**ROLE OF NANOCARRIERS AND NANOSENSORS IN DRUG DELIVERY SYSTEM: A REVIEW**

**Dr Jayshree S. Thaware**

**Associate Professor in Botany**

**S.K.Porwal College, Kamptee-441002 Dist-Nagpur**

jsthaware@gmail.com

**Abstract-**

Nanotechnology has gained acceptance in several commercial enterprises, as it offers powerful and more innovative products. The implementation of nanotechnology in medicine and healthcare is referred to as nanomedicine. It has been used to combat some ordinary as well as chronic diseases.

Nanotechnology is the utilization of the distinctive properties of materials at the nanoscale. Nanotechnology has had a noteworthy impact in more or less all industries and areas of the communities as it provides strong and more reliable, guarded and cleaned, enduring and novel products for therapeutics, communication, daily life products, agriculture and more industries. Nanomaterials allow the mass production of products with increased usefulness, significantly cheap, and flawless mass produce processes, to improve healthcare and reduce the effect of formation of medicines. This present review provides the role of nanocarriers and nanosensors in drug delivery and discussed the recent development in nano-technology in the magnificent area of imaging and delivery of drugs in the body system.

**Keywords:** Nanocarriers, nanosensors, nanomedicine, diseases, drug delivery

**Introduction:**

Nanotechnology is the frontier research area of the twenty first century. With the support of some of the brightest minds in science and engineering, this emerging field of technologies is composed to manufacture tremendous things in drug industries.

Nanoscience is the investigation of the distinctive properties of materials between 1 100 nm, and nanotechnology is the implementation of such research to create or modify novel objects. Nanotechnology is the capacity to exploit structures at the atomic scale allowing for the creation of nanomaterials (Drexler, 1989 and 1986, Belkin et.al., 2015).

Nanoparticles get their name from their nanometer (nm) size (a billionth of a meter). Nanoparticles range from 1 to 100 nm, and recognize or permit them to be easily absorbed by cells. Thus, their use as the transporter of drugs (nanocarriers) has enlarged significantly in the past decade.

For nanoparticles to act as a drug delivery system, the drug has to be absorbed by the nanoparticles first. This step is critical, and there are several ways of achieving this; the drug can be adsorbed or covalently adhered to the nanoparticles surface or the drugs can be encapsulated in the nanoparticles.

Nanotechnologies manifest notable prospects in the field of medical science, including in imaging techniques and diagnostic tools, drug delivery systems, tissue-engineered setups, implants and pharmaceutical therapeutics and to promote treatments for many diseases (Filipponi, 2006; Lombardo et. al., 2019).

**What are Nanocarriers?**

Nanocarriers involved in drug delivery offer particular advantages when differentiate from standard and traditional treatments, allowing an increase in water solubility of somewhat or moderately soluble/insoluble drugs and shielding against degradation and deactivation (Din et. al., 2017). These attributes may provide increased solidity in comparison with conventional formulations. Further, the design of the nanocarriers involved in drug delivery facilitates the drug lingering in the bloodstream for an extended period, which holds up more methodological assemblage at the site of action (Chenthamara et. al., 2019, Halwani, 2022).

Nanocarriers are colloidal medicine carrier systems having submicron particle sizes typically, 500 nm. (Neubert, 2011). Nanocarriers have been significantly investigated in the past few decades as they showed great promise in the area of drug delivery. Nanocarriers, owing to their high surface area-to-volume ratio, can alter the basic properties and bioactivity of drugs. Improved pharmacokinetics and bio-distribution, lessen toxicities, enhanced solubility and stability, controlled release and site-specific delivery of therapeutic agents are some of the features that nanocarriers can incorporate into drug delivery systems (Mishra, et. al.2010 and How et. al., 2013).

Nanocarrier-based perspectives play a significant role in biomedical administration, especially, in drug delivery of chemotherapeutics. Adaptable modifications are brought together to get the better of conventional chemotherapy’s restriction and decrease the toxicity in different nanocarriers. The polymeric-based nanoparticles, magnetic nanoparticles, lipid-based carriers, dendrimers and quantum dots mediated drug delivery systems for anticancer agents that hold promising therapeutic outcomes. So based on the present review, the applications of these few important groups of nanocarriers in cancer drug delivery, drug targeting and cancer diagnosis. It might be suggested that the nanocarriers developed from the healthy cells-friendly biomaterials conjugated with tumour cell markers for the targeted and enhanced drug delivery at the site of action are better than the standard nanocarrier systems (Edis et. al. 2021).

**Types of nanocarriers**

**Types of Nanocarriers**

**Liposomes**

i)1st type of nanocarriers

ii) 80-300nm in size

iii) Spherical shape

iv) Made up of phospholipids

v) Manufactured spontaneously

**Polymeric micelle**

i) Obtained from synthetic polymer

ii) 10-100nm in size

iii) Separated into biodegradable and non biodegradable micelle

iv) Drug combined on exterior by polymerization

**Quantum dots**

i)Fluorescent semiconductor nanocrystals (1-100nm in size)

ii) Shell cored structure

iii) Due to optical properties and size, with high brightness and stability quantum dots used in Medical Imaging.

