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THE USE OF NANOTECHNOLOGY IN MEDICINE

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Abstract:

The most advanced application of nanotechnology in the field of drugs delivery will lead to the development of research methods, advanced drug delivery systems, and new methods for treating diseases or repairing damaged tissues and cells. Nanoparticles are being developed to improve the bioavailability of conduction, a significant constraint in designing new drugs that are taken as fat or polymer molecules based on cell registration because of their small size, and instead of being cleared by the body. These nanoparticles can be used on shuttle medications in cells that may not be medicinal on their own. The nanoparticles may be specifically able to target some cell types, reduce toxicity and improve efficacy

Keywords: Nanotechnology, Nanoparticle, Nanodiamant

INTRODUCTION

Nanotechnology or nanoparticle technology can be defined as a science that is concerned with the design and manufacture of materials and systems while controlling the dimensions of nanometers, that is, at the atomic and molecular levels of materials, and that the basis of nanotechnology is size and control. Typically, nanotechnology deals with measurements between 1 to 100 nanometers, that is, It is concerned with atomic clusters of five atoms or less, which are much smaller than the dimensions of bacteria and living cells.. This term first appeared in 1974 in Japan. A nanometer is a unit for measuring lengths, used to measure very short distances of 10-9 meters. That is, 1 millimeter contains a million Nano (Hubler, 2010 ; Nikalje, 2015).

The uses of nanotechnology applications vary in different areas of life such as energy, medicine, agriculture, electronics, etc. due to the treatment of some materials at the atomic level and thus acquire unique and essential properties that may be visible, electrical, or magnetic properties and others (Glenn, 2015 and Shinn, 2012).

CLASSIFICATION OF NANOMATERIALS: -

Nanomaterials can be classified according to the number of their dimensions that are not in the nanometer range to the following (Nikalje, 2015): -

1- Miniature materials: materials whose dimensions are more than 100 nanometers.
2- One-dimensional materials: They are materials that contain only one dimension greater than 100 nanometers.
3- Two-dimensional materials: They are two dimensions greater than 100 nanometers.
4- Three-dimensional materials: They are materials of all dimensions greater than 100 nanometers.

Characteristics of nanomaterials:

Smallness, speed, less energy consumption, ease of penetration of biological barriers, non-compliance with Newton's laws, and availability of a mechanical quantity (Zhang *et al* ., 2016). As compared to their bulk form, these NPs exhibit considerably improved physical and chemical characteristics and these characteristics include a high surface-area-to-volume ratio, as well as a one-of-a-kind quantum size impact as a result of certain electrical properties structures In addition to their composition, the characteristics of NPs are determined by their size and shape. Generally, in order to obtain monodispersed NPs and simplify their isolation Internalization by cells necessitates the management of their size and form, therefore minimizing aggregation (Boisseau and Loubatonb, 2011; Modi *et al.*, 2022).

Types of nanoparticles:

NPS are classified into different categories based on their shape, size, and chemical characteristics. Some well-known classes of NPs are listed below based on physical and chemical properties:

Various kinds of NPs have been proposed, depending on the application (i.e. diagnosis, imaging, or therapy), with some of them being used for more than one purpose. NPS are classified into two types: organic NPs and inorganic NPs. Micelles, dendrimers, liposomes, hybrid, and compact polymeric NPs are all members of the first group. Fullerenes, quantum dots, silica, and gold nanoparticles comprise the second group(Cartaxo, 2018).

A- Organic nanoparticles

1- Micelles:

A micelle is a cluster of amphiphilic surfactant molecules that spontaneously assemble in water to create a (usually) spherical vesicle. Because the core of the micelle is hydrophobic, it can retain hydrophobic medications until they are released by a drug delivery mechanism. Conventional micelles are made up of small molecules with a hydrophilic, polar, or charged "head" group and a hydrophobic tail, which is usually composed of the hydrocarbon component of long fatty acids (Husseini and Pitt, 2008). Nowadays, biodegradable polymeric micelles having sizes ranging from 10 to 200 nm have received a great deal of emphasis for drug delivery nanocarriers due to their exceptional therapeutic potential (Zhang *et al*., 2008).

