SNS COLLEGE OF PHARMACY AND HEALTH SCIENCES

Coimbatore -641035

COURSE NAME : NOVEL DRUG DELIVERY SYSTEM (BP 706 T)

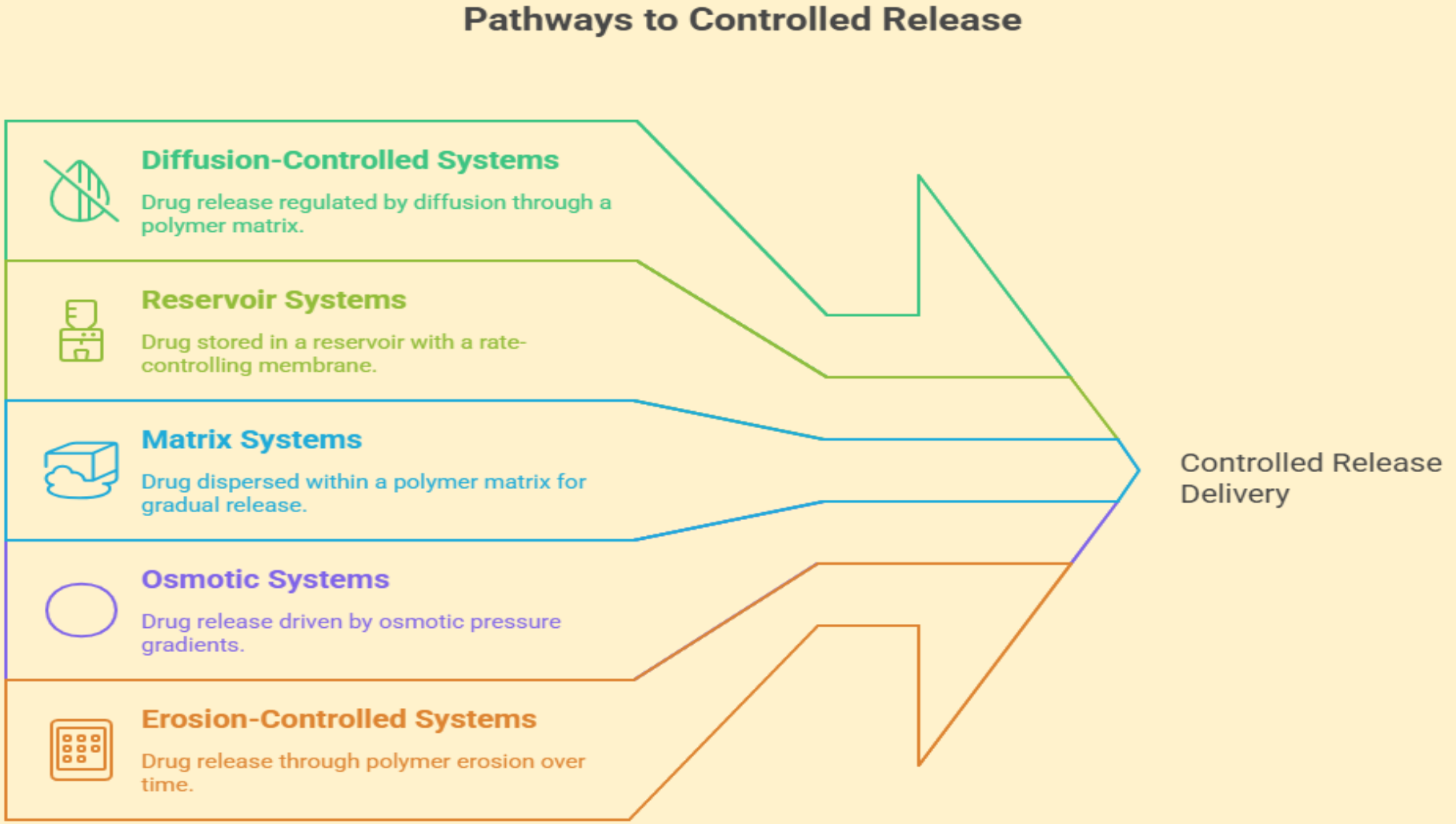
VII SEM / IV YEAR

TOPIC 1 : CONTROLLED RELEASE DRUG DELIVERY SYSTEMS

Design Thinking in CRDDS

1. **Empathize** Deeply understand the user or patient's challenges, needs, and experiences. This involves engaging with patients, caregivers, and healthcare providers to uncover pain points, preferences, and unmet needs
2. **Define**: Reframe the problem based on insights from the empathize phase and establish clear context. This involves synthesizing data to pinpoint the core issue, such as defining the need for a more convenient drug delivery method
3. **Ideate:** Brainstorm and explore a wide range of ideas and potential solutions, including innovative biomaterials or delivery systems.
