International Journal of Humanities Social Science and Management (IJHSSM)
Volume 6, Issue 1, Jan.-Feb., 2026, pp: 514-518 ISSN: 3048-6874
www.ijhssm.org

Advances In Drug Delivery and Research in To Specific Disease Areas

KARETI PRIYANKA
G.Vindhya,K.Ashok,D.Jeevani,K.Sravanthi, Krishna Teja Pharmacy College, Tirupati,.
Corresponding Author: Dr.A.Kiran kumar, M.pharm.,Ph.D.,

Date of Submission: 07-02-2026 Date of Acceptance: 18-02-2026

ABSTRACT: **R**ecent drug delivery systems (DDS) are formulated using advanced technology to accelerate systemic drug delivery to the specific target site,maximizing therapeutic efficacy and minimizing off-target accumulation in the body. It has great advantages when compared with conventional DDS ,due to their enhanced performance,automation,precision,and efficacy.
They are made of nano materials or miniaturized devices with multifunctional components that are bio-compatible,bio-degradable,and have high viscose-elasticity with an extended circulating half life. Cancer drug delivery is a difficulty with poisonous or toxicity,poor drug bio-availability,deficient of effective targeting.Overcoming these difficulties is important for tratement efficacy and patient outcomes. It tells about current drug delivery techniques that reshape cancer therapy in encouraging precise,controlled release to tumour specific sites. It includes nano-technology,immunotherapy,and gene therapy enable intervals at molecular and cellular levels.This mixing therapy address's the complexions of tumor inequality by mixing multiple agents within a single therapeutic work,peptide-conjugates,enhance specificity and potency.

KEYWORDS: Drug delivery system, Bio-printing, Medical devices, Micro-needles, Novel drug delivery system, Liposome drug delivery system.

I. INTRODUCTION

Principles related to DDS preparation is route of administration site specific targeting,metabolism and toxicity.Aimed to optimize efficacy,safety while improving patient convenience and compliance.Key goal is to modify a drug's pharmacokinetics and specificity.By combining it with different excipients,drug carriers,and medical devices designed to control its distribution.Enhancing bio-availability and prolonging duration of action.[1]

Targeted cancer drug delivery systems have gained a greater attention in recent years.Advanced systems offers precise and controlled release of cancer drugs.Main difficulty is high costs and regulatory challenges.The integration is to solve existing problems.

Scientists focus on the recent progress in pharmaceutical technology for drug delivery systems and new drug targeting strategies.It includesimportance,characterization,evaluation,therapeutic applications and future perspectives by pharmaceutical inventors.[2]

It covers a broad range of niosomes as a convenient,cheap,and stable means of delivery of therapeutics in biomedical applications.It also uses nano technology for drug biological systems via nanotechnology and 3-D printing,technologies in fabricating drug delivery systems.

It uses the natural bio-carriers for brain targeting it is the difficult area for targeting.A graphene based system for drug delivery is also are bio-ceramics systems.This review provides an overview of the broad future of nanofibres in the sector of bio-medical applications.[3]

Current efforts in Drug delivery system[DDS]:
Current efforts in drug delivery are vast and include topics such as controlled release formulations, targeted delivery, nanomedicines, drug carriers,3-D printing and the delivery of biologic drugs.

