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NANOBIOTECHNOLOGY: NANO SCALE YET A GIANT LEAP TOWARDS MEDICATION OF SEVERAL DISEASES INCLUDING CANCER

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Abstract : With quantum leaps in the advancements and understanding of different areas of Physics, the researchers and academicians are left spell bound of the intensive application areas for betterment of the society. Certainly it is also fuelling continuous quest to understand the unknown and apply it to known. Nanobiotechnology is one such latest area which has shown immense potential in varied dimensions of life and the living. This paper evaluates the medical scopes and opportunities which are being addressed by nanobiotechnology. One of the many commonly dreaded disease i.e. Cancer is now able to be medicated by this technology impressively which by far was addressed by chemotherapy, radiation or surgery. This know-how has facilitated the progress of nanoscale devices that can be conjugated with numerous functional molecules concurrently, including tumor-specific ligands, antibodies, anticancer drugs, and imaging probes. Better targeting selectivity and improved delivery efficiency are the chief goals in the development of therapeutic agents. Since these nano-devices are 100 to 1,000 times smaller than cancer cells, they can be significantly used in the malignant cells specific delivery systems. We are hopeful that this technology is surely coming up with better medical opportunities to combat the diseases and provide relief to the ailing society and its individuals

Keywords:Nanobiotechnology,Therapeuticagents,nanoscaledevices

I. INTRODUCTION

Advancements in technology are immense, incredible, intriguing, innumerable and important. We are spell bound by the quantum leaps of increment in the knowhow and most importantly the application areas. As is said a sound mind resides in a sound body. In other words, to keep the mind smart and working, we need to keep our body ailment free by providing proper nutrition, care and accurate medication to any health disturbances. Nanotechnology plays a major role in understanding our physique and providing solution to its disturbances. Mankind is combating a plethora of diseases including some very deadly ones like cancer. Nanotechnology has a huge potential to offer solutions due to its unique size of operation ranging from one to hundred nanometres as well as a large surface to volume ratios which provides this technology an edge over others. A summary of the classification of nano materials based dimensionality, morphology, state and chemical composition is provided in the Figure 1 below. According to the intended usage, the nanomaterials may be chosen and applied accordingly.

