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Review on the production and applications of gold nanoparticles as a drug delivery carrier

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***Abstract*---**There are numerous medicinal and industrial uses for nanoparticles in the detection and treatment of disease. Nanoparticles stand out for their ability to perform multiple tasks and their small size. It is possible to use nanoparticles to deliver drugs to specific sites in the body, as well as to increase cellular absorption. Gold nanoparticles, which are the most extensively investigated of all metallo-nanoparticles, are the focus of this review. Anti-cancer medications are available; however, necrosis of both malignant and

non-cancerous cells is a side effect of many of them. The necrosis caused by gold nanoparticles affects exclusively cancer cells. Smaller than human cells, these tailored drug delivery devices can quickly infiltrate tumors and kill malignant cells. Anticancer medicines that have been conjugated with gold nanoparticles are more effective. Due to their photophysical and optical properties, gold nanoparticles are useful in chemotherapy and cancer diagnostics. Proteins, peptides, and nucleic acids can all be used to modify gold nanoparticles. Such devices have a wide range of applications, from biosensors to medication administration.

***Keywords*---**Gold nanoparticles, Anti-cancer, tumour medicines.

Introduction

The biocompatibility and non-cytotoxicity of gold nanoparticles set them apart from other metal nanoparticles. Nanometers are the smallest unit of measurement. These are a millionth of a human cell's size. Chemical inertness is a primary reason why gold has been employed as an internal medicine for the past 50 years. Gold nanoparticles can be synthesised and functionalized to have a specific size by adding or subtracting various groups. The optical scattering of gold nanoparticles in the tumour cells is a sign of their accumulation. As a result, these can serve as a probe in the investigation of cancer cells at the cellular level. [1] They are employed in chemotherapy and cancer cell diagnosis as well. [2] The use of gold nanoparticles in the transport of medicines, genes, and proteins is not limited to biosensors.

From 2 nm to 100 nm, gold nanoparticles can be found. Cellular uptake is most efficient in the 20 to 50 nm particle size range. Particles with a diameter of 40 to 50 nm have been demonstrated to be hazardous to specific cell types. Tumours can readily be recovered by these 40 to 50 nm particles that permeate into them. Particles of a diameter of 80–100 nm, however, do not penetrate the tumour and remain on the periphery [3]. [4] The extinction coefficient of these is extremely high. The size of the surface plasmon band is determined by the number of atoms. It is at this wavelength, 520 nm, that the surface plasmon resonance may be seen. Gold nanoparticle size is determined by the thiol/gold ratio [5]. The particle size will be tiny if the concentration of thiol (SH) is high. To preserve gold nanoparticle crystallisation, thin monolayers are used to coat the particles with a p-mercaptobenzoic acid solution [6].

The primary property of nanoparticles is their multifunctionality. The incorporation of ligands, imaging labels, therapeutic compounds, and other capabilities into nanoparticles allows for targeted drug delivery and cellular absorption. These gold nanoparticles can be conjugated with doxorubicin, an anticancer medication. Doxorubicin's efficacy is increased through conjugation. Doxorubicin's cytotoxic impact is thereby enhanced. It is possible to transform gold nanoparticles from poor active drug to high active drug through functionalization. As a result, gold nanoparticles play an important role in cancer therapy, cancer cell diagnostics, and HIV therapy [8]. In the presence of gold

nanoparticles, the fluorescence quenching effect of gold nanoparticles is reduced due to the presence of polyethylene glycol (PEG) in the Coumarin-PGE-thiol conjugate. So, the gold nanoparticles can be coupled with physiologically ligands like fluorescent dyes, antibiotics, and induce stimuli at the target region through the PEG spacers.