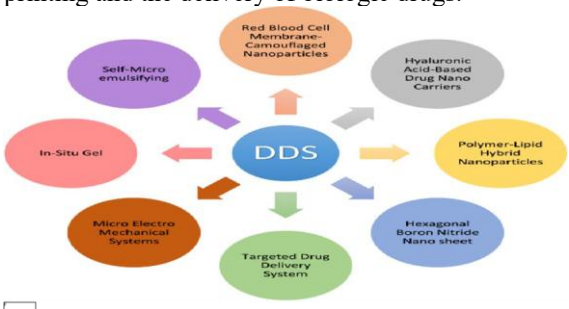

Fig 1:Various fields emerging in drug delivery System

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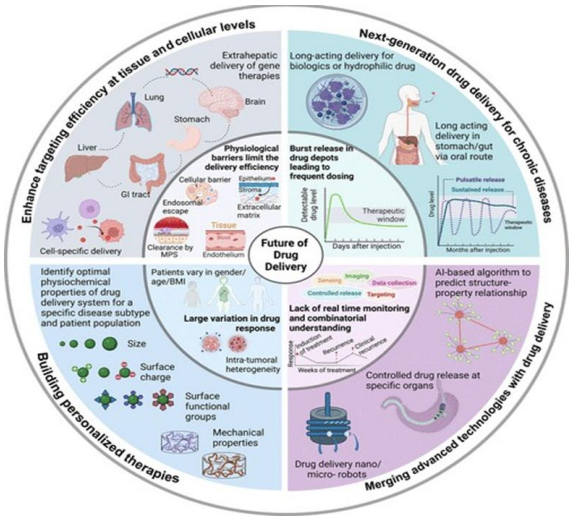

Fig 2: Scope and future of drug delivery

Targeted drug delivery system:

Targeted drug delivery is the delivery of a drug to its target site without having an effect on other tissues.In order to achieve efficient targeted delivery,the designed system must avoid the host's defense mechanisms and circulate to its intended site.

Fig 3: Importance and scope of Targeted drug delivery

TDDSs are where a drug is delivered to a specific location, rather than the whole body or organ, and combine diverse fields of science, such as polymer science, pharmacology, bio conjugate chemistry, and molecular biology. TDD is aimed at managing and controlling the pharmacokinetics,pharmacodynamics, aspecific toxicity, immunogenicity, and bio recognition of therapeutic agents. The end goal is improving treatment effectiveness while reducing side effects. TDDSs differ from conventional or traditional DDS's in that they acquire site-specific release of drugs from a dosage form, while the former depends on drug absorption through biological membranes.

The Need for Targeted Drug Delivery:

The need for TDD over conventional DSs is fourfold: unsatisfied performance of drugs in terms of pharmaco-dynamic, pharmaco kinetic, pharmaceutical, and pharmaco therapeutic features with conventional delivery,Targeting of drugs to a particular area through optimized DD methods is not only important to enhance therapeutic effectiveness but also to reduce the toxicity associated with a small therapeutic index and high doses.

Targeting is needed to achieve solutions to these constraints and innate disadvantages of conventional DDS's. Parenteral delivery is highly invasive, oral administration cannot be used for protein- or peptide-derived drugs, and topical creams and ointments are limited to local effects.

Furthermore, the effectiveness of drug–target interactions is compromised unless the drug is delivered to its site of action at a dosage and rate that produces minimal side effects while maximizing therapeutic effects In addition, simpler drug-administration procedures, decreased drug quantity, which reduces therapeutic costs, and the potential to sharply increase drug concentration in target compartments without adverse effects on nontarget compartments are promising benefits of TDD.
Generally, drug targeting results in increased efficacy, modulated pharmaco kinetics, controlled bio distribution, increased specificity of localization, decreased toxicity, reduced dose, and improved patient compliance.

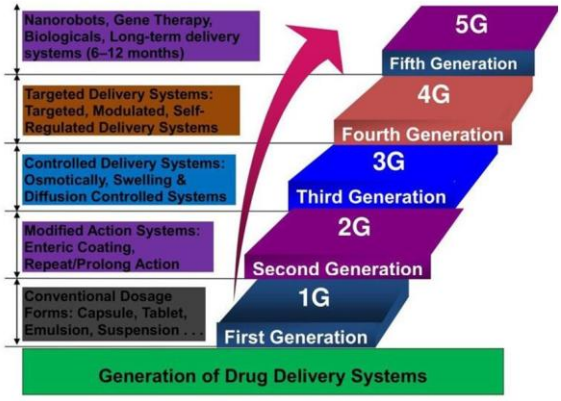

Fig 4:Generation of drug delivery systems

Controlled release formulations:

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These are designed to deliver medications at a steady rate over time,helping maintain consistent drug levels in the blood stream.It minimizes the ups and downs in drug concentration that can cause side effects or lower effectiveness.These systems often take the form of matrix tablets,osmotic pumps,and reservoir type devices,all off.Dexedrine became the first such formulation on the market.It introduces trans-dermal patches,which deliver drugs slowly through the skin.It remains effective for weeks for even months after a single dose.

3-D Bio-printing and uses:

It is also known as additive manufacturing [AM],has made huge leaps in its progress as of recent years.There exist different forms of 3-DP.3-D printers that are frequently used for medical applications are fused deposition modelling[FDM].

