Review On Novel Drug Delivery System.

Authors : Vedant Chimote, Vidya Karhale

Abstract :

Pharmaceutical research has grown with the help of science and technology, especially in developing new ways to deliver oral drugs. Traditional methods often use tablets, but pills can lead to problems like poor absorption, the need to take them often, unwanted side effects, and patients not taking their medicine as directed. Because of this, researchers have started looking for better alternatives to traditional drug delivery systems. One popular approach is the use of rapid dissolving drug delivery systems, which are especially useful for both older adults and children. Some medications work best at certain concentrations, and if the drug levels are too high or too low, it can be harmful or not effective at all. To help prevent the drug from breaking down too quickly, new delivery and targeting methods are being developed. These methods aim to keep more of the drug in the right area of the body, reduce side effects, and improve how well the drug is absorbed. Companies in the pharmaceutical industry are creating new drugs and delivery methods to give patients treatments that are more effective and have fewer side effects. New drug delivery systems act as carriers that keep drug levels within the right range for longer, and can also help move the medicine to the exact area where it's needed.

Keywords :

Drug Delivery Systems, Bioavailability, Therapeutic agents,Drug, Therapeutic Dose, Pharmacological effect.

Introduction :

The new system has made significant progress in our understanding of Pharmacokinetic and Drug Delivery Systems, which are innovative. The drug's pharmacodynamic behavior offers a more logical way to develop the most effective drug delivery methods. The new drug delivery system (NDDS) uses carriers that help maintain therapeutic drug levels for longer periods of time.[1]

New ways of giving medicine offer better options to improve how well the body absorbs the drug, where it goes in the body, how it is released over time, and how stable the drug remains. Examples of these methods include micro-needle patches, liposomes, nanoparticles, and devices that can be implanted.[2]

The phrase "novel drug delivery system (NDDS)" is often used when talking about developing new drugs. The term "novel drug delivery system" (NDDS) mainly refers to creating new ways to deliver medicine that have better features, such as smaller particle size and better permeability. These systems allow medicines to reach specific areas of the body more effectively. When biotherapeutic agents are delivered using NDDSs, they can work better than when they are given in traditional forms.

Compared to the usual ways of giving medicine,

New drug delivery systems have several advantages.

The way medicine is delivered, as explained below, shows these benefits.[3,4]

1 . Over a long time, the best amount of medicine in the blood or in a part of the body can be kept at the right level.

2 . The time it takes for the medicine to work is set in advance, helping it stay effective longer.

3 . The medicine can be made to stay in the body longer even if it breaks down quickly.

4 . By focusing on where the medicine works, unwanted side effects can be reduced.

5 . Less of the medicine is wasted, so it can be given less often.

6 . Patients are more likely to take their medicine regularly.

Novel Drug Delivery System [5,6]

Rate by providing a continuous or prolonged (zero-order) release, respectively, at therapeutically effective concentrations in the bloodstream.

• Rate-limiting drug release near the target site allows for localized drug administration devices to deliver the drug's effect.

• By modifying the release of drug molecules through system design, you can determine the rate of drug delivery to provide the desired drug action.This regulates the molecular diffusion of drug molecules throughout the body.

•Targeted medication delivery uses carriers either for passive or active diffusion or a base to provide drug action.A self-programmed method, typically used with appropriate sensory equipment that can identify its receptor at the targeted location.

A carrier-based drug delivery system involves putting drug molecules into polymeric and/or vesicular structures like polymeric micelles, liposomes, dendrites, and other smart nano systems. These are examples of nanoparticles (NPs).[7] The focus of the discussion is on creating a nano system that has excellent qualities, like the ability to carry more medication. The main goals for designing this delivery system include having a large capacity, small particle size between 50 and 300 nanometers, and a controlled way of releasing the medication.[8] A successful pharmaceutical product.The word "SMART" means the Nano carrier drug delivery system can release the medication when it senses certain body signals.
This allows the drug to be delivered slowly and consistently to the specific cells or tissues that need it.[9]

Mechanisms Of Nano Carrier Transport Throughout The Systemic Circulation Reaching The Specific Target

