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NANOMEDICINE:- CURRENT TRENDS AND FUTURE PROSPECTS DISCUSSING THE APPLICATIONS OF NANOTECHNOLOGY IN DRUG DELIVER DIAGNOSTICS, AND TREATMENT

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ABTRACT

Nanotechnology has extensive applications such as nanomedicine in the medical field. Some nanoparticles have potential applications in new diagnostic devices, imaging and methodologies, targeted drugs, pharmaceutical products, biomedical implants and tissue engineering. Today, highly toxic treatments can be delivered with increased safety using nanotechnology, such as cancer chemotherapy drugs. In addition, wearable devices can detect major changes in vital signs, cancer cell states, and infections that actually occur in the body. We expect these technologies to give clinicians significantly better direct access to critical data about the reasons for changes in vital signs or disease due to a technological presence at the source of the problem. Biomedicine can be used for therapies with predictive analytics and artificial intelligence. To conduct this study, relevant articles on nanotechnology in the medical field from Scopus, Google scholar, ResearchGate and other research platforms are identified and studied. The study discusses the different types of nanoparticles used in the medical field. This article discusses the applications of nanotechnology in the medical field. The class, properties and characteristics of nanotechnologies for medicine are also taught. Scientists, governments, civil society organizations and the general public will need to work together across sectors to assess the importance of nanotechnology and drive its progress in various fields. Current research includes several possible uses of nanotechnology in the medical field. As a result, the study provides a concise and well-organized report on nanotechnology that should be valuable to researchers, engineers, and scientists for future research projects.

KEYWORDS: Nanotechnology Nanomedicine Nanoparticles Medical Treatment.

INTRODUCTION

Nanotechnology is a term used to define areas of science and engineering in which phenomena occurring at the nanoscale are used in the design, characterization, fabrication, and applications of materials, structures, devices, and systems. The term nanotechnology was first introduced in 1959 when iphysicist Richard Feynman gave a presentation on creating things at theatomic and molecular level. Nanotechnology is now considered to be the most promising technology of the 21st century and has been explored by researchers as a new technique in medical research. Nanotechnology will usher in a new era of productivity and prosperity, as evidenced by increased public funding for nanotechnology research and development over the past decade.[1–2] Nanotechnology can accelerate economic growth and increase capacity and quality in industries. It has contributed significantly to the well-being of society and shaped the nature of modern life. It has the potential to significantly change the dynamics of society, economic conditions and human life. For hundreds of years man has searched for miraculous remedies to relieve illness and pain after injury. Many academics believe that the applications of nanotechnology in medicine may be crucial to achieving this goal. These applications include comprehensive monitoring, control, creation, repair and defense of all biological human systems using artificial nanodevices and nanostructures operating at the molecular level. Nanotechnology can radically change medical research and create a new sector of human enhancement.[3-5] The diagnostic, therapeutic and preventive applications of nanotechnology have very narrow boundaries. This technology can deliberately modify the body except for many problems. The used nanomedicines have proven that bioavailability increases, side effects are eliminated, and therapeutic medicine is more efficiently absorbed.[6-7] The presence and entry of each individual molecule in the brain essentially creates a highly selective membrane barrier permeable to molecules with a high partition coefficient. Nanoparticles have recently been used on this membrane as a drug carrier system. In particular, nanoparticles are inhaled and pass through brain membranes. Typical and traditional therapies for vascular thrombosis often have relatively limited benefit due to short plasma half-life, many adverse effects, and rapid drug washout. To improve the stability and even the half-life of the encapsulated drug, immobilizing a specific amount of the substance in the drug delivery system could overcome this limitation. Biocompatibility and biodegradability create polymeric nanoparticles and liposomal nanocarriers are often used.[8-10] Science and technology are used to diagnose disease, treat and prevent trauma, alleviate pain, and maintain and improve human health using molecular tools and a molecular understanding of the human body. Most of the current commercial applications in medicine in nanotechnology are focused on drug delivery. New modes of action can be introduced and existing drug compounds are better targeted and more bioavailable. Nanoprobes, integrated sensor nanoelectronic systems, and multifunctional chemical structures for drug delivery and disease targeting are upcoming applications in nanotechnology.[11–13] Many successes have already been achieved in improving drug delivery using nanotechnology. Specific compounds can improve the targeting and entry of drugs into the cell and improve imaging, intracellular targeting, and controlled release of therapeutic genes. Clinicians could therefore detect and improve their effect on diseased cells and tumors to optimize therapy dosing. Combined with other forms of personalized treatment, nanometry can be tailored to target only diseased cells in an individual patient, minimizing side effects and tissue damage. Scientists have already made several advances that support the development of cells to treat spinal cord injuries. Magnetic nanoparticles and enzyme-sensitive nanoparticles that target brain tumors; smart nanoparticle samples for intracellular drug delivery and gene expression imaging; quantitative endpoints for the detection and quantification of human brain cancer.[14–16] In the field of healthcare, nanotechnology is opening new limits in the life sciences industry. Nanotechnology holds great promise in manipulating things at the atomic level to transform many parts of medical treatment, such as diagnostics, disease monitoring, operating equipment, regenerative medicine, vaccine development, and drug delivery. Through sophisticated research tools, it also paves the way for the development of drugs to improve the treatment of various diseases. Nanotechnology can be used to treat specific cells in the body, thereby reducing the risk of failure and rejection.[17–19] We identified four main research goals for this article: (1) identify types of nanotechnology and nanoparticles with their applications in medicine. field; (2) discuss the classes and taxonomy of nanotechnology-based materials for the field of medicine; (3) identify and discuss related features and characteristics of nanotechnology for the field of medicine; and (4) identify current and future applications of nanotechnology for the field of medicine.

