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1. Introduction

“The process or method of providing a pharmaceutical substance to have a therapeutic effect in people or animals is known as drug delivery” [1]. A drug’s compliance, safety, and efficacy can all be greatly enhanced by transforming it from its traditional form into a unique delivery system. An old drug molecule can be given new life with the use of an advance drug delivery system (ADDS). Various technological advances of unit operations such as drying, filtration, and mixing also help to advancement in modification and improvement in formulations [2]. With the right design, an ADDS can be a game-changer for addressing issues connected with targeted drug delivery. Pharmaceutical companies have been working on innovative drug delivery systems due to the growing demand for safer, more effective methods of administering drugs to patients.

The form in which a drug is administered can have a substantial impact on its efficacy. Some molecules have a range of optimal doses where the greatest benefit is obtained; dosages outside or inside of this range may be hazardous or have no therapeutic value at all [3]. The very gradual improvement in the effectiveness of treating serious diseases, on the other hand, has indicated an increasing need for a multidisciplinary approach to the delivery of medicines to target tissues. As a result, advanced methods for modifying pharmacological effects such as pharmacokinetics, pharmacodynamics, nonspecific toxicity, immunogenicity, biorecognition, and efficacy have been developed [4, 5]. Polymer science, pharmaceutics, bioconjugate chemistry, and molecular biology have all come together to form these advance techniques, which are collectively known as drug delivery systems [6, 7]. Various drug delivery and drug targeting approaches are being developed to limit drug breakdown and loss, reduce undesired side effects, enhance drug bioavailability and the proportion of drugs deposited in the appropriate location. What was once a fantasy or dream, controlled and advance drug delivery is now a reality. Over the past 15 years, researchers from pharmaceutical companies and other institutions have conducted exhaustive studies in this area of drug development. There are many different types of drug carriers, including soluble polymers, insoluble or biodegradable microparticles, natural and synthetic polymers, microcapsules, lipoproteins, liposomes, and micelles [7–10]. The carriers can be designed to break down slowly, respond to stimuli (such as pH or temperature), and be selectively delivered to their intended target (e.g., by conjugating them with specific antibodies against certain characteristic components of the area of interest). In order to deliver the drug to where it needs to go, you need to be able to “target” it. Two main approaches of targeting the sites of drug release: 1. Non-active methods;
II. Directed methods. The increased vascular permeability of tumor tissues relative to healthy tissue results in the preferential accumulation of chemotherapeutic drugs in solid tumors, an example of passive targeting. Surface functionalization of drug carriers with ligands that are selectively recognized by receptors on the surface of the cells of interest is a strategy that could enable active targeting. Given the selectivity of ligand-receptor interactions, this could lead to more targeted drug delivery. One definition of a drug delivery system is a system that consists of two components: (a) a drug formulation, and (b) a medical device or dosage form/technology designed to deliver the medication to its intended site of action inside the body. It has been discovered that certain dosage forms have significant drawbacks, such as increased toxicity, decreased efficiency, and unpleasant side effects. As the healthcare industry has grown, new drug delivery systems have been developed or are in the works to address the shortcomings of the existing drug administration methods. Controlled drug release systems and targeted drug delivery systems are two ways of describing these devices. Increased drug efficacy, site-specific administration, and reduced toxicity/side effects are only some of the therapeutic benefits of these Advance systems. Improved patient compliance, viable treatments for previously incurable diseases, the possibility of preventative applications, and greater ease of use are just a few of the benefits. Drug delivery systems lack a standard. In general, it is thought to depend on two factors: the route of administration (A) and (B) the dosage form. In this context, “drug delivery system” refers to any component of the Cartesian product (A x B) (Figure 1).