- Selective laser sintering [SLS]
- Stereo-lithography [SLA].

It includes generally have a maximum heat temperature of 300º .It includes many polymer ceramic composites such as polyacetic acid[PLA] and aluminium[III] oxide.Employed in the fabrication of reservoir micro-devices to assist in the prolonged delivery of API via the favoured oral route.The printed devices are approximately 500micro meters in diameter.Printed from a sacrificial material like polyvinyl alcohol [PVA],& filled with a desired compatible API.

4-D Bio printing:

✓ It has also been given rise to advancements.

✓ It differs with 3-D Bio printing[3-DBP] in the way of lattice structures which are able to respond effectively to external stimuli.

Includes;

- ❖ Bio-links
- ❖ Thermal
- ❖ Humidity
- ❖ Electrical
- ❖ Magnetic responsive materials

✓ These have greater efficacy of mimicking the native tissue which in turn increases their usefulness upon treatment.

✓ Responsive material is poly [N-isopropy-lacrylamide].

✓ These are able to change shape reversibly depending on the temperature they exposed to,may shrink or swell.

✓ These property is especially useful for tissues like muscles and skin.

✓ These are constantly change the dimensions due to these kinds of stimuli.

Electrospinning:

It is a fiber production method that utilizes electrostatic force to draw charged jets of polymer solutions or melts into ultrafine fibres.Diameters ranging from nanometers to micrometers.

✓ **Principle;**Applying a high voltage to a polymer solution or melt,causing it to form a conical shape at the tip.

Next generation drug delivery for chronic diseases:

Long acting drug delivery formulations that initiates sustained drug release are serious for chronic diseases that require treatment over years for patients,who have limited access to health care.At now,there are 63 FDA approved long acting drug products on the market.22 products are bio-degradable.

Non-degradable implants have CRDDS for longer periods,when compared to bio-degradable parenterals.Injectables long acting parenterals are not suitable for hydrophilic drugs.

Future studies should focus on developing or improving new long acting parenterals which minimizes compact release & are viable to delivery of hydrophilic and biologics.

Oral route also have longer advantage.These are advantageous in asthma,diabetes,and the and the hypercholestrolemia which have cyclic rhythms where the medication time is difficult to improve the therapeutic outputs.

Covid -19,which have great benefit to the people who do not have frequent acess to medical care.Pulsatile drug delivery systems will enable long term release matching the tones of different chronic diseases.

Enhancing targeting efficiency at both the tissue and cellular levels & increasing the delivery of molecules through barriers:

Long acting drug delivery formulations that enable sustained drug release are critical for chronic diseases which requires treatment over years or for patients in low-resource settings that have limited access to healthcare.Some products are bio-degradable formulations.

Non-degradable implants usually enable controlled drug release for longer period when compared to bio-degradable parenterals and implants,which requires surgical removal after use.Bio-degradable parenterals are ideal.They shows burst release.Parenterals are long acting formulations,not suitable for hydrophilic drugs.

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Recent progress in modern drug targeting strategies:

- It covers a brand range of developments in the various drug delivery systems and drug targeting strategies.
- It studies about the solid oral drug delivery system,the most common method of drug delivery &latest advanced developments.
- It also provides a brief sketch of the production,physio-chemical properties,formulations of micro carriers,nano technology,and liposome as drug carrier systems.
- It involves the use of hydro gels in drug carrier systems and the use of polymeric micelle systems for DD & Bio-medical applications.
- Emerging or important role of niosomes as candidate carriers in imaging and drug delivery is also explored.
- Important technologies for drug delivery covered are polymer technologies featuring polymer grafting, inter-penetrating polymer networks(IPN), & polyelectrolyte complex structures for controlled drug delivery.

Recent progress in Bio-Medical applications:

- It covers the role niosomes as a convenient, cheap and stable means of delivery of therapeutics in biomedical applications.
- It also uses nanotechnology for drug biological systems via nanotechnology & 3-D printing, technologies in fabricating drug delivery systems.
- It uses the natural biocarriers for brain targeting, a here to difficult area for drug delivery.
- A graphene based system for drug delivery is also are bioceramics systems. The review provides an overview of the broad future of nanofibers in the sector of biomedical applications.

