International Journal of Engineering, Science and Mathematics
Vol. 5 Issue 4, December 2016,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

Nanoparticles: Miraculous Particles as Drug Carrier

Gajendra Gaur and Yogesh Kumar Sharma*
Department of Chemistry, Swami Shraddhanand College, University of Delhi, Alipur, New Delhi- 110036
*Corresponding Author: E-mail address: yogesh@ss.du.ac..in (Y.K.Sharma)

1. Introduction

Recently nano dimensional particles in the form of powder , crystal or clusters in which they have atleast one dimension less than 100nm attracted the attention of researchers [1-5]. Pharmaceutical drug delivery is now equipped with these nanodimensional carriers due to continuous efforts by scientists from all over the globe. The drug carriers in nanodimensions have been developed for example polymeric and lipidic, liposomal, dendrimers, micelles, nano emulsions and nano suspensions etc. Small size of these carriers provided potential to improve therapeutic index and also helped to make drugs safe, by modifying their ability by suitable ligands for targeting certain parts of human body, These drug carriers with drugs have been clinically employed for the treatment of several acute diseases [6]. Advantage of these nano carriers are ease in supply to human body i.e. oral, dermal, pulmonary and nasal etc. The drug carrier manoparticles are more relevent to the pharmaceutical industries.These are describe with the help of examples of commercially successful systems. In this review attention is given several factors of diseases where nano drug carriers proved to be far good compared to conventional forms [7]. Here we also discuss the different routes of administration

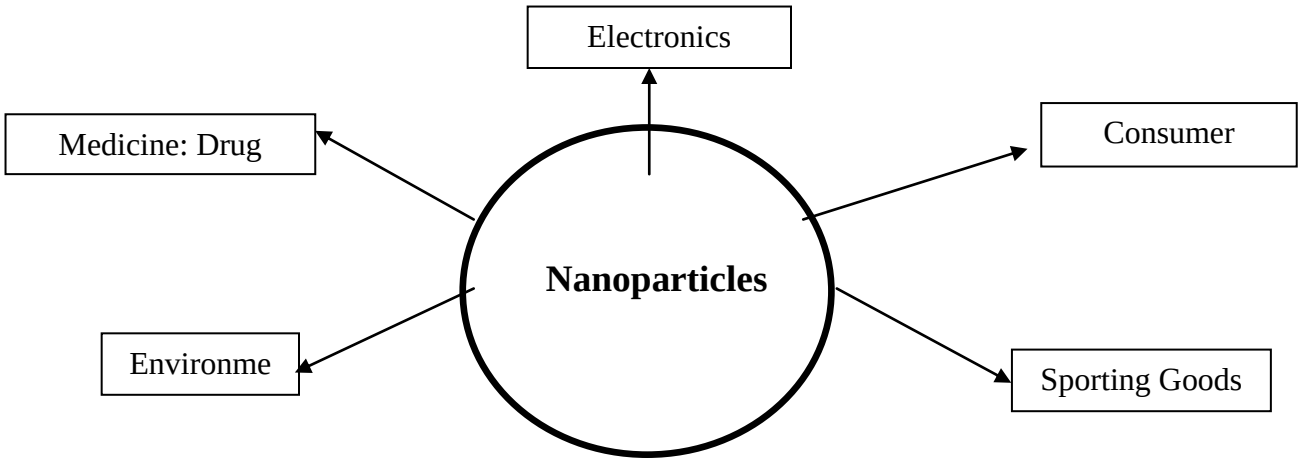


Fig.1: Schematic representation of major applications of nanoparticles.

International Journal of Engineering, Science and Mathematics
Vol. 5 Issue 4, December 2016,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

2. Target Drug Delivery: Drug delivery or transportation to the specific targeted site has a unique system which is explained well in Fig.2.

