1.1 Introduction

Materials whose dimensions are in nanoscale generally taken as being 100 nm or less are called nanomaterials. One millimetre is called as millimetre. They are existing in different forms like rod, fibres, particles, tubes etc. chemical composition in bulk form may have different physico-chemical properties compared to the same in nanoscale. i.e. The properties and functions of nanomaterials are totally different to that of in bulk. The nanomaterials are having interesting optical, magnetic and electrical properties which are having significant effects in the fields of electronic medicine. Nanomaterials have been found naturally as well as...
in engineered commercial products like cosmetics, sunscreen materials and some sports goods (Jacobs et al. 2010).

### 1.1.1 Classifications of Nanomaterials

Based on the composition, nanomaterials are classified as inorganic metal, metal oxide, organic and carbon-based nanomaterials. Metals and metal oxide nanoparticles were obtained from metals like copper (Cu), Cobalt (Co), iron (Fe), Zinc (Zn) etc. (Chavali and Nikolova 2019). These nanoparticles have been prepared with different shapes, surface area and densities which are reflected into their mechanical, electrical, and other properties. Further the efficiency and reactivity of metal nanoparticles may be enhanced by preparation of respective nano sized metal oxide. Some of nano sized organic biocompatible polymer materials have reported for drug delivery applications because of their nontoxicity (Ali and Ahmed 2018). At present carbon-based nano particles like graphene, reduced graphene, carbon nanotube (CNT) have been reported for biomedical applications (Jeong et al. 2018).

### 1.1.2 Different Methods Used for Preparation for Nanomaterials

(a) **Sol-gel method**

In the sol-gel technique, nanoparticles have obtained through the generation of colloidal suspension followed by gelation. Generally, metals or metalloid elements with various active ligands have been used as a precursor for the preparation of the colloids (Zeng et al. 2016). Initially, the precursor is reacted to generate dispersible oxide and it gives a sol in the presence of water or dilute acid. Later on, the sol has kept on evaporation to yield gel in which the size and shape of particles are controlled to form. Finally, the obtained gel is kept for calcination at various temperature which produces metal oxide nanoparticles. The final size and shape of the nanoparticles may be varied with calcination temperature ranges.

We can explain these techniques by taking preparation of SiO$_2$ nanoparticles in which Si(OEt)$_4$ (tetraethyl orthosilicate, or TEOS) (Azlina et al. 2016). Has taken as precursor. The sol-gel technique involves hydrolysis followed by condensation of metal alkoxides which has explained as below:

\[
\text{MOR} + \text{H}_2\text{O} \rightarrow \text{MOH} + \text{ROH} \quad \text{(hydrolysis)}
\]

\[
\text{MOH} + \text{ROM} \rightarrow \text{M O} \quad \text{M} + \text{ROH} \quad \text{(condensation)}
\]
(b) Gas Phase synthesis of nanomaterials
This synthetic method allowing a simple way to prepare nanomaterials with specific size and chemical composition. It is noteworthy to discuss about homogeneous or heterogeneous reactions which are involved in this conventional chemical vapour deposition (CVD) (Kim et al. 2004). In homogenous CVD, nanoparticles have generated in gas-phase and they have deposited on surface of low temperature substrate which can be scrapped into nano-powders. In the case of heterogenous CVD, nanoparticles are formed on the surface of the substrate which generates a dense film. Generally, this method controls the size, shape and crystallinity of materials into required form. Materials which we have prepared by this method are pure and the mechanism involved is known.

(c) Chemical vapour condensation
It is a coating process in which chemical reactions occurred on the substrate at particular temperature. Reagents and precursors were supplied in gaseous form. Solid nanoparticles are obtained by pyrolysis of gaseous precursors at decomposition temperature. For example, Alumina nanoparticles were synthesized by CVC method in which aluminium chloride have been used as a precursor where carbon-dioxide and hydrogen were used for decomposition reaction (Lee et al. 2005).

Alumina may be deposited by the reaction:

$$\text{Al}_2\text{Cl}_6 + 3\text{CO}_2 + 3\text{H}_2 = \text{Al}_2\text{O}_3 \text{ (solid)} + 3\text{CO} \text{ (gas)} + 6\text{HCl} \text{ (gas)}$$

The advantages of this method include the uniform coating of the nanoparticles or nano film. However, this process has limitations including the higher temperatures required, and it is difficult to scaleup.