2- Dendrimers:

Nano-sized, radially symmetric molecules with a very well, homogeneity, and a dispersed structure composed of tree-like arms or branches, Dendrimer molecules have a center atom or collection of atoms identified as the core. From this central structure, branches of other atoms termed 'dendrons' develop through a variety of chemical processes (Abbasi *et al*., 2013).

A dendrimer's core is referred to as generation zero, dendrimers' unique molecular structure allows them to transport pharmaceuticals across their multivalent surfaces via covalent conjugation or electrostatic adsorption, and also dendrimers can be drug-loaded via the cavities in their cores via hydrophobic contact, hydrogen bonding, or chemical linkage (Zhang *et al*., 2008).

3- Liposomes:

Liposomes (also known as solid lipid nanoparticles, SLN) are undoubtedly the eldest and also most intensively investigated nanoparticles that have gotten it into the clinic (Svenson, 2014).

A study was done by Al-Jamal and Kostarelos, (2007) mentioned that the Liposomes are the most therapeutically recognized nanometer-scale systems for delivering cytotoxic and antifungal medicines, genes, and vaccines, as well as imaging agents. Liposomes are spherical vesicles made up of aqueous compartments surrounded by a phospholipid bilayer, When numerous lipid bilayers develop around the main core, the structures created are known as multilamellar vesicles (MLVs) which arise spontaneously when dried lipid films are reconstituted in aqueous solutions (Schwendener, 2007).

4- Hybrid lipid–polymer nanoparticles: have been described as a smart and durable drug delivery mode because of their ease of preparation and high stability when compared to other forms of drug delivery systems. LPHNs are drug nanocarriers made from a variety of natural, semi-synthetic, and synthetic polymers. Because of their tiny size, LPHNs can be employed in a range of applications, including anticancer therapy, lung infection treatment, vaccine administration, and gene delivery (Shi *et al*., 2013). The hybrid creation is thermodynamically advantageous in terms of hydrophobic, van der Waal, and electrostatic interactions (Mukherjee *et al*., 2019).

B- Metallic inorganic nanoparticles:

Metallic nanoparticles have been employed in medication delivery, particularly in cancer therapy, as well as in biosensors Silver and gold nanoparticles are among the most important metals for biological applications (Nikalje, 2015).

1- Gold nanoparticles:

Because of their multifunctionality and unique properties, gold nanoparticles (AuNPs) have various biological uses in diseases detection and treatment, such as targeted chemotherapy and pharmaceutical medication delivery. For site-specific medication delivery, AuNPs can be coupled with ligands, imaging labels, medicinal medicines, and other functional moieties (Sharma *et al*., 2015). occur in particle sizes ranging from 2-100 nm; moreover, particle sizes nm particles have been found to cause 50-40 .ranging from 20-50 nm demonstrated a most effective cellular uptake particular cell toxicity. These 40-50 nm particles quickly penetrate into cancers and recover them. A bigger particle, i.e., 80-100 nm, on the other hand, does not penetrate into the tumor and remains nearby the blood vessels (Pandey and Dahiya, 2016).

2-Silver nanoparticles:

Silver nanoparticles (AgNPs) are increasing to be used in a range of industries due to their specific physical and chemical properties, including medicine, food, health care, consumer products, and industry. Optical, electrical, and thermal properties, as well as strong electrical conductivity and biological qualities, are examples of these (Zhang *et al*., 2016; Lee and Jun, 2019). There have been several techniques described for the creation of silver nanoparticles, including chemical reduction, thermal breakdown, laser ablation, and sonochemical synthesis, the chemical reduction approach and laser ablation method are two of the most regularly used synthetic methods (Ravindran *et al*., 2013). Because of their antibacterial qualities, silver nanoparticles (AgNPs) are the most often employed NPs in commercial goods. AgNPs are used in medical products such as bandages, as well as textiles and household items. Aside from their antibacterial properties, AgNPs are known to cause toxicity in a variety of species, and prolonged exposure to silver is known to cause argyria and/or argyrosis in humans (Beer *et al*., 2011).

Medical uses of nanotechnology: -

Nanotechnology is applied or used in the medical field by using nanomaterials to give successful compensatory treatments as it showed great potential in the process of diagnosis and surgery that require careful intervention as well as used in medicines and antibiotics, vaccines, and chemotherapy (Gurunathan *et al*., 2015). Also, the application of nanotechnology in medicine increased pharmaceutical half-life duration by improving drug internalization, reducing drug degradation/clearance, and providing slow-release mechanisms for loaded medications (El-Sayed & Kamel, 2019; Doroudian *et al*., 2021).

