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A Review on Recent Advancement of Cancer Therapy using Nanoparticles

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Abstract

The review is based on the current advancement of nanoparticles based drug delivery system.Here I have tried to demonstrate some examples using Silver nanoparticles extracted from "Greener Synthesis" in the field of therapeutics has led for great success in the field of targeted cancer therapy. The better methods, slower kinetics helps determining better outcomes and control over stabilization along with crystal growth. Nano silver has created an intense antibacterial, antifungal, anti-viral and anti-inflammatory agent Keywords. As cells utilizing silver nanoparticles has turned out to be successful, but still neither the correct system of activity nor the methods have been known yet.

Keywords: Green Synthesis; Silver Nano-Particles; Cancer Targeted Therapy; Synthesis; Characterization; Nanoparticles Screening; Green Chemistry

Introduction

Nanotechnology is nowadays playing a key role in targeted drug delivery therapy in medicinal field. Nano medicine alludes to the utilization of exactness built by nanomaterial with a specific end goal to uncover novel helpful and analytic apparatuses for human utilizing "Greener Synthesis" [1]. Nanomaterial's are unique and can change their physical chemical and biological properties with respect to surface: volume. Silver Nano particles is however used as a therapeutic and diagnostic process in the field of advanced medicinal invention like drug delivery, anticancer agents, and has increased the dependency on tumor invasion for developing anticancer drugs. But, According to Ruoslahti et al. (2014) proven the effective advancement of penetrating and targeting tumor cells. This new development has helped treating an assortment of sickness, for ex: neurological disarranges, diabetes, osteoporosis, Alzheimer's, Parkinson's, amyotrophic parallel sclerosis, various scleroses, cardio vascular scatters, tuberculosis and tumor. NPs, lipid or polymer can be intended to enhance the pharmacological and helpful properties of medications .Cells take up these NPs in light of their size and capacity of the medication to get into the cell cytoplasm through cell film. NPs have a high surface zone to volume proportion and it permits numerous useful gathering.

The possible screening procedures of AgNPs are (UV-vis spectroscopy), X-ray diffractometry (XRD), transmission electron microscopy (TEM, X-ray photoelectron spectroscopy (XPS, scanning electron microscopy (SEM), FTIR, dynamic light scattering (DLS), atomic force microscopy (AFM).

From "ISI Web of Science' it was found that there was a total of 18825 publications from 2001 to 2011, the number of published papers has grown by nearly 93%. Figure 1(a) illustrates the topic of research areas on Ag-NPs. It includes chemistry (55%), materials science (40.4%), physics (27.3%), engineering (5.7%), polymer science (4.6%), optics (4.1%), spectroscopy (3.6%), electrochemistry (3.0%), molecular biochemistry (2.6%) and other topics (22.1%) [1].

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Figure 1(b) shows the division according to research areas and countries/regions; USA 3809 (20.7%), India 1842 (9.8%), South Korea 1331 (7.1%), Japan 1283 (6.8%), Germany 1079 (5.7%), France 770 (4.1%), Taiwan 669 (3.6%), Spain 540 (2.8%), Russia 539 (2.8%) while china and USA are the leading fields in the development of nanoparticles.

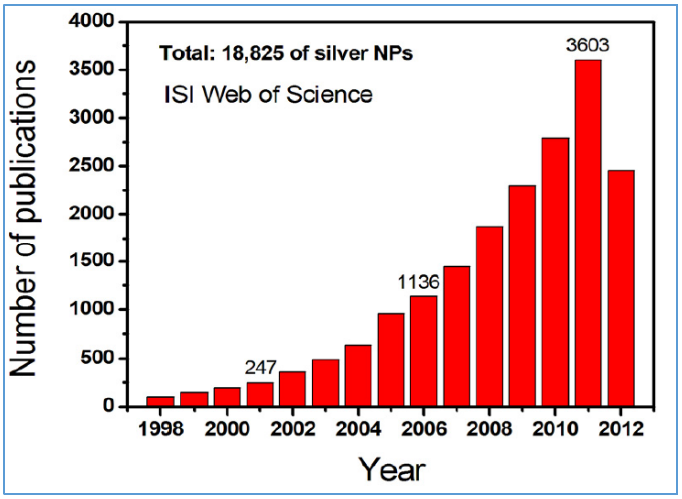

Figure 1(a): Publications v/s Year chart of nanoparticles discovered till 2012. (ISI Web of Science)