(d) Thermolysis
It is an easiest method in which desired nano materials are produced in heat resistant crucible containing required precursors. This method can be applied only those materials which has high vapour pressure at high temperatures (Ranjbar et al. 2011). This can be explained by taking simple example of preparation of lithium nanoparticles from lithium azide which decomposes at 370 °C under nitrogen atmosphere (Tanaka et al. 2016).

(e) Flame assisted ultrasonic spray pyrolysis
In this process precursors are heated to burnt unwanted components to generate required nano materials. SiO₂ nanoparticles were obtained by heating silica tetrachloride in an oxy-hydrogen flame. The white particles are having sizes ranging from 7 to 40 nm (Jang 2001). Acetylene and oxygen gases are supplied to initiate the pyrolysis of precursor compounds.

(f) Hydrothermal/solvothermal Method
In this method, the precursors are taken into sealed vessel containing solvents and reacted under reflux temperature around their critical points with high pressure. If water is used as a solvent then it is called hydrothermal whereas organic solvent is used means that is called as solvothermal process (Nunes et al. 2018). Mostly the reactants have taken in the form of solutions or suspension. With
these organic and inorganic additives are added to increase the homogenous dispersion and to achieve crystalline morphology.

1.1.3 Characterization of Nanomaterials

(a) X-ray diffraction (XRD)
Each and every solid material are having unique diffraction patterns which has been used to identify and characterize the particular nanomaterial. This unique pattern is called characteristic fingerprint region. The principle behind this analysis is diffraction of incident X rays by sample. The diffraction takes place at different directions. Generally, X-ray diffractometer with X-ray diffractometer with Cu-Kα (1.5418 Å) is used to generate X-rays. The X-ray source is kept as stable and the sample to be analysed is kept as mobile which moves by angle theta, the detector moves by 2 theta. The rotation rate is kept at 1°/min and the sample is scanned for 10°–80° scan. The sample is loaded on a soda glass substrate (West et al. 2015).

(b) Scanning Electron Microscope (SEM)
The scanning Electron Microscope technique has been used to analyse surface morphology, chemical composition, size and crystalline structure of the nanomaterials. In this technique electron beams are allowed to fall on the nanomaterials to generate different signals which are characteristics of the surface of the solid nanomaterials. The signal which have been received are more informative which gives more details of the nanomaterials. The signals consist of secondary electrons, backscattered electrons and diffracted backscattered electrons. To imagine the sample, secondary and backscattered electrons are needed. Morphology and topography of nanomaterials have been informed by mostly secondary electrons (Goldstein et al. 2017).

(c) Transmission electron microscopy (TEM)
TEM is a technique in which high energy electron beam is focused through a sample where the interaction between atoms and electrons taken place. The interaction could be useful to know the features such as crystalline structure, grain boundaries etc. This technique is used to find composition, defects. Transmitted portion has to strike phosphor screen where the image is generated. Darker areas of the image represent the transmission of less electrons through while the lighter areas represent transmission of many electrons (Su 2017).

1.1.4 Medicinal Properties of Nanomaterials

(a) Size and Surface Area of the Particle on Toxicity
Nanomaterials with decreased size leads to exponential increase in surface are which plays vital role on their applications in various fields. Oral toxicity of
nanoparticles is directly related to size of nanoparticles (Gatoo et al. 2014). It was observed that copper nanoparticles with decreased size are having low toxicity compared to larger particles which are having moderate toxicity. Nano particles less than 50 nm have diffused quickly to all part of the tissues compared to large particles. Most of the studies on toxicity of nanoparticles have showed that nanoparticles with less than 100 nm causes adverse respiratory health effects compared to larger particles (Chen et al. 2006).

**(b) Effect of particle shape**

The studies on toxicity of nanoparticles like gold, nickel and CNT have reported based on their shape. It has reported that the nano particle with spherical shape are very easy and fast in endocytosis process (Champion and Mitragotri 2006). The rod or fibre nano particles shows very less effect in the studies. Compared to other shapes spherical nanoparticles are more toxicity even they are in homogenous or heterogenous phase.

**(c) Effect of Surface Charge**

Charge on the surface of nanoparticles has significant effect on their toxicity on biological systems on various aspects like colloidal behaviour, plasma protein binding and blood brain barrier integrity (Pietroiusti et al. 2011). It is apparent form the reports, that negatively and neutral charged nanoparticles are showing very less cellular uptake compared to positive charged nanoparticles on opsonization by plasma proteins.