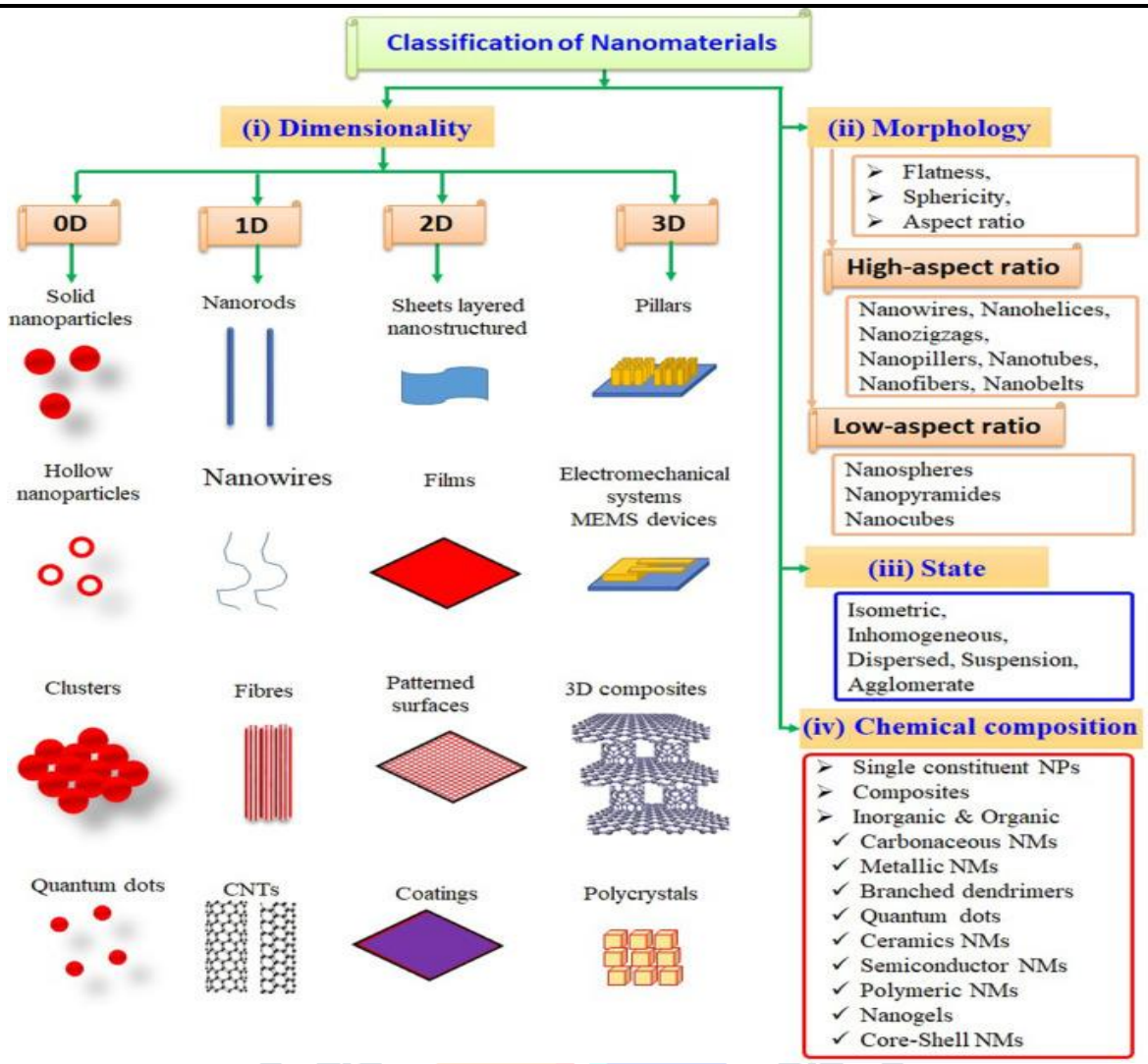

Figure 1 – Classification of nanomaterials

The central idea of nanotechnology is the regulation of material on a scale of 1 to 100 nanometers and fabrication of the devices on this scale of length. Due to the increment in the ratio of surface area to volume, they exhibit very different properties in the nano scale which enable unique applications. Some of them are:

- titanium dioxide nanoparticles in sunscreen
- cosmetics and some food products,
- Silver nanoparticles in food packing, clothing, disinfectants and house-hold appliances.
- Zinc oxide nanoparticles (NP) in cosmetics, surface coatings, paints and outdoor furniture varnishes.

Many more of such unique application areas are under research and are coming up strongly to support nanotechnology as a potent tool in near future. Moving on to the medical applications, it can be categorized into imaging, therapeutics, delivery carriers and diagnostics. The further details are sketched in Figure-2.