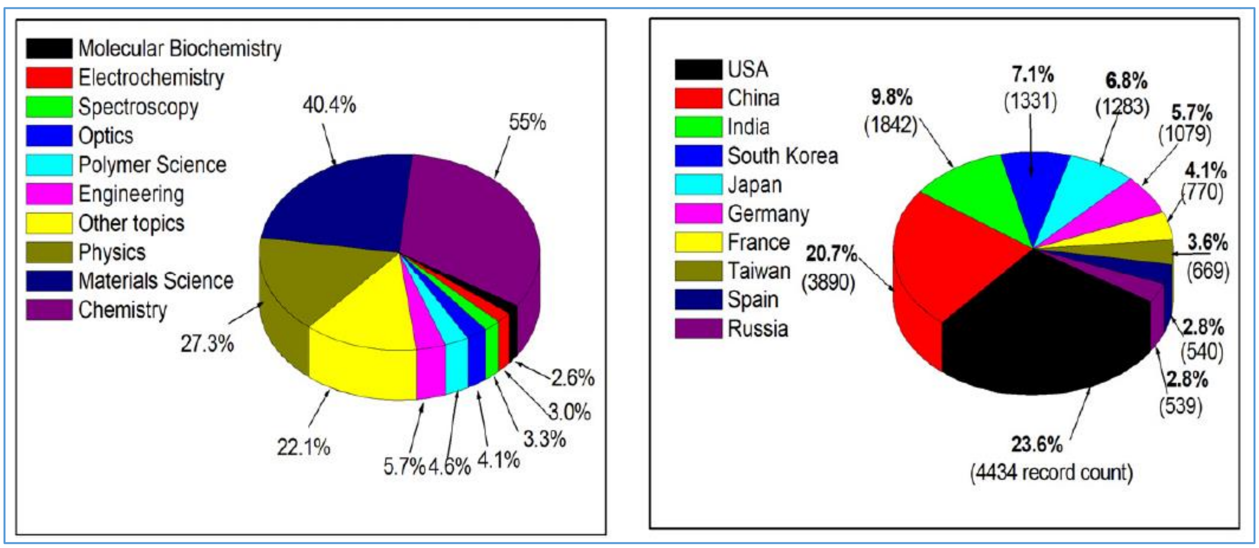

Figure 1(b): Database analyses are divided according to (a) research areas and (b) countries/regions.

Silver Nanoparticles

Silver Nanoparticles (AgNPs) are Nano-particles of size between 1 - 100 nm. They are frequently described as 'silver' some are made out of a vast rate of silver oxide because of their extensive proportion of surface-to-mass silver. Commonly used are spherical silver nanoparticles but diamond, octagonal and thin sheets are also popular.

Synthesis of AgNps

The synthesis of Nano particles is carried out using three different techniques physical, chemical, and biological methods. Among all these techniques, biological method is the simplest, rapid, non-toxic and green approaches that can produce particles of variable size and morphology. The “Green Chemistry” or “Greener Synthesis” shows much more promising.

Synthesis of AgNPs using Physical Method

The synthesis of nanoparticles under physical method is prepared by evaporation and condensation with the help of a tube furnace at atmospheric pressure. Other methods involve pyrolysis and spark discharging used for the synthesis of AgNPs.