1 . Passive Targeting

The main way a colloidal nano system reaches a target area through increased permeability is called passive targeting, which is also known as the EPR effect. A lot of research has already looked into the EPR effect. These studies have shown that how many blood vessels are present and how well the lymphatic system drains fluid at the target site greatly influences the EPR effect. By increasing blood vessel leakage and reducing lymphatic drainage, the EPR effect can be enhanced, leading to better accumulation of nanoparticles at the target location.[10]
Carriers in targeted tissues. Luckily, there's been a major improvement. The EPR effect helps improve delivery of noncolloidal systems to tumors or cancerous tissues for a few key reasons. One major challenge with drug delivery through passive diffusion or convection is the lack of site specificity. Also, blood vessels in these tissues are more leaky compared to healthy tissue. This lack of selectivity can lead to various side effects and make medications less effective over time.[11] Some strategies to deal with this challenge include:
To make colloidal nano systems that can actively and specifically bind to targets, new methods have been created.
One such approach is active targeting [12], which helps in identifying and binding to specific cells after they have moved out of blood vessels.

2 . Active targeting

Active targeting is a complex technique used to ensure that SMART Nano is selective and specific. Targeting antitumor drugs directly to cancerous tissue is now the main way to reduce the harmful effects of the medication. However, the active targeting method might still affect healthy tissues. When making the SMART noncolloidal system, it's important to consider the functionalization process for targeting. The carrier's surface is coated with ligands that attach to specific receptors on the target cell. This ligand-receptor connection helps deliver the Nano system efficiently to the diseased cells instead of the surrounding healthy tissue.[13]

The ligand is attached to the surface of the Nano.Nucleic acids, antibodies, or parts of these molecules are some of the types that can be grouped into this system.These ligands connect to their specific receptors, which are present in large numbers.This method also helps the particles enter tumor cells more effectively, as they target the cell surface where they are concentrated.[14] Endocentric pathway.

The drug delivery is mainly affected by the surface of the targeted cell.

The ligand has a strong binding ability to the receptor, which is present in higher amounts on these cells. After the ligand attaches to the receptor, there are two possible ways the nano system might work.

First, it could start releasing some of the drug it's carrying near the target cells, acting like endocytosis. This process can take in either the whole nano system or just the drug that's slowly being released. The drug starts to come out inside the cell.

The second method Using SMART NPs as a way to carry drugs has become more common recently. This method helps in delivering drugs effectively into cells, especially for cancer treatment. To make the drug target the right cells, specific ligands are added to the surface of the SMART NPs for active targeting.

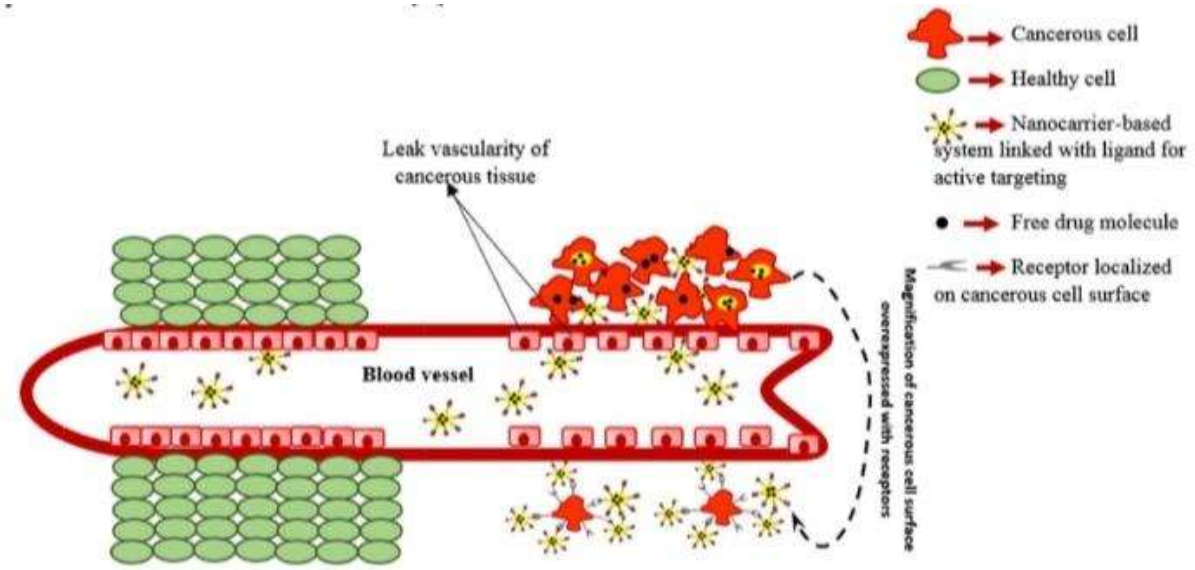

Fig. no 1 : Approaches Of Nanosystem Transport Passive And Active Targeting.

