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ADVANCE DRUG DELIVERY SYSTEM

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ABSTRACT:

The need to specifically target the cells involved in the onset and progression of diseases has arisen due to advancements in molecular pharmacology and a better knowledge of the mechanisms behind the majority of diseases. This is particularly true for the majority of serious illnesses that call for treatment medicines with a wide range of adverse effects, necessitating precise tissue targeting to reduce systemic exposure. Modern drug delivery systems (DDS) are designed with cutting-edge technology to maximise treatment efficacy and reduce off-target accumulation in the body by speeding systemic drug delivery to the precise target site. They therefore have a significant impact on the management and treatment of disease. Because of their improved performance, automation, accuracy, and efficacy, recent DDS provide more benefits than traditional drug delivery methods.

Pharmaceutical research has entered a new era of science and technology, with an emphasis on creating innovative oral drug delivery systems. Traditional dose forms, such as tablets and capsules, are linked to side effects, frequent use, limited absorption, and patient noncompliance. Researchers adopted an alternative to conventional drug delivery systems by creating innovative drug delivery strategies. Fast-dissolving medication delivery devices are highly favoured by both paediatric and geriatric patients. Since fast-dissolving pills carry the risk of suffocation, oral disintegrating films are preferable. In order to increase the oral bioavailability of hydrophobic medications, self-emulsifying formulations have also grown in popularity because of their capacity to avoid the dissolution and first pass effects following oral administration. Osmotic Traditional dose forms, such as tablets and capsules, are linked to side effects, frequent use, limited absorption, and patient noncompliance.

Keywords: Drug Delivery system, Nanoparticales, Pharmacokinetics, Chemotherapy

INTRODUCTION:

Drug delivery systems are technological devices that create and store drug molecules in forms that are appropriate for administration, such as tablets or liquids. They maximise therapeutic efficacy and reduce off-target accumulation in the body by accelerating the delivery of medications to the precise targeted spot in the body.The oral route of administratin, buccal and sublingual routes of administration , nasal and ophthalmic , transdermal and subcutaneous , anal and trans vaginal and intravesical are just a few of the ways that drugs can enter the body. The drug's constituents are in charge of its physiochemical characteristics and the modifications it affects in bodily systems when ingested.Because DDS increases systemic circulation and regulates the drug's pharmacological impact, it has been used successfully to treat illnesses and enhance health. The concept of controlled release emerged as pharmacology and pharmacokinetics advanced, demonstrating the significance of drug release in influencing therapeutic success . Since it was initially authorised in the 1950s, the controlled-release formulation of a medication has garnered a lot of interest because of its many benefits over traditional medications. It delivers medications for a set amount of time and at a set rate. Furthermore, controlled drug delivery systems can endure for days or even years because they are not impacted by physiological variables. Additionally, it offers spatial control over the delivery of drugs In order to provide more convenient, regulated, and targeted distribution, a number of drug delivery systems (NDDS) have recently been developed utilising sophisticated technology. The release rate and mechanism of each medication delivery system are determined by its unique characteristics. Their affinities for different pharmacological compounds will ultimately be impacted by the physical, chemical, and morphological distinctions, which are mostly to blame for this . Research on these has shown that the main release mechanisms include stimuli control, chemical reaction, solvent reaction, and diffusion . To reach the target tissues, for example, the medicine can readily pass through the porous blood arteries and lymphatic system, where the majority of cancer cells can multiply. The term "Enhanced Permeability and Retention" (EPR) .describes this. A well-studied passive diffusion mechanism(1)

The primary goal of a drug delivery system is to release the medication at the appropriate timing and concentration at a designated target site (Vijaya Shanti and Mrudula, 2011). The

physicochemical properties of the therapeutic agent and bio-barriers, such as the skin and organ membranes, typically dictate the conditions necessary for an effective drug administration. Even when used to treat the same symptoms, a drug's qualities can differ significantly depending on its size, chemical makeup, hydro capacity, and capacity to bind a particular receptor. Due to their insolubility in physiological fluids and the limited permeability of various human organs, many medications have inadequate bioavailability. Therefore, the effectiveness of treatment depends not only on the drug's Pharmaceutical businesses concentrated on the creation and design of innovative drug delivery systems in order to get around the drawbacks of traditional drug administration systems. The significant improvements in clinical efficacy, patient compliance, extended product life through controlled drug release, and economic factors including lower frequency and administration costs have prompted the demand for high performance, flexible, and controlled release systems. Novel drug delivery methods may therefore be one of the drug industry's fastest-growing subsectors (VijayaShantiandMrudula,2011).