### 2. Drug delivery carriers

Vehicles for Drug Delivery: Micelle solutions, vesicle, liquid crystal dispersions, and nanoparticle dispersions comprising small particles between 10 and 400 nm in diameter are all examples of colloidal drug carrier systems that have shown...
significant promise as drug delivery methods. The objective of this kind of formulation development is to create substances with desirable characteristics, such as long shelf life, minimal toxicity, and optimum drug loading and release qualities. Incorporated drugs take part in the system’s microstructure and may potentially affect it through molecular interactions, particularly if they have amphiphilic and/or mesogenic characteristics. The amphiphilic block copolymers’ adaptability in terms of chemical composition, total molecular weight, and block length ratios, which permit regulation of the size and shape of the micelles, makes them desirable for use in drug administration applications. Block copolymers that have cross-linkable groups added to them can have their micelles stabilized and their temporal control enhanced. A very promising approach to a wider variety of locations of action with considerably higher selectivity is the substitution of block copolymer micelles with particular ligands.

3. Conventional methods of drug delivery

Pills, eye drops, ointments, and intravenous solutions are the standard methods of conventional drug administration. Numerous cutting-edge methods of administering drugs have emerged in recent years. Chemical drug modification, drug entrapment in macrovesicles for intravenous injection, and drug entrapment within pumps or polymeric materials for targeted delivery to specific anatomical sites are all examples of these methods (e.g., the eye or beneath the skin). These methods have already resulted in delivery systems that benefit human health, and further study has the potential to completely transform the way many medications are administered [11].

4. Evolution of drug delivery

The foundations for the study of drug release were laid between the years 1950 and 1980. The first generation of development occurred during this time, with controlled-release mechanisms being approved by regulatory bodies. For example, in 1952, the FDA approved Spansule (Smith, Kline, & French Laboratories), the first controlled-release drug delivery system. First-generation drug delivery methods relied on four primary drug-release mechanisms: controlled dissolution, controlled diffusion, controlled osmotic pressure, and controlled ion exchange [11]. There was some research into other processes, but from the 1950s to the 1980s, the majority of commercial products used a release mechanism based on dissolution, diffusion control, or a hybrid of the two. The majority of the time, these methods were used to administer drugs orally or topically. The second wave of drug delivery development began with injectables, with the approval of the first long-acting formulation in 1989. Originally developed to prolong the half-life of peptide and protein medications by a month, the poly (lactic-co-glycolic acid) (PLGA) microparticle formulation is an injectable depot formulation [12]. By adjusting the drug’s ratio and molecular weight, the release time was lengthened to a full 6 months [4]. All other polymer-based long-acting injectable formulations have relied on PLGA for approval because of its proven safety. PEGylation, the technique by which poly (ethylene glycol) (PEG) is attached to protein molecules, is another important second-generation breakthrough [4]. By going through this procedure, protein molecules might remain in the body’s bloodstream for a longer period of time. Subsequent research revealed a potential drawback, however, when antibodies were found to be formed within the body against the PEG molecules,
Figure 2.
(a) Conventional dosage forms (b) ADDS.
resulting in quicker blood clearance [5, 6]. PEGylation has to be better understood in order to be used more efficiently. PEGylation, and more especially lipid nanoparticles containing PEGylated lipid, has lately proven essential in the messenger RNA (mRNA) vaccines employed against COVID-19, which has sparked new interest in the field of lipid nanoparticles encapsulation and a Trojan Horse. Delivering mRNA vaccinations has been made practicable, something that was not conceivable when the medicinal application of mRNA vaccines was first proposed, some 30 years ago. This development has been brought to the forefront of world attention by the recent COVID-19 pandemic. In order to protect the vaccine molecules from the damaging effects of enzymes during transport, lipid nanoparticles must be encapsulated around the fragile mRNA. However, after the vaccine has been adequately shielded, it must be administered efficiently and exit the endosome before it can exert its therapeutic impact [4]. Due to decades of research, formulators were able to quickly construct an effective mRNA delivery system employing lipid nanoparticles during the COVID-19 pandemic. Scientists from Nanyang Technological University, Singapore, published a study into the use of conjugated peptide coacervates, a type of protein-based microdroplet, as a drug delivery vehicle for the intracellular administration of a wide variety of macromolecular therapeutics [13]. Therapeutics can enter cells via the protein-based microdroplets, which serve as a “Trojan Horse.” Once the droplets have entered the cells, they breakdown, releasing the biomolecules that contain the drugs. The microdroplets are a useful vehicle for transporting many different types of medicines, including proteins, peptides, and messenger RNAs. The researchers also state that the microdroplets can be used to transport and administer a single or many macromolecular therapies (Figure 2) [13].

