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DIAGNOSIS AND TREATMENT OF DISEASES BY USING METALLIC NANOPARTICLES-A REVIEW

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ABSTRACT

Nanoscale materials that are found in many kinds at nano scale stage. Nanoparticles are vast class of material that contain small discrete mass of matter which have one particular range from 1-100nm. Nanoparticles are zero dimension, two dimensions and three dimensions etc. There are broad class of Nanoparticles which is used in disease diagnosis and treatment. Nanoparticles collaborated with the drug and increase the effectiveness of the target object. Surface of nanoparticles is modified with many agents and used in different disease. One of best purpose of nanoparticles is in drug delivery. Nanoparticles are not effective in human diseases but also helpful in plant disease. Different nanodevices like nanowires and cantilevers are very effective for gastrointestinal diseases. Specialists at Osaka University have joined nanopore sensors with man-made brainpower methods and showed that they can recognize single infection particles. This technique may give fast, purpose of utilization, ID of infections. A strategy for recognizing malignancy cells in the circulation system is being created utilizing nanoparticles called NanoFlares. The NanoFlares are structured tie to hereditary focuses in disease cells, and create light when that specific hereditary objective is found. Nanoparticles uses in different methods like MRI increased its efficiency for imaging. Many of imaging techniques like ultrasound imaging (USI), magnetic resonance imaging (MRI) and optical imaging (OI) ultrasound imaging (USI) for study of inside and outside study of human beings and others. There are different types of nanoparticles used in these techniques which help in vivo and vitro study. For treatment purpose, DNA vaccine coated SiO_2 (LDH) nanoparticles induced antibody is used mostly. For this, nano spray recently discovered that picks up the insects. So, role of nanoparticles is effective.

Key words: Diagnosis; cancer treatment; nanoparticles; quantum dots

Introduction

Nanoscale materials that are found in many kinds at nano scale stage. Nanoparticles are vast class of things that contain small discrete mass of matter which have one particular range from 1-100nm. They are may be zero dimension, two dimension and three dimension etc. The significance of these tools understands when researchers found that nano scale size is a property of this matter. Specialists at UC San Diego are building up a technique to gather and break down nano estimated exosomes to check for biomarkers demonstrating pancreatic disease. Specialists at Osaka University have joined nanopore sensors with man-made brainpower methods and showed that they can recognize single infection particles. This technique may give fast, purpose of utilization, ID of infections. A strategy for recognizing malignancy cells in the circulation system is being created utilizing nanoparticles called NanoFlares. The NanoFlares are structured tie to hereditary focuses in disease cells, and create light when that specific hereditary objective is found [1]. Analysts at Nagoya University are building up a nanowire based sensor to distinguish pointers of bladder and prostate malignancy in pee tests. Analysts are building up a nanoparticle planned to make early location of malignancy tumors simpler. The thought is that since each nanoparticle conveys a few peptides a high grouping of these biomarkers will happen even at beginning periods of malignant growth, permitting early recognition of the illness [2]..

The attractive nanoparticles connect to particles in the circulatory system called microvesicles which start

in mind malignancy cells. NMR is then used to identify these microvesicle/attractive nanoparticle groups, permitting an early analysis. A 20-nm palladium (Pd), platinum, silver (Ag), gold (Au) and NPs have characteristic black, wine red color, yellowish gray and dark black colors, respectively Nanoparticles are complex molecules itself and it is formed from three layers (a) The outer most layer, which may be functionalized with a many biomolecules like proteins, DNA and other polymers and surfactants (b) The middle layer, which is chemically different substance from the inner in all characteristic, and (c) The inner, which is important the inner part of the NP and commonly known as nanoparticles [3].

