A study of Approaches of Nanotechnology in Biomedical

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Abstract— **Bioengineering or Biomedical / Biomedical Instrumentation Engineering involves developing new devices and procedures that solve medical and health-related problems by combining their recent advances knowledge in engineering, biology, and medicine to improves human health through cross-disciplinary activities that integrate the engineering sciences with the biomedical sciences and clinical practice. Biomedical engineers may spend their days designing electrical circuits and computer software for medical instrumentation. In this paper various features, technology, progress of the Nano fibrous structure, drug delivery and application are studied.**

I. INTRODUCTION

Advancement in the field of nanotechnology and its applications to the field of medicines and pharmaceuticals has revolutionized the twentieth century. Nanotechnology is the study of extremely small structures. The prefix "nano" is a Greek word which means "dwarf". The word "nano" means very small or miniature size. Nanotechnology is the treatment of individual atoms, molecules, or compounds into structures to produce materials and devices with special properties. Nanotechnology involve work from top down i.e. reducing the size of large structures to smallest structure e.g. photonics applications in nano electronics and nano engineering, top-down or the bottom up, which involves changing individual atoms and molecules into nanostructures and more closely resembles chemistry biology.

Nanotechnology deals with materials in the size of 0.1 to 100 nm; however it is also inherent that these materials should display different properties such as electrical conductance chemical reactivity, magnetism, optical effects and physical strength, from bulk materials as a result of their small size.
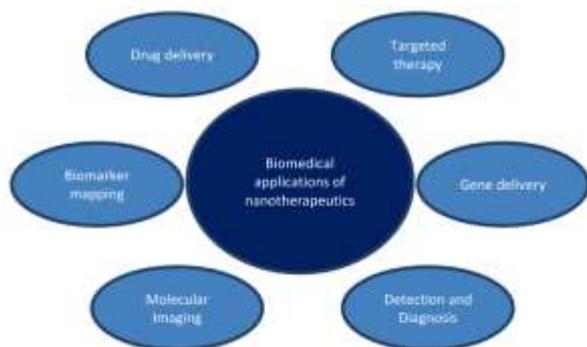

Figure 1: Biomedical applications

Nanotechnology works on matter at dimensions in the nanometer scale length (1-100 nm), and thus can be used for a broad range of applications and the creation of various types of nano materials and nano devices.

- **History of Nanotechnology**

The development in the field of nanotechnology started in 1958 .The nano scale is the place where the properties of most common things are determined just above the scale of an atom. Nano scale objects have at least one dimension (height, length, depth) that measures between 1 and 999 nanometers (1-999 nm) (Figure 1).

The brief explanation of pharmaceutical nano system is as follows: As shown in the schematic diagram (Figure 2), pharmaceutical nanotechnology is divided in two basic types of nano tools viz. nano materials and nano devices. These materials can be sub classified into nano crystalline and nano structured materials. Nano structure consists of nano particles, dendrimers, micelles, drug conjugates, metallic nano particles etc. Carbon nano tubes: These are small macromolecules that are unique.
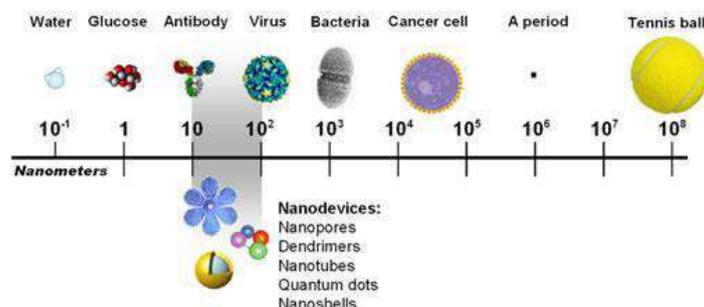

Figure 2: Nanoscale and nanostructures.

II. CLASSIFICATION OF NANO MATERIALS

Nano materials can be classified dimension wise into following categories:

Classification Examples

- Nano rods, nano wires have dimension less than 100 nm.
- Tubes, fibers, platelets have dimensions less than 100 nm.
- Particles, quantum dots, hollow spheres have 0 or 3 Dimensions < 100 nm.