Pharmaceutical industries: -

The advancement of nanotechnology technologies presents unique therapeutic and diagnostic plans to suit medical requirements. Delivering the drug to the tissues with great accuracy, reduces the severity of the side effects, as it deals directly with the diseased cells using the drug vectors (Hosen *et al*., 2015; dos Santos *et al*., 2021) and they are five types:

-Water polymer soluble: highly soluble in water.

-Emulsion

-Nanosphere: Small particles consisting of natural or synthetic polymers

-A vesicle that has a wall similar to the cell wall: liposome

- polymeric micelle

Diagnostic medicine imaging

It is used in medical radiation dyes; So that it reaches the places to be accurately diagnosed and uses quantum dots, which are particles that emit light-sized light under the influence of magnetic resonance, which enables them to obtain clear images of tumors (Ghasemi *et al*., 2009).

It also uses nanoparticles fluorescent: it is a carbon nanoparticle that becomes underneath a more exciting and luminous light source. Where it is used in the diagnosis of some microbial diseases where it adheres to antibodies and adheres to the microbes inside the body, to give a signal after that, the microbe is diagnosed and affects the adhesion of bacteria to the body and facilitates cellular communication.

Eliminating cancer cells

Regular chemical treatments destroy cancerous and non-cancerous cells, prompting more accurate methods of treatment (Gurunathan *et al*., 2015). Among these are:

1-Nanodiamants

They are carbon materials that are from 2 to 8 nanometers that move easily in the blood circulation and inside the cell membranes and reduce the side effects of the drug doxorubicin. This drug is fixed on the Nanodiamnts molecules, which increases its effectiveness (against cancer cells) by staying longer in the affected organ (Kharisov *et al*., 2010).

2-Use of gold-plated nanocortices

As it binds to cancer cells, and after exposing the affected area to laser beams (heating), the released gold kills the cancerous cells. As for diseases of the digestive system, it was possible to detect the presence of esophageal and stomach cancers and inflammation of the intestine because the nanoparticles are significantly absorbed and easily due to their very small size. By activating or deactivating some receptors, as well as affecting the cell cycle and modification of nucleic acids (Walczak *et al*., 2013).

Some medical nanotechnology devices

Dendrimer

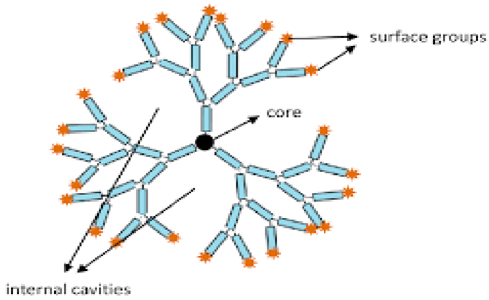
It is a molecule loaded with vitamins that are largely absorbed by the cancer cells due to the availability of a large number of receptors and provide them with the necessary drugs without negative effects.

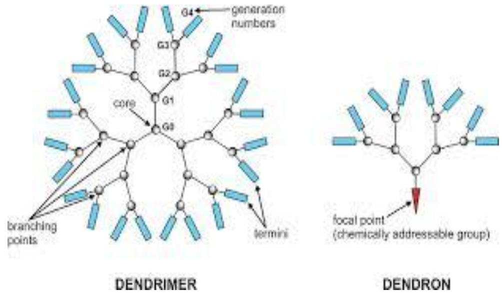
Nanorobotics

They are micro-precision robots, and they are the most exciting inventions in the medical field because they can enter the depths of the body to fix some damage and eliminate microbes and parasites, and immune support as they are used in gene therapy by transferring some parts of DNA and entering them into the nucleus of cells made mainly of carbon (nanotubes) carbon) and has the ability to easily move around in the circulatory system (Kapoor *et al.,* 2012 and Devasena *et al.,* 2018)