### 1.1.5 Role of Nanotechnology in Medical Field

The recent development of nano technology has applied to various field. Mostly in the case of medicinal field it has been showing significant impact on oncology and cardiovascular medicine (Fymat 2016). Furthermore, Molecular diagnostics, drug discovery and delivery applications has marked the importance of nano materials. Nanotechnology and nano materials play vital role in the development of cancer research. They have been employed to deliver drugs and some particles have been engineered to attract infected cells to remove.

Recently, Worcester polytechnic institute have showed that the CNT act as carrier for antibodies in the form of chips to find infected cancer cells in blood at earlier stage itself (Loelian et al. 2019). In this method, functionalized gold nano rods have engineered to bind to the damaged protein cells where the shift in colour of nano rod is observed. This method is designed to find damaged cells at earlier stage.

The University of Wisconsin designed a bandage which act as nanogenerators to apply electrical pulses on wounds to cure (Long et al. 2018). Chase from Western Reserve University has designed artificial platelets from the bio-compatible polymeric materials to reduce blood loss during surgery or trauma. To repair and treat diseased cells, nanorobots have been designed and programmed to antibodies. As nanotechnology opens new avenues in the field of medicinal research which would be developed even in poor countries for their future economic and social welfare.
1.1.6 What Is Mean by Nanomedicine?

Application of nanotechnology to treat diseases is called nanomedicine. The properties of nanomaterials have been used to treat infected cells. It involves the utilization of bio-compatible nano rods, nanoparticles and nanorobots.

The nanomaterials which induce desired physiological responses with the target cells are called biocompatible materials. The special properties of nanomaterials with less undesirable effect have been utilized to treat infected cells or tissue. It may include nanodevices to manipulate target cell and nano sensors to give information on physiological functions of target tissues.

The biocompatibility of nanomaterials mostly depends on the zeta potential of nanoparticles. The charge, less than 30 mV may helpful to reduce the aggregation of nanoparticles. But maximum surface charge may affects the interaction of nanoparticles.

Further the biocompatibility has enhanced by modification of surface of nanoparticles with poly(ethylene glycol) PEG which would increase the biocompatibility by removing phagocytosis. To increase the bio-compatibility of polyethersulfon as hemodialysis, its surface has to be modified by polyvinyl pyrrodone (Hayama et al. 2004). Various methods to modify the surface of nanoparticles have been reported, but the modification process should have best effect on biocompatibility with biological stream.

1.1.7 Need for Nanomedicine

Nanoparticles have been engineered to carry some particular drug molecules to specific tumour cells. The drug molecules can be bound with the nanoparticles by surface modification so that drug molecules could be delivered at the target cancer cell (Hayama et al. 2004).

To enter the blood stream, drug molecules should be soluble. We can explain this by taking an example of the drug paclitaxel which is not soluble in blood stream which causes severe allergic conditions (El-Readi and Althubiti 2019). This problem has been overcome by the development of biocompatible nanoparticles out of the naturally occurring albumin proteins which carried and dissolved a paclitaxel in bloodstream. Generally, tumour cells are surrounded by leaky blood vessels (Ma and Mumper 2013). The intaking of chemotherapy medicine are very small in size and it could be diffused into the vessels and they have not able to reach target cell instead of this they may attack normal adjacent tissues. This problem may be overcome by application of nanoparticles whose size are larger in size than the chemotherapy drugs. These nanoparticles not only act as a carrier and also streams effectively the path of the arrival of drug into target tumour cell.
Objectives of Nanomedicine

- The main objective of nanomedicine can be defined as to control, construct and improve all the human biological systems by molecular level engineered devices and nanostructures.
- Active components whose size could be varied from 1 to 100 nm has to be taken to achieve medical benefit.
- The aim of nano interactions should be taken within a subcellular or cellular system.
- To develop a new regulatory guideline to ensure safe and reliable medical treatment.
- To develop innovative therapeutics to enable tissue regeneration and repair.

1.1.8 Applications of Nanomedicine

1.1.8.1 Cancer Treatment and Chemotherapy

Cancer is one of the complicated health problems to people to die every year globally. This severe disease has been controlled by applying Radiotherapy and chemotherapy to exterminate solid tumours. Chemotherapy is better when compare to radiotherapy which causes destruction of normal cells. The development of chemotherapy to treat damaged cancer cells have become more attractive field of research. The direct administration of chemicals are drugs can cause lot of disadvantages and side effects so it is important to modify the mode of treatment.