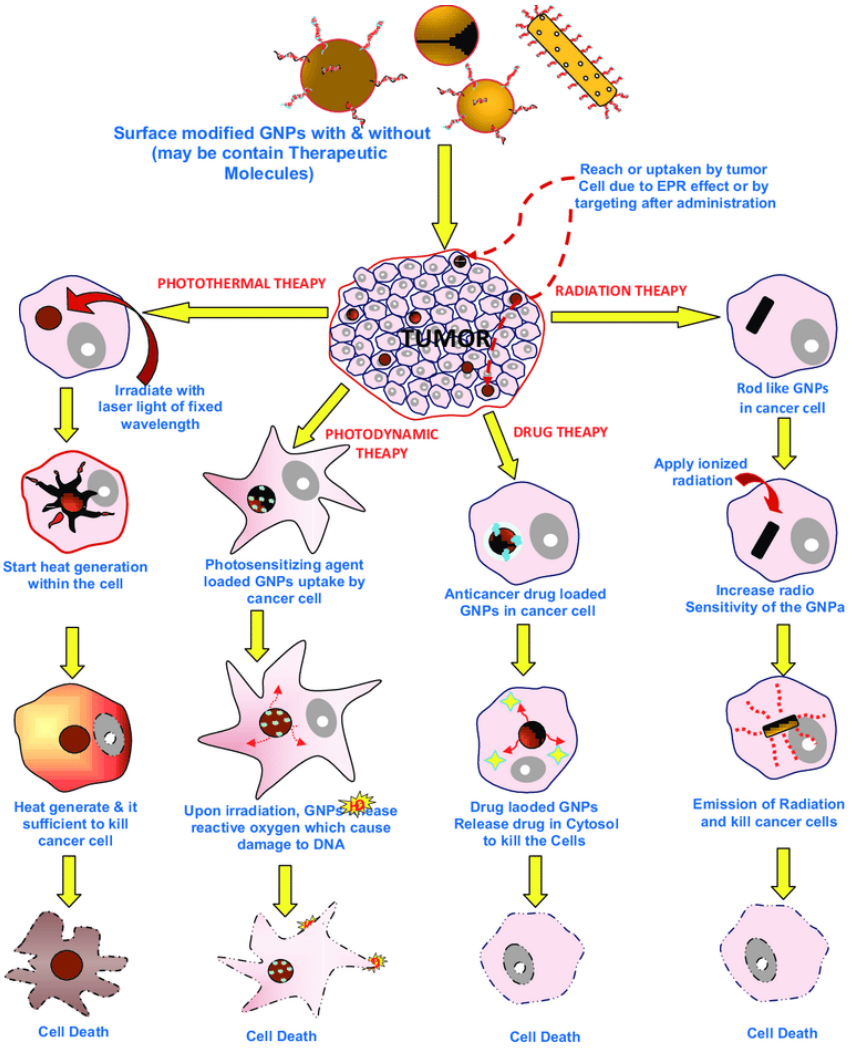

Figure-1

Characteristics of Gold Nanoparticles [3, 5, 10-14]:

There is improved biocompatibility with gold nanoparticles due to their chemical inertness. Gold nanoparticles display optical features such as plasmon resonance. Due to their ability to be functionalized via thiol linkages, they are extremely versatile. In addition, gold nanoparticles can be used as microscopic probes to analyse cancer cells. Apoptosis or necrosis of the individual cell and its receptor are the hallmarks of the cytotoxic action of gold nanoparticles, which accumulate in malignant cells. Due to the gold-sulphur bonding, these are

extremely stable. Their photo physical properties can be used to release drugs from afar.

Types of Gold Nanoparticles [13]:

- Gold nanorods
- Gold nanoshells
- Gold nanocages
- Gold nanosphere
- SERS nanoparticles

Gold Nanorods:
Using a template process, these are built up. Nanoporous polycarbonate template membranes are used to electrochemically deposit gold into their pores. For the diameter of the gold nanorods, we use the template membrane diameter as a guide [13].

Gold Nanoshells:
The design and manufacture of gold nanoshells is based on the usage of visible to near-IR surface plasmon resonance peaks. Gold nanoshells have a silica core with a gold outer surface. The thickness of the shell is controlled by gold [13].

Gold Nanocage:
Gold nanocage is generated via galvanic replacement reaction between truncated silver nanocubes and aqueous HAuCl [13].

SERS Nanoparticles:
SERS is an optical method likefluorescence and chemiluminescence having bettersensitivity, large degrees of multiplexing, resilience andgreater performance in blood and biological [13].

Sold Nanospheres:
These are produced by reduction of an aqueous HAuCl by employing citrate as reducing agent. 4 Through citrates / gold ratio the size of nanospheres can be regulated. By two-phase ratio, the size of nanospheres can be modified by thiol / gold molar ratios [13].

Synthesis of Gold Nanoparticles [14]:
As a first step, make an aquaregia solution to remove metallic particles from the glassware that could interfere with the synthesis process.

