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REVIEW

Recent Developments in the Facile Bio-Synthesis of Gold Nanoparticles (AuNPs) and Their Biomedical Applications

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Abstract: Gold nanoparticles (AuNPs) are extensively studied nanoparticles (NPs) and are known to have profound applications in medicine. There are various methods to synthesize AuNPs which are generally categorized into two main types: chemical and physical synthesis. Continuous efforts have been devoted to search for other more environmental-friendly and economical large-scale methods, such as environmentally friendly biological methods known as green synthesis. Green synthesis is especially important to minimize the harmful chemical and toxic by-products during the conventional synthesis of AuNPs. Green materials such as plants, fungi, microorganisms, enzymes and biopolymers are currently used to synthesize various NPs. Biosynthesized AuNPs are generally safer for use in biomedical applications since they come from natural materials themselves. Multiple surface functionalities of AuNPs allow them to be more robust and flexible when combined with different biological assemblies or modifications for enhanced applications. This review focuses on recent developments of green synthesized AuNPs and discusses their numerous biomedical applications. Sources of green materials with successful examples and other key parameters that determine the functionalities of AuNPs are also discussed in this review.

Keywords: biosynthesis, green materials, gold nanoparticles, AuNPs, biomedical applications

Introduction

Nanotechnology is the combination of science, engineering and technology at the nanoscale typically ranging from 1 to 100nm. This technology has been applied to many fields such as chemistry, biology, physics, material science, engineering and medicine. Nanomaterials can be classified primarily into two categories: naturally and synthetically fabricated nanomaterials. Natural nanomaterials include viruses, substances in bone matrices (such as calcium phosphate crystals) and corals while synthetic nanomaterials can be further divided into four families: metal-based, carbon-based, dendrimers, and nanocomposites. Metal-based synthetic nanomaterials are nanosized metals such as copper (Cu), iron (Fe), palladium (Pt), gold (Au), aluminium (Al), zinc (Zn) and silver (Ag). The properties of metallic NPs support various applications including serving as catalysts, sensing components, optical devices and biomedical applications.[1] Carbon-based nanomaterials are composed of carbon in the form of hollow spheres such as fullerenes, ellipsoids such as graphite, and cylindrical nanotubes. These nanomaterials have led to the manufacturing of batteries and ultrasensitive sensors.[2] Dendrimers (which are also known as arborols or starburst polymers) are nanosized polymers built from branched units to form highly ordered three-dimensional tree-like