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Drug Delivery System: An Overview

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ABSTRACT:
A drug delivery system can be defined asa medication delivery system a composition or apparatus that enables a medicinal material to precisely reach its site of action without entering nontargeted cells, organs, or tissues and providing a proper therapeutic effect.Drugs delivered via various channels, including oral, nasal, and ocular, have a prospective substitute in the form of liposomes, microspheres, and gels. Using this kind of delivery system is also kept in mind to provide a better stable, enhancedsolubility, and bioavailability of the drug. This review primarily focuses on the many kinds, uses, and prospects of drug delivery systems.
Keywords: drug delivery system; therapeutic effects; bioavailability,oral routes, nasalroutes, ocularroutes.

I. INTRODUCTION:

A medication delivery system is a formulation or a technology that allows a medicinal ingredient to directly reach its site of action while avoiding nontargeted cells, organs, or tissues..The process of delivering a pharmaceutical ingredient to produce a therapeutic effect in either humans or animals is known as drug delivery [1]. The administration of drugs has the potential to significantly influence how retinal diseases are treated.The process of creating a novel drug molecule is costly and time-consuming. It has been attempted to improve the safety-effectiveness ratio of older medications through various techniques, including dose titration and therapeutic drug monitoring [1]. Oral delivery of protein and peptide drugs is in dire need of appropriate delivery systems that can deliver the therapeutic agent-incorporated microspheres in the gut in a targeted manner.The growing number of protein and peptide drugs under investigation necessitates the creation of dosage forms with site-specific release. Drugs that are poorly absorbed from the upper gastrointestinal tract and peptide and protein drug molecules can be delivered into the systemic circulation through colonic absorption, which is a novel approach [2].

oral-colon drug delivery method, which has clear benefits over parenteral administration. Naturally, colon targeting is beneficial for the topical management of clone-related illnesses like Crohn's disease, ulcerative colitis, and colorectal cancer. Drugs with sustained clonic release may be helpful in the management of asthma, Angina, and Arthritis.Potential candidates of interest for clone-specific drug delivery include proteins, peptides, and vaccines. For the treatment of inflammatory bowel disease (IBD), clone-specific delivery systems for ipsaslazide and olsalazine have been developed [3]. Tetracycline and metronidazole are administered via ethyl cellulose strips to decrease subgingival microorganisms in periodontal pockets [4]. After receiving supragingial scaling, patients were split into five groups based on how long the medication had been taken. Samples of bacteria were collected for gram analysis and the seats were cleaned and segregated. Methods of culture and staining [5].

DIFFERENT TYPES OF DRUG DELIVERY SYSTEMS:-

1. ORAL:

The most popular form of treatment for gastrointestinal disorders, both local and systemic, is oral administration[6].Food digestion and medication absorption are significantly influenced by the various components of the gastrointestinal tract (GIT), which include the mouth, esophagus, stomach, small intestine, and colon.Drug absorption may also be hampered by various anatomical features, such as the mouth cavity's limited surface area, the gastric mucin bicarbonate barrier, and internal enzymes[7].Conventional drug delivery methods, such as regular tablets, capsules, or sterile drug preparation, have drawbacks such as poor drug accumulation at specific sites, unfavorable body distribution, unfavorable side effects, etc.[7].Although the oral bioavailability of

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drug delivery is very low, nanoparticles have shown great promise in this regard[8].To increase the pharmacologic specificity, biodegradability, and targeting of oral medications, researchers have looked into both organic and inorganic nanoparticles[9-11].Targeting local gastrointestinal diseases like gastric disease, oral carcinoma, etc., is another focus of the majority of oral drug delivery systems[12].Innovative microfabricated devices demonstrated significant promise in breaking down the GIT barrier and enhancing the oral bioavailability of pharmaceuticals[13].