On the basis of phase composition, nano materials in different phases can be classified as,

- The nano material is called single phase solids. Crystalline, amorphous particles and layers are included in this class.
- Matrix composites, coated particles are included in multi-phase solids.
- Multi-phase systems of nano material include colloids, aero gels, Ferro fluids, etc.

III. MANUFACTURING APPROACHES

The two major approaches to get nano materials are -one is the bottom up and the other is top down approach. Bottom up produce components which are made of single molecules, and covalent forces hold them together that are far stronger than the forces that hold together macro-scale components. Enormous amount of information could be stored in devices build from the bottom up. For example, use of AFM, liquid phase techniques based on inverse micelles, sol-gel processing, and chemical vapour deposition (CVD), laser pyrolysis and molecular self-assembly use bottom up approach for nano scale material manufacturing.

Top manufacturing involves the construction of parts through methods such as cutting, carving and molding and due to our limitations in these processes highly advanced nano devices are yet to be manufactured. Laser ablation, milling, nano-lithography, hydrothermal technique, physical vapor deposition and electrochemical method (electroplating) uses top down approach for nano-scale material manufacturing.

Every element of periodic table can be utilized in nanotechnology depending upon the target material which someone is going to fabricate range from nano medicine and goes up to nano concrete via nano electronics. Nanotechnology provides us the chance to synthesize nano scale building blocks with control on size, composition etc. Materials manufacturing will be revolutionized by further assembling into larger structures with designed properties. Without machining, metals, polymers, ceramics etc. can be manufactured at exact shape.

Nanotechnology can benefit chemical catalysis due to the extremely large surface to volume ratio. The various applications of nanoparticles in catalysis range from fuel cell to catalytic converters and photo catalytic devices. It is also important for the production of chemicals. Modern revolution in catalysis is due to the availability of unlimited commercial quantities of zeolites.

IV. APPLICATIONS OF NANOTECHNOLOGY

The different fields that find potential applications of nanotechnology are as follows:

a. Health and Medicine
b. Electronics
c. Transportation
d. Energy and Environment
e. Space exploration

- **Nanotechnology in health and medicine**

Even today various disease like diabetes, cancer, Parkinson's disease, Alzheimer's disease, cardiovascular diseases and multiple sclerosis as well as different kinds of serious inflammatory or infectious diseases (e.g. HIV) constitute a high number of serious and complex illnesses which are posing a major problem for the mankind. Nano-medicine is an application of nanotechnology which works in the field of health and medicine. Nano-medicine makes use of nano materials, and nano electronic biosensors. In the future, nano medicine will benefit molecular nanotechnology. The medical area of nano science application has many projected benefits and is potentially valuable for all human races.

With the help of nano medicine early detection and prevention, improved diagnosis, proper treatment and follow-up of diseases is possible. Certain nano scale particles are used as tags and labels, biological can be performed quickly, the testing has become more sensitive and more flexible. Gene sequencing has become more efficient with the invention of nano devices like gold nano particles, these gold particles when tagged with short segments of DNA can be used for detection of genetic sequence in a sample.

With the help of nanotechnology, damaged tissue can be reproduced or repaired. These so called artificially stimulated cells are used in tissue engineering, which might revolutionize the transplantation of organs or artificial implants.

Advanced biosensors with novel features can be developed with the help of Carbon nano tubes. These biosensors can be used for astrobiology and can throw light on study origins of life. This technology is also being used to develop sensors for cancer diagnostics. Though CNT is inert, it can be functionalized at the tip with a probe molecule. Their study uses AFM as an experimental platform.

i. Probe molecule to serve as signature of leukemia cells identified.
ii. Current flow due to hybridization will be through CNT electrode to an IC chip.
iii. Prototype biosensors catheter development.

