Fabrication of Gold Nanoparticles using Cultured Plant Cells for Medical and Biotechnology Applications

Lead Inventor

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Unmet Need

Gold nanoparticles (AuNPs) have been widely used for medical and pharmaceutical manufacturing applications due to their unique features: bio-compatibly, non-reactivity, and low toxicity.

Conventional preparative techniques for synthesis of Gold Nanoparticles employ physical and chemical methods. Physical methods, including evaporation and laser ablation, are expensive and laborious. In contrast, chemical methods involve the reduction of a gold salt with strong reducing agents and are potentially hazardous to the environment either due to the toxicity of the reagents or of the by-products of the reaction[1]. The quest to discover an environmentally friendly and cost-effective method revealed the potential of inactivated biomass, plant extracts, and intact plants to reduce gold from its ionic form (3+) to metallic (0) form and thereby favoring the process of particle formation[2][3][4]. However, these efforts are hampered by their inability to isolate the nanoparticles, by low yield, and by the inability to control AuNP size and shape, which limit their utility.

Therefore, there remains a need for alternative methods to produce gold nanoparticles.

Opportunity

St. Joseph's University investigators have developed a novel method to manufacture gold nanoparticles by using suspended plant cells in culture. In addition, they have developed techniques to alter the physical properties (size, shape, etc.) of the resulting AuNPs by altering the culture media and growing conditions of the plant cells. Finally, they have developed methods to use the resulting AuNPs for therapeutic treatments.

There is significant potential for this invention in the medical / pharmaceutical manufacturing space due to the non-toxic and tunable nature of the method to create a controllable range of AuNPs sizes and shapes. AuNPs are widely used in therapeutic delivery agents, photodynamic therapy, diagnostics, and as catalysts in a number of chemical reactions.

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[1] Shankar, S. S. et al. Biological synthesis of triangular gold nanoprisms. Nat. Mater. 3, 482–488 (2004). 4. Sharma, N. C. et al. Synthesis of plant-mediated gold nanoparticles and catalytic role of biomatrix-embedded nanomaterials. Environ. Sci. Technol. 41, 5137–5142 (2007).
[2] Starnes, D. L., Jain, A. & Sahi, S. V. In planta engineering of gold nanoparticles of desirable geometries by modulating growth conditions: an environment-friendly approach. Environ. Sci. Technol. 44, 7110–7115 (2010).
[3] GOLD NANOPARTICLES MARKET - GROWTH, TRENDS, COVID-19 IMPACT, AND FORECASTS (2022 - 2027) - https://www.mordorintelligence.com/industry-reports/gold-nanoparticles-market#:~:text=The%20Global%20Gold%20Nanoparticles%20market,impacted%20by%20t%20he%20pandemic.
[4] Global Gold Nanoparticles Market to Reach $7.9 Billion by 2026 - https://www.prnewswire.com/news-releases/global-gold-nanoparticles-market-to-reach-7-9-billion-by-2026--301508586.html

The overall market was estimated at $4.9B in 2022 and is expected to reach $7.9B by 2026[5], growing at a Compund Annual Growth Rate (CAGR) of more than 10%.

Increasing use of AuNPs in the medical industry is a substantial contributor to this high growth rate. Dentistry, particularly dental filling and imaging, and targeted cancer imaging/treatment are also expected to represent significant market growth opportunities for AuNPs in the medical space.

Unique Attributes

- The method's tunable nature enables the creation of a controllable range of nanoparticle size and shape in a non-toxic manner.
- The AuNPs resulting from this method were found to be significantly less cytotoxic to healthy human cells lines while simultaneously being more toxic to cancer cell lines than AuNPs created through chemical means.

Clinical Applications

Therapeutics and targeting agents for oncology applications.

Stage of Development

Preclinical Studies

Intellectual Property

Methods patent US 2022/0049277, published February 2022.

Collaboration or Licensing Opportunity

St. Joseph's University is seeking a licensee to commercialize the use of this method for the creation of AuNPs using cultured plant cells in media and the resulting methods of use for therapeutic purposes.

Publications

Starnes, D. L., Jain, A. & Sahi, S. V. In planta engineering of gold nanoparticles of desirable geometries by modulating growth conditions: an environment-friendly approach. Environ. Sci. Technol. 44, 7110–7115 (2010).

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[5] Global Gold Nanoparticles Market to Reach $7.9 Billion by 2026 - https://www.prnewswire.com/news-releases/global-gold-nanoparticles-market-to-reach-7-9-billion-by-2026--301508586.html