganic nanoparticles and carbon nanotubes form ideal complexes with conjugating agents like antibodies or aptamers. Porous nanoparticles in this regards can be used as stimuli-responsive capping carriers to create intelligent drug delivery systems using conjugating agents. These conjugating agents can cover the pores of porous nanomaterials as biomolecular cap and then these conjugated systems can be considered as gatekeepers. Based on the obtained search results in this work, delivery systems based on conjugated nanoparticles will be used as outstanding therapeutic agents for controlled release of drugs in near future.

Key words: Nanoparticles, Conjugation agents, Biomolecular cap, Intelligent drug delivery.

Introduction

Novel drug delivery systems based on nanoparticles can increase therapeutic efficacy and reduce side-effects by directing the drugs into the specific sites in the body [1]. Many types of drug delivery systems have been introduced for targeted uses. Intelligent drug delivery systems are the main group of them which are capable to control drug release rates in response to a stimulating power [2,3].

From the reported texts, conjugating agents like aptamers are powerful targeting agents for nanoparticles due to their relatively straightforward immobilization on nano-surfaces without altering the affinity possessions. As antibody–antigen reaction, the conjugating agents interact directly with their targets by a binding reaction. Owing to their molecular nature, aptamers include some benefits compare to antibodies such as; low toxicity and immunogenicity, a long shelf-life, and high stability [4-6]. In present review, we will briefly concentrate on the conjugated nanoparticulate systems for drug delivery purposes.

Conjugated nanoparticles

Nanomaterials have unique physical, optical and electronic properties. The conjugating agents like aptamers themselves can home to their specific targets even in vivo media [7]. According to reports, aptamer-nanoparticle conjugates have been used for vast applications include; in vitro detection of cancer cell, in
vivo imaging, targeted drug delivery and specially as dual nanoparticles for magnetic extraction and fluorescent labeling. When these conjugates applied as carriers bound with drugs or functional proteins, they enable to targeted and controlled drug delivery [7]. Therapeutic agents can be loaded in nanoparticles either covalently or non-covalently. Electrostatic adsorption and hydrophobic interaction are usually used for non-covalent introduction of therapeutic agents [8].

When a drug is successfully targeted to a specific site, the main challenge is to control its release profile. Many desirable properties of conjugated nanoparticles such as small size, lack of immunogenicity and ease of isolation leads to their rapid development in biomedical applications as drug delivery carriers [9,10].

**Conjugated nanoparticles as gatekeepers**

Ceramic nanomaterials are particles prepared from inorganic compounds with porous characteristics, such as silica, alumina and titania [11]. Among these, silica nanoparticles have involved much examination attention due to their biocompatibility and ease of synthesis, as well as surface modification [12]. Recent studies have shown that silica mesoporous nanoparticles exhibit superior biocompatibility at concentrations adequate for pharmacological applications. These nanoparticles are commonly used for bioimaging and drug delivery in cancer diagnostics and treatment. Mesoporous nanoparticles can apply as stimuli-responsive smart delivery systems [12]. The surface of silica mesoporous nanoparticles can be modified with organic molecules, peptides, aptamers and antibodies and then these nanoparticles can be considered as gatekeepers. Intracellular or external triggers such as changes in pH, light, enzymatic activity, reducing environment, electromagnetic field or ultrasound is applied to remove cap from nanoparticle and then the drug release is attained. Besides, optical and magnetic contrast agents can also be introduced to form multipurpose drug delivery systems [10,13].

**Conclusion and future direction**

Owing to their various potentials, conjugated nanoparticles display high ability for many medical applications such as drug delivery systems, biomedical sensing, and detection. The aptamer-nanoparticle conjugates enable active controlled delivery of drugs that are incorporated in the nanoparticles once they are bound to a disease site because of the aptamer affinity to this site. Because of the restricted number of conjugating agents, recognition and development of more new aptamers specifically for cancer cells seems to be necessary.

**Conflict of interests**

The authors declare that there are no conflicts of interest associated with this work.

**References**