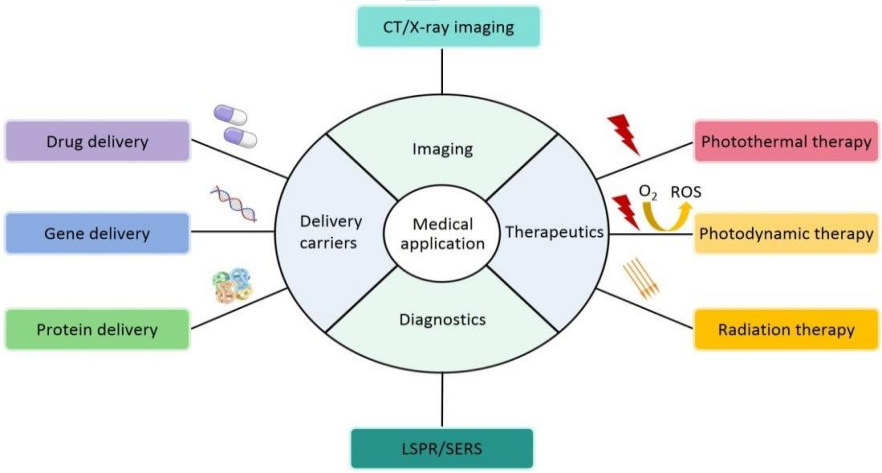

Figure -2 Medical applications of Nanotechnology

2. NANOTECHNOLOGY IN MEDICAL APPLICATIONS

Nanotechnology has a huge contribution to the medical domain already though we can say that only a small portion are used today while others are in various stages of testing. Nanotechnology in medicine revolves around applications of nanoparticles (NP) which are currently under research and development as well as longer range research application which utilizes manufactured nanorobots to make repairs at the cellular level (also referred as nanomedicine). All these technologies are really helping us to proudly proclaim that ideas imagined a few years back are turning into reality in a fast pace. The few broad sub areas in brief are explained in Figure 3. They may be categorized as:

- **Drug Delivery** – Here NP are employed to deliver drugs, heat, light or other such substances to specifically required cells. This technique not only reduces damage to the healthy cells in the body but also allow the early detection of the disease. For example researchers at North Carolina State University are developing a method to deliver cardiac stem cells to damaged heart tissue. They attach nanovesicles that are attracted to an injury to the stem cells to increase the amount of stem cells delivered to an injured tissue.
- **Antibacterial Treatments**—Researchers are developing techniques to kill bacteria using gold nanoparticles and infrared light which is supposed to help in effective cleaning of instruments in the ambience of hospitals and nursing centres. Research is on to investigate the potential of quantum dots to treat antibiotic resistant infections.
- **Wound Treatment**-- This technology has amazing applications in wound treatment. Researchers have come up with a bandage that applies electrical pulses using electricity produced by nanogenerators to cure the wounds of a patient. For trauma patients with internal blood loss, it is very urgent to reduce/stop the blood loss. Researchers are in the process of developing synthetic platelets which can reduce blood loss. Experiments have already confirmed that injections of such platelets are beneficial for reducing blood loss.
- **Cell repair**-- Nanorobots are programmed to repair specific diseased cells which can function analogous to antibodies involved in the natural healing process.

