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TECHNICAL INNOVATIONS IN NANOPARTICLES AND THEIR IMPACT ON PHARMACEUTICAL SIGNIFICANCE

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Abstract:

Use of nanotechnology in medicine and more specifically in delivering the drug at the particular site is set tobe spreading rapidly. At the molecular and sub molecular level the nanotechnology has scrutinize its electrical, optical and magnetic activity as well as their structural behavior. The pharmaceutical sciences are using nanoparticles now a daysto reduce toxicity and side effects which s caused the carrier systems. At present a large number of substances are under research for drug delivery and more precisely for cancer chemotherapy. The nanoparticles caneasily crosses the various biological barriers within the body due to their small size. The potential toxicity of inhaled particles may also influenced by the absorbed species. It is clear that the potential toxicity and potential interactions with tissues or cells, greatly depends on the actual composition of the nanoparticle formulation.Nanotechnology has its capability to revolutionize a series of biotechnology and medical tools and procedures so that they are safier and administered easily. This article gives an general view of some of the currently used drug delivery systems.

Key words: Nanotechnology**,** Drug delivery to BBB, Carbon nanotubes, Solid lipid nanoparticles and Tissue engineering.

Introduction:

Nanotechnology and Nano science refers to an emerging field of science that includes synthesis and development of nanomaterial's in the recent years. Nanotechnology can be defined as design, identification and applications of structures and devices by controlling their shape and size at nanometer range. With the improved advancements in nanotechnology, the diagnosis and treatment of the disease can be significantly improved.Engineered nanoparticles help to increaseanticipated applications in medicine such as drug

delivery systems and both invitro and in vivo diagnosis of a disease and the improved therapies for the treatment of disease. The Nano particles used for medical purposes should be in the based on their important sizeof ≤100 nm. The nanoparticles (NPs) aremore attractive for a medical purpose is because they have large surface area, quantum properties and their ability to adsorb and carry other compounds. Due to their large surfacearea the nanoparticles are able to bind, adsorb and carry other compounds such as drugs and proteins. The nanoparticles which arehaving greater then 100nm are called as large nanoparticles and they are required to load therequired amount of drug onto the particles. The Source materials for the engineered nanoparticles are phospholipids, lipids, lactic acid, and dextran which are biological in origin.

A nanoparticle can be defined as solid colloidal particles (or) particulate dispersions in which the active drug is either dissolved, dispersed or attached to nanoparticle matrixes which are ranging from 1-100nm in size.The prefix "Nanos" is usually a Greek word which means extremely small. Nanoparticles can also be formulated as injections. Polymeric nanoparticles are the only nanoparticles that can be used for the In vivo drug delivery to brain. Polymers are easily biodegradable without the use of co-solvent and thus reduce the toxicity. HEXAPEPTIDE DOLARGIN is the first drug that transported into the brain. A nanoparticle has its various applications in Biomedical, optical and electronic fields and thus it leads to nanoparticles research is an intense scientific interest.

With the use of nanotechnology we can create unique products which are stronger, lighter, cheaper, and precise. Manufacture at low cost. Less pollution and mass production in food and consumables. But it has also some disadvantages like nanoparticles can cause serious illness or damage to human body. Carbon nanotubes could cause infection to lungs.

Types of Nano particles:

Nanoparticles are classified into different types according to their size, morphology, physical and chemical properties. The various types of nanoparticles along with their sizeas shown in the figure no: 1

1. Organic nano particles:

Dendrimers, liposomes and polymeric nanoparticles are commonly known as organic nanoparticles. Nanomaterial's mostly made from the organic matter. Dendrimers are highly branched polymers and it can be used as an tissue –repair scaffolds. Organic nanoparticles are widely used in the biomedical field in drug delivery systems they are efficient and also can be injected on specific parts of the body. These are also

called as targeted drug delivery. This of non-covalent interactions for the designing of molecules helps to converts the organic nanomaterial's into desired structures such as Dendrimers, polymeric nanoparticles, and Liposomes.

2. Quantum dot:

A Quantum dot is a nanostructured semiconductor crystals which has optical different optical and transport properties due to their three dimensional quantum confinement. Due to thespatial confinement of electron hole pairs in one (or) more dimensions within a material leads to the formation of quantum confinement. The confinement is mainly due to electrostatic potentials due to the presence of interface between the different semiconductor materials.It alsohas the discrete energy levels. This level depends upon the size and shape of the quantum dot.The colloidal semiconductor Nano crystals are the small quantum dots in which the atoms size ranges from 2-10nm, andin each quantum dot value atotal of 100 -100000 atoms are present. There are three main ways to confine excitons, such as Lithography, colloidal synthesis, and Epitaxy.

Within the width of human thumb there are nearly 3 million quantum dots with 1onm in diameter could be lined end to end. Quantum wires confines the electrons (or) holes in two spatial directions and allows free propagation in the third direction whereas the Quantum wells allows free propagation of motion of electrons in two directions whereas confines in one direction. Quantum dots can also use in Biosensors, Solarcells, andphoto detectors.

3. Nano crystalline silicon:

It is also known as microcrystallinesilicon. Nano crystalline silicon has small grains of crystalline silicon and it is an allotropic form of silicon. It differs from the polycrystalline silicon in which crystalline silicon grains are separated by grain boundaries. The term Nano crystallinesilicon ranges of materials fromthe amorphousphase to the microcrystalline phase in the silicon thin film. Most of the materials with grains of micrometer rangeare usually fine grained polysillicon, so it suggests as the Nano crystalline silicon.

4. Photonic crystal:

These are also called as photonic band gaps. The photonic crystals are the periodicdielectric structures that are designed to form the energy band structure for photons which may allow (or) refuse the propagation of electromagnetic waves (EM) to certain frequency range. The phenomenon involved in the photonic crystals is diffraction. Photonic crystals operating in the visible region of the spectrumconsists the periodicity of the

photonic crystalline structure should be half of the wavelength of the electromagnetic waves i.e., 300nm. This makes the synthesis more complex and cumbersome

These photonic crystals are the attractive optical materials and can be used for regulating and manipulating the flow of light. They found great interest in both fundamental and applied research, and also in some commercial applications.