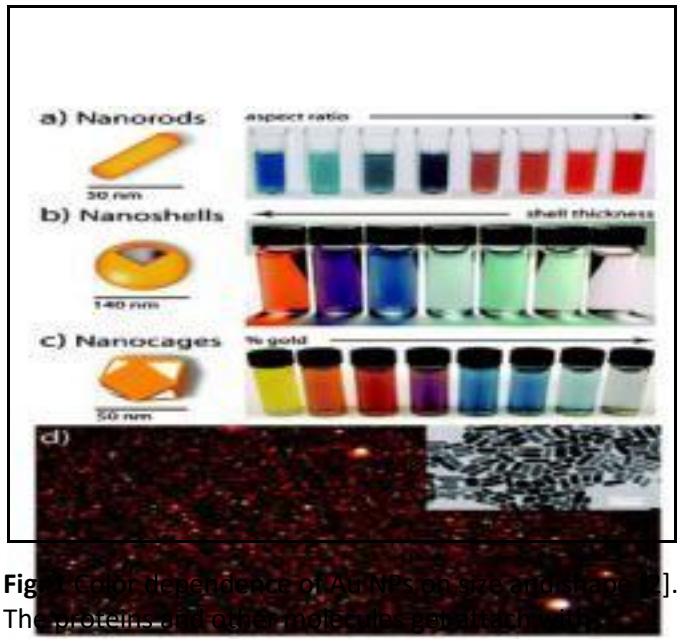

Fig.1 Color dependence of AuNPs on size and shape [2]. The proteins and other molecules get attach

nanomaterials and permit to find the initial stages of the disease. There are many systems have been developed

to detect disease under the nanomaterial. About them,

one is nano sphere inc. that uses AuNPs. These nanospheres have proved in the clinical studies that it has verigene system that involves detecting four special kinds of nucleic acids. Another system being developed known as T2 biosynthesis. This method is more specific and it uses magnetic nanoparticles to recognize the sample including nucleic acids, proteins etc. Gold nanoparticles and carbon nanotubes are widely used as biosensor that detects proteins responsible for oral diseases. A number of tests have been performed by researchers, an accurate detection of oral cancer diseases that provides results within an hour. Viruses and other microscopic components from blood samples are separated by using Ag nanorods. This can be monitored by Raman spectroscopic signals. This method serving detection and identification of bacteria and viruses and allowing results less than an hour[4]

Characterization of nanoparticles

There are different techniques for the characterization of nanoparticles. These techniques are atomic force microscopy, particles size analysis, scanning electron microscopy, X-ray diffraction, transmission, electron microscopy Fourier transform infrared spectroscopy, X-ray photoelectron spectroscopy and Raman spectra [5] . Characterization is the study of many facts like structure of nanoparticles, the material from which nanoparticles can be formed and many other properties [6]. SEM and TEM are the essential techniques.SEM is depends upon electron scanning method [7]. TEM is depends on electron transmittance properties [8]. XRD is based on the structural properties [9].

Classification of nanoparticles

We can classify the nanoparticles into many types according to many properties

- Carbon based Nanoparticles
- Polymeric Nanoparticles
- Ceramics Nanoparticles
- Semiconductor Nanoparticles
- Metal Nanoparticles
- Lipid based Nanoparticles etc [9].

Synthesis of Nanoparticle

There are many methods for the preparation of

nanoparticles, but most common method we used are the

1. Top down approach
2. Bottom up approach [10]

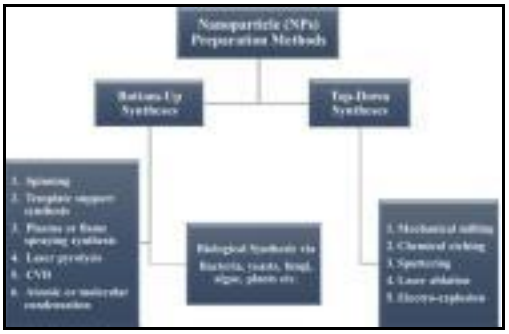

Fig.2 Schematic diagram for the Nanoparticle synthesis [11]

Objective of the study;

The objective of the study is the use of nanoparticles in disease diagnosis and treatment. It enhances the activity of drug delivery in different diseases.

Role of nanoparticles in disease diagnosis and treatment

Material science directly related to the nanotechnology. Nanotechnology deals the small size particles and its major use in not only research field but also in many daily lives. Nanotechnology collectively as diagnosis and treatment of disease is known as nanomedicine. Nanotechnology is used in different fields earlier but the use of this nanotechnology in medicine is most recent [12].The major purpose of medicine early finding of health issues and providing suitable treatment. If nanotechnology is connected with medicine so the treatment of disease is more effective [13]. The tempo of modern world is in major problem about health. Cancer, diabetes, depression and many other diseases are very common with fast moving life. Nanotechnology in the form of nanorobots, microchips and biosensor are mostly used for diagnostic purpose [14].