Solution for Aqua Regia
Three parts HCl and one-part HNO3 It is an extremely caustic and oxidising agent known as Aquaregia Chloroauric acid (HAuCl) is a good starting point for this reaction. NaBH + Deionised water 4 4 NaBH solution 0.1 M HAuCl + NaBH Gold nanoparticles 4 (yellow colour) 4 (ruby red). The colour of gold changes from yellow to ruby red as gold nanoparticles are being prepared. Dialysis bag is the name given to the cellulose membrane dialysis tube. Deionized water is used to clean the dialysis bag. Dialysis bags are then placed in beakers, which are placed in magnetic stirrers for 5 minutes, and then rinsed with deionised water again. After that, use an aquaregia solution to wash it down. After that, add the AuNPs

to a bag and close the lid. Using Transmission electron microscopy, they can be identified. Preparation of gold nanoparticles ranging in size from 1 to 2 nanometers can be accomplished by reducing diborane and stabilising it with phosphine. To avoid agglomeration, sodium cirate can be used as a reducing agent in water and citrate as a stabilising agent to make gold nanoparticles ranging in size from 10 to 150 nm.

Sodium borohydride and sodium citrate are both effective reducing agents. Phosphine and citrate are both good capping and stabilising agents. Ligands replace the capping agents in the other compounds after synthesis.

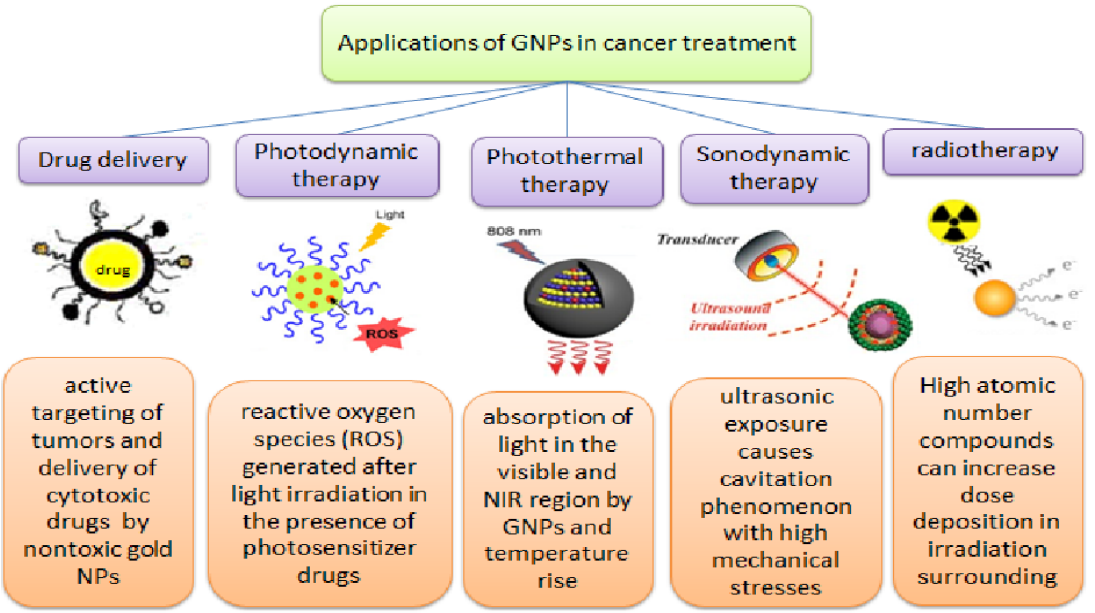

Figure-2

The one-pot approach can be used to generate MPCs (monolayer protected clusters) for the functionalization of gold nanoparticles. HAuCl + NaBH AuNPs MPCs treatment MMPCs (Mixed monolayer protected clusters) can be made either directly or by post-functionalization of Murray's MPCs [15, 16] through place exchange reaction of thiol (Formation of MPCs by Schiffrin Reaction and MMPCs by Murray's Place Exchange Reaction). Polyethylene glycol at one end and gold nanoparticles at the other end make coumarin a luminous dye. Then Coumarin-PGE-impact thiol's is enhanced. Gold nanoparticle fluorescence quenching is lessened as a result of PEG.