5. Polymeric nanoparticles:

Polymeric nanoparticles are the sub-micron colloidal particles whose size ranges from 10-100nm.These nanoparticles was invented by the Speiser et al. Different substances are adsorbed and coated on the surface of the polymeric nanoparticles and these are superior to liposomes in targeting the specific organs. They generally exhibit a long shelf life and a good stability on storage. They represent as alternative drug delivery system to Liposomes. Polymeric nanoparticles can be synthesized from a monomer during its polymerization (or) from thePolyesters. The methods which are used for the preparation of nanoparticles from polymerization of monomers are Emulsion, micro emulsion and interfacial polymerization.

6. Solid lipid nanoparticles:

Solid lipid nano particles consist of a physiological lipid which is dispersed in water that can solubilize the lipophilicmolecules. It has the average diameter of about 10-1000nm.It has been developed as a alternative drug delivery system to polymeric nanoparticles. Itpossess the combined advantages of polymeric nanoparticles, fat emulsions, liposomes. These are Biodegradable, Biocompatible, and non-toxic in nature and also contain some disadvantages such as particle growth and unpredictable gelation tendency.

7. Liposomes:

A liposome is an spherical shaped vesiclewhich mainly consists of one or more phospholipid bilayers , which may resembles the structures of cell membranes. For delivering the drug in to the cell the liposomes can be preferentially used. Liposomes can be primarily consists of naturally derived phospholipids with mixed chains such as egg, or from pure components like Dioeolylphosphatidylethanolamine (DOPE).Due to their Low toxicity, biodegradability and aptitude to trap both hydrophilic and hydrophobic molecules, liposomes have increased rate both as an investigational system and also as a commercial drug delivery system. Liposomal Encapsulation technology (LET) is a newest technique that can be used to transmit drugs which can act as curative promoters to the assured body organs.

8. Other nano particles:

Gold nanoparticles are small gold particles which once dispersed in water it becomes the colloidal gold particles having the diameter of about 1 to 100nm .These nanoparticles provide the microscopic probes for the study of Cancer cell. Gold nanoparticlescan detect and accumulate in the cancerous cell and cause the apoptosis of the specific cell (cytotoxic effect) which leads to death of cancerous cell. Sliver nanoparticles can be used as Biosensorswhereas sliver nanoparticles materials can be widely used as Biological tags for quantitative determination.

Synthesis of nano particles:

Various methods are available for the synthesis of Nanoparticles.They are of mainly

1. Bottom up approach.
2. Top down approach.

1. Top down synthesis:

In top down synthesis the larger molecules are decomposed in to smaller units which can be further converted in to nanoparticles by the destructive approach. In this technique the starting material is present in the solid state. Grinding/milling, chemical vapour deposition and physical vapour deposition techniques are the examples for this method. The milling method was mainly used to synthesize the coconut shell nanoparticles and the raw coconut shell powders with the help of ceramic balls can be further finely milled at different intervals of time with the planetary mill. Scherer equation determines that the nanoparticle's crystallite size decreases as the milling time increases. The SEM technique results were also agreed with the X-ray pattern, that the particle size decreases with increase in time BY the Top down destructive approach, the spherical magnetite nanoparticles size ranges from 20-50nm can be synthesized from natural iron oxide in the presence of organic oleic acid. These techniques are based upon the continuous chemical adsorption of polyoxometalates on the carbon interfacial surface. Due to the continuous adsorption, the carbon black aggregates can be decomposed in to the relatively smaller spherical particles with high dispersion capacity. By using the combination of both grinding and sonication techniques, a series of transition metal dichalcogenide Nano dots (TMD-NDS) were synthesized from their bulk crystals. TMD-NDs with the size less than 10 nm show an excellent dispersion. Through top down laser fragmentation, highly photoactive

photons of CO3O4 nanoparticles size ranges from 5.8+_ 1.1 nm can be syntheised. It is an expensive technique.

2. Bottom up synthesis:

In Bottom up approach the nanoparticles are syntheised from the bottom i.e., molecule by molecule. This method is reverse to the top down syntheses and it is also called as BUILDING UP APPROACH. Examples of this method are sedimentation and reduction techniques and it also includes spinning, laser pyrolysis, sol-gel and biochemical synthesis. Through this technique Mogilev sky et al syntheised titanium dioxide antase nanoparticles with grapheme domains. For the synthesis of photoactive composite for photo catalytic degradation of methylene blue they used the alizarin and titanium isoproxide. Alizarin was selected due to its strong binding capacity with Titanium dioxide through the axial hydroxyl terminal groups. The XRD pattern confirmed the antase form of nanoparticles. The SEM technique reveals that the size of nanoparticles increases with an increase in temperature. This technique is cheaper than Topdown syntheses. The monodispersed spherical bismuth nanoparticles can be syntheised by both Top down and Bottom up approach. In Top down approach bismuth was converted into molten form and then the formed molten drops were emulsified in the boiledethylene glycol to produce the nanoparticles whereas in case of Bottom up approach bismuth acetate was boiled within the diethylene glycol to produce the Bismuth nanoparticles. Nanoparticles can also be syntheised through the biological systems such as plant extracts like Aloe Vera, Tamarind and also from Yeast, Fungi, Algae and Bacteria. The diagrammatic representation of synthesis of nanoparticles through bottom up syntheses is shown in fig no: 3

Mechanism of cellular targeting:

1. Nano particle uptake by tissues:

Themembrane layers generate obstacles for therapeutic drug moieties to target the cellular moieties. The compound is lost in this process due to its inefficacy in crossing the biological membranes. The portioning coefficient of drug molecule depends upon polarity, which is directly proportional to the diffusion, lipophilicity that plays a major role in drug penetration through biological membranes. However the above mentioned creates difficulty for the therapeutic moieties in terms of their effectiveness and intracellular concentrations. Further the therapeutic activity is altered by endocytosis mechanism, delivery of therapeutic agent into metabolism and intracellular trafficking, translocation of active moieties to the targeted area etc.