In simple chemotherapy, drugs that are not associated with the nanoparticles simple pharmacologically active drugs move towards the tissues which are damaged by the cancer. In these old methods, many problems associated. It may kill the healthy tissues due to toxicity is caused by the drug. But nanoparticles using biodegradable polymers are more effective and eradicate the problems [15] .

Quantum dots which are nanoparticles fabrication, when placed in UV light absorb light and glow. When these nanoparticles are moved towards the inner cancerous cell then these quantum dots starts glowing and tells about the tumor. In most present study, antibody linked with the magnetic poly-(D, L-lactide-co-glycolide) nanoparticles with doxorubicin (DOX). Magnetic nanoparticles and (DOX) integrated into the PLGA nanoparticles for targeting the diseased cancerous cell. For targeting the breast cancer antibody herceptin is more effective [16].

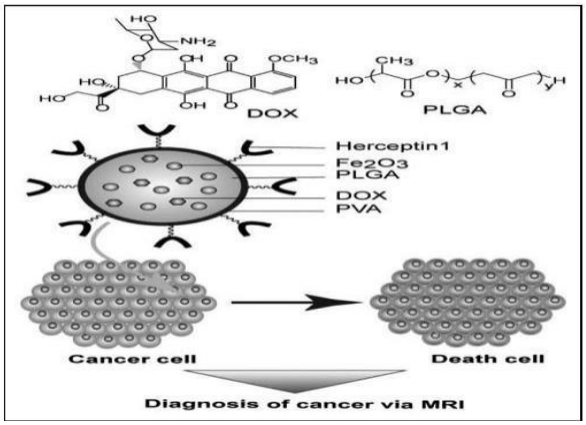

Fig. 3 The magnetic nanoparticles coated on PLGA nanoparticles for cancer diagnosis [17].

Many of imaging techniques like ultrasound imaging (USI), magnetic resonance imaging (MRI) and optical imaging (OI) ultrasound imaging (USI) for study of inside and outside study of human beings and others. There are different types of nanoparticles used in these techniques which help in vivo and vitro study [18]. Many nanoparticles are used in infectious and inflammatory diseases. Hepatitis is the infectious disease which is caused by the virus. It is chronic disease which is associated for whole life. Nanoparticles can be used with for the diagnosis of this disease. Gold nanoparticles are more preferable for this purpose. Gold nano-protein chips are formed, which detect the antibodies for hepatitis. So, these chips are effective in diagnostic purpose. For treatment purpose, DNA vaccine coated SiO_2 (LDH) nanoparticles induced antibody is used mostly [19].

Nanotechnology is also used in treatment of bone inflammation. Metal nanotechnology is most effective in osteoblasts formation. These nanoparticles provide more surface area for osteoblasts formation in proper manner. Titanium (Ti) is usually used nonmaterial for the bone inflammation. Super paramagnetic iron oxide nanoparticles are linked with the PLGA particles used in joint inflammation [20]. Nanotechnology is also effective in skin infection. One of the medicines which is used for the treatment of skin infection is nitric acid coated nanoparticles. Iron oxide nanoparticles have direct link with protein thrombin. Thrombin provides protection against anti thrombin because it takes part in process of tissue repair. Nanoparticles help together anti-inflammatory drugs in penetrating of the skin[21].

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Noble metals and their composite are used as healing agents in earlier time as a medicine for many diseases. These nanoparticles are used for the treatment of many diseases like HIV, TB and Parkinson disease. In the dental field, nanotechnology help in production of nano-filled resin compound that contain small size packing particles which liquefy in higher concentration and deposited the hydroxyapatite on enamel. Pt Nps are used for enameling process that enhances the strength of teeth[22].

Nanotechnology also plays important role in cardiovascular and pulmonary diseases. Nanomaterials are used to improve the heart muscles function. For this purpose, carbon nanofibers enclosed with PLGA and enhance the heart muscles growth. Carbon nanotubes are the more advanced form due to their unique electrical, thermal and mechanical properties. Carbon nanotubes specially functionalized for transport of drugs. Nano-pillars and nano-lines are effectively used in fibroblast that is most effective to check the proliferation of lung carcinoma cell lines. For this purpose choice of nanoroughness and nanospherical surfaces is most significant [23].