2. The need for nanotechnology

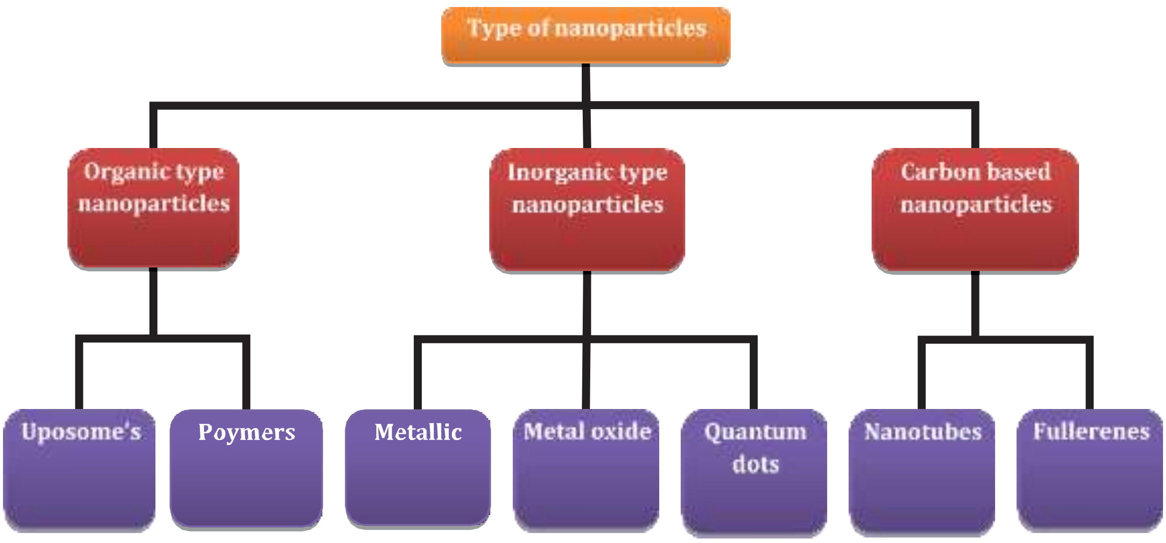
in the field of medicine The discoveries of nanotechnology and nanomedicine are so vast and extensive. Nanomedicine has undergone impressive modifications that are taking medicine to a new level with significant health outcomes. There is a need to study the significant possibilities of nanotechnology in healthcare. There is extensive research into best practices and methodologies in medicine, including nephrology, gene therapy for cardiovascular disease, and cancer therapy. There have been significant developments in traditional treatment and the quality of nanoparticles and nanotechnology has improved and shown encouraging results.[20-21] Gene therapy has also taken advantage of nanomedicine. Several investigations have focused on the applications of viral vectors considered as drug delivery systems.[22–24] Targeting specific cancer cells on smart tablets, nanobots send data back to researchers to ensure patients get the right treatment. Nanotechnology offers the potential for in vitro diagnostics by replacing existing procedures with more economical alternatives that are easy. i.e. use. Nanoparticles can act as molecular imaging agents in these devices, embedding cancer-related genetic changes and functional features of tumor cells. Functional coatings based on nanotechnology also often contain the following nanomaterials depending on the desired function: titanium dioxide, silicon dioxide, carbon black, iron oxide, zinc oxide and silver. Tools and procedures improve the assessment of physicochemical characterization, safety and efficacy of nanomaterials and nanosurfaces integrated into the design of medical devices. Scientists play a key role in creating goods that include new materials, sensors and energy storage systems.[25-26]

