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# Fabrication of Gold Nanoparticles using Cultured Plant Cells

## Lead Inventor

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## Unmet Need

A growing worldwide demand for gold nanoparticles in the glass technology, pharmaceuticals, photometry, and electronics industries, is driving the need for a sustainable, eco-friendly, and commercially practical method for fabricating gold nanoparticles exponentially.

Gold nanoparticles (AuNPs) have been widely used for medical and non-medical applications due to their unique features: biocompatibly, non-reactivity, and low toxicity. Conventional preparative techniques for commercial-scale synthesis of Gold Nanoparticles (AuNPs) employ physical and chemical methods.

Physical methods such as evaporation and laser ablation are expensive and labor intensive. Chemical methods involve the reduction of a gold salt with strong reducing agents, and are potentially hazardous to the environment either because of the toxicity of the reagents or by-products of the reaction. 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. However, these efforts of plant-mediated fabrication using live plants or plant extracts are hampered by their inability to isolate the nanoparticles, low yield, and inability to control AuNP size and shape, which limit their utility.

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

## Opportunity

Dr. Sahi's team has 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.

The invention uses plant cell suspension cultures of the plant species Medicago Sativa combined with gold salts ($KAuCl_4$) to induce fabrication of gold nanoparticles. This process eliminates the need for live plants or extracts as it utilizes lab-grown M. Sativa cell cultures. Furthermore, Dr. Sahi's method allows for the control and specification of shape and size of gold nanoparticles, making the process suitable for commercial production.

Dr. Sahi's research has demonstrated a repeatable and predictable relationship between the concentrations of gold salt introduced into the cell culture suspension and the shape and size of gold nanoparticles induced. The team also has developed a method for extracting the pure nanoparticles from the M. Sativa cell culture suspension.

There is significant potential for this invention in the medical space due to the non-toxic and tunable nature of the method to create a controllable range of sizes and shapes of AuNPs. AuNPs are widely used in electronics such as sensors, probes, and displays; Tx delivery agents; photodynamic therapy; diagnostics; and as a catalyst in a number of chemical reactions.

The overall market was estimated at $4.9B in 2022 and is expected to reach $7.9B by 2026 (7), growing at a CAGR of more than 10%. Major drivers of this growth are increasing usage of AuNPs in the medical industry and increased demand from advanced electronics manufacturers. In particular, the targeted drug delivery market represents the plurality of application bases for the overall AuNP market (6). 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 (7).

## 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.
- Gold nanoparticles extracted from M. Sativa plant cell culture suspensions demonstrate improved characteristics in toxicity effects to cancer cell lines or healthy cell lines compared to the chemically-synthesized, commercially available gold nanoparticles.

## Clinical Applications

Gold nanoparticles have a wide number of commercial and clinical applications in engineering, medicine, and agriculture. Specific examples include but are not limited to: therapeutic agent delivery in medicine, medical diagnostics and imaging, glass technology, photometry, photodynamic therapy, printable conductor inks, microchips, probes, sensors, electronics, and catalysis.

## Stage of Development

Proof of concept has been demonstrated. Plant cell culture medium gold nanoparticle fabrication and extraction has been developed as a repeatable process.

## Intellectual Property

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## Collaboration or Licensing Opportunity

Actively seeking licensee for commercialization.

## References and Publications


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