**Silica materials**

i) Drug loading via adsorption and drug release by diffusion

ii) Spark oxidative stress and production of reactive oxygen

**Dendrimers Nanocarriers**

i) Made up of core, dendrons and surface active groups

ii) Ligands attach to the surface of dendrimers

iii) Modifies the physical and chemical properties of dendrimers

**Solid lipid based nanoparticles**

i) Made up of nanostructure lipid carrier (NLC)

ii) And lipid drug conjugates (LDC)

iii) Provide physical stability and tolerability

iv) NLC and LDC are mergers of solid and liquid lipids to increase load capacity and reduces drug removal

**Carbon nanotubes (CNTs)**

i) Includes nanotubes and nanohorns

 ii) Surface modifications can be added to increase biocompatibility.

iii) High mechanical strength provides the support to other nanocarriers

iv) Drugs added by encapsulation, adsorption or attaching active agents

v) Drug released by physical or chemical conversions

**Delivery of nanocarriers to the target site**

The delivery of drugs to the target site can be attained via active or passive ways. Active methods tangled modifying the physical conditions, such as temperature, pH and magnetism to get the nanoparticles to particular regions. Passive methods involve modifying the vascular permeability and retention (EPR) parameters

The nanocarriers should not assemble in the cell for too long, as they could affect natural biological processes. However, smaller particles may be more reactive due to their increased surface area, and thus potentially more toxic.

  It is believed that in the coming time, the management of accurate doses of drugs with the highest systemic release from the nanocarriers and least toxic effects will not only intensify the use of nanocarriers systems for antitumor drug delivery but also upgrade /enhance patient compliance (Din et.al.2017).

**What are Nanosensors?**

Nanosensors are minute sensors that estimate very small changes in physical or chemical properties. They are used in drug delivery systems to monitor the concentration of drugs in a patient's bloodstream and to adjust the amount of drugs being transported. Nanosensors are also used in other applications, such as environmental monitoring, and biomedical sensing.

Nanosensors possess great potential for characteristic medicine, enabling early identification of disease without dependence on noticeable symptoms. Ideal nanosensor application/execution looks to imitate the response of immune cells in the body, integrating both diagnostic and immune reaction functionalities while passing on data to permit monitoring of the sensor input and response. This model remains a long-term goal, and research is currently focused on the instant distinctive abilities of nanosensors. The intracellular execution of nanosensors integration with biodegradable polymers induces signals that enable real-time monitoring and thus clear the way for progress or improvement in drug delivery and therapy (Yeo et.al.2015).

**Types of Nanosensors**

**Types of nanosensors**

**On used based**

1. Deployable nanosensors

2. Biosensors

3. Electrometers

4. Chemical sensors

**On the basis of energy source**

1. Active nanosensors, for which energy is required eg. Thermistor

2. Passive nanosensors, for which no energy is required eg. Piezoelectric and thermocouple sensors

**On structure based**

1. Electromagnetic nanosensors

2. Mechanical nanosensors

3. Optical nanosensors

To develop cleaver health care with nanosensors, a network of nanosensors, often called Nanonetworks, needs to be established to get the better of the size and power restriction of individual nanosensors. Nanonetworks not only reduce the existing challenges but also provide many developments and advances.

Recently, there have been extensive developments in the field of drug delivery systems to provide therapeutic agents or natural-based active compounds to their target location for the treatment of many diseases (Obeid et.al, 2017). There are several drug delivery systems beneficially employed in recent times, however, there are still certain challenges that need to be addressed and an up-to-date technology needs to be developed for the fruitful delivery of drugs to its recognized sites. Hence the nano-based drug delivery systems have now been studied that will ease the advanced system of drug delivery.

Nanoparticles can be changed in several ways to prolong circulation, enhance drug localization, increase drug efficacy and potentially decrease the development of multidrug resistance through the use of nanotechnologies (Sim and Wong, 2021). There is no doubt that nanotechnologies have helped to upgrade the quality of life of patients by providing a platform for advances in the biotechnological, healthcare and pharmaceutical industries. They have also facilitated healthcare courses of action, from diagnosis to therapeutic involvements and investigated monitoring (Agrawal and Prajapati, 2012).

**The potential risk of nanotechnology in the healthcare system**

Nanoparticles can dissolve in the body via: Inhalation, ingestion, absorption through the skin or injection during the medical course of action. Once nanoparticles have entered the body, their high mobility may allow them to cross the blood-brain barrier. Nanoparticles may influence the body's immune system by overloading the phagocytes. Swelling and stress reactions may be activated, weakening protection against other harmful challenges. They could interrupt the physiological and biological procedures in the body (Singh, 2018; Chandarana et. al., 2018 and Dreher, 2004) as enzyme regulatory mechanisms by adsorbing onto the surface of the cells or fluids they experience in characteristic to their large surface area.