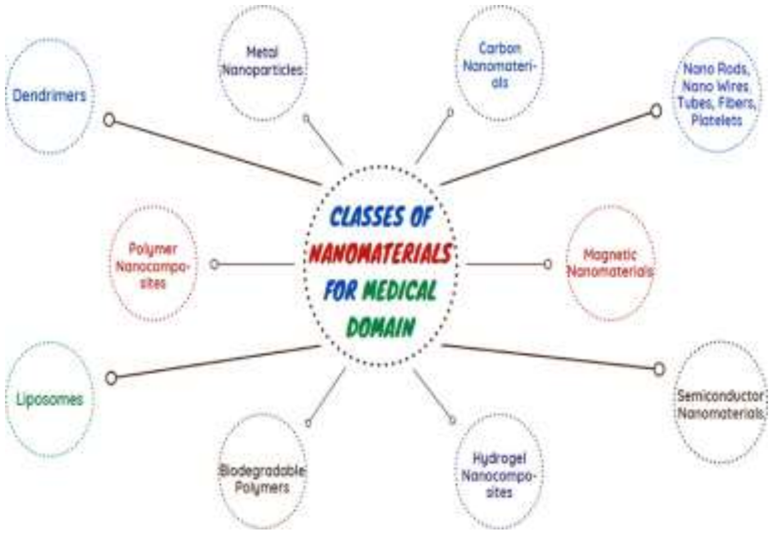
3. Different types of nanoparticles

are used in the medical field Nanoparticles have a significant surface area to volume ratio due to their nanoscale size, which allows them to absorb large amounts of drugs and move rapidly through the bloodstream. Their increased surface area gives them distinct capabilities as it improves their mechanical, magnetic, optical and catalytic properties, allowing them to be used in more pharmaceutical applications. Nanoparticles are classified into three areas based on their chemical composition: organic, inorganic and carbon.[27–29] Fig. 1 shows some primary classifications of nanoparticles. Proteins, carbohydrates, lipids, and other organic molecules are synthesized into organic nanoparticles with a specific dimension, such as a radius of less than 100 nm. Inorganic nanoparticles are non-toxic, hydrophilic, biocompatible and highly stable compared to organic materials. Inorganic nanoparticles include, but are not limited to, elemental metals, metal oxides, and metal salts. Fullerenes, carbon nanotubes, graphene and its derivatives are examples of carbon-based nanomaterials. These materials are attracting attention in various fields, including biomedical applications, due to their unusual structural dimensions and exceptional mechanical, electrical, thermal, optical, and chemical properties. Nanoparticles generally retain the chemical properties of their bulk materials, which can be advantageous in selecting a nanoparticle for various applications.[30–33] The nanoparticles react to light by heating up enough to destroy cancer cells. Scientists believe that the nanoparticles can be directly released into the circulation and become cancerous tumors in the future. Smart pills are medication delivery devices with ingestible sensors that can be wirelessly controlled and adjusted to control the dose of medication based on data collected throughout the body. Nanomedicine faces inherent obstacles like any innovative and revolutionary technology; it is widely used mainly in clinical applications. The environmental impact of nanotechnology accumulates in living tissues and organs and can be accessed on a large scale. Nanobots are a significant advance in nanomedicine.[34–37]