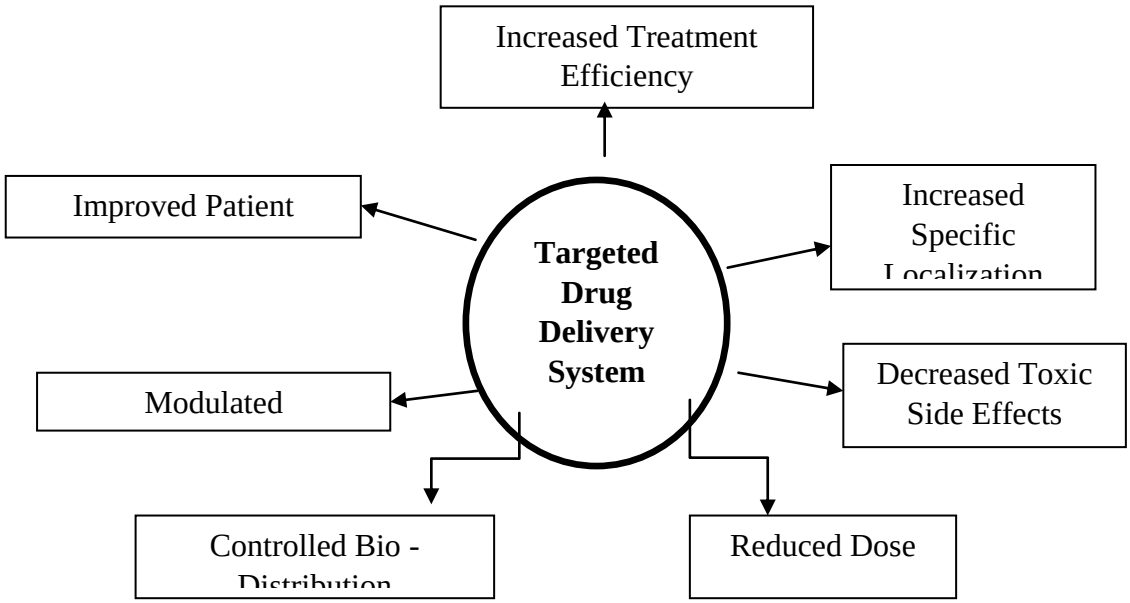
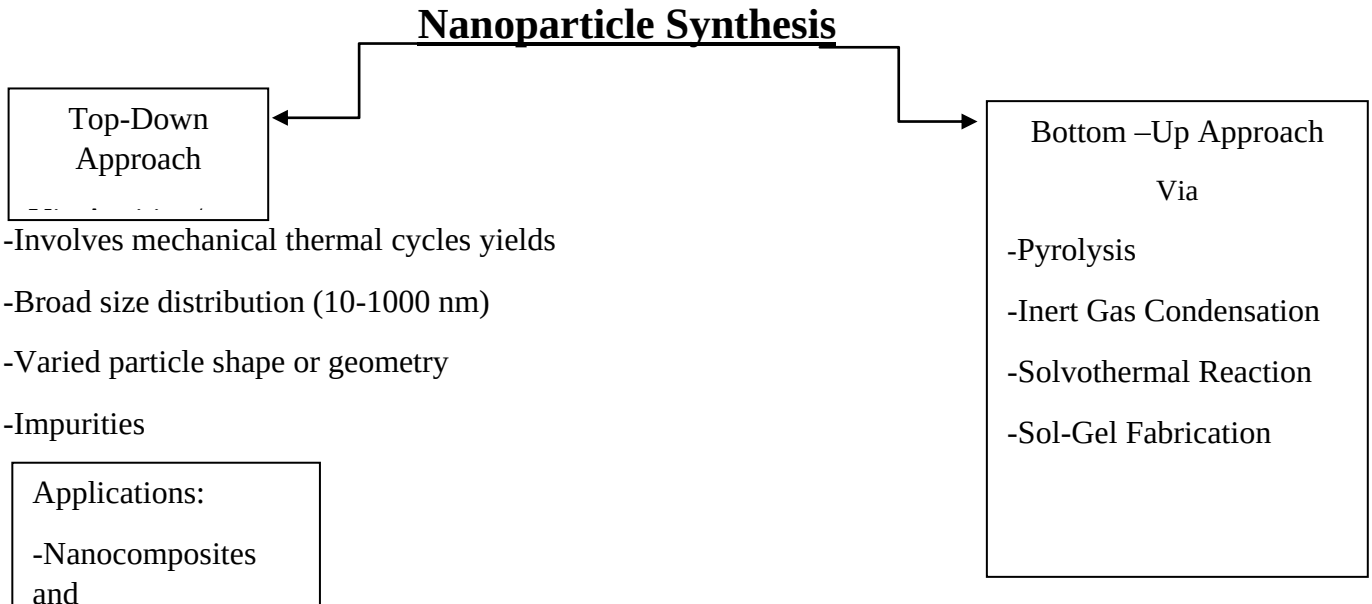


Fig.3: Schematic representation of targeted drug delivery system

3. Synthetic Methodologies for Nanoparticles:

By following simple representations one can easily understand how to synthesize nanoparticles in laboratory.