The above mentioned difficulties can be encompassed by using nanoparticles which the mask the drug concentrations and preserve its therapeutic property. The current property limits its influence on its intracellular concentrations and instead the surface characteristics of the nanoparticles define its release characteristics and intracellular drug concentrations.

The endocytosis which is considered as one of the crucial factor for membrane manipulation is categorized into three types such as pinocytosis, phagocytosis and endocytosis. Phagocytosis is involved in reticulo endothelial system and can ingest particles up to 10mm. whereas pinocytosis is confined to ingestion of sub-micron sized materials and solutions.

2. Cellular phagocytosis/endocytosis:

The Receptor-mediated endocytosis serves as a potentialmeans for cellular targeting. The cellular membrane is designed with various receptors which upon binding with respective ligands transduces a signal. The signal triggers various biochemical pathways and causes ligand internalization and appends nanoparticle through endocytosis. Further the clatherin pores causes membrane indentation of 50 nm diameter and invaginates upon further ligand interactions. The resultant receptor and ligand cross linking generates enfolding and reunification of cellular membranes forming an endosomes. It is believed that the nanoparticles between 20-50 nm are favorable for intracellular localization and endocytosis.

Steps detailing the cytosolic delivery of therapeutic agents through nanoparticle carriers are shown in fig no 4.

(1) Cellular association of nanoparticles,

(2) Internalization of nanoparticles through endocytosis,

(3) Endosomal escape of nanoparticles

(4) Lysosomal degradation of nanoparticle

(5) Therapeutic agent freely distributed into cytoplasm,

(6) Cytoplasmic transport of therapeutic agent to target organelle,

(7) Exocytosis of nanoparticles.

Characterization techniques:

There are different characterizations techniques have been employed for the characterization of nanoparticles. The various techniques include X-RAY DIFFRACTION, X-RAY PHOTOELECTRON

SPECTROSCOPY (XPS), INFRARED (IR), SEM, TEM, PARTICLE SIZE ANALYSIS AND BRUNAUER-EMMETT-TELLER (BET). The most of the properties of the nanoparticles are influenced by the morphological features of nanoparticles. The microscopic techniques such as Polarized Optical microscopy (POM), Scanning Electron Microscopy (sem) and Transmission Electron Microscopy (TEM) are of great importance in studying the morphological features of nanoparticles.

SEM technique:

The SEM technique is mainly based upon the electron scanning principle, and it provides the information at very low level (Nano scale level). This technique is used to study the morphology of their nanomaterial's, and also for the dispersion of nanoparticles into the matrix. ThroughSEM technique we studied the morphological features of ZNO modified a metal organic framework which indicates ZNO nanoparticles dispersions of MOF'S at different temperatures as shown in fig no 5.

TEM technique:

The TEM technique is mainly depend upon the electron transmittance principle. The various morphologies of gold nanoparticles can be studied by the TEM technique as shown in fig no 6. This technique provides the information from very low to higher magnification materials.Through TEM technique we can observe the information about the two (or) more layers materials such as quadrupolar hollow shell structure of co3o4 nanoparticles. These nanoparticles act as anode in lithium –ion batteries.

Structural characterisations:

The structural characteristics are very important to study the composition and nature of bonding materials. It also provides the information about the bulk properties of the subject material. Various techniques such as XRD, ENERGY DISPERSIVE X-RAY (EDX), ZIETA SIZE ANALYZER, and RAMAN AND BET are used to study the structural properties of nanoparticles.

XRD technique is used to reveal the structural properties of nanoparticles. It gives the information about the crystallinity and phase of nanoparticles. This technique performs well in both single phase and multi-phase. It is a surface sensitive technique used in depth profiling studies to determine the overall composition and compositional variation with depth. FT-IR and RAMAN SPECTROSCOPIES can be used the vibrational characterization of nanoparticles. This is the most developed and feasible technique. SURFACE

ENHANCED RAMAN SPECTOSCOPY (SERS) technique is used to study the vibrational properties in quantumdots nanoparticles of zno and PBS.

Particle size and surface area characterization:

Various techniques can be used to study the size of nanoparticles. It includes mainly SEM, TEM, XRD and DYNAMIC LIGHT SCATTERING (DLS). The zeta potential size analyzer (or) DLS technique can be used to find the nanoparticles size at extremely low level. Nanoparticle tracking analysis (NTA) is a newer technique to visualize and analyses nanoparticles in liquid media and it is helpful in the case of biological systems such as proteins and DNA. This technique allows the size distribution of nanoparticles with diameter from 10-100nm in liquid medium. BET technique is the used to determine the surface area of nanoparticles. By comparing with the other techniques this is the best one for determining the surface area.It works on the principle of both adsorption and desorptionand BET theorem. **Optical characterizations:**

This techniquemainly works on the principle of Beer-lambert's law. It gives the information about the absorbance, luminescence, reflectance and phosphorescence properties of nanoparticles. The metallic and semiconductor nanoparticlespossess different colours and these are best suitable for photo- related applications. Optical instruments such as UV/VIS –DIFFUSE REFLECTANCE SPECTROMETER, NULL ELLIPSOMETER and PHOTOLUMINESCENCE are used to study the optical properties of nanoparticles. The uv/vis – DRS is a special technique which can be used to measure the optical absorption, reflectance and transmittance.

Nanoparticle drug delivery for human therapeutics:

Nanoparticles have the wide range of applications in drug delivery, ranging from cancer to infection and it has more than 12FDA approved variants.

