Novel drug delivery systems

Introduction to Novel Drug Delivery Systems (NDDS)

What is a Drug Delivery System (DDS)?

- A Drug Delivery System (DDS) is a formulation or device that enables the introduction of a therapeutic substance into the body and improves its efficacy and safety by controlling the rate, time, and place of release.

Traditional Drug Delivery Systems:

- These include oral tablets, capsules, injectables, ointments, etc.
- While effective in many cases, they often suffer from drawbacks like:
    - Poor bioavailability
    - Frequent dosing
    - Systemic side effects
    - Poor patient compliance

Why Novel Drug Delivery Systems (NDDS)?

- NDDS are designed to overcome limitations of conventional systems by:
    - Targeting the drug to the site of action
    - Controlling the release rate and time
    - Reducing side effects
    - Enhancing therapeutic outcomes
- Thus, NDDS can significantly improve:
    - Drug solubility
    - Bioavailability
    - Stability
    - Patient adherence

Advantages of NDDS

- Improved bioavailability of poorly soluble drugs.
- Controlled and sustained drug release, reducing dosing frequency.
- Targeted delivery minimizes systemic side effects.
- Enhanced patient compliance due to convenient administration.

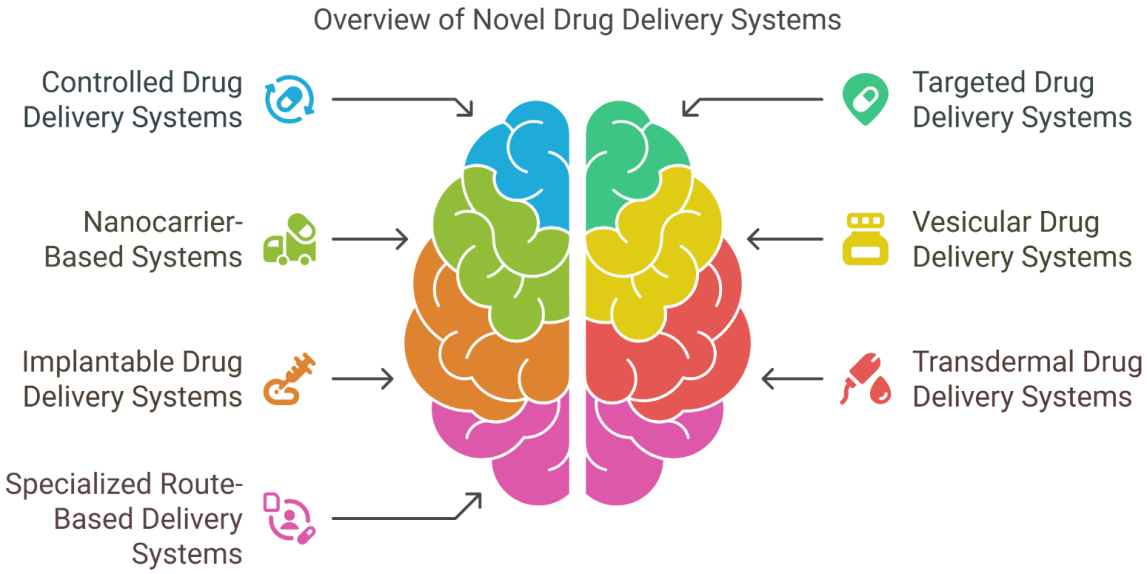
- Protection of drugs from enzymatic or chemical degradation.

Challenges of NDDS

- High development costs and longer approval times.
- Complex manufacturing processes requiring specialized equipment.
- Stability issues, especially with biologics and nanocarriers.
- Regulatory hurdles for novel systems.
- Scale-up difficulties from lab to commercial production.
- Patient variability in drug absorption and response.

Classification of Novel Drug Delivery Systems (NDDS) with Examples

- NDDS can be broadly classified into the following types:



A. Controlled Drug Delivery Systems

- These systems release the drug at a predetermined rate, maintaining a constant drug concentration for a specific period.

Subtypes:

1. Sustained Release (SR) Systems

- Release the drug slowly over time.
- **Example:** SR tablets of diclofenac sodium.

2. Controlled Release (CR) Systems

- More precisely control the release compared to SR systems.
- **Example:** Procardia XL (nifedipine).

3. Prolonged Release Systems

- Extend the duration of drug action without maintaining constant levels.
- **Example:** Theophylline extended-release tablets.

B. Targeted Drug Delivery Systems

- Deliver the drug specifically to the target site (organ, tissue, or cell type), minimizing systemic exposure.

Types:

1. Passive Targeting

- Based on physiological conditions like leaky vasculature in tumors (EPR effect).
- **Example:** Doxil® (liposomal doxorubicin) for cancer.

2. Active Targeting

- Uses ligands or antibodies that bind to receptors on target cells.
- **Example:** Trastuzumab Emtansine (antibody-drug conjugate) for HER2+ breast cancer.

C. Nanocarrier-Based Systems

- Utilize nanoparticles to carry and release drugs, enhancing solubility, stability, and targeting.

Subtypes:

1. Liposomes

- Spherical vesicles made of lipid bilayers.
- **Example:** AmBisome (liposomal amphotericin B).

2. Niosomes

- Vesicles formed from non-ionic surfactants.
- **Example:** Niosomal acyclovir for herpes simplex.

3. Nanoparticles

- Polymer-based particles in the range of 10–1000 nm.
- **Example:** Abraxane (albumin-bound paclitaxel).

4. **Solid Lipid Nanoparticles (SLNs)**
    - Made from solid lipids; offer controlled drug release.
    - **Example:** SLN-based curcumin formulations.
5. **Micelles**
    - Amphiphilic molecules forming a core-shell structure in aqueous environments.
    - **Example:** Polymeric micelles for paclitaxel delivery.

D. Vesicular Drug Delivery Systems

- Use vesicles formed from phospholipids or surfactants to encapsulate drugs.

Types:

1. **Transfersomes**
    - Ultra-deformable vesicles for deep skin penetration.
    - **Example:** Transfersomal diclofenac.
2. **Ethosomes**
    - High ethanol content vesicles that enhance skin permeability.
    - **Example:** Ethosomal acyclovir.
3. **Phytosomes**
    - Complexes of plant extracts with phospholipids for better bioavailability.
    - **Example:** Silymarin-phytosome for liver support.

E. Implantable Drug Delivery Systems

- Devices or matrices implanted in the body to deliver drugs over an extended period.

Examples:

- **Norplant** (levonorgestrel) – contraceptive implant
- **Gliadel wafer** (BCNU) – for brain tumor treatment

F. Transdermal Drug Delivery Systems

- Drugs are administered through the skin into systemic circulation for sustained effect.

Examples:

- Nicotine patches (Nicoderm)
- Fentanyl patches (Duragesic)

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