International Journal of Engineering, Science and Mathematics
Vol. 5 Issue 4, December 2016,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

3.1 (a) Nanoparticle Synthesis by Pyrolysis:

The chemical decomposition of organic compounds using heat is called as pyrolysis. It is the first step of gasification reaction. In absence of oxygen combustion take place and thus it is different from combustion in oxygen. As well as temperature rises also the rate of pyrolysis increases [8]. Generally for pyrolysis more than 430˚C temperature is being applied for industrial purposes, for small scale reactions a lower temperature is applied. For example, pyrolysis of charcoal produces biochar which is obtained by heating wood and coke is produced by heating coal. As a byproduct pyrolysis results with condensable liquids like tar and gases.

3.2 (b) Nanoparticle Synthesis by Inert Gas Evaporation:

The inert gas evaporation – condensation (IGC) method is recently developed by which nanoparticles were obtained by the evaporation of a metallic precursors using an inert gas. Also in the formation of carbon black this technique has been applied. The application of this technique is to produce of ultrafine nanoscalaed powders. In this technique evaporating a metallic precursor using temperature by radio frequency and by laser in a chamber at low pressure [9].

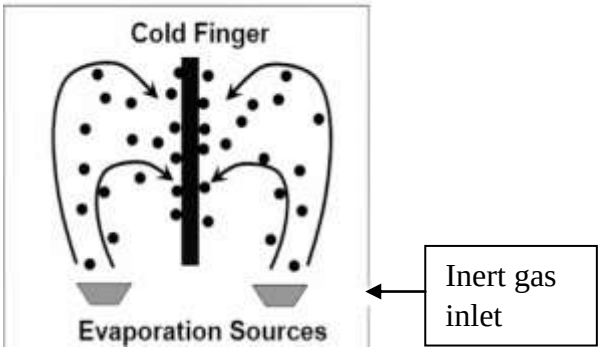


Fig.3: Schematic representation of inert-gas evaporation

Finally, nano dimensional particles may be collected on a cold surface. The nanoparticles obtained by this technique are having aggregate morphology and classified on the basis of the size of the crystal particles.

International Journal of Engineering, Science and Mathematics
Vol. 5 Issue 4, December 2016,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

3.3 (c) Nanoparticles Synthesis by Solvothermal Reaction:

A chemical reaction between precursors in a liquid solvent in a closed vessel at a higher temperature than the boiling temperature of solvent with high pressure [10]. Chemical compounds are formed in this reaction, this route is very similar to the hydrothermal route in which reaction takes place in a stainless steel autoclave or thermal bomb, only difference is the precursor solution . Solvothermal synthesis gives the benefits of both the sol-gel and hydrothermal routes and advantage is for the precise control over the size and shape allocation of metal oxide nanoparticles [11]. The properties of the products can be modified by changing certain experimental factors like reaction temperature, reaction time, solvent type, surfactant type and types of precursor.

3.4 (d) Nanoparticles Synthesis by Sol-Gel Assembly:

The method is used for the production of functional metal oxides especially the oxides of zinc, silicon and titanium. The mechanism is based on conversion of monomers into a colloidal solution [2, 12].