Synthesis of AgNPs using Chemical Method

The silver NPs can be obtained by the dropping of silver particles using ethanol at 800˚C to 1000˚C under certain barometrical condition .In this procedure 20 ml of fluid containing silver nitrate (0.5 g of $AgNO_3$) treated with sodium linoleate ($C_{18}H_{32}O_2$) (1.5 g) in tubes. The tubes containing silver particles and sodium linoleate is further treated with linoleic corrosive and ethanol bringing about the development of an ethanol state containing silver particles. The ethanol in this state lessens the silver particles into silver NPs. Linoleic corrosive are consumed on the surface of the silver NPs with alkyl chains on the external side fit as a fiddle. The fluid turns into cocoa shade showing the formation of 100% Silver NPs formation.

Synthesis of AgNps using Green Chemistry

The synthesis of nano particles using green chemistry has many advantages such as they are simple, cost effective, dependable, and environmentally friendly. The synthesis of Nano particles depends upon three factors, including (a) the solvent; (b) the reducing agent; and (c) the non-toxic material. The major advantage of biological methods for extraction of NPs that they contain amino acids, protein, secondary metabolites. The biological activity of AgNPs depends upon structure and morphology, controlled by size and shape.

Drug Delivery system using AgNPs

The drug is incorporated into the liposome binds with their specific cell containing the targeted receptor. After that the drug is released inside the whole body using those infected cell. The nano sized carriers like micro Nano suspension, liposome, dendrimer, ocular inserts, hydrogels are useful in ocular drug delivery which reduce toxicity. This method of approach will also increase the efficiency of drug delivery than conventional delivery system (Figures 2-4).

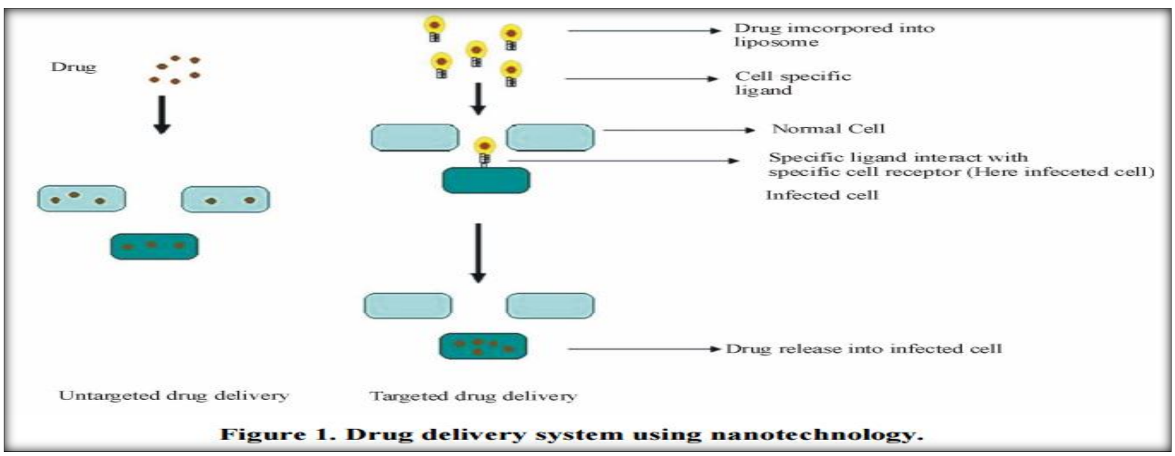

Figure 2: Drug Delivery System using nanotechnology.