4. **Prototype:** Simulate and build delivery devices to enhance patient compliance

MINDMAP


Pathways to Controlled Release
Diffusion-Controlled Systems
Drug release regulated by diffusion through a polymer matrix.
Reservoir Systems
Drug stored in a reservoir with a rate-controlling membrane.
Matrix Systems
Drug dispersed within a polymer matrix for gradual release.
Osmotic Systems
Drug release driven by osmotic pressure gradients.
Erosion-Controlled Systems
Drug release through polymer erosion over time.
Controlled Release Delivery
Made with Napkin

Empathize

INTRODUCTION

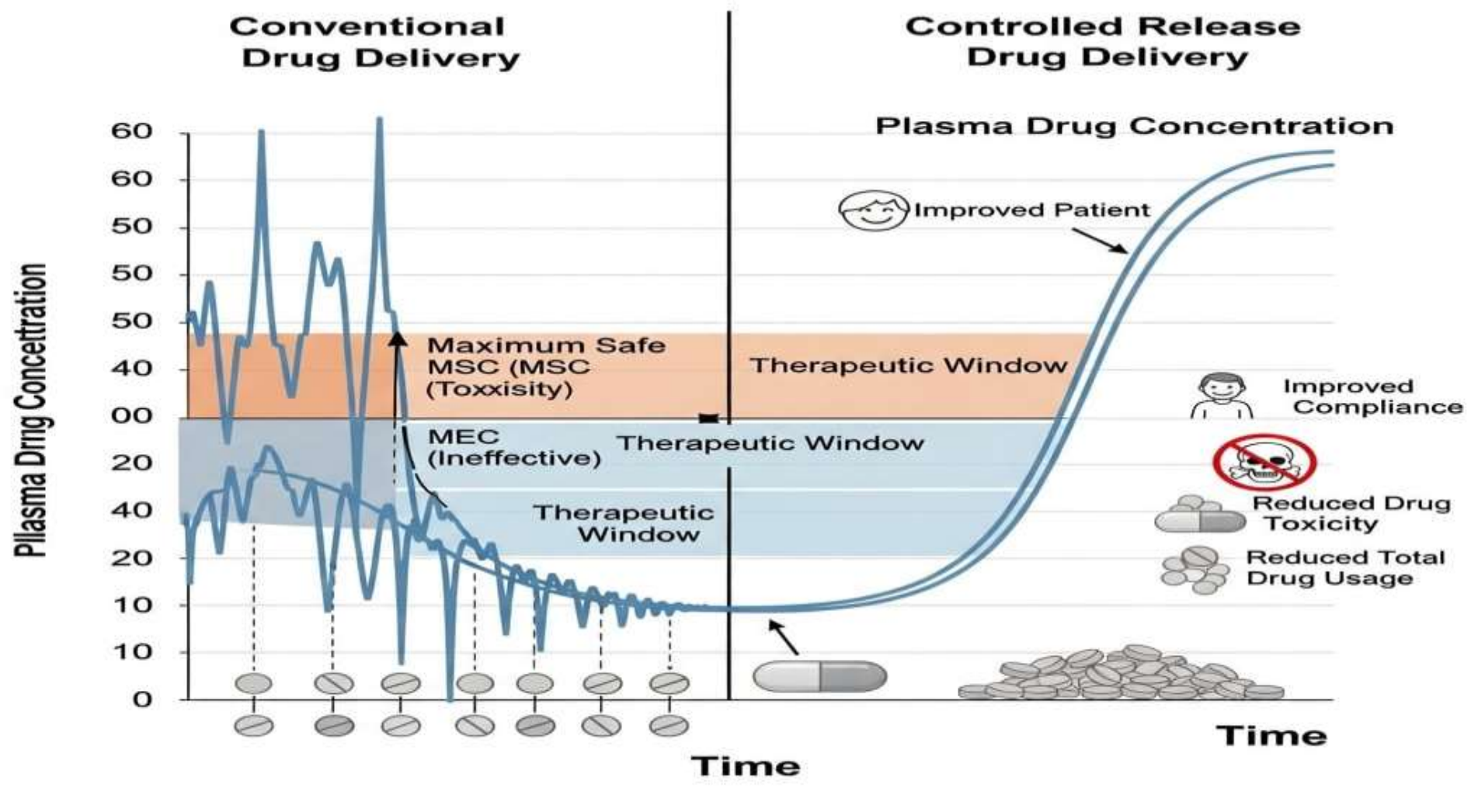
Controlled drug delivery systems can include the maintenance of drug levels within a desired range, the need for fewer administrations, optimal use of the drug in question, and increased patient compliance.