3 . Responsive To Stimulate Targeting

This targeting method is fairly new and is still under study because several issues have been found along the way. Its actual use is still being explored. The main idea behind this approach is that smart nanosystems start releasing their drug once they come into contact with an external trigger. These triggers can include things like changes in pH, temperature, or other environmental factors, such as a magnetic or electric field, ultrasound, or light.[15,16,17]

To use this technique effectively, one or more parts of the nanosystem should react to these triggers.

The benefits of targeting based on stimuli include:

improving how well the nanosystem mixes with target cells and helps them stick to the cells.

•Monitoring the release of the medicine [18],

•causing fewer unwanted side effects [9],

•ensuring effective drug distribution throughout the tumor [19], and improving the bioavailability of certain hydrophobic class II and IV chemotherapeutic drugs.[9]

Types Of Nano Carrier Based Drug Delivery System

Liposomes

Liposomes have a structure with inner and outer parts that interact differently with drug molecules. A liposome is made up of one or multiple layers of phospholipids arranged in a bubble-like shape. The middle part of this bubble has a stronger ability to hold onto water-soluble drugs, while oil-soluble drugs are placed in the outer area between the layers of phospholipids.[20]

Liposomes come in different types, including noisomes, phytosomes, ethosomes, and transferomes. They form when nonionic surfactants are used, and there's not much or no phospholipid present. Since niosome transferomes have a single chain, they are believed to be more flexible and elastic than other types of liposomes. A surfactant that acts as an edge activator is involved. When ethanol is a main component in making liposomes, ethosomes are formed.[21]The active ingredient is surrounded by phospholipids, and they are called phytosomes.[22]
Some medicines come from plants or are made from natural herbs. Liposomes have a round, bubble-like shape. They are becoming a popular way to package different kinds of biotherapeutic drugs, which can have many different chemical properties and complex shapes. Liposomes can hold various types of peptides and proteins, which makes them helpful for making vaccines and delivering cancer treatments.[23]
In recent years, immunoliposomes have been used because antibodies can be attached directly to the surface of the liposomes or through other methods, such as covalent bonding with the polyethylene glycol (PEG) chain in PEGylated liposomes.

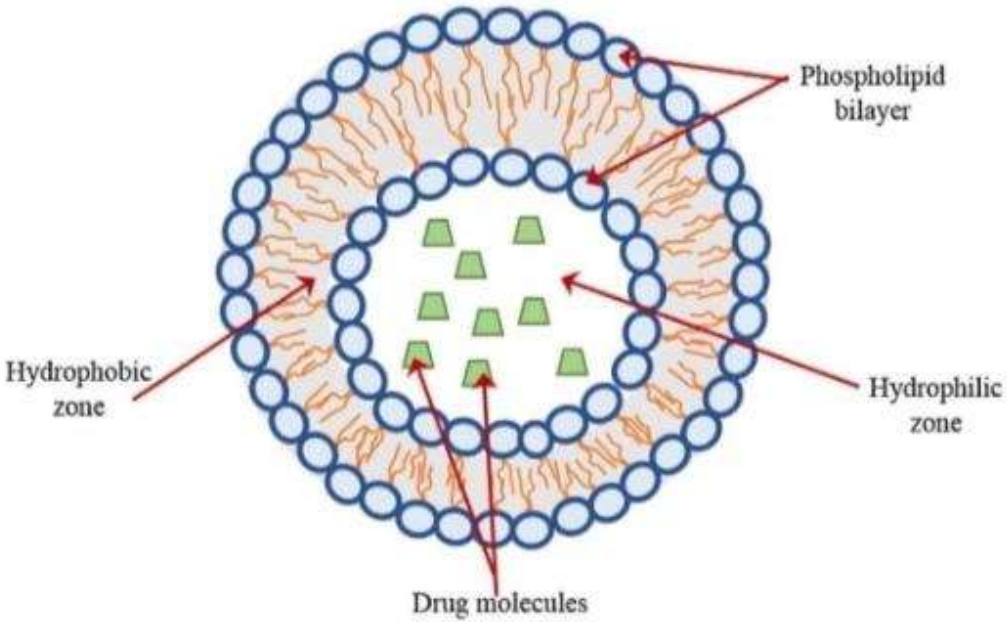

Fig. no 2 : Basic Structure Of Classical Unilayered Liposome.