As a result, gold nanoparticles can be attached to biological ligands like fluorescence dyes and antibiotics, which can then be used to stimulate a specific target area. After preparing gold nanoparticles, coumarin-PEG-thiol conjugation is added to the aqueous dispersion of gold nanoparticles. A covalent bond is formed.

Application

Due to their variable size, gold nanoparticles can be used as carriers for the transport of peptides, proteins, and nucleic acids such as DNA. [17] The cationic 4° ammonium group on gold nanoparticles enables them to bind DNA plasmids via electrostatic interactions and shield them from enzyme degradation. GNPs can be used as peptide and protein carriers, and cationic tetra alkyl ammonium functionalized GNPs have been shown to recognise the cell surface receptor [18]. Insulin can be transported via gold nanoparticles. As a result, insulin can be delivered more effectively across the mucosa via the Chitosan-coated gold nanoparticle surface [19].

When GNPs are treated with light in the range of 800 to 1200 nm, they generate local heating. They cause tumours to be destroyed through photothermal destruction. The drug capsules include GNPs that have been doped into the shells. Figure 3 shows what happens when light is shone on the drug-filled shells. Using Gold Nanoparticles for In Vivo Targeting: There are two ways to do this [21].

- Active Targeting
- Passive Targeting

The gold nanoparticles' surface ligands are recognised by cell surface receptors [22] for active targeting.

Targeting in the Absence of Involvement

When blood arteries in a sick tissue are leaking, vectors can get into the body [23] Gold nanoparticles are used in immunohistochemistry to analyse protein interactions. Lab traces are used to detect the presence of DNA in a specimen. This is why fingerprints are made from these. Aminoglycoside drugs including streptomycin, gentamycin, and neomycin are detected using these. The cancer stem cells can be detected using Gold Nanorods. It is possible to distinguish distinct types of bacteria using gold nanoparticles. Today, bacteria are identified using a costly machine. To identify various bacterial classes that can aid in cancer diagnosis, GNPs are utilised [24].

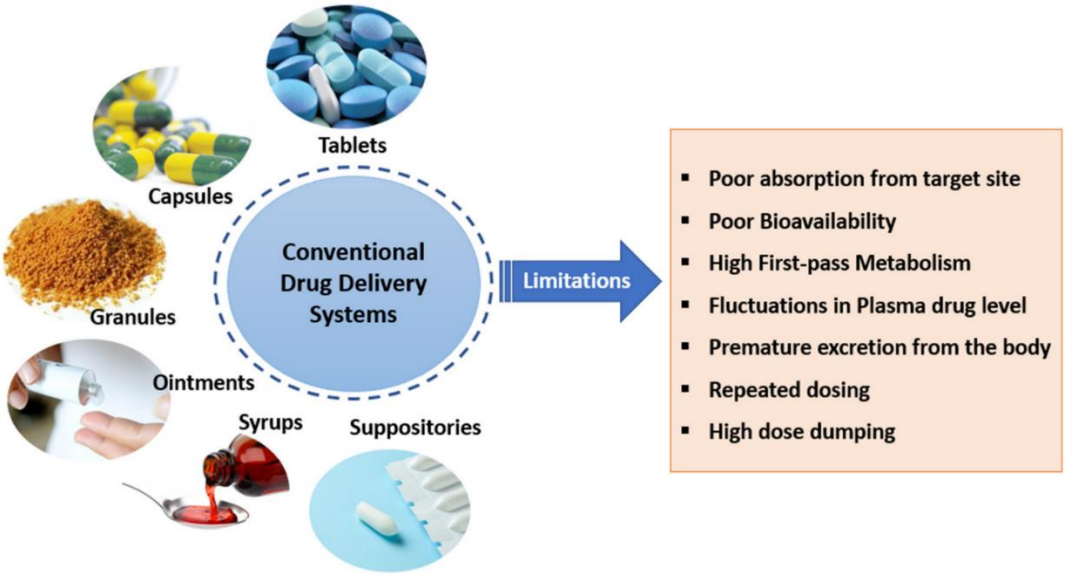

Figure- 3

Conclusion

Gold nanoparticles emerge as promising transporters of bio molecules such protein, peptides, nucleic acid and insulin. Their low inherent toxicity, multifunctionality, high surface area, photo physical and optical properties impart unique attributes that have a major value in chemotherapy, cancer diagnosis and drug delivery.

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