Nowadays the application of nanomaterials to treat tumour cells have been reported. High surface area to volume ratio of nanomaterials have functionalized to bind with some drugs which could be released exactly at targeted tumour cells. Mostly, nanoparticles with different shape, size can be engineered to treat targeted cells or tissue. Nanoparticles prevent the decomposition of attached drugs and increases the absorption of maximum intake of drugs by epithelial diffusion.

The new way of treatment has developed by University of Michigan in which the semiconducting nano materials have been used to destroy the tumour cell by making short-circuiting tumor cell metabolism. An anticancer drug has synthesised when light is illuminated by semiconducting nanoparticle attached with platinum electrode (Kotov et al. 2009).

1.1.8.2 Treatment for Lung Cancer Chronic Obstructive Pulmonary Disease

Nanosized particles have been used to carry chemotherapeutic drugs as inhalers or spray materials for lung cancer. In this treatment, drugs are misted with nanosized fine particles which directly delivers the drug into all parts of the lungs for quick medical effect (Fymat 2016). Recently, some smart nanoparticles employ as carrier
to deliver therapeutic drugs at tumor cells present in the deepest part of lungs. These nanoparticles are processed by using their magnetic properties. Every day, we have inhale air with no of bacteria and viruses.

Chronic obstructive pulmonary disease (COPD) causes irreversible obstruction of lung airways causing which can be treated only by nanomedicine due to potential penetration of drugs by nano sized carrier. These diseases have caused by infection of lungs by some viruses and bacteria. These virus outbreak some of airborne deadliest epidemic diseases like influenza and pneumonia (Kotov et al. 2009). Currently, the Covid-19 outbreak effects lungs very severely in which nasal administration nanomedicine would be very useful to treat. Nanomedicine can be penetrated very easily to the virus surface where it stops their RNA replications.

1.1.8.3 Pancreatic Cancer

One of the most life threatening diseases is pancreatic cancer which can’t be controlled due to lack of diagnosis and some disadvantages in pharmaceutical treatment. Targeted tumour cells produce resistance against anticancer drugs and leads to critical conditions. Now some of nano technology-based carriers have been used for both diagnosis and treatment. Nanosized drug delivery process resists the tumour cells while decreasing toxicity. The nano-drug combined formulations which consist of liposomes polymeric nanomaterials, CNT, hybrid nanooptics and quantum dots, have developed to treat pancreatic cancer (Sielaff and Mousa 2018). Some chitosan functionalized poly(ethylenimine) with amphiphilic poly(allylamine) nano formulations have been used to carry hydrophobic drugs to target cells. Recently it is reported that curcumin filled polymeric nanoparticles have reduced the growth of primary tumour (Manzur et al. 2017; Rebelo et al. 2017).

1.1.8.4 Diabetes

The rate of diabetes is increasing day by day and it affects all the people irrespective of the age group. The application of nanotechnology becomes very significant in the management of diabetes (Gupta 2017). Normally, the oral administration of insulin has destroyed by acid present in the stomach and it makes the objective of the treatment useless. In order to deliver the insulin directly into bloodstream, nanotechnology approach has to be used. In this, the insulin molecules are bound to colloidal nanoparticle which protects the insulin form gastrointestinal tract and transports into systemic circulation. Hydrogels, antiproteases, cyclodextrins are used to encapsulate insulin molecules and the residence duration of insulin has been increased in the vicinity of intestinal cells for successful absorption.

The most effective biocompatible polymeric nanoparticles are being used as a carrier for insulin. Polymeric nanomaterials like N,N-dimethylaminoethyl methacrylate, polyanhydrides, polyurethanes, polyacrylic acids and polyacrylamide have been reported as very good insulin carriers. These polymers are pH sensitive and it
releases the loaded insulin when a desirable pH is achieved (Harsoliya et al. 2012; Cui et al. 2009).

1.1.8.5 Skin Diseases Therapies

Generally, the skin inflammation is a common among people. These inflammations are caused by exposure of skin in UV light. Now a day’s nanotechnology is applied to treat skin related problems. Nano emulsions Nano capsules, nanoliposomes, and nanoparticles are commonly formulated into cosmetic products and body lotions (Basavaraj 2012). These materials diffuse the stratum corneum part of the skin. Currently, sunscreen cosmetic materials have formulated with insoluble titanium dioxide or zinc oxide nanoparticles, which are colourless and reflect/scatter ultraviolet more efficiently than larger particles (Nohynek et al. 2007). Lipid nanoparticles are one of the ingredients is added to enhance the film forming ability of cosmetic products and also to hydrate the dry skin.