Neurological cancers (glioblastoma multiforme):

The blood brain barrier limits the uptake of various therapeutic moieties and contrast agents which is due to limited pinocytosis, tight intracellular junctions. The microvasculature of brain consists of endothelial cells; astrocytes foot processes, pericytes and nerve endings. The endothelial cells in pericytes are involved in immune surveillance and other side of the membrane is surrounded with astrocytes foot processes. The endothelial cells of blood brain barrier forms very tight junctions there by reducing pinocytosis to a hundred fold. Therefore theaccesses to central nervous system through either receptor mediated endocytosis (or) by

means of lipid mediated free diffusion .glioblastoma multiforme is a critical neoplasma which demands multidisciplinary treatment such as radiotherapy, chemotherapy, and surgery .The transport of various chemotherapeutic agents across blood brain barrier is critical and a series of investigations revealed Nano particles as a favorable means of drug transport.

Low density lipo proteins increase the number of receptors on GBM (glioblastoma multiforme) cellular surfaces tobetween 128000 and 950000 receptors per tumour cell. Natural low density lipoproteins (LDL) particles are 22-27nm in diameter which consists of a core of lipids mainly composed of cholesteryl esters along with the small amounts of triglyceride .Thus targeting LDLR offers the effective therapeutic selectivity in chemotherapeutic drug delivery.

Diseases:

Alzheimer's disease (AD) is a progressive disease that mainly destroys the memory and other mental functions. It is most common in people over 65 years of age. The neurodegeneration in Alzheimer'sdisease can be caused by oxidative stress triggered by various mechanisms that can be suggested by the current therapies such as acetyl cholinesteraseinhibitors, cholinesteraseinhibitors, antioxidants amyloid –B-targeted drugs, Nerve growth factors and vaccines.

The central nervous systemis particularly susceptible to oxidative stress, especially those catalyzed by transition metals such as copper (cu) and zinc (Zn). Iron concentrations are increased in patients with this disease due to the iron metabolism. Aluminum concentration is also high in the patients with AD. However, free radical damage is increased due to aluminum can act in coordination with the iron. The pathophysiological development of AD can be reduced by the chelation of these metals. Desferrioxamine (DFO) is a metal chelator have been used clinically.DFO has strong affinities for zinc, copper and aluminum and it also exhibit the serious toxicity such as neurotoxicity and also poorly absorbed in the GIT. Desferrioxamine cannot be penetrate through the blood brain barrier due to its hydrophilic nature and it is useless in neurodegenerative disease therapies.

The synthetic chelator were examined in brain tissue sections in Alzheimer's disease patients and these chelator remove iron from ferritin and from brain tissues more effectively than Desferrioxamine.The syntheticchelator can be conjugated with the nanoparticles through covalent bonding to amino and carboxyl groups on the surface of nanoparticles.

Therapeutic applications:

1. Targeted drug delivery for cancer:

The Cancer drug delivery is previously enclosing the drug in new formulations for various routes of delivery. Advances in molecular biology of cancer and pathways involved in malignant transformation of cells are developing thenew approach to cancer treatment with a focus is on targeted cancer therapy. The present focusin the development of cancer therapies is on the selected drug delivery to provide the remedial concentrations of anticancer agents at the site of action and remain unaffected the normal tissues.

Monoclonal antibodies (MAbs) can be used both for diagnosis and therapy in cancer. Monoclonal antibodies are attaches to form pair with powerful toxins and radiopharmaceuticals to design specific agents which can identify the cancer cells and destroy them.

2. Chemotherapy of Tuberculosis

Nanoparticles are also used through the oral route of administration. The properties of nanoparticles in gastrointestinal tract system have also investigated in a number of studies. Usually the intake of nanoparticles takes place through 1.Transcytosis through the micro fold cells, 2.Intracellular uptake and transport through the epithelial cells lining the intestinal mucosa 3.Uptake through the Peyer's patches.

Pandey and his colleagues stated that after oral route of administration nanoparticles have given the prolonged release of anti TB drugs and their increased efficacy. Rifampin, isoniazid, and pyrazinamide are the three first line drugs which were coenveloped in Poly lactide-co-glycolide nanoparticles. After a single dose oral route of administration this formulation to mice the plasma drug concentration is 4D for RMP and 9D for INH and PZA.Therapeutic concentrations in the tissues were maintained for 9-10 days. In contrast the protein bound free drug was cleared within 12 to 24 hours after administration. Tuberculosis injected mice was treated with nanoparticles bounddrugs which results inthe complete clearance of bacteria from the organs. Free forms of drugs are able to clear the bacteria, after daily administration of 46 doses. In guinea pigs the nanoparticle bound drugs with similar efficacy was also observed.The covalent attachment of wheat germ agglutinin to the anti TB Drugs improves the efficacy of PLG based formulations. Oral administration of wheat germ agglutinin coated PLG nanoparticles loaded with RIF, INH and PGA in mice, have given the prolonged plasma half-life detectable RIF serum levels were observed for 6 to 7 days and INH and PGA for 13-14 days. All these three will present in lungs,liver, spleen for 15 days. The Lectin modified formulations

have cleared all the bacteria in these organs after three oral dose administered for every 14 days. The prolonged half-life of drugs encapsulated in Wheat germ agglutinin grafted nanoparticles might be allocated to the fact that Lectins enhances the prolonged adhesion to the surface of intestine to allow 1.an increase in the absorption time intervals, 2.an increased concentration gradient between the Luminal and serosal sides of the membrane.

3. Intravenous administration:

The Micro particleshaving the diameter of more than 1 μm that cannot be administered through the intravascular routes and in these case nanoparticles are small enough to pass through the intrapapillary passage followed by an efficient cellular uptake.When these nanoparticles are administered intravenously, it follows the route of foreign particulates (or) intracellular pathogens and these pathogens are endocytosed by the macrophages and bythe circulating monocytes. In some of the infection's caused bythe intracellularly (present within the cell) persisting microbes like salmonella, mycobacteria, macrophages become reservoirs forthe pathogens, thusit represents one of the targets for delivery of antimicrobial agents.