Polymeric Micelles

Polymeric micelles are made up of a central part that doesn't mix with water and an outer layer that does mix with water. The part that doesn't mix with water is good for holding medicines that aren't soluble in water. The way this works is that the outer layer helps hide the micelle from the body's defenses. This hiding is called the Stealth effect. The Stealth effect lets the micelle move through the blood without being picked up by the immune system's cells, which reduces the chance of an immune reaction.

Dendrimers

The less common type of carrier-based nano system is called a dendrite. It is different from most vesicular systems. Its three-dimensional structure has a central core and a surrounding area. This outer part is made up of tightly packed, hyper-branched chains that look like a tree. These chains can be built using dendritic units that are arranged in a symmetrical way. Additional modifications, such as adding targeting ligands, can be made. These modifications are used in diagnostics [24] by linking them to imaging agents or by creating "SMART" dendrimers.[25] Dendrimers are macromolecules that are either nanoscale or microscale and have a uniform structure. The central part of dendrimers, known as the core cavity, can hold different types of molecules. Based on the properties of their building blocks, dendrimers can be either water-loving (hydrophilic) or oil-loving (lipophilic). Dendrimers can be classified into several types, including peptide dendrimers, chiral dendrimers, tecto dendrimers, and amphiphilic dendrimers, each category determined by

their specific structure. [25]. In recent times, dendrimers have been used for delivering genetic material and improving the efficiency of gene transfer.

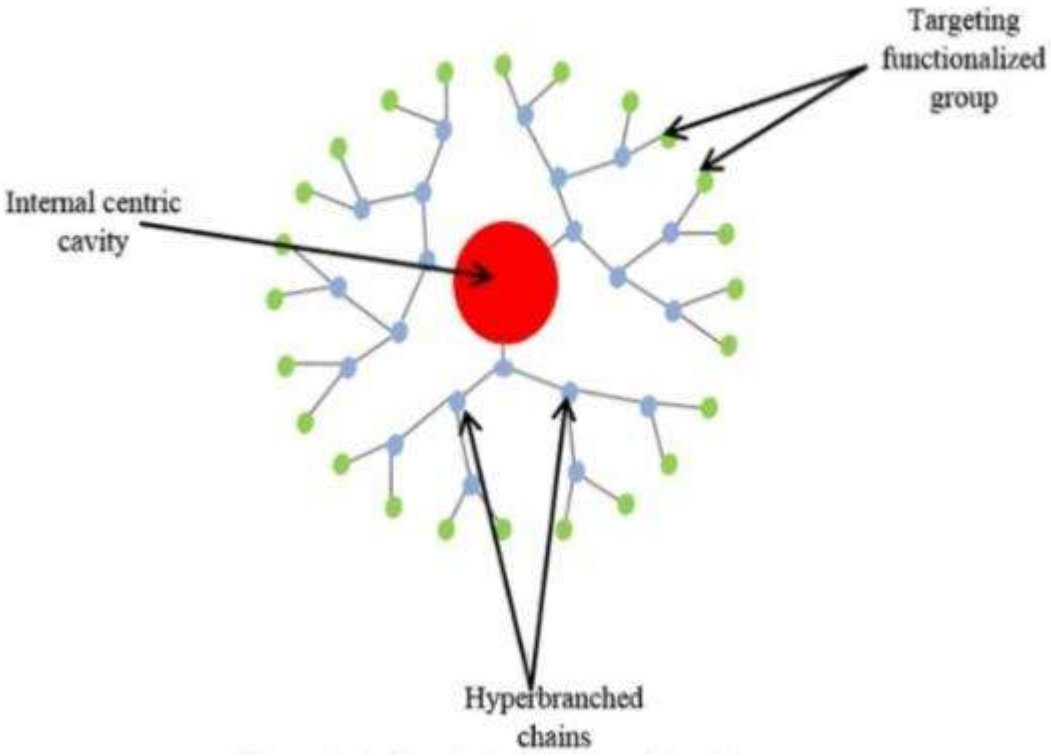

Fig.no 3 : Classical Structure Of Dendrimers.

Nanoparticles.