4. Classes and taxonomy of materials based on nanotechnology for the medical sphere

fig. 2 explores the various classes and categorizations of various nanotechnology-based materials that have special applications and uses in the field of medicine. Several classes have been reported in the available literature namely; metal nanoparticles, dendrimers, liposomes, biodegradable polymers, carbon-based nanomaterials, hydrogel nanocomposites and many others that promote and expand medical applications and services through the concept of nanotechnology.[38-39] Nanofibers are used in wound dressings, surgical textiles and implants, tissue technology, and artificial organ components. Scientists are creating smart bandages that are absorbed into the tissue after the wound has healed. In these smart dressings, embedded nanofibers can contain coagulation, antibiotics, and even sensors to detect signs of infection.[40-42] Nanomedicine ensures longer life and will help people live longer and support them in good health.





way for the Earth and requires the removal of their natural resources. Another approach to nanotechnology could be nanomachines to prepare for space colonization by building structures and creating ecosystems for other planets. Researchers are also investigating ways to modify human physiology to better adapt to the atmospheric conditions of other worlds. In health applications, nanomedicine uses nanotechnology such as therapy and diagnosis of various diseases using nanoparticles, nanoelectronic biosensors, and molecular nanotechnology. It provides the ability to evaluate the human body, drugs and medical equipment at the nano level, guaranteeing that medicine is ultimately much more accurate. The healthcare sector uses this technology for diagnostics and medical equipment.

Rapid advances in nanotechnology mean that new diagnoses and therapies are being developed with higher success rates. Currently, nanomedicine is used to develop smart drugs and cancer.[43–45] In recent years, this technology has been used to produce new nanoparticles and industries have changed significantly. Medical applications of nanotechnology include the development of microscopic biomechanical devices such as nanomachines and nanorobots. Products based on nanotechnology are often expensive, which prevents their mass production. These products will help create this technology expanded with affordable production options. Nanoparticles can sensibly increase glucose and respond by releasing insulin, eliminating the requirement for self-monitoring and self-administration of insulin. Implanted nanoparticles in the human circulation can proactively identify disease by detecting certain enzymes indicative of tumor growth.[46–48] If nanotechnology is used in healthcare, it can make substantial progress in the diagnosis, treatment and prevention of diseases. Innovators are increasingly interested in the potential health uses of nanotechnology, and this may lead the industry into a new age of growth. Diagnosis and therapy now depend on clinical expertise and interpretation of external biometric data; The focus of future research is expected to be directly derived from nanotechnology data at the site of disease. By enabling our bodies to use artificial mechanics, this technology is helping to define proactive, preventative and personalized medicine for everyone from the inside out. The use of nanomaterials is one of the most frequently mentioned cases. Manipulation of nanometer-scale devices and systems provides numerous opportunities for disease diagnosis and treatment, and more precise testing.[49–51] Nanomaterials are used in healthcare for diagnosis, therapy, control and prevention of diseases. Development of better and safer drugs, tissue-targeted activities and personalized activities nanomedicine is powered by nanoparticles. For example, this technology was used to disinfect surfaces and personal protective equipment during the 2019 coronavirus disease pandemic. Nanoparticles can deliver drugs precisely to the desired site, thereby substantially improving their efficacy and limiting toxicity to other tissues in the body.[52–54] To deliver drugs to brain in hard-to-treat diseases, nanoparticles can also be developed. cross the blood-brain barrier.

5) Associated features and characteristics of nanotechnology for the medical Various classic related features and characteristics of nanotechnology for the field of medicine include (1) wound treatment; (2) antibacterial treatment; (3) minimize damage to healthy cells; and (4) the diagnostic technique of nanomedicine. Use of nanovesicles, nanoparticles, carbon nanotubes, etc. further streamlined and streamlined the applications of nanotechnology-based principles in medicine, where precision with cleverness is essential on a larger scale.[55-56] For preventive medical methods, nanotechnology is as good as reactive. Wearable monitors can be designed to transmit data back to hospital systems, simplifying the care of elderly patients who often require attention in remote locations. Similarly, nanomaterials long considered progenitors of metastatic malignancies may be able to control circulating tumor cells. The technology industry uses individual atoms and molecules, especially nanoscience, with futuristic implications for science, engineering and technology. It can have a noticeable impact and influence on the development, characterization, development and implementation of specific atoms and molecules. Among others, medicine, energy, food production, basic chemicals, cosmetics, agriculture, equipment, biotechnology and textiles are fundamentally changing.

