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NANOTECHNOLOGY- A REVOLUTION IN HUMAN HEALTH

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ABSTRACT

Nanotechnology- the ability to engineer systems with designed structure and function on the nanometer scale – is in the process of driving a new wave of medical innovation. The challenge for the future is to develop newer and more sophisticated nanotechnologies that can address problems associated with the diagnosis, treatment, and management of multi gene diseases e.g; cancer, cardiovascular diseases, environmental diseases, Alzheimer's disease, organ dysfunction and structural diseases, etc. This paper also summarizes the applications of nanotechnology to the prevention and treatment of human diseases, which holds great promise, but has great hurdles. Efforts in this area are focused on the development of nanomaterials and which must be of biocompatible, non-toxic, and functional in biological conditions. Applications of nanomaterials will involve the development of medications that take advantage of unique aspects of nanostructures to achieve or enhance therapeutic activity. These applications include antimicrobial compounds, drug and gene delivery, and functional imaging. We hereby focus on identifying fundamental changes that nanoscience and nanotechnology can bring to the study of life processes and that can lead to effective interventions for treating disease and promoting human health.

Key words: Nano science, medical innovation, nano material's, human health

INTRODUCTION

Nanotechnology refers to science, engineering, and technology that involve the manipulation of atoms and molecules on the nanometer (one billionth of a meter) scale or three orders on magnitude smaller than a micron, roughly the size scale of a molecule itself (eg., a DNA is about 0.25 nm long while a sodium atom is about 0.2 nm) to engineer materials and devices that novel properties because of their small size and uniform structure. Most past efforts in this area are focused on the development of inorganic nanomaterials for non medical applications, such as the use of carbon nanotubes for microelectronics. Recently, however, there has been recognition of the potential impact on medicine of nano scale materials and devices that can act on the small scales as molecules and cells. This, in turn, means that nano engineered substrates can be designed to exhibit very specific and controlled bulk chemical and physical properties as a result of the control over their molecular synthesis and assembly.

For application to medicine and physiology, these materials and devices can be designed to interact with cells and tissues at a molecular (i.e, sub cellular) level with a high degree of functional specificity, thus allowing a degree of integration between technology and biological systems not previously attainable.

Hence, parallel advances in molecular biology and genetic engineering have provided a separate and equally powerful means to engineer biological

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molecules with novel structures and functions on the nanometer scale.
The convergence of these fields now offers exciting new possibilities for using nanostructures and intelligent nano scale devices to improve human health, and hence to open a new era of “nano medicine”. In this paper, we explore potential area in which nano technology may have a significant effect on the future of medicine and specific opportunities and challenges in the burgeoning field.

- **Scientific and application-oriented research**

Expenses for health care are increasing astronomically, and soon will reach the point at which health care will not be affordable for the average citizen. Today’s medicine is based almost entirely on treatment; a significant part of tomorrow’s medicine will be based on early detection and prevention[1, 2]. Genetic testing will identify a person’s disease susceptibility at an early age, and ultra sensitive imaging modalities[3, 4] will be able to detect epigenetic disease alterations long before they are expressed clinically. Living cells are full of complex and highly functional “machines” at nanometer scale. They are compressed of macro molecules, including proteins. They are involved in practically every process in the cell, such as information transfer, metabolism and the transport of substances. Nanotechnologies offer new instruments for observing the operation of these machines at the level of individual molecules, even in living cells[5].

Nanostructured components also may be incorporated with in micro and even meso scale systems that have additional functionalities, including components for power generations, movement, and self assembly based manufacturing[6]. This revolution in health care will be further accelerated by the use of nanoscale tools to greatly advance our understanding of the molecular and cellular origins of many diseases, Implanted sensors and non invasive diagnostic tests will look for physiological markers that define early-stage changes of progression to a disease state, and much of this monitoring may eventually be performed at home and recorded at a distant site by the attending physician. The same technologies that sense these markers and lesions also will deliver prophylactic or therapeutic agents; in some cases, these smart devices will be embedded and responsive to the appearance of early-stage disease markers, so that problems are treated as they arise and long before symptoms appear. Nano technology also can be used to design better multifunctional materials that are simultaneously diagnostics, therapeutics, and monitors of response to therapy.