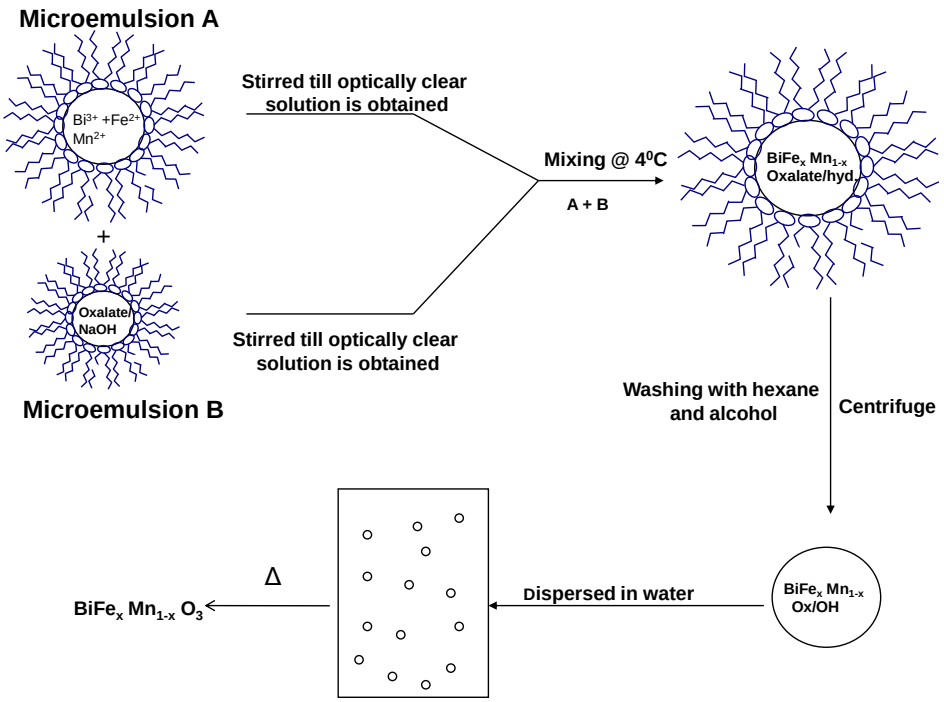


Fig.4 : Schematic representation of sol-gel technique applied to synthesize multiferroic nanoparticles by authors recently for innovation project SSNC-207.

3.5 Sol-Gel Synthesis of Nanoparticles Requires the Following Important Steps:

(i) Formation of stable sol solution
(ii) Gelation via a poly condensation or poly esterification reaction
(iii) Gel aging into a solid mass causes contraction of the gel network by Phase transformations and Ostwald ripening
(iv) Drying of the gel to remove liquid phases. Can lead to fundamental changes in the structure of the gel.
(v) Dehydration at temperatures as high as 800 degree Celsiusused to remove M-OH groups for stabilizing the gel, i.e. to protect it from rehydration.
(vi) Densification and decomposition of the gels at high temperatures (T > 800 degree Celsius) i.e. to collapse the pores in the gel network and to drive out remaining organic contaminants.

4. Mechanism of Transportation of Nanoparticles:

The targeted drug delivery is of two types i) active such as some antibody medications and ii) passive targeted drug delivery such as the enhanced permeability and retention effect (EPR-effect). Nanoparticles ability to aggregate in particular areas of a diseased tissue are helpful for targeted drug delivery (passive or active) [13].

4.1 Drug Delivery by Passive Targeting:

The successful drug transportation is directly related to circulation time with the nanoparticles with its coating. Very few substances are used to achieve this process i.e. polyethylene glycol (PEG). The addition of PEG to the solution of nanoparticle acts like hydrophilic and bind with water molecules via oxygen molecule on PEG making hydrogen bond. Resulting the bond in the form of film of hydration appear around the Nanoparrticle and substance becomes antiphagocytic [14]. Property due to the hydrophobic interactions that are natural to the reticuloendothelial system (RES) and nanoparticles with drug are possible to transport for a

certain long hours. It has veen observed that in passive targeting, nanoparticles of the size 10 and 100 nm circulate for longer periods of time [15].

4.2 Mechanism of Active Targeting:

The drug's transportation can also be achieved by utilizing magneto-liposomes, usually used as a contrasting material in magnetic resonance imaging (MRI). In this process, The liposomes with a potent drug to deliver to a part of the body and therefore magnetic positioning could aid with this [16]. A nanoparticle can have capability to be activated with drug to the target part of body or organ. The targeted drug carrier moves according to the pH of targeted part. Generally human body has neutral pH. Another targeted drug delivery is based on the redox potential. We know that reason to side effects of tumors is hypoxia, which change the redox potential and start the payload release the vesicles are selective to different types of cancers.