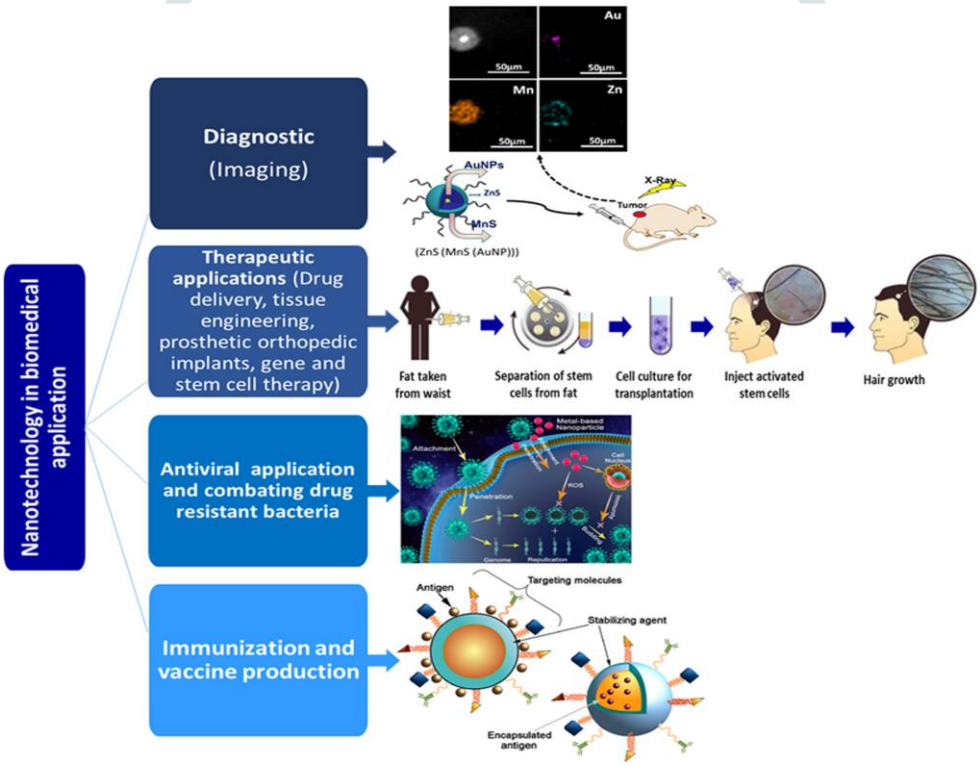

Figure- 3 Various aspects of biomedical applications of nanotechnology

NANOTECHNOLOGY IN CANCER TREATMENT

Cancer is one of the most dreadly disease affecting the mankind and unfortunately the cases are ever increasing. The most common cancer treatments include chemotherapy, radiation and surgery. These current treatment methods are challenging for human systems due to non specific systemic distribution of antitumor agents,inadequate drug concentartations reaching the tumour and the limited monitoring abilities for therapeutic responses. This may lead to complications and drug resisistance. Greater targeting selectivity and better delivery efficiency are the prime necessities for development of therapeutic agents so that it does minimal damage to the normal tissues. Nanoparticle delivery of anticancer drugs to tumor tissues can be achieved by either passive or active targeting. A therapeutic drug can be selectively enriched in the tumor lessions with minimal damage to normal tissues. For this the drugneeds to conjugate with monoclonal antibodies or other ligands that selectively bind with antigens or receptors that generally uniquely expressed on tumor cell surface. Several ligand-targeted therapeutic strategies, including immunotoxins, radioimmunotherapeutics, and drug immunoconjugates, are being developed. Although these conjugated agents have demonstrated promising efficacy compared with conventional chemotherapy drugs in preclinical and clinical trials.

POSITIVE SCOPE AND FUTURE AHEAD

As is understood researches are on, the scopes are extending and phenomenal growth is expected. A few specific areas of concentrated thoughts are:

- ***Silicon Nanoparticles.*** The development of new semiconductor nanoparticles as efficient, inexpensive, stable, and tunable luminescent probes for biological staining and diagnostics is one future direction. Silicon and germanium nanoparticles are potent choices. Nanoscale silicon has been extensively studied since 1990, when visible luminescence from porous silicon was first reported (Canham, 1990). An advantage of using silicon is that, through a controlled oxidation process, a thin shell of silica can be created on a silicon nanocrystal. This silica shell can then be functionalized to attach to DNA or to target specific biospecies.
- ***Nanophores for Photodynamic Therapy.*** This therapy holds considerable scope for the treatment of tumours. The efficiency of these nanophores still needs to be improved.There appears to be an inverse relation between the efficiency of up-conversion and the size of nanocrystals. However, larger particles cannot enter the cell through endocytosis. An appropriate balance of these two factors, has to be found. Real-time imaging and spectroscopy is employed to determine the efficacy of photodynamic therapy(PDT).
- **In Vivo *Studies.*** The *in vivo* studies related to the application of nanoparticles is quite less. The biocompatibility of the nanoparticles and nanoprobes, as well as their long-term toxicity, is a potential area to be studied.
- **Nanoarrays.** The development of nanoarray technology for DNA and proteins is another promising area of research. Nanoarrays can be subjected to high-density analysis as well as for work with minute quantities of specimen.The use of optical methods to fabricate nanoarrays and the use of fluorescence detection for DNA or protein binding at nanodomains. can be a challenging probing zone.
- ***BIONEM:*** The fusion of biomedical technology with nanotechnology are nanoelectromechanical systems (NEMS) or BIONEMS and nanofluidics. The NEMS devices are nanoscale analogues of microelectro-mechanical systems (MEMS) which can convert mechanical energy to electrical or optical signals, and vice versa. In the case of biotechnology, MEMS and NEMS have been used in a broader sense to include micro- and nanosize motors, actuators and even sensors. They provide future research pathways to include the structural flexibility shown by plastics.