Due to the physicochemical properties of the carrier the selective uptake of nanoparticles is being accomplished. This technology improves drug delivery to macrophages, thus increasing the drug delivery to the site of action, and decreases the adverse effects. The Nano particle bound antibiotics such as Clofazimine, is used to treat patients sufferingwith M. avium infection. But the use of this drug was restricted due to its poor solubility. But this problem can be overcomed by the use of Nano suspension of Clofazimine which it consistsonly the drug and a minimum number of surfactants. When this Nano crystalline formulation of Clofazimine is injected intravenously to the mice with M.avium infection, there is a considerable reduction of bacterial loads in the liver, spleen, and lungs. This study is a vivid example for the overcoming the solubility problems of poorly soluble drugs in nanotechnology.

4. Drug delivery to the CNS:

To deliver the drugs or other molecules across the blood brain barrier and potential to target a specific group of cells (a tumor) requires a number of things to happen together. A Nano delivery-drug complex would be administered intravenously but would identify the CNS while producing minimal systemic effects. These technique demanding obstacles will require multidisciplinary solution between various fields such as Chemistry, physiology, Engineering, Cell biology and medicine.

5. Diagnosis of liver cancer:

Gold nanoparticles can recognize the small cancer cells as even 5mm in the liver. These particles with a polyelectrolyte coating can make smaller tumors more visible by the x-ray scatter imaging, thus help to enable earlier diagnosis of liver cancer.

Miscellaneous applications

1. Filtration:

Nano chemistry can be used for waste water treatment, air purification. Nano filtration mainly used for the removal of ions and for the separation of different fluids. It is also useful for ultrafiltration in renal dialysis. By using the magnetic separation techniques the magnetic nanoparticles are used to clear the heavy metal pollutants from the waste water.

By using Nano scale particles the efficiency to absorb contaminants increases and it is inexpensive when compared to filtration methods.

2.Recycling of batteries:

Due to the low energy densities of batteries the operating time is limited and recharging is required. Byusing the nanomaterial's in the rechargeable batteries we can increase the rate of recharging and it also helps in the reduction of battery disposal problems.

3. Displays:

By using the Carbon nanotubes we can produce the displays with low energy consumption. For the production of high efficiency field emission displays the carbon nanotubes can be used as field emitters due to high electrical conductivity nature and their small size.

4. Energy harvesting:

The scarcity of fossil fuels is increasing in the recent years due to their non-renewable nature. Therefore Scientists have found that nanoparticles are the best substances to generate energy due to their large surface area, Optical behavior and catalytic nature. Nanoparticles are majorly utilized toproduce energy from electrochemical and the photo electrochemical water splintering.

Solar cells and piezoelectric generators are used to generate energy. Nano generators can also be used recently which converts the mechanical energy into electricity.

5. Tissue engineering:

Nanotechnology can also help to reproduce (or) repair the damaged tissue. This is called as TISSUE ENGINEERING. By the use of suitable nanomaterial's and growth factors these technique produces the artificially stimulated cell growth. Tissue engineering also replaces the today's commercial treatments such as Organ transplantations etc.

Conclusion:

In this review, we presented a detail overview about NPs, their types, synthesis, characterizations of NPs, mechanism's and applications. Through different characterization techniques such as SEM, TEM and XRD, it was revealed that NPs have size ranges from few nanometers to 500 nm. Nanoparticles are the suitable candidate for various applications due to their small size which leads to increase in their surface area for incorporating the large amount of drug. Beside this, the optical properties are also dominant at that size, which further increase the importance of these materials in photo catalytic applications. NPs have many applications, but still there are some health hazard concerns due to their uncontrollable use and discharge to natural environment, which should be consider for make the use of nanoparticles more convenient and environmentally friendly.