2. PARENTERALS:

From the two words "para" and "enteron," which mean to avoid the intestine, the word parenteral was formed[14].Good absorption characteristics and good bioavailability of drugs are also provided by parenteral routes of administration, such as subcutaneous, intramuscular, intravenous, intradermal, and intraarterial[15].USP 24/NF19 defines parenteral articles as preparations meant to be injected via the skin or another external boundary tissue, as opposed to the alimentary canal, to administer the active ingredients straight into a lesion, blood vessel, organ, or tissue. In today's healthcare environment, parenteral products are an essential part of hospitalized patients' therapy[16].Using a combination of synthetic polymer, polyvinyl alcohol, and the naturally occurring macromolecule gum arabica, Kushwaha discovered that the amount of drug loaded in the matrix, as well as the drug's solubility in the matrix and the release medium, determine how long the drug will release[17].Patients in beds and hospitals are entirely reliant on parenteral routes[18]. Despite their many advantages, parenteral formulations are more expensive than conventional formulations. Parenteral formulation preparation and administration call for specific tools, instruments, and methods[19].

3. DENTAL PRODUCTS:

The upper respiratory tract, the digestive system, and the external environment are all in communication with the complex environment that is the oral cavity[20,21].The oral cavity is home to a diverse range of microorganisms, including fungi and bacteria like candida albicans, lactobacillus species, and streptococcus mutans[22,23].Permanent teeth carry approximately ten diseases, with the highest incidence for years with disability, according to the global burden of disease (GBD) study[24]. Concerning the oral cavity, it is important to take into account how the oral environment affects the medications. Drug delivery via the oral cavity is impacted by the bacterial biofilm's complexity as well as the environment's complexity on a physical, chemical, and physical level[25].For instance, saliva flow rates in the mouth may have a slight impact on the effectiveness of topical anesthesia, but systemic administration can reverse drug resistance and side effects[26].Experiments in this field have also demonstrated that the right hybrid nano-films, with higher permeability and no cytotoxicity, containing an electric mixture of 5% lidocaine-prilocaine (LDC-PLC) exhibit a better anesthetic effect[27].

4. COLON-SPECIFIC DRUG DELIVERY:

The drug delivery system designed specifically for the colon should be able to safeguard the drug while it is being transported there. This means that the drug shouldn't be released or absorbed in the stomach or small intestine and that the bioactive ingredient shouldn't be broken down in any of the dissolution sites before it is released and absorbed in the colon[28].For the local treatment of many bowel diseases, including ulcerative colitis, Crohn's disease, amebiasis, colonic cancer, and systemic delivery of protein and peptide drugs, targeted drug delivery into the colon is highly desirable[29,30].Although the oral route is the most practical and recommended method, colon-specific drug delivery systems (CDDS) can also be administered via other routes. The quickest way to target medication delivery to the colon is through rectal administration. However, it's challenging to administer medication via the rectal route to the proximal portion of the colon. Additionally, patients may find rectal administration uncomfortable, and compliance may not be at its best[31].Due to the colon's high capacity for absorbing water, most medications are not readily available to the absorptive membrane because the colon's contents are highly viscous and poorly mixed. The resident flora of the human colon consists of over 400 different species of bacteria, with a potential population of up to 1010 bacteria per gram of colonic contents. These gut flora perform a variety of reactions, including enzymatic cleavage (glycosides) and azoreduction[32].The idea behind using continuous PH variations throughout the GI tract as a trigger for drug release in the colon is based on these variations[33] Colonic drug delivery has grown in significance due to its potential to deliver therapeutic peptides

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and proteins as well as medications for the treatment of localized diseases related to the colon[34].