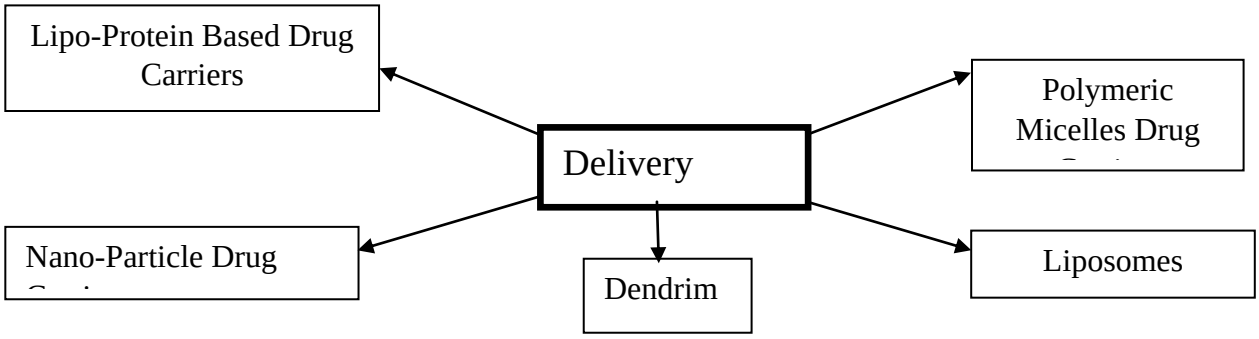


Fig.5: Schematic representation of various types of available drug carriers**.**

4.3 Transportation of Nanoparticles in the Lymphatic System and Blood:

The small size nanoparticles having suitable surface area so that they do not aggregate in capillaries (arteries and veins) may be carried in the blood circulation and enter the interstitial space where they may be internalized by cells in peripheral tissues. These nanoparticles may be retained inside the cells for a longer period of time [17].

4.4 Mechanism by which Miraculous Drug Nanocarriers Work:

Nanoparticles are known to target cancer cells by accumulation or by introducing itself in tumor cells generally known as passive targeting. This event is called as enhanced permeability and the retention effect by leaky angiogenetic vessels and poor lymphatic drainage. When nanoparticles in the bloodstream reach cancer cells then due to lower pH dissociate the polyethylene glycol (PEG) molecule and thus revealing a tumor-targeting antibodies Y-shaped threads in Figure and Gemini quaternary ammonium groups black strands in Figure 6. These two groups help the particles to penetrate cancer cells [18].

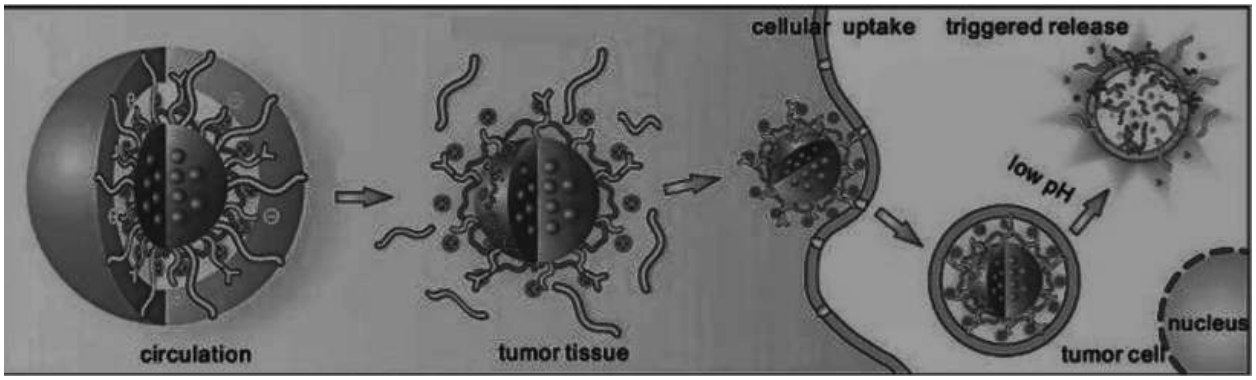


Fig. 6: Schematic representation of mechanism by which multi block polymer nanoparticles attack tumors.

5. Summary:

Research of drug delivery through nanoparticles includes:

- More specific drug targeting and delivery
- Reduction in toxicity while maintaining therapeutic effects
- Greater safety and biocompatibility and faster development of new safe medicines

6. ACKNOWLEDGEMENTS

Authors are thankful to University of Delhi for granting Innovation Project SSNC-207 and Swami Shraddhanand College, University of Delhi for providing necessary infrastructure .