1.1.8.6 Cardiovascular Diseases

Hypertension and hypercholesterolemia are two main risk factors lead to cardiovascular diseases like thrombosis, infarction and stroke. Multiple drug therapy has given for treatment however it may show adverse effects. Now the applications of nanotechnology play protective. Carrier to deliver the diversity of active ingredients (Janko et al. 2013). The gold and silica nanoparticles have designed to deliver nitric oxide in the treatment of hypertension where the lowest concentration of nitric oxide has to be increased. It has reported that intravenous injection of CeO$_2$NP with highest antioxidant property, decreases the microvascular dysfunction and hypertension. Size of CeO$_2$NPs should be handled carefully because small variations in its dimension may become toxicity (Minarchick et al. 2015). Blood clots which is formed at the blood vessels are called as thrombosis which leads to block the blood circulation and it makes the patient to get cardiac attack. To treat this, nanoparticle is loaded with tissue plasminogen activator (tPA) which is directed to thrombus site and it removes the blood clots and makes free to blood circulation (Cicha 2015; Torchilin 2014).

1.1.8.7 Antimicrobial Activity of Nanomedicines

Day by day the reports on increased antibiotic resistance becomes challenging to human health. The poor solubility, chemical stability and enhanced side effects are decreasing the efficiency of currently using antibacterial drugs. To overcome this, researchers are using nanomedicines. Natural or synthetic polymers with silver nanoparticles composite materials have been used as effective antibacterial agents since decades.
Silver incorporated silver sulfadiazine has been treated for a decade. Silver sulfadiazine is active when it was used at higher concentrations only (Ullah et al. 2019). The antibacterial agent is more active when silver nanoparticles are incorporated by electrospinning method. The antibacterial activity of polyvinyl alcohol and chitosan is enhanced by incorporation of silver nitrate by electrospinning method. Wide antibacterial applications of silver nanoparticles are increased when they have incorporated with zein, polymethyl methacrylate, chitosan, polyvinylpyrrolidone, polyacrylonitrile (PAN), and other polymers. Recently, CNT and GM are more active than silver nanoparticles against bacteria (GhavamiNejad et al. 2015; Yang et al. 2016; Maharjan et al. 2017).

Another major challenge for public health is fungal infection which develops substantial resistance against most of the drugs. The resistance has overcome by using nanoparticles as related to increased drug efflux from microbial cells, bio film formation. Nanoparticles deliver the required does of drug at infected site in that way it decreases resistance of microbes with less adverse effect. The required drug has entrapped or encapsulated in to the nanoparticle matrix and they are by the drug has reserved until it reaches the infected site or tissue. Because of the small dimensions it can be easily diffused in to the target cells to deliver active drug into the sites where it has supposed to be released.

The existence of the unique physiochemical and biological properties of nanostructures makes them compatible material for biomedical applications. Encapsulation of drugs into some of polymer nanoparticles has been done during their polymerization reaction. The oral administration of the drug would be reserved for long duration at gastrointestinal pathway for complete absorption. Poly-ε-caprolactone (Sinha et al. 2004), polyacrylamide (Sana et al. 2019), polyacrylate (Bilensoy et al. 2009), DNA (Bai et al. 2007), chitosan (Turos et al. 2007; Mao et al. 2001; Rejinold et al. 2011), and gelatin are some of the polymer nanoparticles in which drug has encapsulated during their polymerization reaction.

Antifungal drug delivery system of carbon nanotubes, MNPs, and silica NPs has been reported. Benincasa et al. (2011) showed that AmB conjugated to carbon nanotubes presented an excellent activity against clinical isolates of Candida spp. The antimicrobial activity against bacteria and fungi (C. albicans) was also demonstrated by scanning electron microscopy, showing that microbial cells were wrapped or entrapped by carbon nanotube networks (Olivetti et al. 2013). The reduced graphene oxide nanosheets have antifungal activity against Aspergillus niger, A. oryzae, and Fusarium oxysporum (Sawangphruk et al. 2012). In 2014, Cui et al. (2014) showed graphene oxide as a novel two-dimensional nanomaterial for applications in health biomedical with antifungal properties and low cost. Also, Hussein-Al-Ali et al. (2014) demonstrated the antimicrobial activity of MNPs loaded with ampicillin to form a nanocomposite decreases the activity of C. albicans. Niemirowicz et al. (2015) also reported an inhibition of the growth of C. albicans by using MNPs that can be removed from human plasma, blood, serum, and abdominal and cerebrospinal fluids.
1.1.9 Nanomedicine and Tissue Engineering