Future nano medical technologies will be even more elaborate and might include, for example, “smart fishing nets” that assemble and disassemble to recognize, capture, and analyse disease markers from blood, saliva, or other body fluids, and intelligent delivery systems that will circulate through the body as innocuous materials until they are activated at injury are disease sites to deliver drugs locally, in both cases, materials that can reversibly change their properties or catalyze ordered self assembly reactions in response to distinct molecular signals will be used to provide these nano scale systems with “intelligence”.

Nanotechnology also can be used to design better multi functional materials that are simultaneously diagnostics, therapeutics and monitors of response to therapy.

which will open totally new avenues for medical diagnosis and therapy.

Nanotechnology will be critical in major health challenges. These include environmental disorders developmental diseases, and finally, degenerative diseases. *Fig-1:* explores the significance of nanoscience latest nanotechnologies for human health.

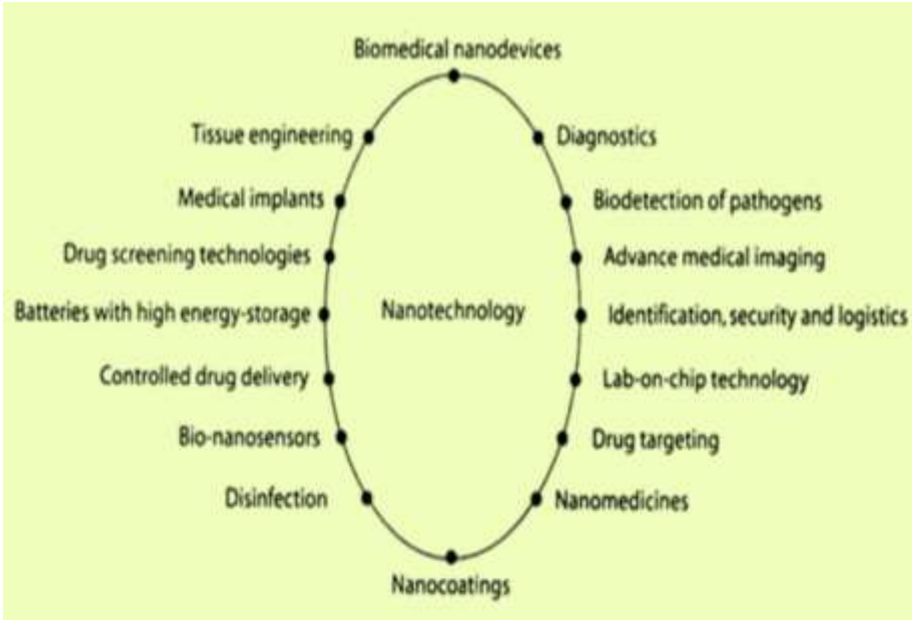

Fig: 1: schematic representation of nanotechnology revolutionizing biomedical sciences

Enabling nanotechnologies with application to human health

The interface of nanotechnology and biotechnology has produced some early successes. Examples included the use of non bleaching florescent nanocrystals (eg: Quantum dots) in place of dyes, pulled glass capillaries with nanoscale tips implanted for cellular and subcellular electrophysiological monitoring for microinjection of membrane impermeable molecules (eg: proteins , DNA), and the use of oriented arrays of carbon nanotubes for the delivery of bio molecular components to cells[7-11] and smart bio hybrid materials[12] that enhances bio analytical and diagnostic technologies by providing new avenues for regulating the activity of proteins and DNA component. Nanofibers are providing tools for the controlled delivery of molecular materials (eg: DNA) either in free form or tethered to nanofibers. An example of a smart polymeric drug delivery system for protein & nucleic acid drugs and vaccines is shown in *Fig-2.*