Red blood cell membrane camouaged nanoparticles drug delivery system:

- Red blood cell membrane – hide nanoparticles which is a recent class of DDS.
- Nature of biological significance of red blood cells(RBCs) which allow for their use as an efficient system as a nanoparticle material.
- Because, RBC are most important circulating cells in body, their biocompatibility, biodegradability, and extended circulating half-life, making them an ideal vehicle for drug delivery.
- This structured RBCs are tested and found to be an excellent carriers for a variety of chemicals, including enzymes, medications, proteins and macromolecules.
- Because, of their increased number red blood cells membranes acts as a hiding agents, which allows the nanoparticles to combine the actions of natural RBC membranes with those of nano material.
- Some techniques are developed to load the agents onto RBCs without comprising the structure and the physiological function of RBCs.
- The coated nano particles will mimic RBCs and interact with the environment to establish long systemic circulation when injected.
- Sonication is most widely used method for creating RBC hided nanoparticles.
- Each one has advantages and disadvantages in word of synthesis, scaleup challenges, reproducibility of natural products.
- Before the fusion, the RBC membrane derived vesicle is taken or collected through hypotonic treatment of fresh whole blood from an organism.
- The hypotonic treatment will help to remove unwanted cells and plasma.
- The use RBCM – NPs drug delivery system is extremely promising and offers numerous advantages due to their low immunogenicity and ability to maintain long systemic circulation(life span 120 days).
- Because of more number of cell membranes RBC vesicles are biocompatible and biodegradable and can easily achieve high and can easily achieve high load capacity, resulting in higher accumulation at the target site.
- RBC membrane coated nano-formulations have been extensively applied in anticancer research for improvement.
- Used in cardiovascular diseases.
- Also employed in encephalopathy.

Microneedles:

MNs which promote novel procedure which delivers the Active pharmaceutical ingrediant through the transdermal route.This is includes the API is limited.Restricted to APIs with suitable lipophilicity [log p within 2-3].Low melting points and molecular weights <500 Daltons.MNs can appear in many different forms which includes,hollow and dissolvable which contains similar design of base.The needles measurement in size within the micron range 10-2000 micro meters.It improves the bio-availability of the drug.

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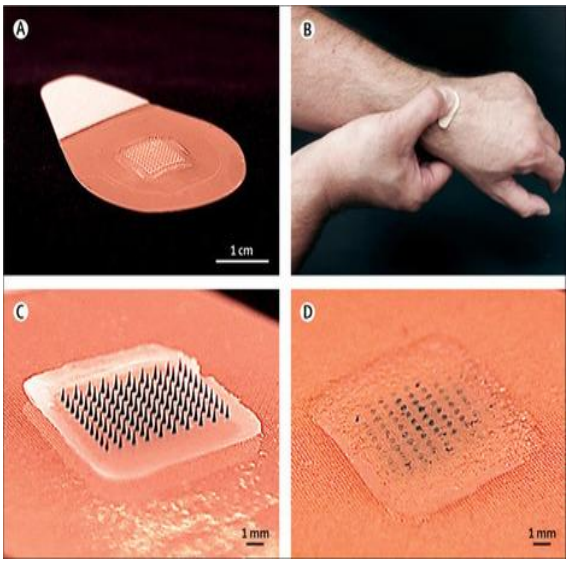

Fig:5-Figure showing microneedle application

Conclusion:

In conclusion, Pharmaceutical development of drug delivery system is being pursued enthusiastically in many laboratories in India. These are being investigated *in vitro* for release pattern and in some cases *in vivo* in animals for pharmacokinetics but less frequently for efficacy. There is a paucity of data on clinical studies and utility of the DDS in patients. It is necessary that pharmacologists should be involved in the investigation of pharmacokinetics and pharmacodynamics of DDS if the products have reached their meaningful outcome - the clinical use**.**

The integration of drug delivery systems and regenerative medicine has revolutionized healthcare by providing innovative solutions for treating a wide range of conditions, including neurodegenerative diseases, cardiovascular disorders, musculoskeletal injuries, and cancer. This review has explored key advancements in biomaterials, controlled drug release strategies, regenerative medicine, and tissue engineering, demonstrating their potential to enhance cell survival, targeted drug delivery, and functional tissue regeneration. By improving the precision and efficacy of therapeutic interventions, these technologies offer new hope for patients suffering from conditions that currently have limited treatment options.

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