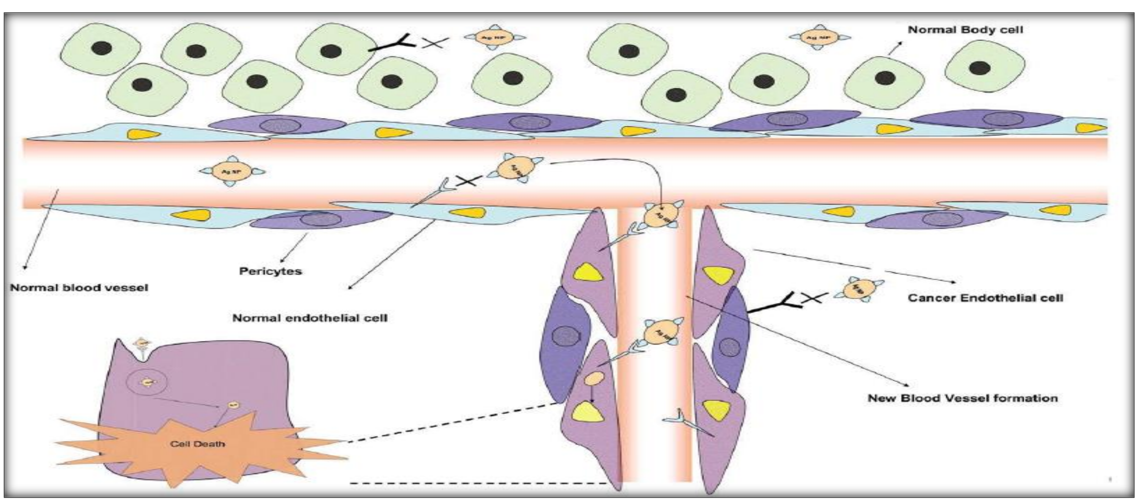

Figure 3: Targeted Drug Delivery System using AgNp.

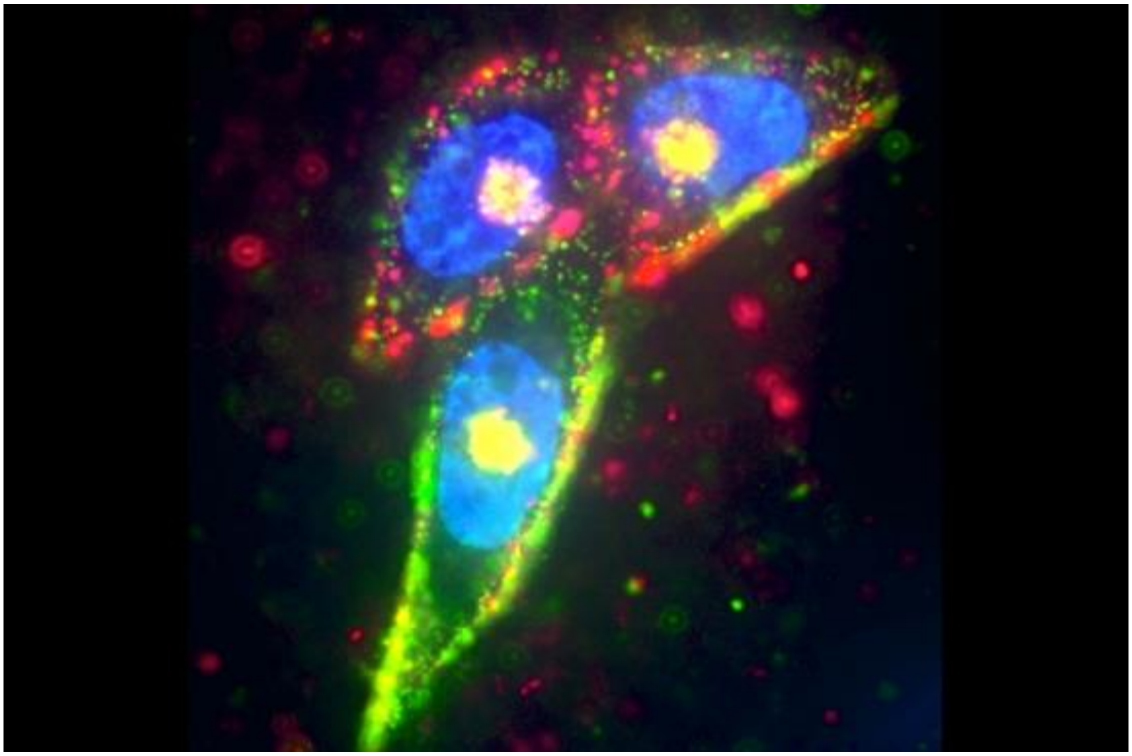

Figure 4: Prostate cancer cells were targeted by two separate silver nanoparticles (red and green), while the cell nucleus was labeled in blueusing Hoescht dye.

