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Gold Nanostructures for Photodynamic Cancer Therapeutics

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Abstract

Gold Nanostructures (Au-NSs) are beneficial as carriers for drug delivery for cancer therapeutics. In the present mini-review, we investigate the characteristics, synthesis methods of Au-NSs and their application in photodynamic cancer therapeutics.

Keywords: Gold nanostructures; Cancer cells; Photodynamic therapy

Introduction

The usage of nanocarriers for cancer therapeutics and the drug delivery precisely into the tumor cells [1]. Indeed, metal nanostructures are used for biomedical applications, and one of the most popular nanocarriers is Au-NSs due to their fascinating properties include chemical inertness, low toxicity, intense light absorption, appropriate dimensions and the ability to interact with different tissues have many applications in medicine, particularly in photodynamic cancer therapeutics, and drug delivery [2]. It is proven that Au-NSs are an adaptable platform for diagnostics and therapeutic techniques.

Characteristics of Au-NSs

Au-NSs have different characteristics that cause using them for cancer diagnostics, therapeutics, bio-labeling, and drug delivery [3]. The superior aspects of Au-NSs are low toxicity, shape-related optoelectronic properties and superb biocompatibility; all of the characteristics turn Au-NSs into excellent appliances in Nanobiotechnology and Nanomedicine [4]. Also, the surface plasmon resonance band of Au-NSs and significant physical characteristics are relevant to their physiology and morphology including shape, solvent, surface ligand, core charge, and temperature [5]. The optical characteristics of Au-NSs make them one of the best composite therapeutic elements for clinical therapeutics. The morphology and physiology of Au-NSs are related to the optical features. Variability in the size of the nanostructures can change the color of colloidal Au-NSs. This feature is used for the principles of colorimetric detection. The spherical Au-NSs indicate a spectrum of colors including orange, red and purple simultaneously increasing core size in a range of 1 nm to 100 nm with the demonstration of size related to absorption peak in a range of 500 nm to 550 nm at its aqueous solution [5].

Synthesis Methods of Au-NSs

There are various synthesis methods for providing Au-NSs based on their applications in various fields, and each method has its own benefits and drawbacks. Hence, selecting a convenient method is profoundly vital because of the growth of nanostructures and their characteristics considerably depend on the synthesis methods. Some of the popular techniques include physical, biological and chemical methods. Generally, chemical methods include utilization of reducing factors in aqueous solutions [6]. The Turkevich method is a chemical method that includes reduction AuCl4 in the solution carrying citrate that is extensively applied due to the high stability, facility synthesis, and excellent controllable size of NSs. Moreover, physical methods in Au-NSs synthesis principally include the use of irradiation wavelengths like a laser. In such methods, radiation provides heat and a reduction factor and emitting specific wavelengths that provide Au-NSs with changeable characteristics, such as size and surface plasmon resonance. Although these two methods need to increase the temperature and pressure, that enhances the risk of detrimental effects, and as a result, bounding the use of Au-NSs formulated drugs. Hence, scholars are progressively conducting investigations in the biological fields. Biological techniques regularly include using microorganisms

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for the synthesis of nanocarriers. Typically, biological approaches utilize biosynthetic frameworks for decreasing metal salts in order to get steady and bio-friendly metals.

Au-NSs for Photodynamic Therapy

PDT is a noninvasive and alternative technique with minimum toxicity that is included three important factors such as visible light, Photo Sensitizer (PS) medium, and Reactive Oxygen Species (ROS) and it is absolutely dependent on the accessibility of O2 in target cells [7]. In this technique, the PS which is located in the target cells in the presence of the visible light in a wavelength which is extremely equal to the exciting wavelength of PS will be excited. Light exposure of target cells activates the PS that optionally accumulates in the target cells and causes a photochemical reaction that leads to destroying the target cells. Moreover, PS transfers energy to oxygen in order to produce and expand the ROS level at the tumor target cells [4]. The ROS generates significant cytotoxicity, cell oxidation, and cell death. In spite of the facts that conceptually clear, the effective PDT preparation is full of a few disadvantages. One of the great disadvantages is that many PS are naturally hydrophobic, which causes them to bound their bio-distribution and pharmacokinetics. This disadvantage can be dominant when the PS is joined with nanocarriers for aqueous scattering and an effective PDT process. Also, Au-NSs play a significant role in science and medicine due to their specific size, shape, properties and a wide range of potential applications.

Conclusion

Considering all of the facts, Au-NSs have special optical and surface characteristics that make them preferable to other nanostructures and use their potential for cancer therapeutics. In spite of successful *in-vitro* and *in-vivo* results, there are a variety of points that should consider and demand more investigation regarding biosafety and detrimental effects. Further research should investigate the immunological reactions to Au-NSs carriers in PDT cancer therapeutics.

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