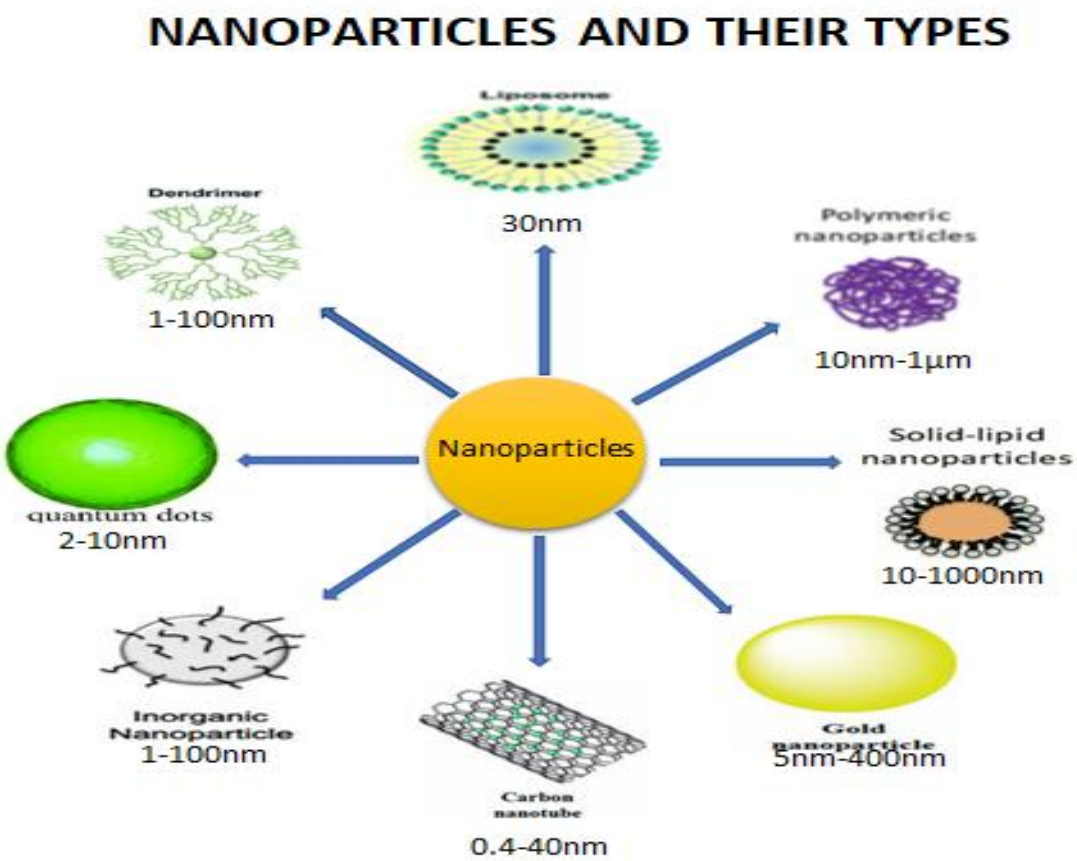

Figure-1 Nanoparticles and types of nanoparticles.

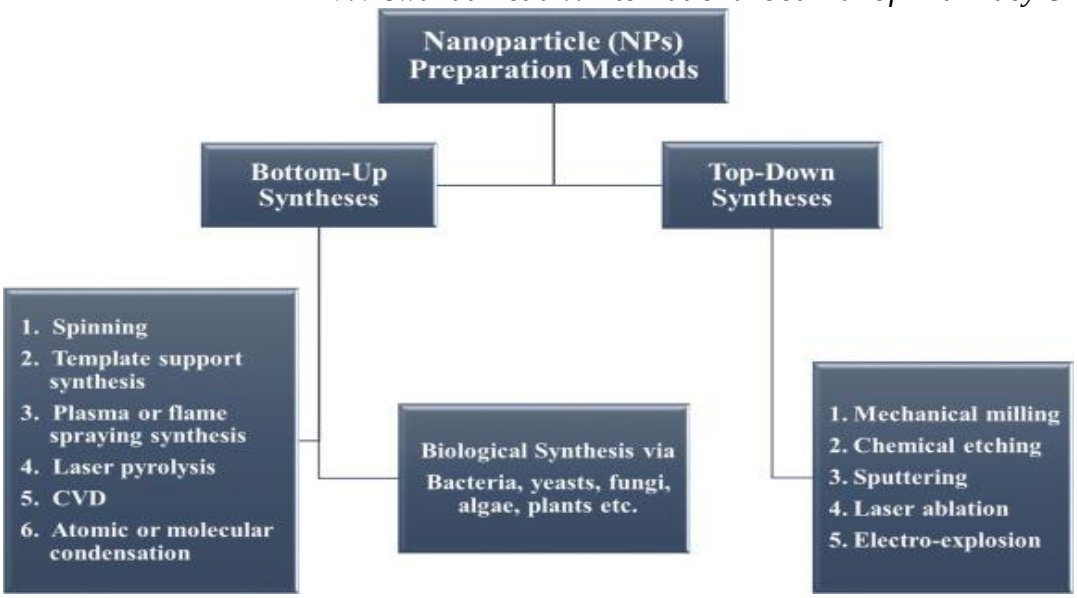

Fig no: 2synthesis of nanoparticles through top down and bottom up synthesis.

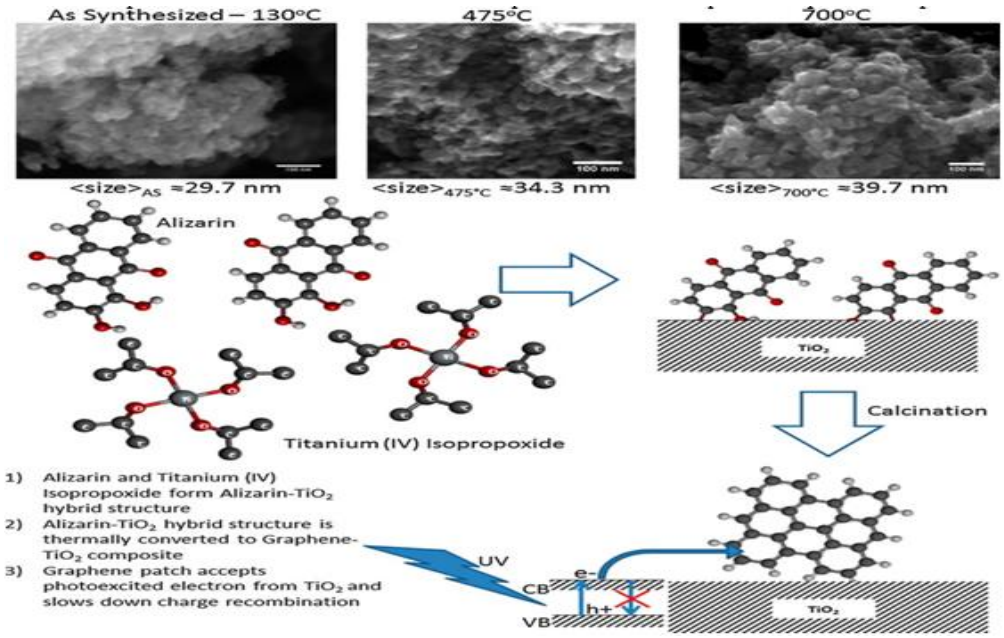

Fig no 3: synthesis of nanoparticles through bottom up technique.