Role of Nanoparticles as Medicine

Nanoparticles have an enormous effect in the treatment of different sorts of tumor growth, as prove by the various nanoparticle-based medications and conveyance frameworks that are in clinical utilize. Paclitaxel is a notable hostile to malignancy specialist used to treat different sorts of tumor. This medication meddles with the elements of malignancy cells by microtubule adjustment, coming about in the end in apoptosis. These NPs can be utilized for site particular conveyance by maintaining a strategic distance from the undesirable poisonous quality because of non-particular appropriation and enhance the nature of the patients. NPs may have anti-inflammatory activity.

Nanotechnology-based Drug Delivery in Cancer

There are many techniques of using nanoparticles using

Carbon nano tubes: 0.5–3 nm in measurement and 20–1000 nm length are utilized for identification of DNA change and for recognition of ailment protein biomarker.

Dendrimers: Less than 10 nm in size are helpful for controlled discharge tranquilizes conveyance, and as picture differentiation operators.

Nano crystals: of 2-9.5 nm estimate cause enhanced detailing for ineffectively solvent medications, naming of bosom malignancy marker HeR2 surface of disease cells. Nano particles are of 10-1000 nm estimates and are utilized as a part of MRI and ultrasound picture differentiate operators and for focused medication conveyance, as saturation enhancers and as columnists of apoptosis, angiogenesis.

Nano shells: They are discovered as an application in tumor-particular imaging, profound tissue warm removal.

Nano wires: They are valuable for ailment protein biomarker identification, DNA transformation discovery and for quality expression recognition.

Quantum dots: 2-9.5 nm in size can help in optical location

Approaches of Nanoparticles

The small size of nano particles has put to a great use in oncology. The nano particles along with cancer therapy are benefiting patients from chemotherapy drugs that utilize nanocarriers to decrease systemic toxicity and advanced therapeutics.

Some of the examples of nanomedicines used for cancer are Doxil, Lynparza and Abraxane which are FDA approved drugs used for cancer treatment.

Doxil(Doxorubicin Hydrochloride)

In 1995, Doxilon of the first nanomedicines approved by FDA. It was ovarian cancer and multiple myeloma. Conventional doxorubicin is a chemotherapeutic agent that is widely used in the treatment of breast, ovarian, bladder, and lung cancer. It is very effective, Side effects of such drugs are myelosuppression and cardiotoxicity have limited its use.

The current Doxil advancement contains doxorubicin in polyethylene glycol (PEG)-coated liposomes that are about 100 nm in diameter. The advanced liposomal formulation decreases the cardiotoxicity of doxorubicin. Clinical it was proven that epitome of doxorubicin in liposomal NPs enhances the viability of Doxil because of amplified flow time and aggregation at tumor destinations through misuse of the EPR impact.

Abraxane(Paclitaxel)

In early 2005, Abraxane, an albumin-related nano-formulation of paclitaxel, was approved for the treatment of metastatic breast cancer. Conventional paclitaxel (Taxol) is poorly soluble in aqueous solutions, so its formulation includes Cremophor EL (polyethoxylated castor oil, BASF) and ethanol.

The Abraxane targets tumors through the EPR effect; it binds with the endothelial glycoprotein 60 (gp60) receptor. Abraxane also had fewer side effects even though a higher dose of conventional paclitaxel had been administered. Abraxane is being assessed for various different diseases, including melanoma, and in addition cervical, peritoneal, ovarian, and non–small-cell lung cancers. Other paclitaxel nanoformulations are additionally being produced; including a polymeric micelle detailing (Genexol-PM, Samyang) that also eliminates the need to use Cremophor EL as a solubilizer.

Lynparza(olaparib)

In 2014, FDA approves another medicine for treatment of advanced ovarian/breast cancer associated with mutated BRCA genes.