Innovative drug delivery systems are logically designed to improve the performance and distribution of current medications in comparison to conventional systems. Unlike conventional medication delivery systems, novel ones combine drug delivery systems are logically designed to improve the performance and distribution of current medications in comparison to conventional systems. Unlike traditional drug delivery systems, novel drug delivery systems target, control, and adjust drug administration by combining innovative dosage forms and sophisticated methodologies. A medicine's efficacy, safety, and patient compliance can all be significantly enhanced by switching from a traditional to a revolutionary drug delivery system . Novel drug carriers seek to meet two requirements: the medication must be delivered to the precise target site at a rate and level determined by the body's needs, and the active unit must be monitored.

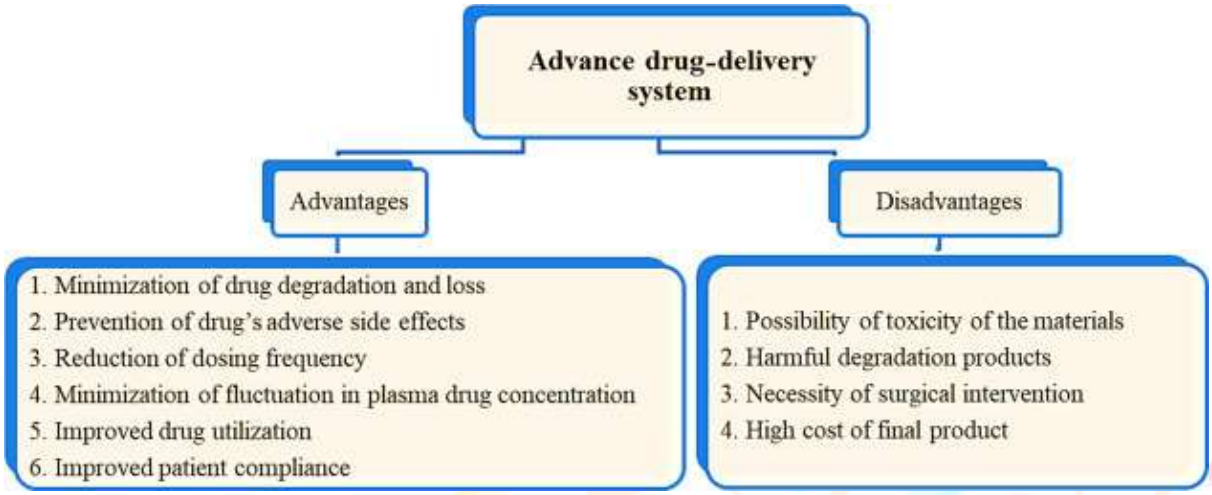
Drug delivery systems (DDS) are the means by which a medicinal substance is introduced into the body to achieve therapeutic efficacy. The key aim is to successfully deliver drugs (DD) to invading cells using carrier agents. Therefore, DD's primary objective is to maximise a pharmaceutical material's efficacy while simultaneously minimising patient compliance. Obtaining therapeutic plasma levels and their long-term even presence together with adsorption and bioactivity with preferred efficacy is crucial to achieving the goal of therapeutic

performance . In this case, the conventional drug delivery system (CDDS) primarily entails the release of dosage forms followed by drug absorption through biomembranes. Poor drug selectivity, poor aquatic solubility, and other issues plague the CDDS.Drugs must primarily go through adsorption, absorption, distribution, dissemination, and bioavailability to invading cells in addition to metabolism in order to function in the body. In addition to the aforementioned, the form, size, number of pores, interaction, bioactivity, and surface morphology of the drug carriers' agents determine their appropriateness and perfectibility, all of which can be superbly accomplished with ADDS

Several decades or even centuries ago, pharmaceutical therapies began with injectable active chemical medications , or the oral administration of solid pills (and liquids) . Aspirin, for example, has been used since 1828. Repeated doses are necessary to maintain the medication dose in the body when one of these approaches is used. Even though these therapies are beneficial, it is inevitable that sub-therapeutic drug levels may alternate with dose peaks during administration periods. Consequently, a significant disadvantage was the inability to maintain drug level control over an extended length of time. Over the last 20 years, new methods and techniques have been created to regulate a number of factors that are thought to be crucial for improving the effectiveness of treatment, including the rate, duration, and delivery targeting.The scientific community became interested in targeted medication delivery, and as a result, there have been significant advancements in this field within the past ten years. Targeting active chemicals entails combining several fields relevant to biological systems, genetic techniques, active compound design, active compound carriers, and precise molecular design.A number of actions must be taken in order to increase the efficacy of the current drug delivery techniques. Delivering appropriate active chemicals to the intended target without exhibiting any signs of degradation during the entire process is the primary objective. The research community's ultimate goal is to create a controlled delivery system that can be taken orally, is less costly and uncomfortable for patients, and is also incredibly successful when considering a particular ailment.