The basic idea behind CDDS concept is to alter the pharmacokinetics & pharmacodynamics of bioactivities either by modifying the molecule structure or physiological parameters.

Empathize

ADVANTAGES OF CRDDS

Empathize

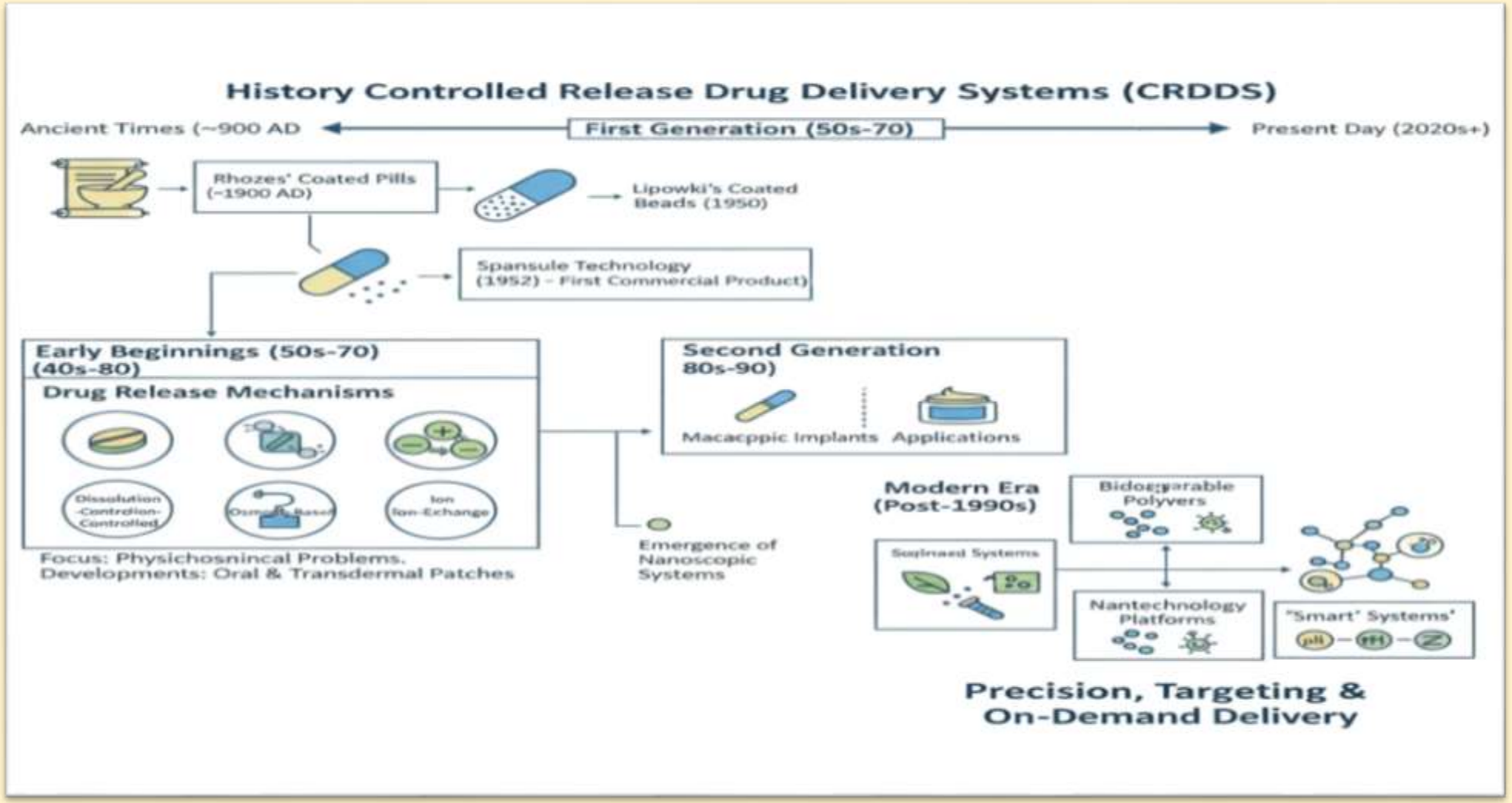


Empathize

DRUGS SUITABLE FOR CRDDS