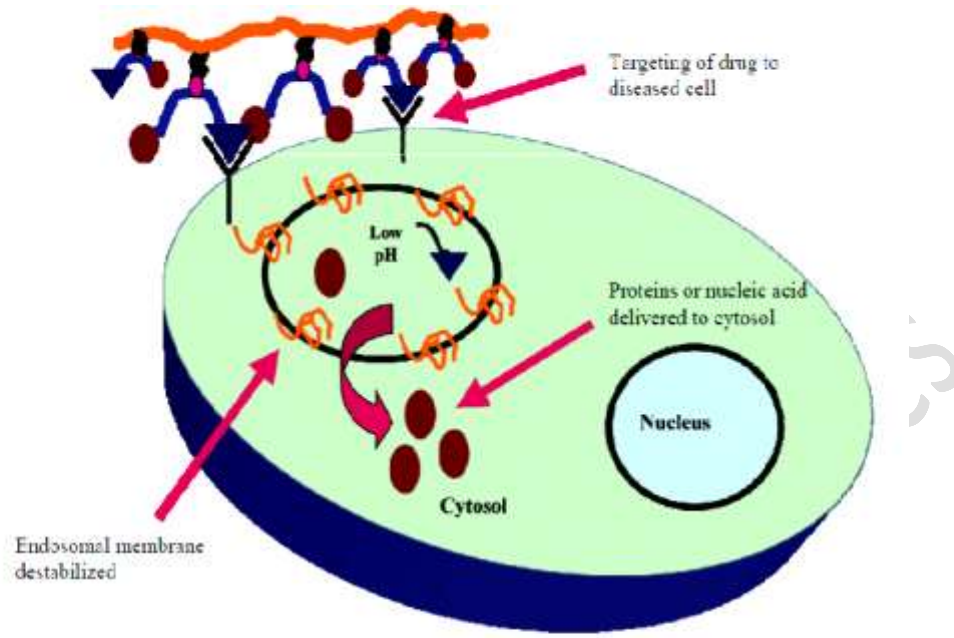

Fig: 2 System activated at low pH to dissemble and enhance drug delivery

These early advances hold promise of new approaches for the diagnosis and prevention of disease such

Diagnostics

The enormous increase in knowledge of the human genome and of expression products, proteins, makes it possible in an increasing number of cases to trace disease to abnormalities at the molecular level. The impact of nanotechnologies in the field of molecular biomarkers is noticed first [13-15].

In the laboratory

DNA chips used for analyzing DNA have been available for a few years now. They are currently widely used in scientific, biomedical research but they are rarely used in clinical practices. Nanotechnologies are also increasingly playing a role in producing the chips and increasing their sensitivity and reliability[16-17].Detection methods based on cantilevers, nanowires or nanotubes offer the added advantage that it is not necessary to label the samples. Labs-on-a-chip are pocket sized laboratories. They can be used for analyzing bio polymers and also for research and for manipulating cells. They are expected to play an important role in the further development of biosensors for the detection of pathogenic bacteria[18].

In - vivo diagnostics and Imaging

In the case of in – vivo diagnostics, patients are given contrast agents or radio pharmaceuticals. Their specific properties mean that these agents are useful in imaging pathophysiological changes and functional changes such as changes in blood flow in cells, tissue, and organs. The term molecular imaging is often used, as today's imaging techniques are increasingly concerned with making molecular bio-markers. Various techniques have been developed, each with its own contrast agents and imaging equipment: methods based on ultrasonic vibration, radioactive substances (including positron emission tomography, PET), magnetic resonance imaging (MRI), and fluorescent substances. Each has its own possibilities for applications and its own restrictions [19].

Drug delivery and therapeutics

More sophisticated "smart" systems for drug delivery have to be developed that sense and respond to specific chemical agents (e.g., releasing insulin in response to glucose), deliver drugs and genetic agents to specific sites, and are tailored to each patients on the basis of genotype. Multi

Vol 11, Issue 4 , April/ 2020
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functional nano devices need to be developed that can simultaneously detect, diagnose, treat and monitor response to the therapy. New treatments for diseases are needed that have benefits for exceeding current therapies, or that build on newly derived information about how the nanoscale machinery of cells carries out its varied critical functions. This would include targeted medication that have greater benefits and fewer side effects, as well as individualized medications that would address patients – specific disorders. *Fig: 3* explore the great deal from nanomedicine, especially in longer term.