Tissue engineering is the branch of science, which studies the development of new tissue and organs starting from a base of cells and scaffolds. Factors that influences the growth of the cell is introduced into the scaffolds to achieve completely functional organs or tissues for implantation. In this field nanoparticles have been used for control drug delivery, DNA probing, for controlled drug delivery (Wilson et al. 2010; Shi et al. 2010), imaging of specific sites, probing of DNA structures (Mironov et al. 2008; Koo et al. 2005), biomolecular sensing, gene delivery, photothermal ablation of cells (Prasad 2009) and, most recently, (Basarkar and Singh 2009; Wang et al. 2008). Additionally, many therapies utilize nanoparticles for the treatment of cancer, diabetes, allergy, infection and inflammation (Panyam and Labhasetwar 2003; Brigger et al. 2012; Kataoka et al. 2012). The nanoparticles plays vital role to improve the biological, electrical and mechanical properties of gene delivery, DNA transfection and viral transduction. Significantly, GNP s and TiO2 nanoparticles have applied to increase the rates of cell proliferation for bone and cardiac tissue reformation. The contribution of GNP s enhances the osteoclast (bone resorbing cell) generation form hematopoietic cells in bone TE. Gene delivery for matured cells or stem cells has become significant field of research in TE. Human mesenchymal stem cells are multipotent cells that show immunoospressive properties and have an intrinsic capacity to differentiate into various types of cells, including chondrocytes, osteoblasts, myocytes and adipocytes.

While nanoparticles have demonstrated promising potential in TE applications such as enhancment of biological, mechanical and electrical properties; antimicrobial effects; gene delivery and construction of engineered tissues, many challenges still lie ahead to introduce them into widespread clinical applications. For example, a compelling need exists, at first, for better assessment tools and methods of nanoparticle toxicity, carcinogenicity and teratogenicity. Second, the toxicity, carcinogenicity and teratogenicity of nanoparticles are all highly dose-dependent and exposure-dependent. In many applications, the nanoparticles are used below their threshold concentrations at which they are considered not harmful. However, bioaccumulation of nanoparticles inside the body over a large period of time is well known. Thus, any nanoparticle used in the human body has the potential to accumulate over a long period of time to reach a concentration that can cause toxicity to cells, cancers or harmful effects on reproductive systems and fetuses before their birth. In addition, even though there are numerous products containing nanoparticles/nanomaterials already in the market there are still some scientific and methodological gaps in the knowledge on specific hazards of nanomaterials. Currently, to the best of our knowledge, there are no international standards yet for nano-specific risk assessments, including specific data requirements and testing strategies. The risk assessments of nanomaterials are laborious and costly. Currently, manufacturers are committed to assess the safety of their nanoparticle-based products and to implement the necessary safety measures (self-supervision). To date, the regulatory tools are not nano-specific; e.g., the data requirements for notification of chemicals,
criteria for classification and labeling requirements for safety data sheets are still not widely available. Thus, there is a need for precautionary measures for applications of nanoparticles wherever there is a possibility of chronic bioaccumulation.

1.2 Conclusion

Nanoparticles exhibit superior biocompatibility and well-established strategies for surface modification, which have made them highly effective in numerous biomedical applications. The electric coupling between decellularized cells and proliferation rates upon several tissues have also been enhanced using nanoparticles. The validity of nanoparticles, when it comes to antibacterial growth, has also been studied with much promise. These nanoparticles have been deposited on biocomposite scaffolds, thus regulating bacterial infection during reconstructive bone surgery. Induction of cell mechanotransduction, which is responsible for many physiological processes in the body, was also stimulated by remotely controlled nanoparticles. This review has mentioned a new method for gene delivery. Specifically, magnetofection, which was accomplished through the use of plasmid DNA cationic lipids with complexes of DNA as they interacted through a magnetic force, thus increasing transfection efficiency. Related to this is the use of nanoparticles for the purpose of cell patterning. Three strategies were investigated for cell patterning: the use of MCLs, RGD motif-containing peptide coupled to the phospholipid of magnetite cationic liposomes and aminosilane modified with PEG and magnetic force.

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