The four types of polymeric-based DDS that are now on the market are solvent-activated, chemically controlled, magnetically controlled, and diffusion-controlled systems. Reservoir and matrix systems are both included in diffusion-controlled systems. A polymeric membrane enclosing a drug-containing core forms the basis of the first kind of system, whereas a polymer matrix with uniform drug distribution forms the basis of the second type. Diffusion

governs drug release in both situations. The polymeric membrane of the reservoir systems must be resistant, though, as its rupture would result in an abrupt release of the medicine.(4)



Localized disorders originate in, and are confined to, a certain area of the body or an organ system. When treated inappropriately, many of these conditions can progress to a systemic state, affecting the entire body. Most of the research focused on local delivery based this approach by the idea that the systemic treatment using model drugs leads to inevitable side effects, and local delivery instead appears to be a more effective and safer route with regard to the minimal invasiveness. Nonetheless, the development of effective local treatment options is highly challenging. One of the main reasons is poor penetration of therapeutic agents from the drug delivery system to the affected side, and advanced delivery platforms are highly desirable.

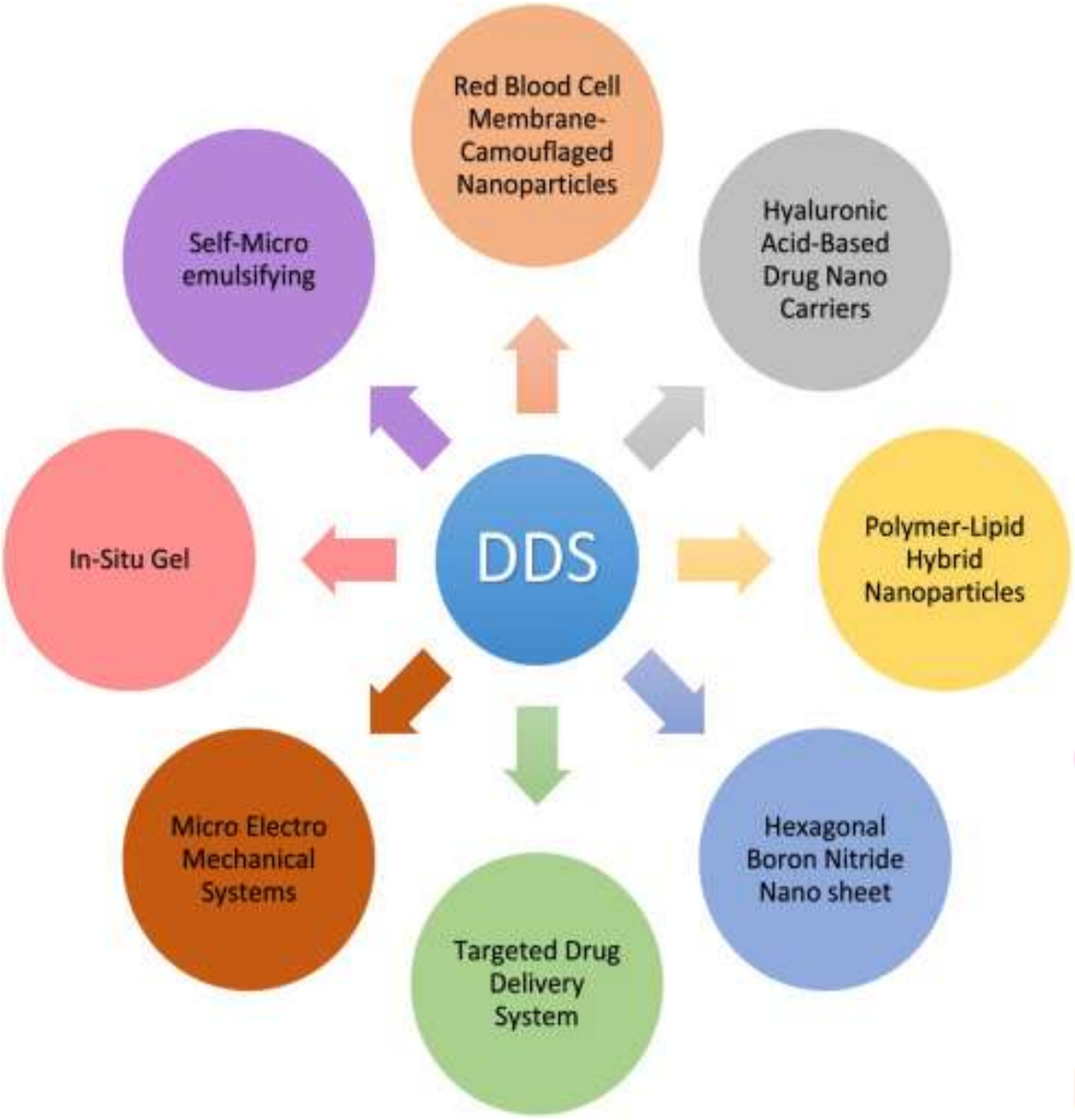
The commonly researched local treatment systems in alignment with the abundance of conditions associated with them include skin, eyes, mucosal epithelium-lined organs like the vagina, and lungs, which have been a focus of this review. Clearly, these are not easily accessed by most therapeutic agents given the protective nature of our bodies aiding in survival.