Atherosclerosis is the most commonly coronary disease which mostly occurs in young age. The major cause of this disease is the progressive plaque deposition in the major arteries of the body that caused the blockage of arteries. For this purpose, drug eluting stents (DES) performed. This is not more effective. Therefore, Anti-proliferative drugs can be delivered using nanoparticles, which help in drug delivery [24].

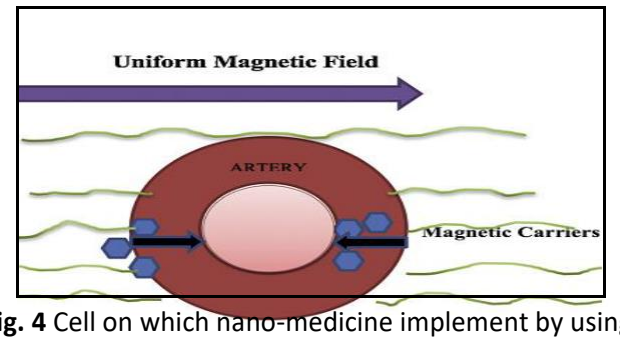

Fig. 4 Cell on which nano-medicine implement by using magnetic field [25].

Drug delivery is one of the most important one of the most important aspect, especially in the research field. It's more application in clinical field. For this purpose many nanoparticles are used for delivery of drugs in the diseased part of the body. For this many nanoparticles are used but more preferable nanoparticles are gold nanoparticles (Au NPs). We can use gold nanoparticles in drug delivery because have many advantages (1) can easily synthesized in the nano range such as rod like and cage like (2) due to the presence of negative charge on surface of nanoparticles they can easily functionalized with any biomolecules (3) less toxic and so on. For proper delivery of drugs, nanoparticles is functionalized with biomolecules such DNA etc enhance the modification. There are two types of interaction through which nanoparticles functionalized (1) through covalent (2) non covalent interaction. After the modification of nanoparticles, antibody or transport drug attached with Au NPs through ionic and covalent interaction. Drug delivery is more prefer for the endocellular diseases. Methotrexate is like folic acid control the disease and act like anti cancer drug if the disease is cancer. But in some cases (DOX) is attached with nanoparticles. After the attachment, this enhanced modification and it targeted on receptor cell [26].

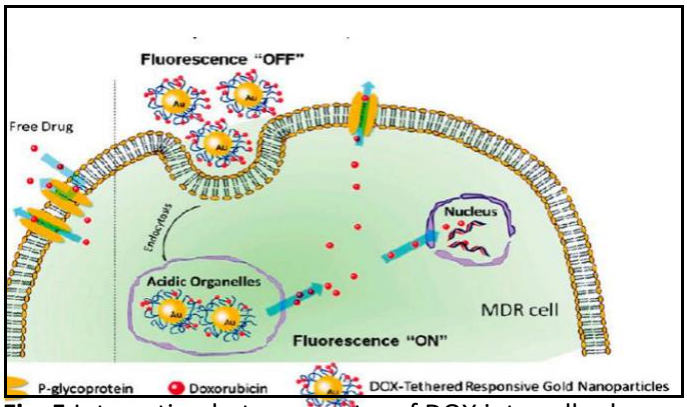

Fig. 5 Interaction between entry of DOX into cell release of DOX into cell [26].

Gene therapy is an approach for the treatment of genetic diseases. For this, oligonucleotides like DNA, RNA and plasmids have healing effects. Gold nanoparticles are an ideal for RNA and DNA delivery. Oligonucleotides act as intra cellular regulatory agents. Gold nanoparticles surface is modified with the attachment of oligonucleotides. These enhance the property of NPs. These modified gold nanoparticles are important in development of therapy and gene delivery [27].

Alzheimer's disease (AD) is one of the most common diseases in early age people and it is serious problem in 35 million people about all over the world. The effects of this disease are increasing every year. It is

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neurological effect and its result in memory loss due to the side effect of acetyl cholinesterase inhibitors and N-methyl-D-asparate. Receptors are used to eliminate this disease. For this purpose, dual function nanoparticles on the basis of PEGylated Poly (lactic acid) (PLA) are prepared. Two peptides TDN and QSH are liked with nanoparticles. TGN is target on the blood brain barrier (BBB). BBB of normal person is different from AD patient. By targeting the nanoparticles in vivo and vitro brain tissue and different techniques are used to determine and cure the disease [28].