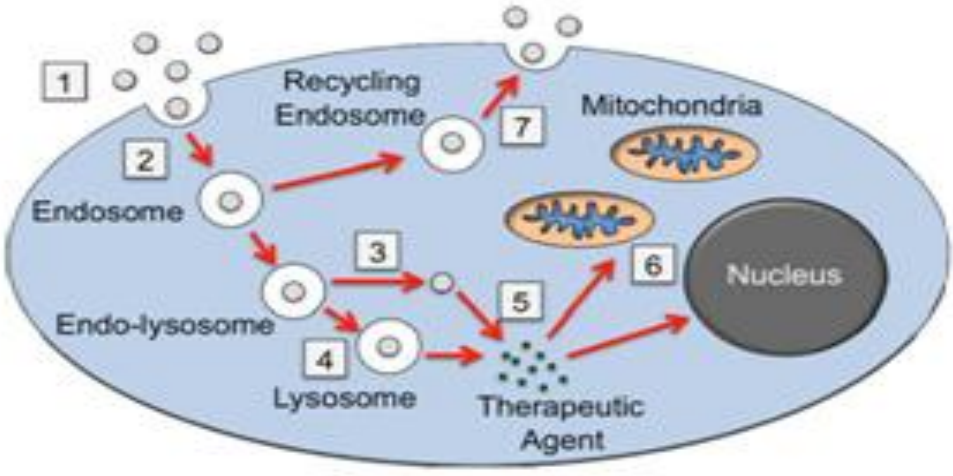

Fig no 4: cellular phagocytosis.

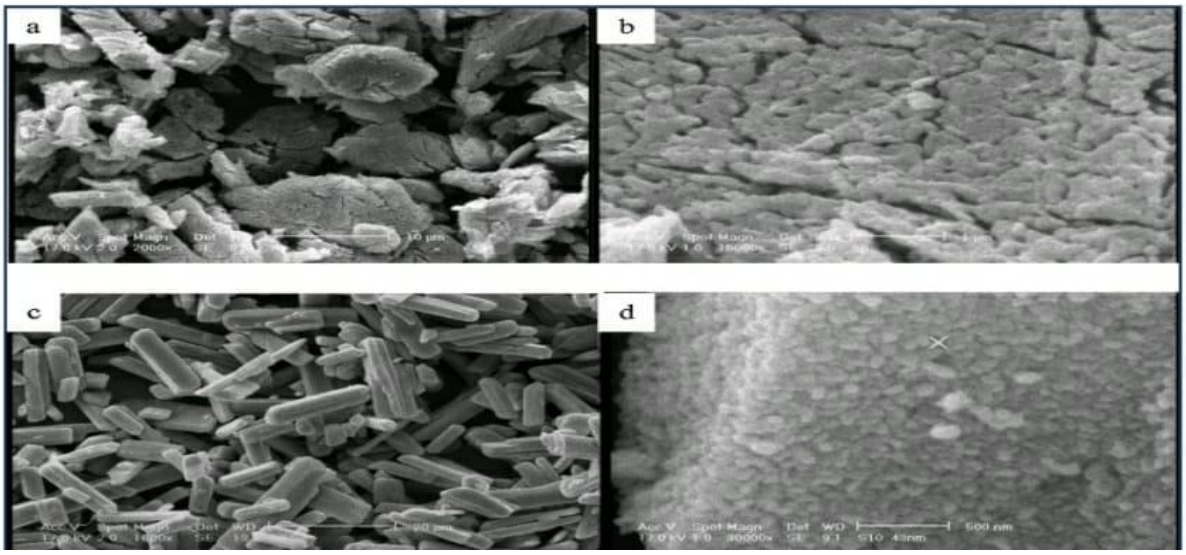

Fig no 5: SEM images of zno modified MOFS at different temperatures.

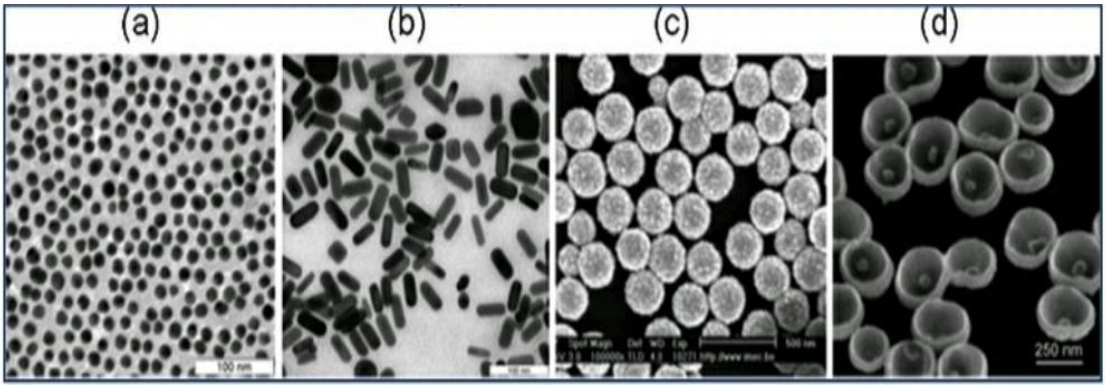

Fig no 6: TEM images of different form of gold nanoparticles syntheised by different techniques.

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References:

1. Uner, G. Yener. Int. J. Nanomedicine., 2010; 2(3):289-300.
2. Helgason, T. S. Awad, K. Kristbergsson, D. J. McClements, J. Weiss. Effect of surfactant surface coverage on formation of solid lipid nanoparticles (SLN). Jrnl. of Coll. and Int., 2009; 334:75–81.
3. R. Sinha, S. Srivastava, H. Goel, V. Jindal. Solid Lipid Nanoparticles (SLN'S) – Trends and Implications in Drug Targeting. Int. J.Adv. Pharm., 2010; 1:212-238.
4. P. Kaur, R. Bhandari, S. K.Bhandari. J. controlled Rel.., 2008; 127:97-109.
5. Mukharjee, S. Ray, R. S. Thakur. Ind. J. Pharm., 2009:349-358.
6. Mehnart and K. Mader. Problem associated with SLN. Adv. drug delivery review. 2011; 47:165-195.