Nanotechnology has made excellent contribution in the field of stem cell research. For example, magnetic nanoparticles (MNPs) have been successfully used to isolate and group stem cells. Quantum dots have been used for molecular imaging and tracing of stem cells, for delivery of gene or drugs into stem cells, nano materials such as carbon nano tubes, fluorescent CNTs and fluorescent MNPs have been used. Unique nanostructures were designed for controllable regulation of proliferation and differentiation of stem cells is done by designed unique nano structures. All these advances speed up the development of stem cells toward the application in regenerative medicine. The recent applications of nanotechnology in stem cell research promises to open new avenues in regenerative medicine. Nanotechnology can be a valuable tool to track and image stem cells, to drive their differentiation into specific cell

lineage and ultimately to understand their biology. This will hopefully lead to stem cell-based therapeutics for the prevention, diagnosis and treatment of human diseases.
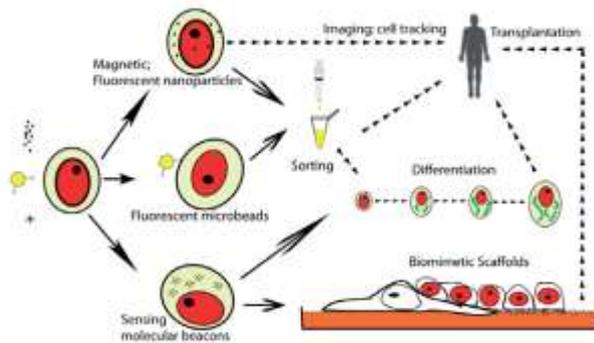

Figure 3: Nanotechnology applications in stem cell biology and medicine

Nano devices can be used in stem cell research in tracking and imaging them. It has its applications for basic science as well as translational medicine. Stem cells can be modulated by mixing of nano carriers with biological molecules . Nano devices can be used for intracellular access and also for intelligent delivery and sensing of biomolecules. These technologies have a great impact in stem cell microenvironment and tissue engineering studies and have a great potential for biomedical applications.

- **Nanotechnology, energy and environment**

Nanotechnology will play a critical role in coming 50 years by protecting the environment and providing sufficient energy for a growing world. The advanced techniques of nanotechnology can help storage of energy, its conversion into other forms, ecofriendly manufacturing of materials and by better enhanced renewable energy sources.

Nanotechnology can be used for less expensive energy production and for renewal energies, in solar technology, nano-catalysis, fuel cells and hydrogen technology. Carbon nano tube fuel cells are used for storage of hydrogen, thus finds application in power cars.

Nanotechnology is used on photovoltaic , for making them cheap, light weight and more efficient, which can reduce the combustion of engine pollutants by nano porous filters, and can clean the exhaust mechanically, with the help of catalytic converters made up of nano scale noble metal particles and by catalytic coatings on cylinder walls and catalytic nanoparticles as additive for fuels.

Nanotechnology can help in developing new ecofriendly and green technologies that can minimize undesirable pollution. Solid state lightening can reduce total electricity consumption. Nano technological approaches can lead to a strong reduction of energy consumption for illumination.

- **Medical use of Nano Materials**

Nano medicine is a relatively new field of science and technology. By interacting with biological molecules at nano scale, nanotechnology broadens the field of research and

application. Interactions of nano devices with bio molecules can be understood both in the extracellular medium and inside the human cells. Operation at nano scale allows exploitation of physical properties different from those observed at micro scale such as the volume/surface ratio.

Two forms of nano medicine that have already been tested in mice and are awaiting human trials; use of gold nano shells to help diagnose and cure cancer, and the use of liposome as vaccine adjuvants and as vehicles for drug transport. Similarly, drug detoxification is also another application for nano medicine which has been used successfully in rats. Medical technologies can make use of smaller devices are less invasive and can possibly be implanted inside the body, and their biochemical reaction times are much shorter. As compared to typical drug delivery nano devices are faster and more sensitive.