6. Significant emerging areas for nanotechnology applications

in the medical field Nanotechnology speeds up the process with a compact, portable device that takes small samples and allows for near-instant processing and analysis. In vitro diagnostic testing will continue to increase sample sizes and biosensors. Nanoparticle formulations when applied to iron oxides and specialty polymers will increase their imaging capacity by using lower and more effective doses of diagnostic compounds, enabling early detection of genetic abnormalities, tumors and a range of disease states. Nanomedicine, like biotechnology, raises concerns in certain areas, especially regarding security and privacy.[72–75] Immunoassays are suitable applications because of the robust connectivity between antibodies and antigens, leading to excellent sensitivity. Regenerative immune sensors are an interesting new challenge that enables repeatability for statistical rigidity and semi-continuous monitoring. Nanomedicine is a very immature subject in cancer, so the clinic needs to determine the possible influence.

6.1) In the past decade, imaging has become a powerful tool in disease diagnosis.
Advances in magnetic resonance imaging and computed tomography are impressive. However, nanotechnology offers tools for in vitro and in vivo diagnostics that are sensitive and very accurate, far exceeding the capabilities of modern devices. As with any advance in diagnostics, the ultimate goal is to enable doctors to diagnose disease at the earliest opportunity. Nanotechnology is believed to enable cellular diagnostics and possible subcellular diagnostics.

6.2. Development of therapy It is believed that the most significant effect of nanomedicine in administration and treatment will be achieved in therapy. Nanoparticles allow doctors to target drugs at the cause of disease, increasing efficacy and reducing side effects. They also provide new opportunities to regulate therapeutic releases. Nanomedicine has gained tremendous advantages in instrumentation and pharmaceutical synthesis with several types of nanomedicines and drug and diagnostic applications. The research area of nanoparticle production and nanotechnology-based processing is developing.

6.3. Disease Detection

Nanomedicine is an exciting application for the prevention, detection, therapy and monitoring of diseases, from bioengineered nanoparticles that target and kill cells and implantation of biocompatible tissue to implanted nanoscale biosensors. However, while basic nanomedical applications such as customized drugs and medical devices have already been pursued in mainstream medicine for more ambitious applications such as multi-component nanomedical devices, the unique properties of nanoparticles can be exploited at the molecular level. At this small scale, there is more surface area for chemical attachment, which facilitates fine manipulation of molecules and modification of particle behavior. Nanomaterials are also small enough to enter living cells.

6.4 Oxygen detection

in the body Nanosensors can detect oxygen and carbon dioxide concentrations in the body and the presence of hazardous materials. The detection of malignant digestive organs and food sensitivities allows individual diet and nutrition programs to be part of their use. A significant problem in treatment with frequent chemotherapy and radiation is damage to healthy cells. New methods of nanomedicine are being used to treat skin cancer, which enable adequate supply of specific tumor locations and cell targeting with less harmful side effects of drugs and other theoretical therapies. A new way of identifying circulating cancer cells called NanoFlares is used in nanomedicine. NanoFlares are particles designed to attach to the genetic targets of cancer cells and emit light when that particular genetic target is identified.

6.5. Economic healthcare

Nanomedicine holds great promise for better, more efficient and cost-effective healthcare for millions of people and may provide good answers to a number of diseases. Nanotechnology affects almost all areas of contemporary medicine, from diagnostics to disease monitoring via surgery, chemotherapy or regenerative medicine. The benefits that nanotechnology can bring are currently beneficial to many areas of medical care. Nanoscale diagnostics is another emerging area of nanomedicine. The goal is to diagnose the disease as early as possible. Many patients with organ failure or severe injury are hoping for new approaches to regenerative medicine. Artificial skin, bone and cartilage are advancing, with some already on the market today. 6.8. Improve the effectiveness of the drug Drug delivery using smart materials and nanoparticles is a promising research area that can help pharmaceutical companies improve the effectiveness of existing medicine and eliminate some systematic side effects. It consists of transport agent assemblies; imaging devices and drugs are designed to target the affected tissues while monitoring the process. In other words, specific functional requirements must be differentiated into necessary physicochemical characteristics and linked to biological behavior.