There are many different kinds of nanomaterials with various shapes, which are grouped into several types of nanoparticles, such as nanocapsules, nanospheres, nanopores, and nano shells. These materials have a particle size that ranges from 20 to 250 nanometers. The drug molecule can be placed inside the inner part of polymeric nanoparticles, or in some cases, it can be released. It may also stick to the surface of the nanoparticles, leading to a quick release of the drug right after it is given.[26,27]

Polymeric materials such as polylactic-co-glycolic acid (PLGA) and its variants like PLGA-PEG-PLGA or PEG-PLGA-PEG are commonly used to make nanoparticles. These materials are safe for the body and can break down naturally. They are widely used in do nanoparticles [21]. Moreover, special groups can be added to the surface of these nanoparticles. These groups can connect with specific receptors on the cell membrane. This helps the nanoparticles be taken up more efficiently by the target cells and reduces their effect on healthy cells nearby.

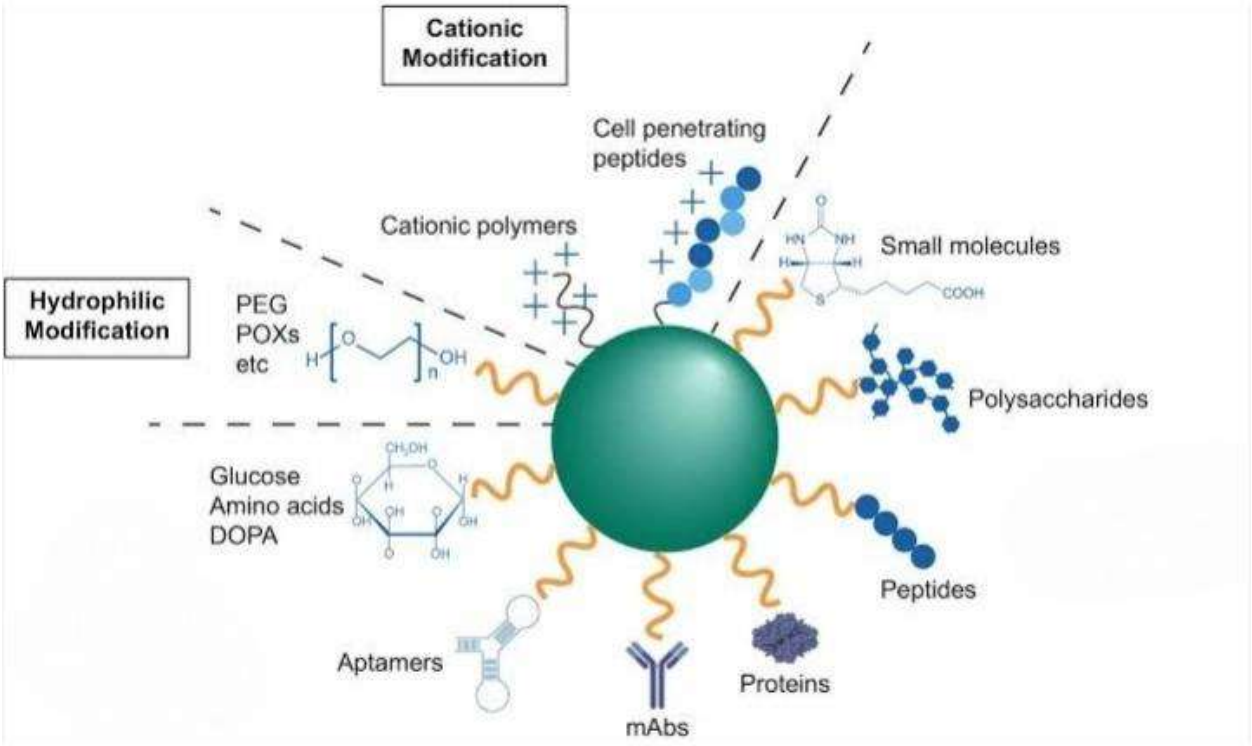

Fig.no 4 : Structure Of Nanoparticle

For Cellular Targeting

The first step is to modify the surface of SMART NPs with specific groups to help target cells. These targeting ligands then attach to receptors on the cell surface, allowing the NPs to reach their intended destination.
Another approach is to wrap anticancer drugs in pH-sensitive polymers.
Once these drugs reach the cancerous cells, the acidic environment causes the polymer to break down, releasing the medication freely inside the cell.
The third method uses polymers that carry a strong positive charge, which helps them attract and bind to infected cells.[28]

Smart extended release drug delivery system

Controlling how medications are released from standard dosage forms has been a focus of discussion to reduce the need for frequent dosing and help patients stick to their treatment plans. Many pharmaceutical techniques, such as floating systems and dissolution matrix or reservoir approaches, have been developed for this purpose.[29,30] and diffusion Matrix [31,32]
In this area, osmotic systems [34] and [33] have been developed, but they come with several drawbacks.