The skin is the largest organ of the human body which forms a barrier between the body and its surroundings and plays a vital role in maintaining homeostasis . Whilst a treatment of skin conditions offers a noninvasive administration to patients, the skin barrier effect interferes with active agents' delivery The biggest challenge for any therapeutic materials is to overcome the function of the *stratum corneum* which is blocking external agents regarded as hazards and permeate into deeper skin layers Moreover, considering the complex structure of the skin, the

ideal molecule for delivery should be extremely small and amphiphilic, which are often unmet criteria by current medicines

.RECENT DRUG DELIVERY SYSTEMS

Significant progress has been made in recent years toward the successful development of drug delivery systems based on organic, inorganic, and hybrid nanoparticles as drug carriers for active targeting, particularly in chemotherapy. Recent drug delivery systems (DDS) are formulated with improved properties such as smaller particle size, increased permeability, increased solubility, efficacy, specific site targeting, stability, toxicity, and sustained delivery. They can significantly improve therapeutic agent performance over conventional dosage forms .In the development of an optimal drug delivery system, recent drug delivery systems are recognized to be the newest developments and innovative understanding of the pharmacokinetic and pharmacodynamic behavior of pharmaceuticals. Because these DDS are transporters, they can keep medication concentrations in the therapeutic range for a long time while also delivering material to the site of action. The adoption of the delivery mechanism is directly tied to the commercial and therapeutic success of the innovation. This would entail involving patients early in the development process, recognizing any problems, and ensuring they receive the most out of the device. Improving delivery systems that reduce toxicity while increasing efficacy



APPLICATION:-

RED BLOOD CELL MEMBRANE-CAMOUFLAGED NANOPARTICLES DRUG DELIVERY SYSTEM

Researchers have recognized the potential benefits of nanotechnology in vastly improving medicine delivery methods throughout time. Red blood cell membrane-camouflaged nanoparticles are a new class of drug delivery systems. The nature and biological significance of red blood cells (RBCs) allow for their use as an efficient system as a nanoparticle camouflaging material . Because red blood cells (RBCs) are the most abundant circulating cells in the body, their biocompatibility (non-immunogenic), biodegradability, and extended circulating half-life, making them an ideal vehicle for drug delivery . Engineered RBCs have been investigated and found to be an excellent carriers for a variety of bioactive chemicals, including enzymes, medications, proteins, and macromolecules . Because of their abundance, red blood cell membranes serve as a "camouflage," allowing nanoparticles to combine the benefits of native red blood cell membranes with those of the nanomaterial. Several strategies have been developed to load therapeutic agents onto RBCs without comprising the structure and the physiological function of RBCs. The coated nanoparticles will mimic RBCs and interact with the environment to establish long systemic circulation when injected. Sonication is the most common method for creating RBC camouflaged nanoparticles. Other methods of RBC fusion with nanoparticles include in-situ polymerization, microfluidic electroporation, and extrusion. However, each has advantages and disadvantages in terms of synthesis, scale-up challenges, reproducibility, and the nature of the final product . (1)