6.6. Disease Management

Nanotechnology provides an extra effective tool for the prevention and treatment of diseases with increasing antibiotic resistance in bacteria worldwide. The effectiveness of bacterial membranes at the nanoscale can be made more incredible by antimicrobial compounds such as nanosilver. These properties can minimize the need for antibiotics when integrated into traditional materials while protecting the patient from infection. Nanotechnology has the potential to revolutionize patient care. In life sciences research and development and others at the forefront of healthcare, this technology is still a long way from becoming ubiquitous. The economic situation in which nanotechnology is at the forefront of health care may now become too difficult and dangerous to justify the investment, given the rising costs of health care and the cost of research and development in the life sciences. Treatment with oral pain relievers would usually be easier to administer and provide adequate patient comfort. 6.10. Fight cancer In today's fight against cancer, nanotechnology is considered one of the most promising breakthroughs in the drug supply. Typically, rather than drugs, nanoparticles are likely to deliver standard cancer drugs to tumors with fewer side effects and enable targeted killing of cancer cells in unconventional therapies. With nanoparticle-enabled delivery of chemotherapeutic agents, more cytotoxic drug can be delivered to the target site and off-target toxicity and efficacy are reduced.

6.7. Useful in cardiovascular diseases

In the medical field, nanomedicine uses the expertise of nanotechnology to prevent and treat serious conditions, including cardiovascular disease and heart disease. Nanomaterials, including biocompatible nanoparticles and medical nanobots, have helped doctors understand the targets of a living creature in recent advances in nanotechnology.

7. Future scope

From prediction to monitoring, nanomedicine will undoubtedly play a vital role in the future of personalized medicine. Nanomaterials are the basis for increasingly sensitive sensors and biomarkers that can be used to simultaneously and accurately identify multiple diseases at an early stage. Nanomedicine enables highly accurate disease mapping with increased targeting and chemical sensitivity. Once the condition is diagnosed, nanomedicine can be used more effectively to attack cells while reducing side effects and damage to healthy cells. Several products are already in use, including the previously mentioned nanoencapsulated doxorubicin. Future challenges essentially include advances in drug loading and release and further development of the diagnostic and therapeutic potential of metal nanoparticles. Like any advanced technology, nanomedicine must balance the attractive potential against the dangers of the future. As with any medical device and treatment, nanomedicine must be rigorously controlled and thoroughly evaluated before its full potential can be realized, with toxicity evaluations and multistage clinical trials conducted. In the future, nanotechnology may detect problems on the spot, rather than depending on a combination of input from external sensors, medical knowledge and probabilistic diagnostic algorithms. The use of nanotechnology in athletes could also be another application to evaluate which muscles have superior circulation and develop lower lactic acid, allowing athletes to respond to their underperforming muscles by altering frequency and training. They can adjust their efficiency and maximize their less effective muscle potential.

8). DISCUSSION

Nanomedicine is an upcoming medical field that uses knowledge of nanotechnology to prevent and treat serious conditions, including cancer, cardiovascular disease, and other diseases. Recent advances in nanotechnology have enabled physicians to sensitize actionable targets in the living body using nanoparticles, including biocompatibility of nanoparticles and nanobots. Scientists are also using nanomedicine to stimulate immunotherapy. In recent years, there have been extensive advances in nanomedicine that have expanded the nanomedicine market. Applications in nanomedicine, such as nanomachine diagnostics, offer the ability to monitor the internal chemistry of an organ and allow direct access to diseased areas. Nanomedical treatments have demonstrated several significant benefits, including improved water supply and increased biological activity

9) CONCLUSION

The revolution in healthcare is driven by nanotechnology, which emphasizes the preventive management of population health. Nanotechnology helps solve the problem of targeted treatment delivery, reduces the risk of side effects and maximizes therapeutic efficacy. This technology is suitable for the identification, treatment and gene therapy of cancer. Nanomedicine is the most promising application of nanorobotics. Its applications span several areas such as vaccine development, drug delivery, wearable devices, diagnostic and imaging devices, and antimicrobial products. The development of more effective drugs has improved the gadgets and early detection of various diseases is expected to lead to nanomedicine. By combining standard anti-cancer drugs with nanotechnology, they can pass intact and circulate in the brain. This technology offers huge potential markets and benefits, entire classes of current drugs. Nanomedicine is produced with a critical mixture of manganese and citrate using nanotechnology techniques. It is possible to develop tailored drug delivery mechanisms, new diagnostic methods and nanoscale medical devices.

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