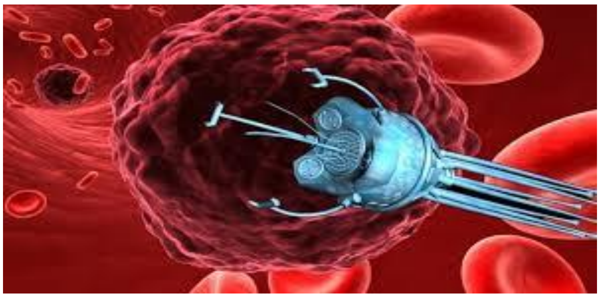
Nanosonde

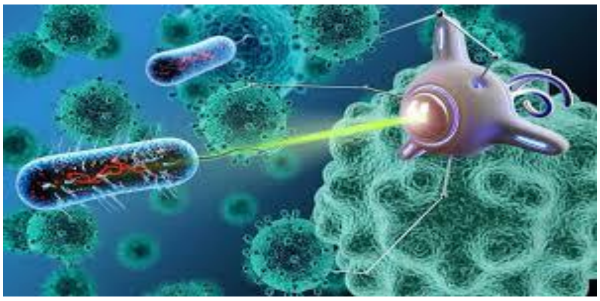
It is used to perform surgeries on a microscopic level and is connected to a computer.





Dendrimer





Nanorobotics

Nanosonde

REFERENCES:

1. Abbasi, E., Aval, S. F., Akbarzadeh, A., Milani, M., Nasrabadi, H. T., Joo, S. W., ... & Pashaei-Asl, R. (2014). Dendrimers: synthesis, applications, and properties. Nanoscale research letters, 9(1), 1-10.
2. Al-Jamal, W. T., & Kostarelos, K. (2007). Liposome–nanoparticle hybrids for multimodal diagnostic and therapeutic applications. Nanomedicine, 2(1), 85-98.
3. Beer, C., Foldbjerg, R., Hayashi, Y., Sutherland, D. S., & Autrup, H. (2012). Toxicity of silver nanoparticles—nanoparticle or silver ion?. Toxicology letters, 208(3), 286-292.