**Conclusion**

A relatively new nano-drug and nanomedicine delivery system are rapidly developing science in which materials in the nanoscale range are working to distribute as a diagnostic tool or to act as an agent in therapeutic to specifically selected sites in a controlled manner. Multiple benefits in treating chronic human diseases by site-specific and target-oriented delivery of precise medicine are provided by Nanotechnology. Nanotechnologies are making a noteworthy contribution in this area through the development of novel modes for drug delivery, and some of these methods have proven effective in a clinical setting and are clinically used.

**REFERENCE**

Drexler K E (1989). Nanosystems: Molecular Machinery, Manufacturing, and Computation. John Wiley & Sons, New York, NY.

 Drexler K E: (1986). Engines of Creation: The Coming Era of Nano-technology. Anchor Books, Doubleday.

 Belkin A, Hubler A and Bezryadin (2015). A: Self-assembled wiggling nanostructures and the principle of maximum entropy production. Sci. Rep. 5: 8323.

Filipponi L and Nicolau DV (2006). Cell Patterning. Wiley Encyclopedia of Biomedical Engineering. John Wiley & Sons.

 Lombardo D, Kiselev MA and Caccamo MT (2019). Smart Nanoparticles for Drug Delivery Application: Development of Versatile Nanocarrier Platforms in Biotechnology and Nanomedicine.  J. Nanomater 12: 1 26.

Din, F.U., Aman, W., Ullah, I., Qureshi, O.S., Mustapha, O., Shafique, S. and Zeb, A. (2017). Effective use of nanocarriers as drug delivery systems for the treatment of selected tumours. Int. J. Nanomed.  12: 7291–7309.

 Chenthamara, D., Subramaniam, S., Ramakrishnan, S.G., Krishnaswamy, S., Essa, M.M., Lin, F.H., Qoronfleh, M.W. (2019). Therapeutic efficacy of nanoparticles and routes of administration. Biomater. Res.

 Halwani, A.A. (2022). Development of Pharmaceutical Nanomedicine: From the Bench to the Market. Pharmaceutics.  14:106.

Neubert RH (2011). Potentials of new nanocarriers for dermal and transdermal drug delivery. Eur. J. Pharm. Biopharm. 77(1):1–2.

 Mishra B, Patel BB, Tiwari S. (2010). Colloidal nanocarriers: a review on formulation technology, types and applications toward targeted drug delivery. Nanomedicine. 6(1):9–24.

 How CW, Rasedee A, Manickam S, Rosli R. (2013).Tamoxifen-loaded nanostructured lipid carrier as a drug delivery system: characterization, stability assessment and cytotoxicity. Colloids Surf. Biointerfaces. 112: 393–399.

Edis, Z., Wang, J., Waqas, M.K., Ijaz, M., Ijaz, M. (2021). Nanocarriers-Mediated drug delivery systems for anticancer agents: An overview and perspectives. International Journal of Nanomedicines. 16: 1313-1330.

Sim, S. and Wong, N.K. (2021). Nanotechnology and its use in imaging and drug delivery (Review). Biomedical Reports. 14: 42

<https://www.news-medical.net/life-sciences/Nanocarriers-for-Drug-Delivery.aspx>

Din, F., Aman, W., Ullah, I, Qureshi, O.S., Mustapha, O., Shafique, A. and Zeb, A. (2017). Effective use of nanocarriers as drug delivery systems for the treatment of selected tumours. International Journal of Nanomedicine, 12:7291-7309.

Yeo, David, Wiraja, Christian, Chuah, Yon Jin, Gao, Yu, Xu, Chenjie (2015). A Nanoparticle-based sensor platform for cell tracking and status/function assessment. Scientific Reports 5(1):14768.

Obeid MA, Al Qaraghuli MM, Alsaadi M, Alzahrani AR, Niwasabutra K, Ferro VA.(2017). Delivering natural products and biotherapeutics to improve drug efficacy. Ther. Deliv. 8: 947–56.

Agrawal, S. and Prajapati, R. (2012). Nanosensors and their Pharmaceutical Applications: A Review. International Journal of Pharmaceutical Sciences and Nanotechnology. 4 (4):1528-1535.

Singh P (2018). Impacts of nanotechnology on the environment (Review). Int. Arch. App. Sci. Technol. 9: 14 -16.

Chandarana M, Curtis A and Hoskins C (2018). The use of nanotechnology in cardiovascular disease. Appl.  Nanosci. 8: 1607 -1619.

Dreher KL(2004). Health and environmental impact of nanotechnology: Toxicological assessment of manufactured nanoparticles. Toxicol. Sci. 77: 3 -5.