- **Drug Delivery**

In nanotechnology nano particles are used for site specific drug delivery. In this technique the required drug dose is used and side-effects are lowered significantly as the active agent is deposited in the morbid region only. This highly selective approach can reduce costs and pain to the patients. Thus variety of nano particles such as dendrimers, and nano porous materials find application. Micelles obtained from block co-polymers, are used for drug encapsulation. They transport small drug molecules to the desired location. Similarly, nano electromechanical systems are utilized for the active release of drugs. Iron nano particles or gold shells are finding important application in the cancer treatment. A targeted medicine reduces the drug consumption and treatment expenses, making the treatment of patients cost effective.
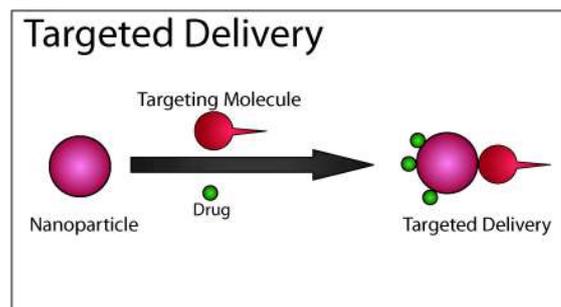

Figure 4: Target Drug Delivery

Nano medicines used for drug delivery, are made up of nano scale particles or molecules which can improve drug bioavailability. For maximizing bioavailability both at specific places in the body and over a period of time, molecular targeting is done by nano engineered devices such as nano robots . The molecules are targeted and delivering of drugs is done with cell precision. *In vivo* imaging is another area where Nano tools and devises are being developed for *in vivo* imaging. Using nano particle images such as in ultrasound and MRI, nano particles are used as contrast. The nano engineered materials are being developed for effectively treating illnesses and diseases such as cancer. With the advancement of nanotechnology, self-assembled biocompatible nano devices can be created which will detect

the cancerous cells and automatically evaluate the disease, will cure and prepare reports.

The pharmacological and therapeutic properties of drugs can be improved by proper designing of drug delivery systems, by use of lipid and polymer based nano particles. The strength of drug delivery systems is their ability to alter the pharmacokinetics and bio-distribution of the drug. Nano particles are designed to avoid the body's defense mechanisms can be used to improve drug delivery. New, complex drug delivery mechanisms are being developed, which can get drugs through cell membranes and into cell cytoplasm, thereby increasing efficiency. Triggered response is one way for drug molecules to be used more efficiently. Drugs that are placed in the body can activate only on receiving a particular signal. A drug with poor solubility will be replaced by a drug delivery system, having improved solubility due to presence of both hydrophilic and hydrophobic environments. Tissue damage by drug can be prevented with drug delivery, by regulated drug release. With drug delivery systems larger clearance of drug from body can be reduced by altering the pharmacokinetics of the drug. Potential nano drugs will work by very specific and well-understood mechanisms; one of the major impacts of nanotechnology and nanoscience will be in leading development of completely new drugs with more useful behavior and less side effects.

Thus nano particles are promising tools for the advancement of drug delivery, as diagnostic sensors and bio imaging. The bio-distribution of these nanoparticles is still imperfect due to the complex host's reactions to nano- and micro sized materials and the difficulty in targeting specific organs in the body. Efforts are made to optimize and better understand the potential and limitations of nano particulate systems. In the excretory system study of mice dendrimers are encapsulated for drug deliver of positively-charged gold nano particles, which were found to enter the kidneys while negatively-charged gold nanoparticles remained in the important organs like spleen and liver. The positive surface charge of the nanoparticle decreases the rate of opsonization of nanoparticles in the liver, thus affecting the excretory pathway. Due to small size of 5 nm, nano particles can get stored in the peripheral tissues, and therefore can get collected in the body over time. Thus nano particles can be used successfully and efficiently for targeting and distribution, further research can be done on nano toxicity so that its medical uses can be increased and improved.

- **The applications of nano particles in drug delivery**

Abraxane, is albumin bound paclitaxel, a nano particle used for treatment of breast cancer and non-small- cell lung cancer (NSCLC). Nano particles are used to deliver the drug with enhanced effectiveness for treatment for head and neck cancer, in mice model study ,which was carried out at from Rice University and University of Texas MD Anderson Cancer Center. The reported treatment uses Cremophor EL which allows the hydrophobic paclitaxel to be delivered intravenously. When the toxic Cremophor is replaced with

carbon nano particles its side effects diminished and drug targeting was much improved and needs a lower dose of the toxic paclitaxel.