HYALURONIC ACID-BASED DRUG NANOCARRIERS DRUG DELIVERY SYSTEMS

The usage of hyaluronic acid is one of the drug delivery techniques. Hyaluronic acid is a novel polymer that can be used to make medication delivery systems . It has a linear macromolecular muco polysaccharide made up of proportionately connected glucuronic acid and *N*-acetyl glucosamine saccharide units .. It exhibits biocompatibility, biodegradability, and high

viscoelasticity, and it can be coupled with a specific cell surface receptor . Because Hyaluronic acid is a natural component of eye tissue and plays an important function in wound healing, it makes sense to use it as a carrier for ocular drug delivery as long as the integrated pharmaceuticals are released consistently. They aid in the thickening, sustained release, and transdermal absorption of drugs, as well as improving drug targeting. Drug distribution to cancer cells was significantly improved using active targeted HA-based drug nanocarriers. In addition, lipid nanoparticles with an appropriate HA coating have been developed as biocompatible drug carriers with a great potential for targeted drug delivery to the target tissue while minimizing side effects and harming other tissues. Benefits of utilizing HA-based nanocarriers for cancers with elevated expression of the CD44 receptor include improved drug delivery, increased therapeutic efficacy, higher cytotoxicity, and considerable reduction of tumor development, as well as a high potential for targeted chemotherapy.

HEXAGONAL BORON NITRIDE NANOSHEET DRUG DELIVERY SYSTEM

As technology continues to advance and science evolves, more and more materials are being researched and studied to help improve drug delivery. Among these materials is Boron nitride (BN) which is a crystalline material with a balanced stoichiometry of nitrogen (N) and boron (B) atoms. This material occurs in various forms such as cubic BN (c-BN), hexagonal BN (h-BN), wurtzite BN (w-BN), and rhombohedral BN (r-BN). Hexagonal Boron Nitride is a two-dimensional (2D) layered-dense structure with sp2 hybridized B–N bonds. It can also be called white graphene sometimes regarded as an analogue of graphite . The B–N atoms substitute the carbon atoms and are held together by a strong covalent bond forming interlocking rings. The layers of the compound are held together by van der Waals forces with a bond length of 1.466 Å and an interlayer space of 3.331 Å. This compound is partially ionic and as a result of this unique characteristic has its B–N bonds to be polar. H-BN is an insulator that has gained wide applications in various fields of life such as cosmetics, dental, cement, ceramics, and most especially in medicine as a drug carrier similar to graphene or grapheneoxide .Hexagonal Boron Nitride has been proven to be useful in drug research and delivery systems . The research by Jedrzejczak-Silicka and her colleagues reported a reduction in the proliferation of MCF-7 cell line cultures when compared with the normal L929 cell lines upon exposure to H-BN loaded with gold particles. H-BN was exfoliated via chemical treatment using modified Hummers' method, sonication treatment, and was finally functionalized with gold particles for the studies

and analyzed using Neutral Red (NR) uptake assay . compound is being recognized today as an effective chemotherapeutic agent. (1)

POLYMER-LIPID HYBRID NANOPARTICLES DRUG DELIVERY SYSTEM

Nanocarriers are gaining wide usage as drug delivery systems because of their increased stability in storage, improved targeting ability on disease cells, sustained drug release, and higher encapsulation ability . Amongst the widely accepted nanoparticles being used today for drug delivery, liposomes and polymeric nanoparticles are the most widely accepted. Liposomes which is a lipid-based nanoparticles though showed excellent biocompatibility still suffered drug leakage and instability upon storage while the polymeric nanoparticle which is a polymer-based nanoparticle was able to curb this limitation by exhibiting high encapsulation/drug loading ability as well as stability. However, it had its own shortfalls in that it showed lower biocompatibility . In order to overcome these shortcomings and obtain an effective nanomaterial, researchers sought and developed a hybrid system that will combine the unique properties of the two classes of nanoparticles, which is known as Polymer-lipid hybrid nanoparticles (plhnps). This hybrid system was able to satisfy the requirements of biocompatibility, high storage stability, sustained drug release, minimal drug leakage, small particle size, and high encapsulation . As a result of its efficacy, this system is being used today for different therapeutic purposes as well as diagnostic applications. Plhnps is made up of three distinct components which include: A polymeric core that encapsulates both hydrophilic and hydrophobic drugs effectively. (1)