5. An evolving approach to drug delivery

Oral administration of an instantly active medicinal material has historically been the primary focus of medication delivery strategies. Due to the need for greater doses, the necessity for frequent administration, and the uncontrollable release of the therapeutic, the “traditional” modes of drug delivery have proven restricting for formulators as drug molecules have evolved and newer modalities have been researched. Because of this, bio/pharmaceutical firms have been putting a lot of effort into developing advanced drug delivery systems (ADDSs) to circumvent the drawbacks of current methods. The market trajectory for ADDS, which reflects the industry’s attention, is predicted to develop at a compound yearly growth rate of 20.8% between 2021 and 2026, reaching an estimated value of $28.1 billion by the conclusion of the forecast period [14]. The advantages of controlled-release drug delivery, the existence of in vivo biological barriers that impact different properties of a drug substance, and the increased adoption of controlled-release drug delivery systems by certain patient populations due to non-adherence to treatment regimens are all factors that are expected to contribute to this growth [11, 15].

6. ADDS of herbal formulation

ADDS for herbal medications has received a lot of research and development attention in recent decades. There are two conditions that the unique carriers should ideally meet. The first requirement is that the drug is administered at a pace...
determined by the body’s requirements during the course of treatment. Secondly, it needs to transport the herbal medicine’s active ingredient to the affected area. None of these can be fulfilled by the standard or extended-release dose formulations currently available. Bioactive and plant extracts have been used in a wide range of innovative herbal formulations, including polymeric nanoparticles, nanocapsules, liposomes [16], phytosomes, nanoemulsions [17], microspheres [18], transfersomes, and ethosomes [19, 20]. In 2008, the advanced drug delivery systems industry was worth $134.3 billion worldwide, and in 2009, that number is expected to rise to $139 billion. The 2014 forecast of $196.4 billion represents a CAGR (over the next five years) of 7.2%. Targeted medication delivery is the largest market sector, with 2009 revenues of $50.9 billion and projected revenues of $80.2 billion in 2014, a CAGR of 9.5%. With projected revenues of $36.1 billion in 2009 and $45.8 billion in 2014, or a CAGR of 4.9%, sustained-release products hold the second greatest market share. In the case of drugs with a short half-life, sustained release can lead to less frequent dosing, improved compliance, and fewer fluctuations in plasma and blood levels, all of which contribute to a more reliable therapeutic effect [21, 22].

7. Conclusion

A new drug delivery system is an alternative to the conventional methods of administering drugs. In order to treat a patient, modern medicine first determines where in their body the disease is manifesting, and then delivers the medication directly to the area of the body where it will have the most effect. Poor bioavailability and plasma drug level variations characterize traditional drug delivery systems (tablets, capsules, syrups, ointments, etc.), rendering them incapable of achieving sustained release. Without a reliable method of administration, a treatment may as well not be attempted at all. Poor bioavailability and changes in plasma drug level characterize traditional drug delivery modalities (tablets, capsules, syrups, ointments, etc.). The entire therapy process may be ineffective without a reliable delivery method. Advanced drug delivery systems can be roughly categorized into three groups according to their intended use: rapid drug delivery, sustained drug delivery, and highly efficient drug delivery. Nanoparticles: The term “colloidal drug delivery system” refers to a broad category that includes nanoparticles. Microcapsules, nanocapsules, macromolecular complexes, polymeric beads, microspheres, liposomes, and niosomes are all types of encapsulation systems. Delivery of poorly soluble medicines and bioavailability difficulties for poorly soluble clinical candidates are major challenges in drug delivery systems. New methods have been developed for the transportation, surmounting of bioavailability barriers, and rational formulation design of poorly soluble medicines. There will be extensive use of NDDS in the treatment of chronic pain and other illnesses in the near future. Safety consciousness is evolving, and with that comes the necessity of narrowing in on a specific area to protect.
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