Chapter 7
NOVEL DRUG DELIVERY SYSTEM

→ The meaning of Non-conventional - Non-traditional is Newer = NOVEL It is a different methodology or a new approach for drug delivery other than the conventional drug delivery system.

→ A Novel Drug Delivery System (NDDS) is referred as a fresh approach that combines inventive development, formulations, new technologies, novel methodologies for supplying pharmaceutical mixtures in the body as required to safely achieve its anticipated pharmacological effects.

→ It may include scientific site targeting within the body, improves drug potency, control drug discharge with extended pharmacological effect.

→ It involves the growth of novel, better and safer drugs with long half-life and huge therapeutic indices.

→ It is necessary to critically assess different terms used in the different broad groups of novel drug delivery system

1. **Sustained- or Controlled-Drug Delivery Systems :** These systems deliver drug action at a pre-determinedrate by giving a prolonged or constant (Zero-order) discharge respectively, at the therapeutically effective levels in the flow.
2. **Localised Drug Delivery Devices :** These systems deliver drug action through spatial or temporal regulator of drug release (usually rate-limiting) in the area of the target
3. **Rate-Pre-Programmed Drug Delivery Systems :** These systems deliver drug action by influencing the release of drug molecules by system design which controls the molecular diffusion of drug particles
4. **Targeted Drug Delivery :** These systems deliver drug action by carriers either for passive or active targeting or one base of self-programmed method, usually anchored with appropriate sensory devices, which recognise their receptor at the target

Classification

Sustained and Controlled Release Drug Delivery

→ The rate at which a drug is released from resonate is dependent on several factors. In various cases, to controlthe resultant effect or sustain the release of medicine over several hours, the rate is made suitably slow.

→ Further medication can be attained by the use of coatings that limit the release.

→ control the site of release Dextromethorphan (coated), diclofenac and nicotine are examples of the drugs using this technique

→ Another advantage of this technology is that the drug does not needs to be in crystalline form.

Microencapsulation

→ Microencapsulation is a process where small droplets or particles of solid or liquid substances are covered by a nonstop film of polymeric materials.

→ By delivering the active agent at optimal rate to the target tissue and causing slight toxicity and least side effects, the maximum therapeutic value can be attained Delivery of a drug in a sustained controlled release way is done by microsphere as carriers for drugs.

→ In the microencapsulation, the covering of the particles is reaching dimensionally from some tenths [of a micron to 5000 micron size

Parenteral Controlled Release System

→ The parenteral route of administration is the most common and effective way for delivering drugs with low bio availability and fine therapeutic index.

→ Therefore, the drug therapy will not only benefit compliance, but also improve the quality of the therapy when the frequency of injection will be reduced.

→ This reduction in the entire number of drug dosing is reached by the use of a formulation technology that promises the release of the drug is in a controlled manner twice monthly or even less frequently.

→ In addition, humanising patient comfort and reducing the frequency of injection of drugs in the form of depot formulation are the objective of parenteral controlled release system.

→ The depot formulations are likely to not only boost the therapeutic profit but also to lessen unwanted side effect

Buccal Drug Delivery System

→ Buccal region deals with suitable route of administration for systemic drug delivery from the various transmucosal available sites.

→ For the purpose of delivery of the therapeutic agents for both Buccal as well as systemic delivery used as retentive dosage forms, buccal cavity mucosa is the most convenient and available site.

→ Mucosa is relatively permeable because of rich blood supply.

→ The Buccal drug delivery system includes fast dissolving tablets, sublingual tablets, chewing gum, buccal patches

Transdermal Drug Delivery Systems

→ Transdermal drug delivery system delivers the drug through the skin at a controlled rate to the systemic circulation when distinct dosage forms is applied on the intact skin.

→ Topical use has been applicable for centuries, mostly in the treatment of localised skin ailments.

→ Native treatment requires only the drug permeation through the outer layer of the skin to treat the diseased state, hoping that this occurs with slight or no systemic accumulation.

Ocular Drug Delivery System

→ The complication of the eye provides unique difficulties to drug delivery plans, Conventional eye drops, used for treating many ocular diseases has several disadvantages.

→ Elderly patients, children and even practised users injure their eyes upon contacting with the bottle tip leadings to bacterial contamination.

→ Preservatives also cause morphological alterations to vital parts of the eye such as conjunctiva, cornea and tendon resulting in alteration of scarring behaviour after glaucoma surgery

→ For maintaining chemical stability of the drugs used preservatives and pH regulations are added. Both of them lead to enhance tear flow causing poor pharmacokinetics of eye drops due to dilution of the active moiety.