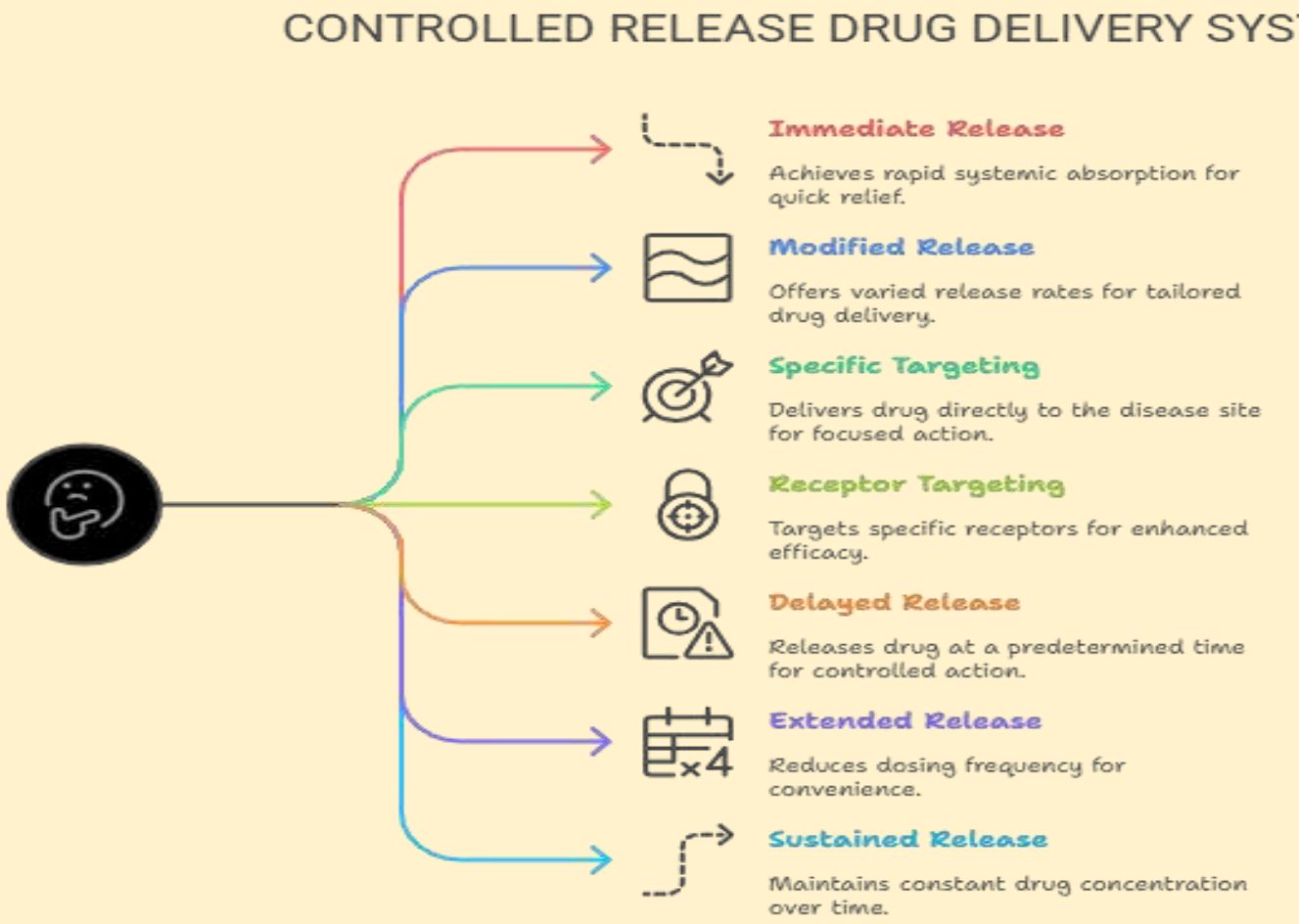
Define

HISTORY OF CRDDS



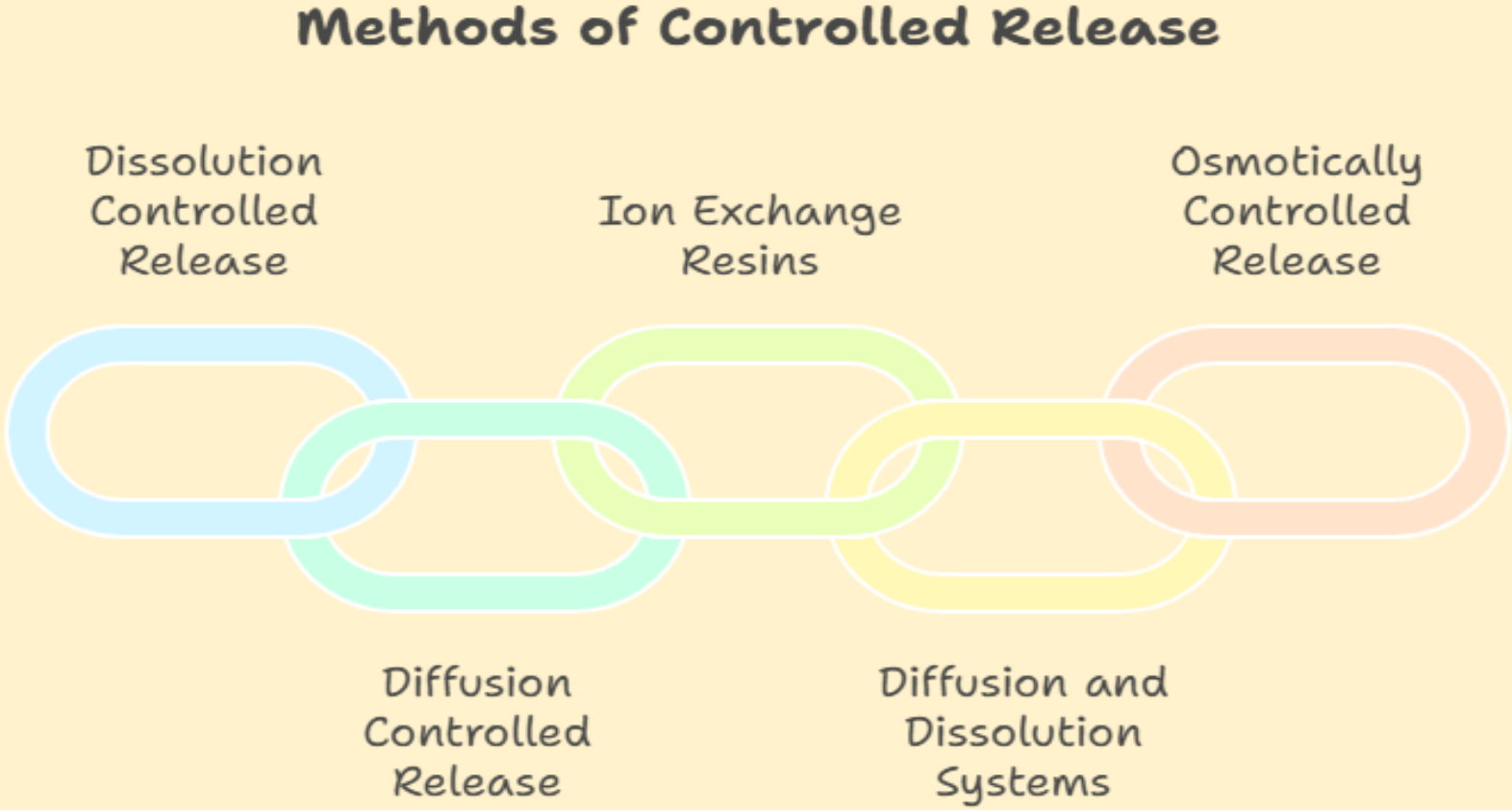
TERMINOLOGY USED IN CRDDS

Define