Nano particle chain was used to deliver the drug doxorubicin to breast cancer cells in a mice study at Case Western Reserve University. The scientists prepared a 100 nm long nano particle chain by chemically linking three magnetic, iron-oxide nano spheres, to one doxorubicin-loaded liposome. After penetration of the nano chains inside the tumor magnetic nanoparticles were made to vibrate by generating, radiofrequency field which resulted in the rupture of the liposome, thereby dispersing the drug in its free form throughout the tumor. Tumor growth was halted more effectively by nanotechnology than the standard treatment with doxorubicin and is less harmful to healthy cells as very less doses of doxorubicin were used.

Polyethylene glycol (PEG) nano particles carrying payload of antibiotics at its core were used to target bacterial infection more precisely inside the body, as reported by scientists of MIT. The nano delivery of particles, containing a sub-layer of pH sensitive chains of the amino acid histidine, is used to destroy bacteria that have developed resistance to antibiotics because of the targeted high dose and prolonged release of the drug. Nanotechnology can be efficiently used to treat various infectious diseases.

Researchers in the Harvard University Wyss Institute have used the biomimetic strategy in a mouse model .Drug coated nano particles were used to dissolve blood clots by selectively binding to the narrowed regions in the blood vessels as the platelets do. Biodegradable nano particle aggregates were coated with tissue plasminogen activator, were injected intravenously which bind and degrade the blood clots. Due to shear stresses in the vessel narrowing region dissociation of the aggregates occurs and releases the tPA-coated nano particles. The nano therapeutics can be applied greatly to reduce the bleeding, commonly found in standard thrombosis treatment.

The researchers in the University of Kentucky have created X-shaped RNA nano particles, which can carry four functional modules. These chemically and thermodynamically stable RNA molecules are able of remaining intact in the mouse body for more than 8 hours and to resist degradation by RNAs in the blood stream. These X-shaped RNA can be effectively performing therapeutic and diagnostic functions. They regulate gene expression and cellular function, and are capable of binding to cancer cells with precision, due to its design .

'Minicell' nano particle are used in early phase clinical trial for drug delivery for treatment of patients with advanced and untreatable cancer. The minicells are built from the membranes of mutant bacteria and were loaded with paclitaxel and coated with cetuximab, antibodies and used for treatment of a variety of cancers. The tumor cells engulf the minicells. Once inside the tumor, the anti-cancer drug destroys the tumor cells. The larger size of minicells plays a better profile in side-effects. The minicell drug delivery system uses lower dose of drug and has less side-effects can

be used to treat a number of different cancers with different anti-cancer drugs .

Nano sponges are important tools in drug delivery, due to their small size and porous nature they can bind poorly-soluble drugs within their matrix and improve their bioavailability. They can be made to carry drugs to specific sites, thus help to prevent drug and protein degradation and can prolong drug release in a controlled manner.

- **Proteins and Peptide Delivery**

Protein and peptides are macromolecules and are called biopharmaceuticals. These have been identified for treatment of various diseases and disorders as they exert multiple biological actions in human body. Nano materials like nano particles and dendrimers are called as nano biopharmaceuticals , are used for targeted and/or controlled delivery.

- **Cancer**

Due to the small size of nano particles can be of great use in oncology, particularly in imaging. Nano particles, such as quantum dots, with quantum confinement properties, such as size-tunable light emission, can be used in conjunction with magnetic resonance imaging, to produce exceptional images of tumor sites. As compared to organic dyes, nano particles are much brighter and need one light source for excitation. Thus the use of fluorescent quantum dots could produce a higher contrast image and at a lower cost than organic dyes used as contrast media. But quantum dots are usually made of quite toxic elements.

Nano particles have a special property of high surface area to volume ratio, which allows various functional groups to get attached to a nano particle and thus bind to certain tumor cells. Furthermore, the 10 to 100 nm small size of nanoparticles, allows them to preferentially accumulate at tumor sites as tumors lack an effective lymphatic drainage system. Multifunctional nano particles can be manufactured that would detect, image, and then treat a tumor in future cancer treatment . Kanzius RF therapy attaches microscopic nano particles to cancer cells and then "cooks" tumors inside the body with radio waves that heat only the nanoparticles and the adjacent (cancerous) cells.

