Nanotechnology- A paradigm shift from fiction to reality

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ABSTRACT

Nanotechnology is rapidly developing subdivision of technology that effects on many fields.Medicine is also influenced by nanotechnology . Convergence of nanotechnology and medicine recently led to an interdisciplinary field, nanomedicine, which brings together engineers, physicists, biologists, chemists, mathematicians, and physicians striving to improve detection, imaging, and drug-delivery devices.

Keywords: Drug delivery, nanoparticles, oral cancer, nanorobots

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INTRODUCTION

Science and technology always go hand in hand .With the advent of newer methods and varied distribution in disease it led to the application of nanoscience in the modern era: the era of nanotechnology.The technology has unprecedented applications in various fields including biotextiles,health care, medical,dental, agriculture ,electronics and industrial. The word "nano," which is derived from the Greek word (nannos) meaning "dwarf," is a prefix that literally refers to 1 billionth of a physical size. [1] One nanometer (nm) is a unit of length that equals 1 billionth of a meter. [2] The size of atoms is approximately 0.1nm. Considering that the size of a usable nanostructure is 1 to 100 nm, it is clearly seen that the area of nanotechnology works at the level of atoms and molecules. [2].This means that what we consider nanomaterial or a nanodevice, has the smallest dimension of about 100 nm i.e. maximum 1×10^{-7} m. For comparison, the diameter of human hair is about 50 μm and it is 50,000 times larger than the size of 1 nm . Further, the average diameter of the bacterium Streptococcus mutans is around 0.321±0.007 μm , while the size of a hydrogen atom is in the range of 0.1 to 0.2 nm [3].According to the definition of the National Nanotechnology Initiative, nanotechnology is the direct manipulation of materials at the nanoscale [4]. Nanotechnology will give us the ability to arrange atoms as we desire and subsequently to achieve effective, complete control of the structure of matter. [5]

The aims of nanotechnology are to enable the analysis of structures at the nanoscale, to understand the physical properties of structures at the nanoscale dimension, to manufacture nanoscale structures, to develop devices with nano-precision, and to establish a link between nanoscopicand macroscopic universes by inventing adequate methods [6] .What makes nano-particles interesting and bestows unique features upon them is the fact that their size is smaller than the critical lengths defining many physical events.[7].Nano-phase materials were first discussed academically in 1959 at the annual meeting of the American Physical Society. At this meeting, Nobel Prize winning physicist Richard P. Feynman (1918- 1988) gave a speech titled "There is plenty of room at the bottom." In this speech, Feynman said that manufacturing at the dimension of atoms and molecules would result in many new inventions; in addition, he stated that particular methods for measurement and manufacturing at the nanoscale should first be developed to realize such a possibility. [7]Advances in the medical implementations of nanotechnology have resulted in the formation of a new field called nanomedicine. [8]Accordingly, the potential applications of nanotechnology in medicine are drug and genetic material delivery (viral vectors, non-viral vectors, such as nanoparticles, liposomes, or dendrimers and so-called "gene guns"), imaging, molecular diagnosis, therapy, cardiology, orthopedics, etc. [9-10]Nanodentistry has a potential to improve oral health by providing

sophisticated preventive, diagnostic and therapeutic measures using nanomaterials, biotechnology and nanorobots . [11] That way, advanced dental care could be delivered throughout the world population The structure of material that has particles of a nanometer size possesses special properties. Physical and chemical properties of materials become quite different when number of constitutional atoms is greatly reduced. A small number of atoms allow different positioning and distance between them making those properties to be dominant physical and chemical properties of the object
[12-13]

APPLICATIONS OF NANOTECHNOLOGY

Bottom-up approaches [14-15] Assembly of small components into compound structures.**Top-down approaches [**14-15]Creation of small structures by using bigger ones in guiding their assembly

LOCAL ANAESTHESIA - A colloidal suspension containing millions of anesthetic dental nanorobots would be used to induce local anesthesia. The technique employs use of nanorobots on gingival tissue that would reach the dentin and pulp ,will thereby block the sensation which can be revert back to normal .The technique is highly in control of the dentist monitored by the computer .It reduces apprehension and results are fast .

HYPERSENSITIVITY – Nanorobots using local organic materials, could result in effective occlusion of particular tubules, resulting in rapid and stable treatment. [8]

NANOTECHNOLOGY IN PERIODONTICS – Subocclusally dwelling nanorobotic dentrifice delivered by mouthwash or toothpaste could patrol all supragingival and subgingival plaque and destroy pathogenic bacteria residing in the oral environment .It metabolizes trapped organic matter into harmless and odourless vapours leading to continuous debridement of calculus.[16]

NANOTECHNOLOGY IN CONSERVATIVE DENTISTRY -Nanoproducts Corporation has successfully manufactured non agglomerated discrete nanoparticles that are homogeneously distributed in resins or coatings to produce nanocomposites. The nanofiller used include an aluminosilicate powder having a mean particle size of 80 ran and a 1:4 M ratio of alumina to silica and a refractive index of 1.508. It shows Superior hardness, Superior flexural strength, modulus of elasticity and translucency, 50% reduction in filling shrinkage and excellent handling properties. [17]

NANOTECHNOLOGY IN CANCER
Cancer remains one of the most fatal diseases affecting the mankind with cancer of oral cavity reported to be the 6th most common cause of mortality . Newer advances in the field of medicine has improvised the drug delivery methods by the use of nanoencapsules, dendrimers, fullerens, nanogold, Liposomes , quantum dots to support this dreadful disease in its treatment.Nanotechnology has the potential to offer solutions to current obstacles in cancer therapies, due to its

unique size (1-100 nm) and large surface-to-volume ratios. Nanoparticles with the size in the range of 200 nm are known to accumulate at the solid tumor site by the enhanced permeation and retention effect. [18]Nanoparticles based on noble metals, particularly gold, have an immense potential for cancer diagnosis and therapy based on their surface-plasmon resonance-enhanced light scattering and absorption. [19] As nanoparticle exists in the same size as proteins or cells, it is suitable for biotagging or labeling which function efficiently in a living organism whose cells are generally 10 μm across. However, the cell parts are much smaller and are in the sub-micron size domain. Even smaller are the proteins with a typical size of just 5 nm, which is comparable with the dimensions of smallest manmade nanoparticles. This simple size comparison gives an idea of using nanoparticles as very small probes that would allow us to spy at the cellular machinery without introducing too much of the interference.[20] A tight control of the average particle size and a narrow distribution of sizes allow creating very efficient fluorescent probes that emit narrow light in a very wide range of wavelengths. This helps in creating biomarkers with many and well-distinguished colors.Cancer nanovaccines could be designed, manufactured and introduced into the human body to improve health, including cellular repairs at the molecular level. The nanovaccines are so small that it can easily enter the cell; therefore, nanovaccines can be used in vivo or in vitro for biological applications. This has led to the development of diagnostic devices, contrast agents, analytical tools, physical therapy applications and drug delivery vehicles. Drug consumption and associated side-effects can be significantly lowered by depositing the active agent at the desired location. **[**21]

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