→ Preservatives persuade irritation like tearing, stinging. hyperemia, burning and allergy and punctuate dermatitis, a common ocular reaction of usual eye drops.

→ In common drug supply devices like the NODS (new ophthalmic drug delivery system) an accuser is demonstrated to be harmless and tolerated in the human eye and are proficient delivery systems

Nasal Drug Delivery Systems

➢ Nasal administration provides an interesting and promising different technique for reaching the systemic drug effect to the parenteral route Now a day, as compared to oral administration many drugs have improved systemic availability through the nasal route.

➢ Biotechnological expansion has led to the development of new and large amount of protein and peptide frogs for managing several ailments Oral administration is not possible because drugs knowingly degrade in the GIT or rendered metabolised by first pass effect in the liver.

➢ Intranasal drug delivery provides a capable alternative of administration route for such drugs.

➢ Nasal drug delivery systems are suitable when confined and hitched blood brain barrier has to be crossed so that drug can be supplied to the biphasic of CNS.

➢ It is also used for the administration of vaccines.

➢ It is used for therapeutic purposes as it provides rapid systemic drug absorption and quick onset of action because of anatomical, physiological and histological characteristics of the nasal cavity.

Pulmonary Drug Delivery Systems

- Pulmonary route is used to treat respiratory diseases for centuries.
- The use of leaves from plants, vapours from aromatic plants, balsams and myrrh was done in ancient inhalation therapies.
- The development of a safer inhalation therapy depends on the pharmacological activity of molecule and the delivery system applications.
- The respiratory tract is open to a fairly very huge number of biological and non-biological particles.
- A characteristic of the effective lung defence mechanism is that healthy people's lungs are sterile below the larynx.
- In the management of obstructive respiratory disease.
- The pulmonary route is the best alternative to other routes since it can minimize the required dose.
- At its worst, it can be a barrier for patient compliance with the specific drug regimea vital to most effectively treat the disease, since certain patients pick irregular treatment or no treatment at all when encountered with recurrent injections.

Intra-Uterine Drug Delivery Systems

- IUD is a little plastic contraceptives device that is gently introduced into the uterus (womb) by either a physician or nurse practitioner IUD are about 98-99% operational in avoiding pregnancy and one type of IUD stays place for up to 10 years before needing to be replaced
- Once inserted, the IUD is instantly effective and when removed, its contraceptive effect is instantly stopped The IUD may affect the manner the sperm or egg moves and it prevents the egg and sperm from uniting (fertilization).
- The copper IUD causes thickening of the cervical mucus, forming a barrier that averts sperm from entering the uterus.
- For most women, IUD is very safe and effective: The IUD is an excellent choice for a female who has children and wants long term, but not permanent contraception.
- The IUD is a good choice for females who cannot take birth control pills, use DEPO Provera or Norplant and who choose not to use a barrier method of contraception like diaphragm or vaginal foam.

Gastrointestinal Drug Delivery System

→ Not all drugs are absorbed consistently throughout the GIT is chief limit in orally controlled release drug delivery system However, some drugs are absorbed habitually through gastrointestinal tract.

→ Some drugs are absorbed in exact proportion of gastrointestinal tract or to an altered extent in several segments of gastrointestinal tract Such drugs have an "absorption window"
→ So the drug released in the region proceeding and in close nearby area to the absorption window is accessible for absorption.
→ Later crossing the absorption window, the released drug goes to waste with slight or no absorption.
→ This severely reduces the time available for drug absorption and bounds the victory of delivery system These concerns have led to the growth of oral Gastro Retentive Dosage Forms (GRDF) possessing gastric retention capability.
→ One of the most viable approaches is to regulate the gastric residence time (GRT) using GRDF that offer a new and better choice in drug therapy for achieving a prolonged and expected drug delivery profile in gastrointestinal tract.
→ Dosage forms that can hold in stomach are called gastro retentive drug delivery systems /

Targeted Drug Delivery System

→ It is for delivery of drugs to part or organ or the receptors of body to supply the drug entirely. Two distinct approaches based on this definition are:

1. The drug is directly selected for the target site where it is concentrated and shows its reaction.
2. The chemical agent is steadily offered but is active and/or activated only at the target site.

→ Targeted drug delivery study is done on area that concentrates on the development and estimation of systems with precise features.
→ The features can be of selective or regional drug delivery, controlled drug delivery, or the combination of all.
→ Targeted delivery system is made available for routine use.
→ It is important to critically establish the evaluation procedures and the benefit over a conventional dosage form, if any, is documented.
→ The progress of preclinical estimation of microsphere, drug conjugates, liposomes and alike systems.