Nano wires are used to prepare sensor test chips, which can detect proteins and other biomarkers left behind by cancer cells, and detect and make diagnosis of cancer possible in the early stages from a single drops of a patient's blood .

Nano technology based drug delivery is based upon three facts: i) efficient encapsulation of the drugs, ii) successful delivery of said drugs to the targeted region of the body, and iii) successful release of that drug there.

Nano shells of 120 nm diameter, coated with gold were used to kill cancer tumors in mice by Prof. Jennifer at Rice University. These nano shells are targeted to bond to cancerous cells by conjugating antibodies or peptides to the nano shell surface. Area of the tumor is irradiated with an infrared laser, which heats the gold sufficiently and kills the cancer cells .

Cadmium selenidenano particles in the form of quantum dots are used in detection of cancer tumors because when exposed to ultraviolet light, they glow. The surgeon injects these quantum dots into cancer tumors and can see the glowing tumor, thus the tumor can easily be removed.

Nano particles are used in cancer photodynamic therapy, wherein the particle is inserted within the tumor in the body and is illuminated with photo light from the outside. The particle absorbs light and if it is of metal, it will get heated due to energy from the light. High energy oxygen molecules are produced due to light which chemically react with and destroy tumors cell, without reacting with other body cells. Photodynamic therapy has gained importance as a noninvasive technique for dealing with tumors.

Some other applications of various nano systems in cancer therapy are summarized as:

- **Carbon nano tubes,** 0.5–3 nm in diameter and 20–1000 nm length, are used for detection of DNA mutation and for detection of disease protein biomarker.

- **Parkinson's disease:** This can improve current therapy of Parkinson's disease (PD). Parkinson's disease (PD) is the second most common neurodegenerative disease after Alzheimer's disease and affects one in every 100 persons above the age of 65 years, PD is a disease of the central nervous system; neuro inflammatory responses are involved and leads to severe difficulties with body motions. The present day therapies aim to improve the functional capacity of the patient for as long as possible but cannot modify the progression of the neurodegenerative process.

Aim of applied nanotechnology is regeneration and neuro protection of the central nervous system (CNS) and will significantly benefit from basic nanotechnology research conducted in parallel with advances in neurophysiology, neuropathology and cell biology. The efforts are taken to develop novel technologies that directly or indirectly help in providing neuro protection and/or a permissive environment and active signaling cues for guided axon growth. In order to minimize the peripheral side-effects of conventional forms of Parkinson's disease therapy, research is focused on the design, biometric simulation and optimization of an intracranial nano-enabled scaffold device (NESD) for the site-specific delivery of dopamine to the brain, as a strategy. Peptides and peptidicnano particles are newer tools for various CNS diseases.

Nanotechnology will play a key role in developing new diagnostic and therapeutic tools. Nanotechnology could provide devices to limit and reverse neuro pathological disease states, to support and promote functional regeneration of damaged neurons, to provide neuro protection and to facilitate the delivery of drugs and small molecules across the blood–brain barrier. For the delivery of CNS therapeutics, various nanocarriers such as dendrimers, nano gels, nano emulsions, liposomes, polymeric nano

particles, solid lipid nano particles, and nano suspensions have been studied. Transportation of these nano

- **Dendrimers,** less than 10 nm in size are useful for controlled release drug delivery, and as image contrast agents.
- **Nano crystals,** of 2-9.5 nm size cause improved formulation for poorly-soluble drugs, labeling of breast cancer marker HeR2 surface of cancer cells.
- **Nano particles** are of 10-1000 nm size and are used in MRI and ultrasound image contrast agents and for targeted drug delivery, as permeation enhancers and as reporters of apoptosis, angiogenesis.
- **Nano shells** find application in tumor-specific imaging, deep tissue thermal ablation.
- **Nano wires** are useful for disease protein biomarker detection, DNA mutation detection and for gene expression detection.
- Quantum dots, 2-9.5 nm in size, can help in optical detection of genes and proteins in animal models and cell assays, tumor and lymph node visualization.