5. LIPOSOMAL AND TARGETED DRUG DELIVERY SYSTEM:

Liposomes are self-assembling (phospho) lipid-based drug vesicles that surround a central aqueous compartment in the form of a concentric series of multiple bilayers or a bilayer (uni lamellar)[35]. Liposomes are between 30 and micrometers in size, with a phospholipid bilayer that is 4-5 nm thick[36].According to the FDA and EMA's approved drug database, 14 different types of liposomal products have been authorized.The liposomal drug delivery methods that are currently approved offer stable formulation, enhanced pharmacokinetics, and a certain level of passive or physiological targeting of tumor tissue[37].The conjugation of mAb fragments to liposomes to create immunoliposomes is a method for molecularly targeted drug delivery[38].Additionally, targeting based on antibodies is being developed in tandem with polymer systems. In a similar vein, the use of liposomes and polymers in conjunction with growth factors, hormones, vitamins, peptides, or other particular ligands is being investigated for ligand-based targeting[39].Liposomes are amphipathic phospholipids in the form of concentric bilayered structures. They are categorized as large unilamellar, multilamellar, or small unilamellar based on the number of bilayers. Their diameters range from 0.025 to 10 meu. Liposome composition and preparation technique control liposome size and shape. Liposomes are used to deliver genes, vaccines, and medications for a range of illnesses[40].

APPLICATION OF DRUG DELIVERY SYSTEM:

1. CANCER THERAPY:

Many lives have been saved by the type of cancer therapy used today, but the severe side effects of the treatment-caused by the non-specificity of the chemotherapeutic agent-affect the entire body. The rapid and uncontrollably dividing and multiplying nature of cancerous cells is one of the hallmarks of this extremely complex biological phenomenon [41].The primary goal of chemotherapy is to kill off any rapidly growing cells, including those in the patient's intestinal epithelium and hair follicles, to relieve side effects[42]. With specially designed nanoparticles that target drug delivery at the tumor site and prevent toxic effects on other tissues and organs, the development of nanoparticles has led to the creation of a new chemotherapy technique[43]. 500Cancer treatment candidates include carbon nanotubes, liposomes, carbon nanotubes, C60 (spherical) molecules, and their derivatives.

2. DIAGNOSTIC TESTING:

Fluorescent nanoparticles provide researchers a way around the shortcomings of fluorescent markers, which impede current diagnostic testing technology. These shortcomings include color matching, fading of fluorescence after a single use, and restricted use of dyes due to a bleeding effect[44].One significant development in quantum dots is their ability to be custom-made in a wide range of distinct colors. They have a high quantum yield and an absorption spectrum that stretches from the ultraviolet to a wavelength in the visible spectrum. The location of each particle in the spectrum is determined by the size of the nanodot[45].The quantum dot offers a lot of benefits. They can be illuminated with white light, to start. Second, they can be connected to biomolecules that can stay in a living system for a considerable amount of time to study different biomechanisms[46].

3. HIV AND AIDS TREATMENT:-

HIV infection can cause acquired immune deficiency syndrome (AIDS), in which a person's immune system is nearly destroyed, if treatment is not received [47].By encapsulating antiretroviral medications in polymeric nanoparticles, researchers have demonstrated how to increase the efficacy of this therapy[48].According to Khalid (2011), this technology can be utilized in vaccinations to prevent HIV infections[49].HIV primarily infects and multiplies in lymphoid tissues. According to several reports, antiretroviral drug-loaded nanoparticles can specifically target monocytes and macrophages in vitro[50].The researchers prepared nanoparticles entrapping lopinavir, efaisirenz, and ritonavir using poly (lactic-co-glycolic acid). While free drugs were removed in 48 hours (2 days) and the nanoparticle system produced sustained release for more than 4 weeks, the latter resulted in a serious HIV-related neurocognitive disorder[51].