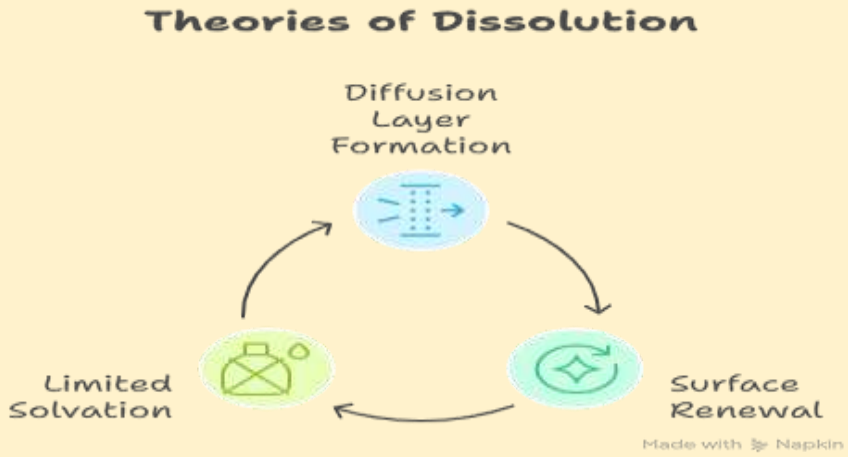
APPROACHES TO DESIGN CONTROLLED RELEASE FORMULATIONS

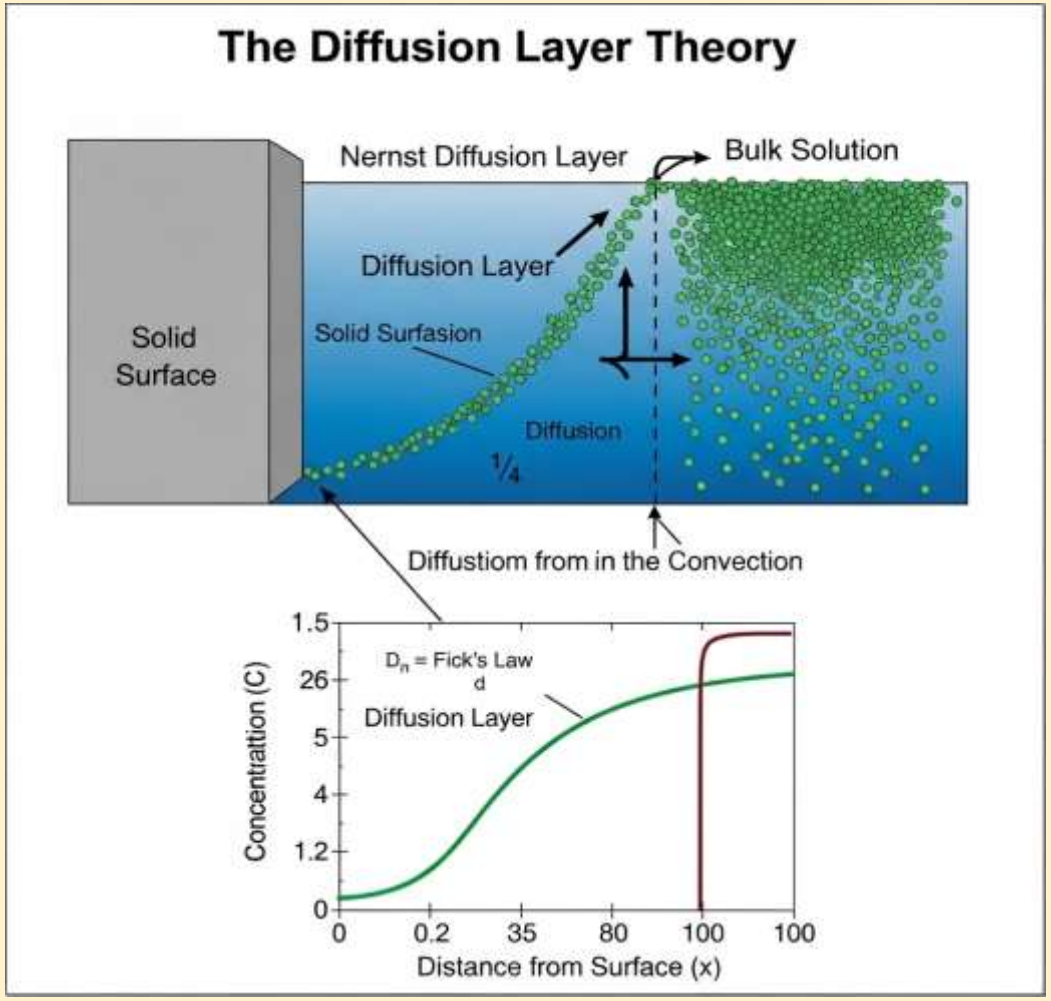
Ideate



DISSOLUTION CONTROLLED RELEASE