These issues were found after the systems were used clinically, such as:

1 . Being easily broken down during the first pass through the body.

2 . High costs to produce.

3 . Difficulty in handling drugs that have a large molecular size or are not very soluble.

4 . Causing irritation in the gastrointestinal tract.

The importance of new ways to give medicine.

1 . Medicines work better when delivered in new ways.

2 . Patients experience fewer unwanted side effects.

3 . Medicines stay effective for longer periods.

4 . Medicine can be delivered directly to the area that needs it.

5 . The release of medicine can be controlled over time.

6 . More of the medicine reaches the body where it's needed.

7 . These methods make it easier to create and improve new medicines.

Application

New technology has many potential uses in the fields of medicine and pharmaceuticals. These systems help improve patient care by ensuring that patients take their medication correctly, making treatments more effective and helping to avoid unwanted side effects. Here are some important ways these methods of drug delivery are used:

1 . Targeted Drug Delivery:

This is one of the most important new drug delivery systems. These systems deliver medicines directly to a specific part of the body, such as a particular organ or a tumor. This allows for local treatment, reducing the amount of medicine that enters the bloodstream and helping to avoid harmful side effects.

2 . Controlled Release:

New methods allow medications to be released slowly and steadily over a set period of time. This ensures that the right amount of medicine is available at the right time, making the treatment more effective. Controlled release also means patients don't have to take their medicine as often, making it easier for them to follow their treatment plan.

3 . Personalized Medication:

Drug delivery systems can be tailored to each patient's specific needs. This allows for individualized treatment, where medicines are delivered in a way that enhances their benefits and reduces unwanted side effects based on the patient's unique situation.

4 . Managing Chronic Diseases:

These systems help manage long-term illnesses by delivering medication over a long period. This reduces the need for frequent dosing and makes it easier for patients to stick to their treatment plans.

5 . Combination Therapies:

New delivery methods can be used to give multiple medications at the same time or in sequence. This allows for combination treatments where different medicines work together, often improving results, especially in treating complex or resistant diseases.

6 . Cellular and Gene Therapy:

These methods play a big role in treating diseases at the genetic and cellular level. They can deliver genetic material or cells to specific areas of the body. This helps in effective, targeted treatment, and also protects the genetic material or cells from being broken down and helps them reach the right cells more efficiently.

7 . Vaccines:

New delivery methods can also be used in making and giving vaccines. These systems can make vaccines more stable, help the body better recognize the vaccine, and ensure that vaccine components are released over time. This leads to a stronger immune response and better protection against infectious diseases.

8 . Transdermal Delivery:

Medicines can be delivered through the skin using patches and similar methods. This allows the medicine to be absorbed into the bloodstream without going through the digestive system. This is especially helpful for medicines that are not very effective when taken by mouth.

Conclusion :

A smart nanotechnology that can do many things and targets multiple ways. Because it releases medicine slowly over time, the new drug delivery system is more precise, has fewer side effects, is more effective, and is easier for patients to follow. This system uses new ways to give medicine and advanced methods that work better than usual forms. The new drug delivery system has many benefits, like giving the right amount of medicine at the right time and place, using medicine more efficiently, and making medicines more expensive but also cheaper to make. This helps patients feel better, be more comfortable, and enjoy a better quality of

life. Examples of these new ways to deliver medicine include targeted drug delivery and controlled drug delivery systems.

References :

1 . Roop k khar, s.p vyas, farhan J ahmed, gaurav k jain "the theory and practice of industrial pharmacy "4th edition lachman's/lieberman's cbs distributors, 2013; 872, 902, 905, 943.

2 . Lordi, N.G. Sustained release dosage forms. In: Lachman, L., Lieberman, H.A. and Kanig, J.L. (eds.) The theory and practice of industrial pharmacy, 3rd edn (Indian edn). Varghese Publishing House, Bombay, 1987; 430–456.

3 . Charman w.n, chan k, finnin BC & chairman SA drug delivery: a key factor in realising the full therapeutic potential of drug. Drug development research, 1999; 46: 316-27.