4. NEUTRACEUTICAL DELIVERY:

Nutraceuticals are standardized food ingredients that have noticeable health benefits. They are often taken in addition to allopathic treatments to offer additional health benefits and lower the risk of developing several chronic

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illnesses[52].The majority of neutraceuticals are lipophilic molecules, which include phytochemicals, polyunsaturated lipids, and fat-soluble vitamins A, D, E, and K. Once more, nanotechnology provides all-encompassing support, and the majority of studies have focused on enhancing the neutraceutical's dissolution mechanism through the creation of nanoparticles[53].Numerous nutraceuticals have been shown to have anti-inflammatory, antioxidative, antiapoptotic, and antiangiogenic properties; of these, curcumin (diferuloglmethane) is the most well-known and researched. Numerous techniques, including liposomes, phospholipid, vesicles, and polymer-based nanoformulations, have been used to address the problem because it is particularly water-insoluble and has very low bioavailability[54].

THE CURRENT USE OF DDS IN MEDICINE AND THEIR OUTLOOK FOR THE FUTURE:

Drug delivery technologies have demonstrated numerous benefits to treatment outcomes, such as improving therapeutic efficacy, decreasing toxicity, raising patient compliance, and opening the door to completely new medical treatments. As the therapeutic landscape has changed over time, moving from small molecules to new classes of drugs that include proteins, peptides, monoclonal antibodies, nuclei avoidance, and even living cells, DD technologies have also had to adapt to suit these new therapeutics' specific delivery requirements.[55]Many efforts have been made to extend the drug release of small-molecule-based medications by encasing them in biodegradable injections with a dissolution-based formulation made of cellulose derivatives and crosslinked poly(acrylic acid) polymers[56].By extending the duration of small molecule therapeutic delivery from a few days to weeks or months, these term approaches have improved patient compliance and decreased the frequency of dosing. Such extended-acting delivery systems have revolutionized the management and treatment of several illnesses, such as advanced prostate cancer, pain, and psychotic disorders [57-59].

Through altering the local pharmacokinetics of medications, the application of long-action systems has also enhanced the therapeutic result.Compared to free drug delivery in the initial weeks after injection, the PLGA microsphere-based intra-articular formulation of a corticosteroid produced a noticeably higher drug level in the knee joint, improving the therapeutic benefit[60].Additionally, nanoparticles have shown promise in extending the half-life in systemic circulation, improving tissue targeting, and changing the biodistribution of small molecule drugs. The approved products Doxil and ambroxane were primarily focused on reducing side effects and extending circulation time rather than the superior efficacy of the drug, despite the fact that a major focus for nanoparticles has been to achieve tumor targeted delivery [61].

Lipid nanoparticles were used in 2018 to successfully deliver siRNA to the liver [10]. This advancement in nanoparticle delivery technology laid the groundwork for all m-RNA vaccines, which tackled the global COVID-19 pandemic [62]. Reflecting on the past seven decades, remarkable advancements in drug delivery technologies have been made to lower the barrier separating novel therapeutic candidates from their targets in tissue and cells. We predict that the pharmaceutical drug delivery market will grow at a compound annual growth rate of 5.9% to reach 22065.5 billion dollars by 2026 [63].

The main areas of focus in the future will be:

1) improving targeting efficiency at the tissue and cellular levels and increasing the delivery of molecules through barriers like the brain, intestine, lung, and vagina
2) creating next-generation long-acting delivery technologies to enhance medication PK and accomplish long-term, preprogrammed pulsatile release.
3) creating drug delivery systems for customized treatment plans.
4) Combining drug delivery with cutting-edge technologies like artificial intelligence, machine learning, and soft electronics[64].

II. CONCLUSION:

In recent years majority of the industrial laboratories and institutional laboratories havetaken a keen interest in the pharmaceutical development of different drug delivery systems. To create an appropriate delivery system, they are now all researching various drug release patterns, solubility, bioavailability, and effectiveness. With the use of a sustained-release drug delivery system, a medication with high solubility can now be taken for extended periods at lower dosages. Given that medicine is now moving toward more precise, effective, and affordable drug delivery systems, this suggests that the area of drug delivery systems will have a promising future. Thus, many medicine

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delivery methods are contributing to a healthier and better future.

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CONFLICT OF INTEREST:s

No author shows any conflict of interest according to my knowledge.

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