REFERENCES:

[1] Hari Singh Nalwa,Handbook of Nanostructured Materials and Nanotechnology, Five-Volume Set, Academic Press **(1999)**.

[2] C. N. R. Rao, J. Gopalakrishnan, New Directions in Solid State Chemistry, 2nd edition, Cambridge University Press **(1997)**.

[3] S. Svenson, R. K. Prud'homme, Multifunctional Nanoparticles for Drug Delivery Applications: Imaging, Springer **(2012)**.

[4] Akira Tsuda, Peter Gehr, Nanoparticles in the Lung: Environmental Exposure and Drug Delivery, Taylor & Francis **(2014)**.

[5] Tianmeng Sun, Yu Shrike Zhang, Bo Pang, Dong Choon Hyun, Miaoxin Yang, Younan Xia, Engineered Nanoparticles for Drug Delivery in Cancer Therapy, Angewandte Chemie **(2014).**

[6] Wooram Park, Kun Na, Advances in the Synthesis and Application of Nanoparticles for Drug Delivery, WIREs Nanomedicines and Nanobiotechnology, Willey **(2015)**.

[7] Rochelle R. Arvizo, Sanjib Bhattacharyya, Rachel A. Kudgus, Karuna Giri, Resham Bhattacharya, Priyabrata Mukherjee, Intrinsic Therapeutic Applications of Noble Metal Nanoparticles: past, present and future, **Chem. Soc. Rev., 41**, 2943-2970 **(2012)**.

[8] Kalyana C. Pingali, Shuguang Deng, David A. Rockstraw, Synthesis of Nanowires by Spray Pyrolysis, Journal of Sensors **(2009)**.

[9] Panagiotis Grammatikopoulos, Stephan Steinhauer, Jerome Vernieres, Vidyadhar Singh and Mukhles Sowwan, Nanoparticle Design by Gas-Phase Synthesis, Advances in Physics, 81–100 **(2016)**.

[10] Elvin R. Beach, Krenar Shqau, Samantha E. Brown, Steven J. Rozeveld, Patricia A. Morris, Solvothermal Synthesis of Crystalline Nickel Oxide Nanoparticles, Materials Chemistry and Physics, 115, 371-377 **(2009)**.

[11] S.-H. Feng, G.-H. Li, Chapter 4 - Hydrothermal and Solvothermal Syntheses, Modern Inorganic Synthetic Chemistry (Second Edition), Elsevier , 73-104 **(2017).**

[12] M. Khan, A. Ansari, M. Hameedullah, Sol-gel Synthesis of Thorn-Like ZnO Nanoparticles Endorsing Mechanical Stirring Effect And Their Antimicrobial Activities: Potential Role As Nano-Antibiotics. Sci Rep 6, 27689 **(2016)**.

[13] M. Azzah Bannunah, Driton Vllasaliu, Jennie Lord, Snjezana Stolnik, Mechanisms of Nanoparticle Internalization and Transport Across an Intestinal Epithelial Cell Model: Effect of Size and Surface Charge, Mol. Pharmaceutics 11, 12, 4363–4373 **(2014)**.

[14] V.P. Torchilin , Passive and Active Drug Targeting: Drug Delivery To Tumors As An Example. Handb Exp Pharmacol.,197, 3-53 **(2010)**.

[15] H Ye, X Chu, Z Cao, X Hu, Z Wang, M Li, L Wan, Y Li, Y Cao, Z Diao, F Peng, J Liu, L Xu., Int. J. Nanomedicine, 16, 1051-1066 **(2021).**

[16] CH Choi, CA Alabi, P Webster, ME Davis, Mechanism of Active Targeting In Solid Tumors With Transferrin-Containing Gold Nanoparticles, Proc Natl Acad Sci U S A. 107 (3), 1235-40 **(2010).**

[17] S. Behzadi, V. Serpooshan, W Tao, Cellular Uptake of Nanoparticles: Journey Inside The Cell, Chem. Soc. Rev.; 46 (14), 4218-4244 **(2017)**.

[18] J.W. Nichols, Y.H. Bae Odyssey of A Cancer Nanoparticle: From Injection Site To Site of Action. Nano Today, 7 (6), 606-618 **(2012)**.