Gold nanoparticles are significant for finding their possessions of riveting brightness in detectable and near-infra red choice. These possessions are strappingly reliant on their contour and extent [29]. Therefore, they grasp huge swear for imaging and analysis of cancer where inherent and protein biomarkers are being used for the reason. For the cancer treatment, it is a greatest condition for a medicine to go into in the intention cell. Due to this reason, it may of slighter to move in the cell [30].

Gold nanoparticles have unique properties like shape, size, morphology and other chemistry of materials. These nanoparticles have many properties like surface Plasmon resonance, magnetic properties, and fluorescence resonance properties. These properties are used in many cases, DNA hybridization, and Protein and nucleic acid biosensors, CT-MRI and in Immunological assay. Using nanoparticles the treatment of disease is effective. Gold nanoparticles have many optical properties. Due to high surface area, they have more scattering properties. These properties are used in biomedical fields. These nanoparticles have high absorption properties and used in biological analysis.

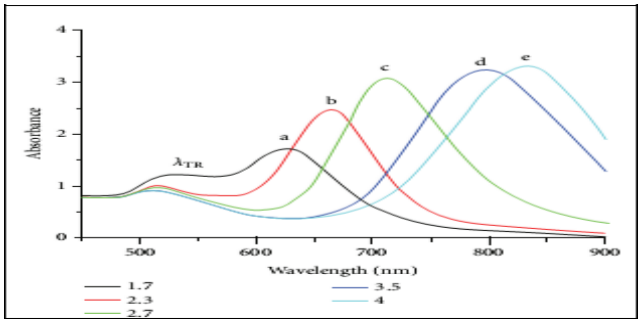

Fig. 6 Absorption spectra of gold nanoparticles [31].

AuNPs have average width of 50nm [30] which is quite consistent for its entry inside into any type of cell including the cancerous tissue. It is an eminent detail that slighter nanoparticles can achieve better surrounded by many implementation as compared with the larger one. Because cancerous cells are easily divide, there are much probability of passing higher number of gold nanoparticles in them as compared with usual tissues and also has aptitude to with no trouble get detached from the body by any process of secretion.

AuNPs hurdle with numerous trastuzumab antibodies also subjugated to specifically target the human epidermal growth factor receptor (HER)-2 in human SK-BR-3 breast cancer cells. The gold-HER particle with the HER-2 receptor initiate to be internalized by the cell and resulted into two-fold increase in trastuzumab cytotoxicity [32] . Radiotherapy is the effective for this.

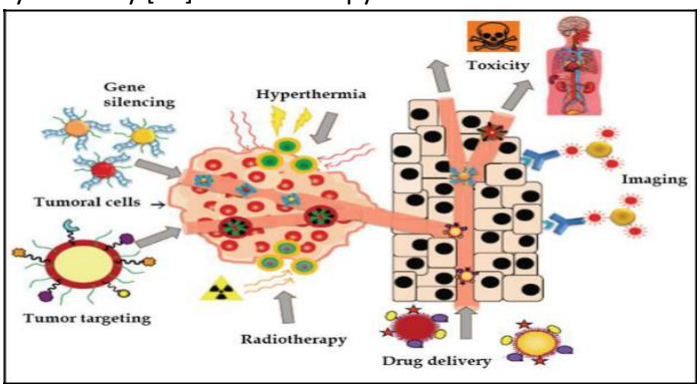

Fig. 7 Nanoparticles delivery system [33].

Nanoparticles are one of effective is on not only the human diseases but also on plant disease. Many nanoparticles are used in diagnosis and treatment of disease in plants. Silicon is commonly known to resistance against disease. For this nano sized silica silver is one of effective as it retards the fungal growth. In recent studies, there is formation of nano pesticides spray which is in the form of Alumino-Silicate nanotubes, which spray on some plants and it picks up insects etc. Nanoparticles are used in packing of much food it avoid the anti microbial agents and saves the life [34]. The fascinating and vital properties of Ag nanoparticles amongst the other metallic nanoparticles like gold, tin, palladium etc have wide range of applications like anti bacterial, anti cancer, antiviral etc [35].

As, we know that nanoparticles are used in formation of nanomedicine. Nanoparticles can be formed from the elements which they have large surface area. They include polymers, carbon, silicates and lipids. Nanoparticles labeled with radio chemically active compounds. These nanoparticles have great importance

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in medicine field. These nanoparticles used in circulation of blood. Micelles have water repelling inner side and outer covering made from water loving. They are mostly used in drug delivery system [36].