4 . Santini JT, Richards Ac, scheidt R, cima MJ and longer R. Microchips as controlled drug delivery devices angew chem. Int. Td, 2000; 39: 23, 96-407.

5 . Santini JT, Richards Ac, scheidt R, cima MJ and longer R. Microchips as controlled drug delivery devices angew chem. Int. Td, 2000; 39: 23, 96-407.

6 . Kopeek J. Smart & genetically engineered biomaterials & drug delivery systems. European journal pharmaceutical science, 2003; 20: 1-16.

7 . R. R. Bhagwat, I. S. Vaidhya, Novel drug delivery systems: an overview, Int. J. Pharm. Sci. Res. 4 (2013) 970—982.

8 . C. C. Mu¨ller-Goymann, Physicochemical characterization of colloidal drug delivery sys- tems such as reverse micelles, vesicles, liquid crystals and nanoparticles for topical administration, Eur. J. Pharm. Biopharm. 58 (2004) 343—356. Available from: https:// doi. org/10. 1016/j. ejpb. 2004. 03. 028.

9 . K. Bajwa, B. Qorri, A. Decarlo, M. R. Szewczuk, Recent advances in "smart" delivery systems for extended drug release in cancer therapy, Int. J. Nanomed. 13 (2018) 4727—4745.

10 . Y. H. Bae, K. Park, Targeted drug delivery to tumors: myths, reality and possibility, J. Control. Release. 153 (2011) 198—205.

Available from: https://doi. org/10. 1016/j. jconrel. 2011. 06. 001.

11 . C. Pathak, F. U. Vaidya, S. M. Pandey, Mechanism for development of nanobased drug delivery system, Appl. Target. Nano Drugs Deliv. Syst. , Elsevier Inc, 2019, pp. 35—67. Available from: http://doi. org/10. 1016/b978-0-12-814029-1. 00003-x.

12 . D. Peer, J. M. Karp, S. Hong, O. C. Farokhzad, R. Margalit, R. Langer, Nanocarriers as an emerging platform for cancer therapy, Nat. Nanotechnol. 2 (2007) 751—760. Available from: https://doi. org/10. 1038/nnano. 2007. 387.

13 . C. Pathak, F. U. Vaidya, S. M. Pandey, Mechanism for Development of Nanobased Drug Delivery System, Elsevier Inc, 2019.
Available from: http://doi. org/10. 1016/b978-0-12- 814029-1. 00003-x.

14 . F. Danhier, O. Feron, V. Pre´at, To exploit the tumor microenvironment: passive and active tumor targeting of nanocarriers for anticancer drug delivery, J. Control. Release. 148 (2010) 135—146. Available from: https://doi. org/10. 1016/j. jconrel. 2010. 08. 027.

15 . X. Li, M. R. Szewczuk, C. Malardier-Jugroot, Folic acid-conjugated amphiphilic alter- nating copolymer as a new active tumor targeting drug delivery platform, Drug Des. Devel. Ther. 10 (2016) 4101—4110. Available from: https://doi. org/10. 2147/DDDT.
S123386.

16 . V. P. Torchilin, Multifunctional, stimuli-sensitive nanoparticulate systems for drug delivery, Nat. Rev. Drug Discov. 13 (2014)

813—827. Available from: https://doi. org/ 10. 1038/nrd4333.

17 . H. Priya James, R. John, A. Alex, K. R. Anoop, Smart polymers for the controlled deliv- ery of drugs — a concise overview, Acta Pharm. Sin. B. 4 (2014) 120—127. Available from: https://doi. org/10. 1016/j. apsb. 2014. 02. 005.

18 . X. Li, M. McTaggart, C. Malardier-Jugroot, Synthesis and characterization of a pH responsive folic acid functionalized polymeric drug delivery system, Biophys. Chem. 214—215 (2016) 17—26. Available from: https://doi. org/10. 1016/j. bpc. 2016. 04. 002.

19. J. Du, L. A. Lane, S. Nie, Stimuli-responsive nanoparticles for targeting the tumor microenvironment, J. Control. Release. 219 (2015) 205—214. Available from: https:// doi. org/10. 1016/j. jconrel. 2015. 08. 050.

20 . X. Li, D. Chen, C. Le, C. Zhu, Y. Gan, L. Hovgaard, et al. , Novel mucus-penetrating liposomes as a potential oral drug delivery system: preparation, in vitro characteriza- tion, and enhanced cellular uptake, Int. J. Nanomed. 6 (2011) 3151—3162.