CONCLUSION

The emerging ideas and applications of nanotechnology provide us the confidence of ushering in a new era of theuraptics and medical relief. Researches are in full swing in various parts of the world to enlighten the world with the miracles of nanoparticles. Cancer patients may now have the hope of defeating the menace and fighting back to normalcy with the boon of nanotechnology. The global market is investing huge funds, intellectual energy and time to provide the authentic footing to enrich the world of medical care. We hope that the nanotechnology will lighten up our lives with smiles and healthy promises.

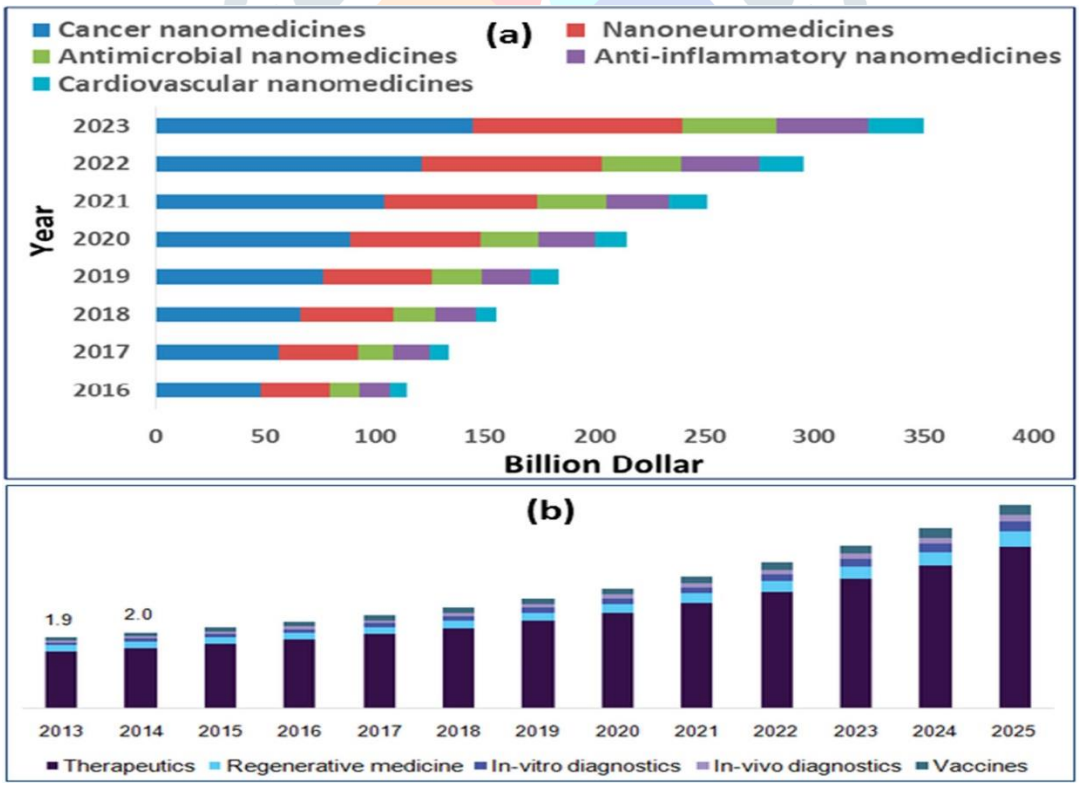

Figure 4- Global nanomedicine market revenue trends and future scope

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