7. K. Sharma, A. Diwan, S. Sardana, V. Dhall. Int. J. Research in Pharma., 2011; 2(3):450-461.
8. Uner, G. Yener. Int. J. Nanomedicine., 2010; 2(3):289-300.
9. Helgason, T. S. Awad, K. Kristbergsson, D. J. McClements, J. Weiss. Effect of surfactant surface coverage on formation of solid lipid nanoparticles (SLN). Jrnl. of Coll. and Int., 2009; 334:75–81.
10. R. Sinha, S. Srivastava, H. Goel, V. Jindal. Solid Lipid Nanoparticles (SLN'S) – Trends and Implications in Drug Targeting. Int. J.Adv. Pharm., 2010; 1:212-238.
11. P. Kaur, R. Bhandari, S. K.Bhandari. J. controlled Rel.., 2008; 127:97-109.
12. Mukharjee, S. Ray, R. S. Thakur. Ind. J. Pharm., 2009:349-358.
13. Mehnart and K. Mader. Problem associated with SLN. Adv. drug delivery review. 2011; 47:165-195.
14. K. Sharma, A. Diwan, S. Sardana, V. Dhall. Int. J. Research in Pharma., 2011; 2(3):450-461.
15. Uner, G. Yener. Int. J. Nanomedicine., 2010; 2(3):289-300.
16. Helgason, T. S. Awad, K. Kristbergsson, D. J. McClements, J. Weiss. Effect of surfactant surface coverage on formation of solid lipid nanoparticles (SLN). Jrnl. of Coll. and Int., 2009; 334:75–81.
17. R. Sinha, S. Srivastava, H. Goel, V. Jindal. Solid Lipid Nanoparticles (SLN'S) – Trends and Implications in Drug Targeting. Int. J.Adv. Pharm., 2010; 1:212-238.
18. P. Kaur, R. Bhandari, S. K.Bhandari. J. controlled Rel.., 2008; 127:97-109.
19. Mukharjee, S. Ray, R. S. Thakur. Ind. J. Pharm., 2009:349-358.
20. Mehnart and K. Mader. Problem associated with SLN. Adv. drug delivery review. 2011; 47:165-195.
21. K. Sharma, A. Diwan, S. Sardana, V. Dhall. Int. J. Research in Pharma., 2011; 2(3):450-461.
22. 2. Heiligtag F J, Niederberger M. Mater Today. 2013; 16:262–271. doi: 10.1016/j.mattod.2013.07.004. [CrossRef] [Google Scholar]
23. 23. Walter P, Welcomme E, Hallégot P, Zaluzec N J, Deeb C, Castaing J, Veyssière P, Bréniaux R, Lévêque J-L, Tsoucaris G. Nano Lett. 2006; 6:2215–2219. Doi: 10.1021/nl061493u. [PubMed] [CrossRef] [Google Scholar]
24. 24. Johnson-McDaniel D, Barrett C A, Sharafi A, Salguero T T. J Am Ceram Soc. 2013;135:1677–1679. doi: 10.1021/ja310587c. [PubMed] [CrossRef] [Google Scholar]
25. Schaming D, Remita H. Found Chem. 2015; 17:187–205. Doi: 10.1007/s10698-015-9235-y. [CrossRef] [Google Scholar]

25. 26. Artioli G, Angelini I, Polla A. Phase Transitions. 2008; 81:233–252. Doi: 10.1080/01411590701514409. [CrossRef] [Google Scholar]
26. 27. Brun N, Mazerolles L, Pernot M. J Mater Sci Lett. 1991; 10:1418–1420. Doi: 10.1007/BF00735696. [CrossRef] [Google Scholar]
27. 28. Leonhardt U. Nat Photonics. 2007; 1:207–208. Doi: 10.1038/nphoton.2007.38. [CrossRef] [Google Scholar]
28. 29. Freestone I, Meeks N, Sax M, Higgitt C. Gold Bull. 2007; 40:270–277. Doi: 10.1007/BF03215599. [CrossRef] [Google Scholar]
29. 30. Nakai I, Numako C, Hosono H, Yamasaki K. J Am Ceram Soc. 1999;82:689–695. Doi: 10.1111/j.1151-2916.1999.tb01818.x. [CrossRef] [Google Scholar]
30. 31. Rytwo G. La revista Macla. 2008; 9:15–17. [Google Scholar]
31. 32. Mie G. Ann Phys (Berlin, Ger.) 1908; 330:377–445. doi: 10.1002/andp.19083300302. [CrossRef] [Google Scholar]
32. 33. Rittner M N, Abraham T. JOM. 1998; 50:37–38. Doi: 10.1007/s11837-998-0065-4. [CrossRef] [Google Scholar]
33. 34. Samsung and its attractions - Asia's new model company. London, United Kingdom; 2011. [Jul 12; 2017]. Available from: http://www.economist.com/node/21530984. [Google Scholar]
34. 35. Benefits, Risks, Ethical, Legal and Social Aspects of Nanotechnology. nanoforum.org, European Nanotechnology Gateway; 2004. [Jul 15;2017]. 2nd edition, October 2005. Available from: https://www.nanowerk.com/nanotechnology/reports/reportpdf/report3.pdf. [Google Scholar]
35. 36. Alexiou C, Arnold W, Hulin P, Klein R, Schmidt A, Bergmann C, Parak F G. Magnetohydrodynamics. 2001;37:318–322. [Google Scholar]
36. 37. Odenbach S. Colloids Surf, A. 2003; 217:171–178. doi: 10.1016/S0927-7757(02)00573-3. [CrossRef] [Google Scholar]
37. 38. Déry J-P, Borra E F, Ritcey A M. Chem Mater. 2008;20:6420–6426. Doi: 10.1021/cm801075u. [CrossRef] [Google Scholar]

38. 39. Morphing mirror could clear the skies for astronomers. London, United Kingdom; 2008. [Jul 17;2017]. Available from: https://www.newscientist.com/article/dn15154-morphing-mirror-could-clear-the-skies-for-astronomers/ [Google Scholar]

39. 40. O'Regan B, Grätzel M. Nature. 1991; 353:737–740. Dossi: 10.1038/353737a0. [CrossRef] [Google Scholar]

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