SELF-MICRO EMULSIFYING DRUG-DELIVERY SYSTEM

Recently, lipid-based drug preparations have received a lot of interest, with a specific focus on self-micro emulsifying drug-delivery systems (SMEDDS) . Inadequate bioavailability is one of the most difficult aspects of developing oral dosage forms of drugs . Accordingly, minimal hydrophilicity is an essential factor for bioavailability in this context, because drugs cannot be absorbed via the gastrointestinal tract (GIT) except it exists in solution forms . Aqueous solubility is a problem for many chemical compounds having notable and favorable pharmacological effects . Furthermore, almost 30% of widely marketed medicinal entities and

nearly 50% of innovative drug compounds accessible for product manufacture are hydrophobic in nature, meaning they have low water solubility . The utilization of a lipid-based carrier system to boost the bioavailability of less water-soluble medications has grown in popularity in recent years . The main rationale behind this formulation is to sustain the hydrophobic components in solution all through the digestive system .Lipid-based carriers come in a variety of forms, including suspensions, dry emulsions, microemulsions, and self-emulsifying drug-delivery systems (SEDDS).

IN-SITU GEL DRUG DELIVERY SYSTEM

The foremost goal of any drug delivery system is to change the drug's pharmacokinetic characteristics and tissue distribution in a meaningful way . Over the last 60 years, there has been a lot of focus on developing controlled and well reliable drug delivery systems . In-situ gel medication administration has emerged as one of the most innovative drug delivery systems. By virtue of its unique property of transitioning from Sol to Gel, the in-situ gel drug delivery system aids in the prolonged and regulated release of medications, as well as increased patient compliance and comfort . In most case, formulations in solution form become transformed into gel form under certain physiological conditions before it enters the body . A variety of stimuli, such as pH change, temperature modulation, and solvent exchange, combine to transform a solution into a gel , Oral, nasal, injectable, vaginal, rectal ocular, intraperitoneal, and parenteral routes have all been used in various research. Many polymeric methods capable of delivering pharmaceuticals have been created . When these polymers come into touch with physiological stimuli, they go through a sol-gel transition. In situ gel drug delivery systems are made from a variety of natural and synthetic polymers Four processes are known to produce the formation of in-situ gel biomaterials, viz; (1) temperature and pH variations, (2) variations of the physical properties of the biomaterials such as solvent exchange and swelling, (3) Biochemical modification such as enzymatic and chemical reactions, and (4) photo-polymerization .the stomach's acidic medium. The oral in situ gel distribution procedures employ natural polymers such as xyloglucan, pectin, and gellan gum..

MICRO ELECTRO MECHANICAL SYSTEMS (MEMS) FOR DRUG DELIVERY:

MEMS technology has vast applications in fields such as actuators, drug delivery, motion sensing, accelerometers, and inkjet printing]. The devices produced through this technology incorporate microfabrication techniques to produce micro/nano-sized electromechanical and mechanical devices or implants . Interestingly, the use of these techniques enhances the efficacy of these devices by allowing considerable control over their topography, microarchitecture, and size of the resulting devices Among the numerous materials and processes available for designing these MEMS-based devices, the most commonly used, incorporate creative blends of varying micromachining techniques such as; deposition (an addictive process), etching (a subtractive process), lithography (a patterning process), ink jetting, ion implantation, oxidation, and micromolding. As drug delivery systems, MEMS technology fabricates miniaturized systems comprising of various materials such as silicon, glass, metals, and nitrides, as well as polymers, micropumps, sensors, microvalves, reservoirs, actuators, and high-performance processors These distinct components function synergistically, to provide the broadly reported multi-functionality and precision of MEMS devices, relative to other conventional drug delivery systems. overall functionality of the MEMS-based delivery devices.

CONCLUSION:

The construction of more efficient controlled release delivery systems gets increasingly difficult as the physiological and pathological causes of disease come into sharper focus.The creation of novel polymers that are better suited as biomaterials enables their widespread use in medication targeting, gene and protein delivery, and the design of delivery devices. Additionally, the potential for creating smaller systems, such micro- and nanoparticles, makes studying polymers an extremely appealing area of study. Recent developments in the CLRP of a number of monomers have produced stimuli-responsive polymers and hydrogels, opening up a number of possibilities that will eventually enable the development of a new and more potent generation of DDS.

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