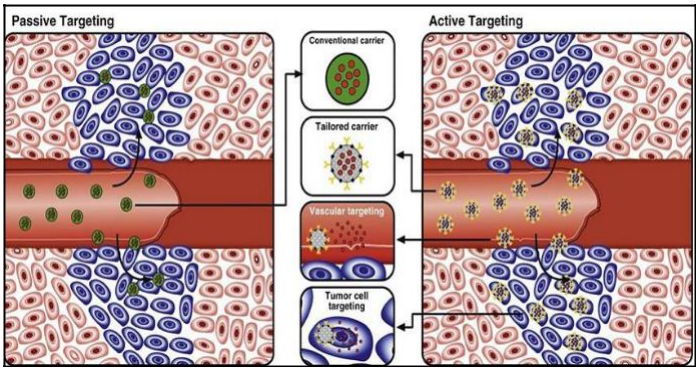

Fig. 8 Active targeting vs. passive targeting [37].

Nanoparticles are used in Alzheimer's disease (AD) treatment. For this purpose, many nanoparticles are used includes, zinc and silver oxide, titanium oxide and silica dioxide. Many works have done on bioactive compounds like flavonoids and selenium with oxidant nanoparticles used in treatment of Alzheimer's disease. Nanoparticles affect on brain by increase the amount of production of reactive oxygen species by decrease in production of amyloid β (Aβ). This disease is caused due to accumulation of amyloid β (Aβ) in the brain. So, selenium rich nanoparticles are more effective in cure of (AD) [38].

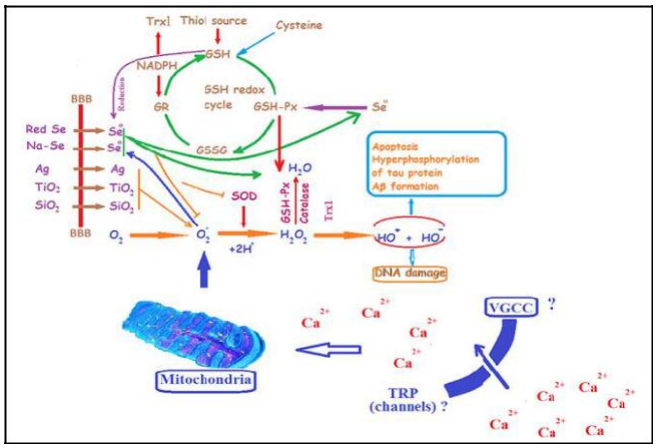

Figure 8; nanoparticles effect in the formation of amyloid β (Aβ) in Alzheimer's patient [38].

Viral nanoparticles (VNPs) are one class of the nanoparticles which are used in disease diagnosis and treatment. VLPs are more suitable for production in heterologous expression systems. VLPs can produce directly by alkaline hydrolysis of nucleic acid. Many of these nanoparticles are used in targeting and imaging [39].

Kidney disease is one of the serious diseases. It is common chronic disease. Magnetic resonance imaging (MRI) is the technique used for this treatment and investigation. This technique provides information about function and structure of kidney. MRI is using nanoparticles in addition to it [40]. Oral cancer is the sixth common disease present in the world. There are 5% chances to cure about this disease. So, needs to be early detection about this disease. There are many techniques which are used in the detection of disease. Most commonly used techniques are MRI, Raman spectroscopy and PET. But these methods not gave early detection about disease. When antibody bonding gold nanorods is employed in Raman spectroscopy, it will give sharper and better result [41].

Atherosclerosis is a disease. It is cardiovascular disease. Nanoparticles have role in diagnosis and treatment of atherosclerosis. The $\alpha_v\beta_3$-targeted anti-angiogenic perfluorocarbon nanoparticles have role in diagnosis and treatment of this disease. These are most effective nanoparticle [42]. Nanoparticles are used in different gastrointestinal diseases. Many nanoparticles devices like quantum dots, nanowires, dendrimers and Cantilevers are very effective. Cantilevers are most preferable because of its high sensitivity associated with it. It can withstand high temperature and stability. For this, introduced antibody is coated with cantilevers. It easily reached the disease part of the body and provides information about the disease part of body. It is connected with any communication system to provide real time for disease diagnosis.