- **Nanotechnology in the treatment of neurodegenerative disorders**

One of the most important applications of nanotechnology is in the treatment of neuro degenerative disorders . For the delivery of CNS therapeutics, various nano carriers such as, dendrimers, nano gels, nano emulsions, liposomes, polymeric nano particles, solid lipid nano particles, and nano suspensions have been studied. Transportation of these nano medicines has been effected across various *in vitro* and *in vivo* BBB models by endocytosis and/or transcytosis, and early preclinical success for the management of CNS conditions such as, Alzheimer's disease, brain tumors, HIV encephalopathy and acute ischemic stroke has become possible. The nanomedicine can be advanced further by improving their BBB permeability and reducing their neurotoxicity medicines has been effected across various *in vitro* and *in vivo* BBB models by endocytosis and/or transcytosis, and early preclinical success for the management of CNS conditions such as, Alzheimer's disease, brain tumors, HIV encephalopathy and acute ischemic stroke has become possible. Future development of CNS nanomedicines needs to focus on increasing their drug-trafficking performance and specificity for brain tissue using novel targeting moieties.

- **Tuberculosis treatment:** Tuberculosis (TB) is the deadly infectious disease. The long duration of the treatment and the pill burden can hamper patient lifestyle and result in the development of multi-drug-resistant (MDR) strains. Tuberculosis in children constitutes a major problem. There is commercial non availability of the first-line drugs in pediatric form. Novel antibiotics can be designed to overcome drug resistance, cut short the duration of the treatment course and to reduce drug interactions with antiretroviral

therapies. A nanotechnology is one of the most promising approaches for the development of more effective and compliant medicines. The advancements in nano-based drug delivery systems for encapsulation and release of anti-TB drugs can lead to development of a more effective and affordable TB pharmacotherapy.

V. METHODOLOGY

In order to be able to place the nanotechnology applications in medical technology in the right perspective, it is necessary to have a basic understanding of the origin of the unique properties of nanomaterials. In this paper greater emphasis is given on highlighting promising nanotechnology-based approaches in medical technology than on consensus taxonomies of scientific/engineering disciplines.

a) *NANOMATERIALS: NANOSCALE FEATURES*

The prefix nano is from the Greek word nanos (νανοσ) which means dwarf. Commonly, nano is associated with the SI length unit metre and denotes one-billionth. Thus, nanomaterials are characterized at the nanometre scale in one, two orthree dimensions, leading to quantum wells (e.g., thin films, layers, surface coatings), quantum wires (e.g., nanotubes,nanowires) or quantum dots (q-dots), respectively (Figure 1). Nanoparticles with a diameter of less <100 nm are for example fullerenes, dendrimers and semiconductor quantum dots. Nano powders contain particles less than 100 nm in size — 1/10,000th the thickness of a human hair. The physical, chemical and biological properties of such small particles allow industry to incorporate enhanced functionalities into products. Figure 3 shows the different types of products.
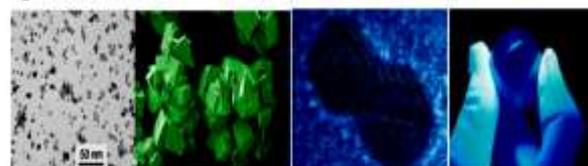
a) Scale of Nano Powder   b)Nanocubes stores large   c)Nano particles of gold   d) Ceramic products for Implants amount of H2

Figure 6 different types of products

b) Carbon nonmaterials:

The bonds between carbon atoms are such as to follow the formation of some of the most interesting nanostructures.Solid carbon at room temperature has two classical structures or allotropes: diamond and graphite. In diamond, carbonatoms are connected each to four other carbon atoms in a tetrahedral lattice structure and these bonds form a three dimensional network. Diamond is the hardest mineral known to man and is an excellent electrical insulator. In graphite the carbon atoms are arranged in hexagons and strongly bonded into parallel planar sheets. The sheets are held together by much weaker Van der Waals forces, which is the reason why graphite can be used as

material in pencils and as the basis of some lubricants. Unlike diamond, graphite is a conductor of electricity. As illustrated by these classical examples, physical properties can vary considerably within pure carbon materials. Figure 3.Shows the Representation of a C60 molecule source.
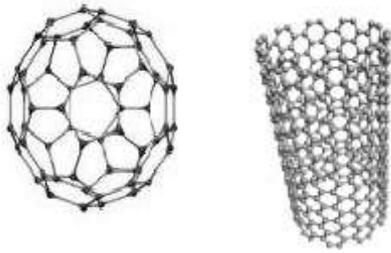