It is an ADP-ribose polymerase (PARP) inhibitor that blocks enzymes involved in repairing damaged DNA; it acts against the BRCA 1 and BRCA 2 genes responsible for breast and ovarian cancer. Common side effects of Lynparza included nausea, fatigue, vomiting, diarrhea, abdominal pain etc.

Advantage of Nanoparticles

Nanoparticles in medication can be utilized for site-coordinated/focused on medication delivery. Nanoparticles decrease amounts Nano grams since the solution is conveyed/actuated by any of different techniques at the correct site of requirement. Nanoparticles alter the medications to be focus on infections and tumors and allow solid tissue to sit unbothered. This is known as bioavailability: conveying particles to where they are most required, for instance growth drugs authoritative to tumor locales.

Dis-advantages of Nanoparticles

Blending nanoparticle tranquilize conveyance frameworks has dependably been muddled by planning a fitting size to convey successful medication/quality payload and capacity to focus to the perfect place. Unseemly size circulation, vague structure/shape, poor biocompatibility, and uncalled for surface science are conceivable hazard figures the organic environment. Creation of nanoparticles with sub-200 nm size requires control over every single stride in the system, which is continually testing.

List of companies doing ongoing research on nanoparticles

Nanomedicine Company	Product
Parvus Therapeutics	Nanoparticles designed to fight autoimmune diseases
Selecta Biosciences	Nanoparticle based synthetic vaccines
Sirnaomics	Nanoparticle enhanced techniques for delivery of siRNA
Smith and Nephew	Antimicrobial wound dressings using silver nanocrystals
SignaBlok	Targeted delivery of drugs and imaging agents
Starpharma	Dendrimer nanoparticles for use in drug delivery
T2 Biosystems	Diagnostic testing using magnetic nanoparticles
Taiwan Liposome	Drug delivery using lipsomes
Z-Medica	Medical gauze containing aluminosilicate nanoparticles which help blood clot faster in open wounds.

Nanospectra	AuroShell particles (nanoshells) for thermal destruction of cancer tissue
Nanosphere	Diagnostic testing using gold nanoparticles to detect low levels of proteins indicating particular diseases
Nanotherapeutics	Nanoparticles for improving the performance of drug delivery by oral or nasal methods
Oxonica	Diagnostic testing using gold nanoparticles (biomarkers)
NanoViricides	Drugs called nanoviricides™ designed to attack virus particles
NanoMedia	Targeted drug delivery
Nano Science Diagnostics	Diagnostic testing system
Blend Therapeutics	Nanoparticle based drug delivery
Cristal Therapeutics	Polymeric micelle nanoparticles to deliver drugs to tumors
CytImmune	Gold nanoparticles for targeted delivery of drugs to tumors
DNA Medicine Institute	Diagnostic testing system
Invitrogen	Qdots for medical imaging
Luna Inovations	Bucky balls to block inflammation by trapping free radicals
Makefield Therapeutics	Nanoparticle cream for delivery of nitric oxide gas to treat infection
MagArray	Diagnostic testing system
NanoBio	Nanoemulsions for nasal delivery to fight viruses (such as the flu and colds) or through the skin to fight bacteria
NanoBioMagnetics	Magnetically responsive nanoparticles for targeted drug delivery and other applications
Nanobiotix	Nanoparticles that target tumor cells, when irradiated by xrays the nanoparticles generate electrons which cause localized destruction of the tumor cells.
Nanoprobes	Gold nanoparticles for radiation therapy enhancement

Conclusion

The review is basically based on the synthesis, advancement, dis-advantage of Silver Nano particles with special specification in therapeutic approaches in cancer using AgNPs. During the past few years the synthesis and development of Nano material has drastically put an effect to work as a next-generation anticancer therapeutic agent. The silver Nano particles can overcome poor delivery and the problem of drug resistance. The method of production bio-distribution, stability, accumulation, controlled release, cell specific targeting and toxicological issues in human too.

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