4. Boisseau, P., & Loubaton, B. (2011). Nanomedicine, nanotechnology in medicine. Comptes Rendus Physique, 12(7), 620-636.
5. Cartaxo, A. L. P. (2018). Nanoparticles types and properties–understanding these promising devices in the biomedical area. Int. J. Nanomed, 1-8.
6. Devasena U. R.; Brindha D. and Thiruchel (2018). A review on DNA nanobots– A new technique cancer treatment. ASIAN journal of pharmaceutical and clinical research, 11, (6), 2018.
7. Doroudian, M., O'Neill, A., Mac Loughlin, R., Prina-Mello, A., Volkov, Y., & Donnelly, S. C. (2021). Nanotechnology in pulmonary medicine. Current opinion in pharmacology, 56, 85-92.
8. dos Santos, J., de Oliveira, R. S., de Oliveira, T. V., Velho, M. C., Konrad, M. V., da Silva, G. S., ... & Beck, R. C. (2021). 3D printing and nanotechnology: A Multiscale alliance in personalized medicine. Advanced Functional Materials, 31(16), 2009691.
9. El-Sayed, A., & Kamel, M. (2020). Advances in nanomedical applications: diagnostic, therapeutic, immunization, and vaccine production. Environmental Science and Pollution Research, 27(16), 19200-19213.
10. Ghasemi, Younes; Peymani, Payam and Saba, Afifi (2009) Quantum dot: magic nanoparticle for imaging, detection and targeting. ACTA BIOMED 2009; 80: 156-165.
11. Glenn JC, Florescu E. Millennium project team. 2015-16 state of the future. Journal of Socialomics. 2016;5(3):1-6. DOI: 10.4172/2167-0358.1000168.
12. Gurunathan, S.; Park, J.H.; Han, J.W.and Kim, J.H.(2015) Comparative assessment of the apoptotic potential of silver nanoparticles synthesized by Bacillus tequilensis and Calocybe indica in MDA-MB-231 human breast cancer cells: Targeting p53 for anticancer therapy. Int. J. Nanomed. 2015, 10, 4203–4222.
13. Hosen, S.M. Zahid; Dash, Raju; Junaid, Md.and Khanam, Umma Hane(2015). PHARMACEUTICAL NANOTECHNOLOGY- A Short Review.
14. Hubler, A. (2010). "Digital quantum batteries: Energy and information storage in nanovacuum tube arrays". Complexity. 15 (5): 48–55.
15. Husseini, G. A., & Pitt, W. G. (2008). Micelles and nanoparticles for ultrasonic drug and gene delivery. Advanced drug delivery reviews, 60(10), 1137-1152.
16. Kapoor ,Deepak N.;Singh, Arvind and Singh, Sushila(2012). Nanorobotics, DHR International Journal Of Pharmaceutical Sciences (DHR-IJPS), Vol. 2, Issue 1, 2012
17. Kharisov ,Boris I.; Kharissova ,Oxana V. and Guerrero,Leonardo Chavez(2010) Synthesis Techniques, Properties, and Applications of Nanodiamonds. Synthesis and Reactivity in Inorganic, Metal-Organic, and Nano-Metal Chemistry, 40:84–101, 2010.
18. Lee, S. H., & Jun, B. H. (2019). Silver nanoparticles: synthesis and application for nanomedicine. International journal of molecular sciences, 20(4), 865.
19. Modi, S., Prajapati, R., Inwati, G. K., Deepa, N., Tirth, V., Yadav, V. K., ... & Jeon, B. H. (2021). Recent Trends in Fascinating Applications of Nanotechnology in Allied Health Sciences. Crystals, 12(1), 39.
20. Mukherjee, A., Waters, A. K., Kalyan, P., Achrol, A. S., Kesari, S., & Yenugonda, V. M. (2019). Lipid–polymer hybrid nanoparticles as a next-generation drug delivery platform: state of the art, emerging technologies, and perspectives. International journal of nanomedicine, 14, 1937.
21. Nikalje, Anna Pratima(2015) Nanotechnology and its Applications in Medicine. Med chem, an open access journal, Volume 5(2): 081-089.
22. Pandey, P., & Dahiya, M. (2016). A brief review on inorganic nanoparticles. J Crit Rev, 3(3), 18-26.
23. Ravindran, A., Chandran, P., & Khan, S. S. (2013). Biofunctionalized silver nanoparticles: advances and prospects. Colloids and Surfaces B: Biointerfaces, 105, 342-352.
24. Ray, S.C.; Saha, Arindam; Jana, Nikhil R. and Rupa Sarkar (2009). Fluorescent Carbon Nanoparticle: Synthesis, Characterization and Bio-imaging Application. Centre for Advanced Materials, Indian Association for the Cultivation of Science, Kolkata-700032 (India).
25. Schwendener, R. A. (2007). Liposomes in biology and medicine. Bio-Applications of Nanoparticles, 117-128.
26. Sharma, N., Bhatt, G., & Kothiyal, P. (2015). Gold nanoparticles synthesis, properties, and forthcoming applications-a review. Indian Journal of Pharmaceutical and Biological Research, 3(2), 13.
27. Shi, J., Xu, Y., Xu, X., Zhu, X., Pridgen, E., Wu, J., ... & Farokhzad, O. C. (2014). Hybrid lipid–polymer nanoparticles for sustained siRNA delivery and gene silencing. Nanomedicine: Nanotechnology, Biology and Medicine, 10(5), e897-e900.
28. Shinn, E. (2012). "Nuclear energy conversion with stacks of graphene nanocapacitors". Complexity. 18 (3): 24–27.
29. Svenson, S. (2014). What nanomedicine in the clinic right now really forms nanoparticles?. Wiley Interdisciplinary Reviews: Nanomedicine and Nanobiotechnology, 6(2), 125-135.
30. Walczak ,Agata P. ; Fokkink, Remco ; Peters ,Ruud ; Tromp, Pete ; Rivera, Zahira E. Herrera ; Rietjens, Ivonne M.C.M.; Hendriksen ,Peter J.M. and Hans Bouwmeester.(2013). Behaviour of silver nanoparticles and silver ions in an in vitro human gastrointestinal digestion model.
31. Zhang, L., Gu, F. X., Chan, J. M., Wang, A. Z., Langer, R. S., & Farokhzad, O. C. (2008). Nanoparticles in medicine: therapeutic applications and developments. Clinical pharmacology & therapeutics, 83(5), 761-769.

32. Zhang ,Xi-Feng ; Liu, Zhi-Guo ; Shen, Wei and Gurunathan, Sangiliyandi (2016) Silver Nanoparticles: Synthesis, Characterization, Properties, Applications, and Therapeutic Approaches. September 2016 International Journal of Molecular Sciences 17(9):1534.