Figure 6 Types of carbon nanotubes

Carbon nanotubes

Carbon nanotubes have exceptional electric and electronic properties. They are metallic or semiconducting depending on the precise structure, i.e. the helicity and diameter of the tube Metallic carbon nanotubes can transport very high current densities of up to 109 A/cm2 without being damaged Normal metal wires (e.g. copper, gold) can transport current up to 105-106 A/cm2 and higher currents would vaporise these metals because of resistive heating. Metallic carbon nanotubes conduct electricity with essentially no resistance at room temperature.

c) Field emission applications:

Carbon nanotubes can be used for flat panel displays, lighting applications such as vacuum tube elements, house hold light bulbs and flat panel luminescent lamps, gas discharge tubes, X-ray generators, and electron guns for the next generation scanning electron microscopes and transmission electron microscopes. Carbon nanotubes might be analternative to bulky cathode-ray tubes, such as used for televisions and computer monitors, and the more recent liquid crystal panels and plasma displays. Based on prototypes, the advantages of carbon nanotubes in flat panel displays are suggested to be low power consumption, high brightness, viewable from any angle, fast response rate, wide operating temperature range, no burn-in, lightness, and thinness. Other major companies involved are Motorola Labs and Eikos.Nanotube-based cold cathodes for compact, portable, and miniature X-ray generators are manufactured by Xintek, Inc.

These Xray tubes can be set up in a narrow space and possibly X-ray endoscopic imaging and provide improved highresolutionimages in industrial, biological and medical applications.

d) Nanoelectronic applications:

As carbon nanotubes behave like electrical conductors or semiconductors, they could be extremely useful for nanoscaleelectronics applications. An all-carbon-based nanoelectronic technology can be foreseen in which the electric wiring consists of metallic carbon nanotubes and the active devices are made of semiconductor carbon nanotubes.

A lot of progress is yet to be achieved before routine production of carbon nanotube-based integrated circuits becomes possible, though it is currently feasible in an experimental set-up to build a nanocircuit that has wires, switches and memory elements made entirely from carbon nanotubes and other molecules. Currently, Nantero Inc. (Woburn, Massachusetts,USA) is developing NRAM™, a high density non-volatile random acess memory chip using carbon nanotubes as the active memory elements.

e) Chemical gas sensors :

Semiconductor SWCNTs are highly sensitive to detect changes in the chemical composition of the surrounding atmosphere at room temperature. Carbon nanotube-based chemical gas sensors have great (commercial) potential innumerous areas ranging from medical applications, environmental monitoring, agricultural applications to the chemical industry and beyond. A plastic composite of carbon nanotubes could provide shielding for electromagnetic interference which is of much concern to military applications. Nowadays command, control and communications are highly digitised and the system must be protected from weapons that emit electromagnetic pulses.

f) Battery technology:

Carbon nanotubes can be used as additives in lithium-ion battery systems, lead-acid batteries, and electric double-layer capacitors improving their performance. The merit of electric double-layer capacitors is their high discharge rate, which make them applicable as hybrid energy source for electric vehicles and portable electric devices.

g) Thermal properties & applications:

Prior to the discovery of carbon nanotubes, diamond was the best thermal conductor with the highest thermal conductivity of 2600 W/m·K for blue diamond at room temperature. Deduction of experimental values and theoretical calculations for SWCNTs yielded a thermal conductivity ranging from 2980 up to 6600 W/m·K These thermal properties are of great importance for thermal management of nano/microelectronic devices.

VI. CONCLUSION

Nano particles were found useful in delivering the myelin antigens, which induce immune tolerance in a mouse model with relapsing multiple sclerosis. This paper focus on various methodology used in biomedical using nanotechnology, its application areas, nanomaterials etc. It can be concluded that nanotechnology plays an very important role in the field of biomedical and its aplications.

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