Brain Targeting Drug Delivery System

➢ It is aiming of drug to a specific site of the brain for the preferred duration to obtain pharmacological action.
➢ The brain is a gentle and composite organ in the human body and progress has built extremely capable ways to guard it.
➢ It would not add up for brain to become the site of infection and immune response.
➢ Incredible improvements in brain targeting research in the world's leading cause of disability, brain and central nervous system disorders comprise new hospitalisations and prolonged care than other diseases altogether.

Nanocarriers Drug Delivery System

- In about 90% of all drugs, the active elements are in the form of the particles.
- Now it is possible to prepare drug nanoparticles by a range of new ways with the expansion in nanotechnology.
- Nanotechnology is often useful in fibre, textiles, agriculture, electronics, forensic science, space and medical therapeutics namely disease discovery.
- controlled drug delivery, as biosensors in tissue engineering and so on.
- Nanoparticles drug formulation decreases the patient costs and risks of toxicity.
- Nanocapsulation of drugs (nanomedicines) raises drug efficacy, specificity, and therapeutic index of corresponding drugs,
- New drug delivery pathways can be used to enhance drug efficacy and reduce side effect. For better growth of the nanoparticulate systems, it is vital to know the pharmaceutically relevant properties of nanoparticles.

Proteins and Peptides

→ The most common route of protein and peptide drug delivery is parenteral However, the route is related to pain on administration causing poor patient compliance and the preparation needs to be sterile.

→ Drugs inserted by the gastrointestinal route are likely to undergo acid hydrolysis and extensive gut and/or hepatic first-pass metabolism

→ Thus, these protein drugs may show poor oral bioavailability Non-invasive mucosal and transdermal delivery route is partial to potent drugs while lipophilic composites do not give rapid blood levels and are less permeable than oral mucosa Various absorption mucosas have been known and explored for systemic drug delivery including nasal, ocula, pulmonary, rectal vaginal mucosa

Implantable Drug Delivery System

- These are present beneath the skin as a tiny colloid particles and are unknown to the patient.
- They are intended to permit the drugs and fluids into the bloodstream without the constant inclusion of needles.
- Two approaches to this problem appear possible and realistic
- The use of implant electrically driven pumps that can be restocked by simple drug injection through septum into the pump reservoir is the most important approach.
- The main disadvantage is the huge size of the device and the requirement for surgical implantation having the risk of infection
- The use of polymeric systems in future as implants needs more input from polymer chemistry and allied fields

Advantages

- ✓ Controlled delivery by sustaining desired drug concentration and controlled rate
- ✓ Precise dosing
- ✓ Improved efficacy and safety
- ✓ Site / Target specific delivery of drug with an optimum dose
- ✓ Reduced toxicity/side effects
- ✓ Helpful to patients for better comfort and standard of living

Challenges

- → Delivery of poorly soluble drugs and bioavailability hurdles for poorly soluble clinical candidates are the major challenges in Drug Delivery Systems.
- → There are some Novel tactics in the delivery.
- → Overcoming bioavailability difficulties and Rationale formulation design of poorly soluble drugs.
- → Other major challenges in drug delivery are protein drug delivery, pediatric and geriatric drug supply Self-Emulsifying Drug Delivery Systems (SEDDS) retains unparalleled potential in refining oral bioavailability of poorly water-soluble drags
- → The event Pharmaceutical 2016 took dosage form into concem making it a dosage form meeting. Despite of having a vast freedom and advantages of NDDS, it also has some downsides and limitations.
- → The administration and implementation cost of Nanomedicine is much more costly.
- → Cytotoxicity of the nanoparticles develops a threat for future.
- → Due to their much greater cost and complexity.
- → Nano product is facing greater difficult. For a large number of users, partial availability and lesser production rate of personalised medicine and device are challenging.
- → Some innovative and non-invasive supplies improve the patient approval by dropping the marketed price and production cost which marks product degradation & quality issue.
- → Novel drugs given through the oral cavity must possess the risk of enduring acid or enzymatic degradation or hydrolysis.
- → Certain medical devices like Nanoshell. Nanotube, and Nanopores are difficult to introduce in the body of some patients, babies, or old people.
- → All kinds of drugs or medicines cannot be given through the nanoparticles, carriers or devices as they cannot be merged in the polymer matric or they can be degraded.
- → But the scientists and researchers are always trying to overcome the downsides through their inventions.

1. It helps in blocking drug supply in tumors.
2. It overcomes the challenges and barriers of ocular drug delivery.
3. It helps in poorly soluble drugs preparation design.
4. It helps in vegetative preparation.
5. It helps in drug release testing and pharmaceutical equipment.

6. It is helpful in academy and in industry perspective.

THANK YOU