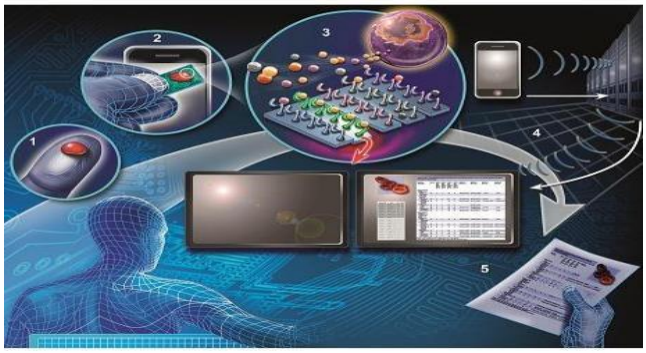

Figure 9; 1-test in home **2**-using chip in lab **3**-cantilever technologies **4**-result from cantilever sends to physician **5**-by checking the result, it can be easy for treatment of disease and delivery of drugs [43].

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Multiple sclerosis (MS) is a disease in which body's immune cells start attack on the on central nervous system and result in conditions like destroying myelinated axons and demyelization. There are different conditions for (MS); in Relapsing-remitting MS case 85% affect the patient, in Progressive-relapsing MS only 5% affect on patient. Nanotechnology is used for diagnostic purpose is a biocompatible. These NPs easily interact with the D.N.A, proteins and other organelles. Extracellular scaffolds used in this, caused the easily attachment and repair of the nerve cells.

Table 1; Nanoparticles applications in disease diagnosis and treatment **[44].**

Application area	**Example of drugs and nanoparticle composition**	**Results**
Therapeutics		
	Quantum dot complexed with MMP-9-Si RNA, MMP-1- loaded	Reduced MMP9 expression in brain
	PLGA nanoparticles	micro vascular endothelial cells, leukocyte inhibition
	pMHC-coated iron oxide nanoparticles	Inhibition of MMP-9 and inflammation
	ITE- and MOG-loaded gold NPs	Dendritic cell-induced T-reg cell differentiation
	Mannosylated liposomes carrying MBP fragments	Nullified MBP antibodies showing EAE abrogation
	Epigallocatechin gallate- and a-lipoic acidloaded gold NPs	Strong antioxidant activity
	CeO NPs	Strong antioxidant activity
	Fullerene (C60) suspension	Strong antioxidant activity
	Nano-encapsulated H. pylori	Hypothesized for future MS therapy
	Trimethyl chitosan-loaded IFN-b microparticles	Sustained drug release
	Fullerenol (polyhydroxylated C60)	Strong neuroprotection antagonizing glutamate receptors suppress neuro inflammation and increase motor function in the cerebral palsy
Diagnosis	MBP-coated TiO2 nanocomposites films	Enhanced detection sensitivity of Carbon
	Nanotubes	Determination of epithelial cell chirality

Conclusion

Nanoparticles due to their small size have more surfaces to volume ratio. The surface provides larger area for chemical reaction. Nanoparticles made drug delivery easy in a specific way. Nanoparticles have been used in many equipment and methods, made them very effectives. Though they are not very cheap but they increase the sensitivity. Due to SPR and fabrication properties of Ag nanoparticles, these are used in optoelectronic, bioengineering, medicine nanotechnology and other advanced fields. Recently, Ag nanoparticles have been used as antibacterial and antifungal agent.Through this, early findings of the disease like cancer are very important. They are very effective in kidney and gastrointestinal diseases. The proteins and other molecules get attach with nanomaterials and permit to find the initial stages of the disease. There are many systems have been developed to detect disease under the nanomaterial. About them, one is nano sphere inc. that uses AuNPs. These nanospheres have proved in the clinical studies that it

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kinds of nucleic acids. Another system being developed known as T2 biosynthesis. This method is more specific and it uses magnetic nanoparticles to recognize the sample including nucleic acids, proteins etc. Gold nanoparticles and carbon nanotubes are widely used as biosensor that detects proteins responsible for oral diseases. A number of tests have been performed by researchers, an accurate detection of oral cancer diseases that provides results within an hour. Viruses and other microscopic components from blood samples are separated by using Ag nanorods. This can be monitored by Raman spectroscopic signals. This method serving detection and identification of bacteria and viruses and allowing results less than an hour. At the end, nanoparticles are very beneficial

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