"Tomorrow" nanodiagnostics, imaging & therapies will be the major biomedical tools.

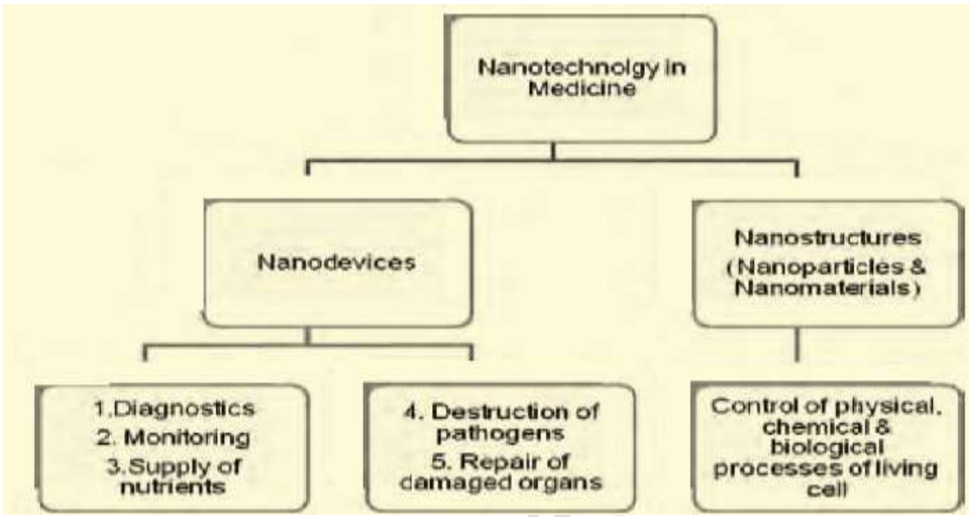

Fig: 3 Nanotechnologies in medicine

Recent advances in materials science and molecular engineering are making the possibility of creating various types of nanoscale materials, structures, devices, and machines a reality. These nanostructures materials range from analytical tools to intelligent drug delivery/ therapy programmable systems as shown in Table: 1.

Table: 1 Advance from Nanotechnology.

Nanostructured materials	Nanotools	Nanomanufacturing (that affects miniaturization)	Nanocomponents	Intelligent multifunctional nanodevices
Biomolecular self-assembly (e.g., liposomes)	Molecular detection and imaging of activities	Soft lithography used for MEMS and other analytic microsystems	Energy production	Nanomachines (integrated combinations of nanocomponents)
Biocompatible inorganic nanomaterials (e.g., magnetic nanoparticles)	Nanosurgery of molecular elements within cells	Nanopatterning-directed molecular assembly	Motors	Self-powered nanorobots with programmable functions and read-out capability
Membranes with nanopores		Molecular assembly–directed nanopatterning	Pumps	
Nanofilaments and networks			Synthetic factories	
Novel polymer structures Dendrimers Molecular Imprinting			Nanoassembly plants	
Self-assembling molecular mimetics and bionics (e.g., for tissue engineering)			Nanostructure-directed self-assembly	

CONCLUSION

The multidisciplinary field of nanotechnology's application for discovering new molecules and manipulating those available naturally could be dazzling in its potential to improve health care. The introduction of biocompatible materials and devices that are engineered on the nanometer scale that interact with biological molecules and cells and provide specified diagnostic , therapeutic, and imaging functions will change the way in which health care is provided in the future. Through ultra miniaturization a single nanodivice may provide more than one function and potentially even act as a self-powered unit with real time sensors & transmitters. Because of their small site and precise control of the packaging, such devices may be introduced with minimal disruption of living tissue. The continued advancement in the field of bio medical nanotechnology is the establishment and collaboration of research groups in complementary fields. The domaine gives better understanding of living and thinking systems, revolutionary biotechnology processes, and synthesis of new drugs and their targeted delivery, regenerative medicine, and developing a sustainable environment. This paper explores the significance of Nano science and latest nanotechnologies for human health.

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Vol 11, Issue 4 , April/ 2020
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