21 . C. K. Sudhakar, S. Jain, R. N. Charyuliu, A comparison study of liposomes, transfer- somes and ethosomes bearing lamivudine, Int.
J. Pharm. Sci. Res. 7 (2016) 4214—4221. Available from: https://doi. org/10. 13040/IJPSR. 0975-8232. 7(10). 4214-21.

22 . M. Lu, Q. Qiu, X. Luo, X. Liu, J. Sun, C. Wang, et al. , Phyto-phospholipid complexes (phy- tosomes): a novel strategy to improve the bioavailability of active constituents, Asian J. Pharm. Sci. 14 (2019) 265—274. Available from: https://doi. org/10. 1016/j. ajps. 2018. 05. 011.

23 . V. Nekkanti, S. Kalepu, Recent advances in liposomal drug delivery: a review, Pharm. Nanotechnol. 3 (2015) 35—55. Available from: https://doi. org/10. 2174/2211738503666150709173905.

24 . S. Svenson, D. A. Tomalia, Dendrimers in biomedical applications-reflections on the field, Adv. Drug Deliv. Rev. 57 (2005) 2106—2129. Available from: https://doi. org/ 10. 1016/j. addr. 2012. 09. 030.

25 . A. K. Patri, J. F. Kukowska-Latallo, J. R. Baker, Targeted drug delivery with dendrimers: comparison of the release kinetics of covalently conjugated drug and non-covalent drugInclusion complex, Adv. Drug Deliv. Rev. 57 (2005) 2203—2214. Available from: https://doi. org/10. 1016/j. addr. 2005. 09. 014.

26 . D. H. Abdelkader, S. A. El-Gizawy, A. M. Faheem, P. A. McCarron, M. A. Osman, Effect of process variables on formulation, invitro characterisation and subcutaneous delivery of insulin PLGA nanoparticles: an optimisation study, J. Drug Deliv. Sci. Technol.
43 (2018) 160—171. Available from: https://doi. org/10. 1016/j. jddst. 2017. 10. 004.

27 . D. H. Abdelkader, M. A. Osman, S. A. El-Gizawy, S. J. Hawthorne, A. M. Faheem, P. A. McCarron, Effect of poly(ethylene glycol) on insulin stability and cutaneous cell prolif- eration in vitro following cytoplasmic delivery of insulin-loaded nanoparticulate carriers — a potential topical wound management approach, Eur. J. Pharm. Sci. 114 (2018) 372—384. Available from: https://doi. org/10. 1016/j. ejps. 2017. 12. 018.

28 . D. Liu, F. Yang, F. Xiong, N. Gu, The smart drug delivery system and its clinical potential, Theranostics 6 (2016) 1306—1323. Available from: https://doi. org/10. 7150/ thno. 14858.

29 . M. Xu, C. V. Liew, P. W. S. Heng, Evaluation of the coat quality of sustained release pellets by individual pellet dissolution methodology, Int. J. Pharm. 478 (2015) 318—327. Available from: https://doi. org/10. 1016/j. ijpharm. 2014. 11. 057.

30. C. A. Mccarthy, R. J. Ahern, R. Dontireddy, K. B. Ryan, A. M. Crean, Mesoporous silica for- mulation strategies for drug dissolution enhancement: a review, Expert Opin. Drug Deliv. 13 (2016) 93—108. Available from: https://doi. org/10. 1517/17425247. 2016. 1100165.

31 . K. Park, Controlled drug delivery systems: past forward and future back, J. Control. Release. 190 (2014) 3—8. Available from: https://doi. org/10. 1016/j. jconrel. 2014. 03. 054.

32 . Mu¨llertz, A. , Perrie, Y. , & Rades, T. (Eds.) (2016). Analytical techniques in the phar- maceutical sciences. Springer.

33 . B. N. Singh, K. H. Kim, Floating drug delivery systems: an approach to oral controlled drug delivery via gastric retention, J.
Control. Release. 63 (2000) 235—259. Available from: https://doi. org/10. 1016/S0168-3659(99)00204-7.

34 . M. Zaman, J. Qureshi, H. Ejaz, R. M. Sarfraz, H. U. Khan, F. R. Sajid, et al. , Oral con- trolled release drug delivery system and characterization of oral tablets; a review, Pakistan J. Pharm. Res. 2 (2016) 67. Available from: https://doi. org/10. 22200/ pjpr. 2016167-76.