It is a rate determining step when liquid is diffusing from solid.

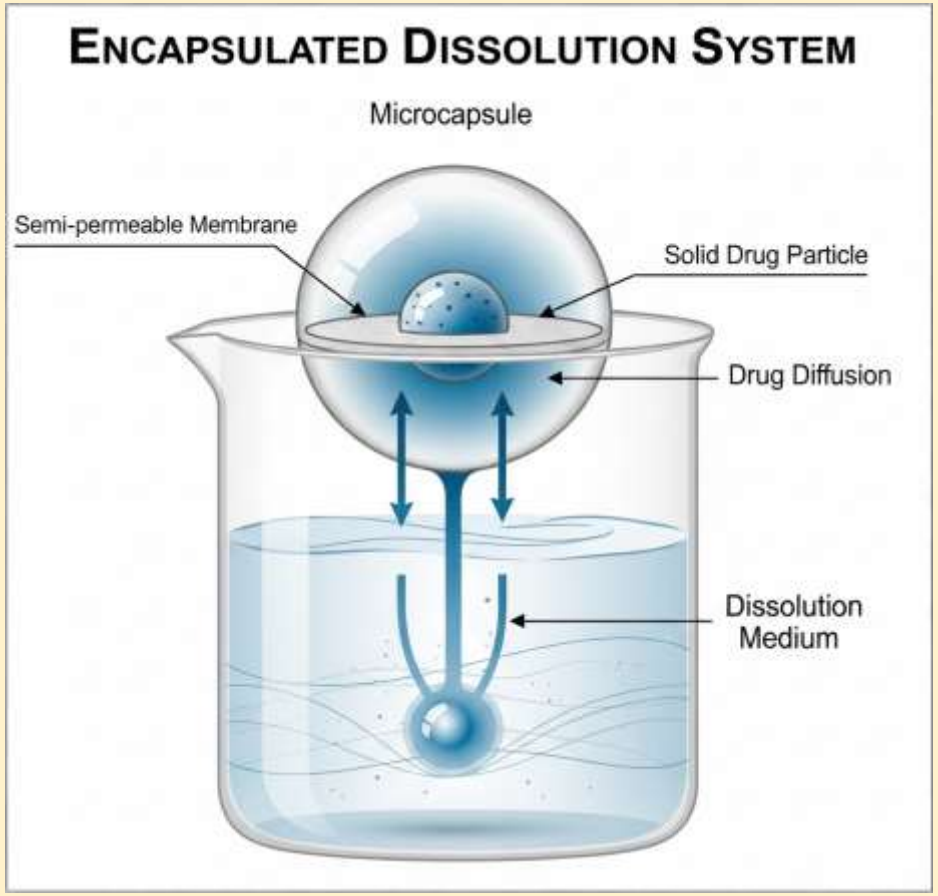




ENCAPSULATED DISSOLUTION SYSTEM

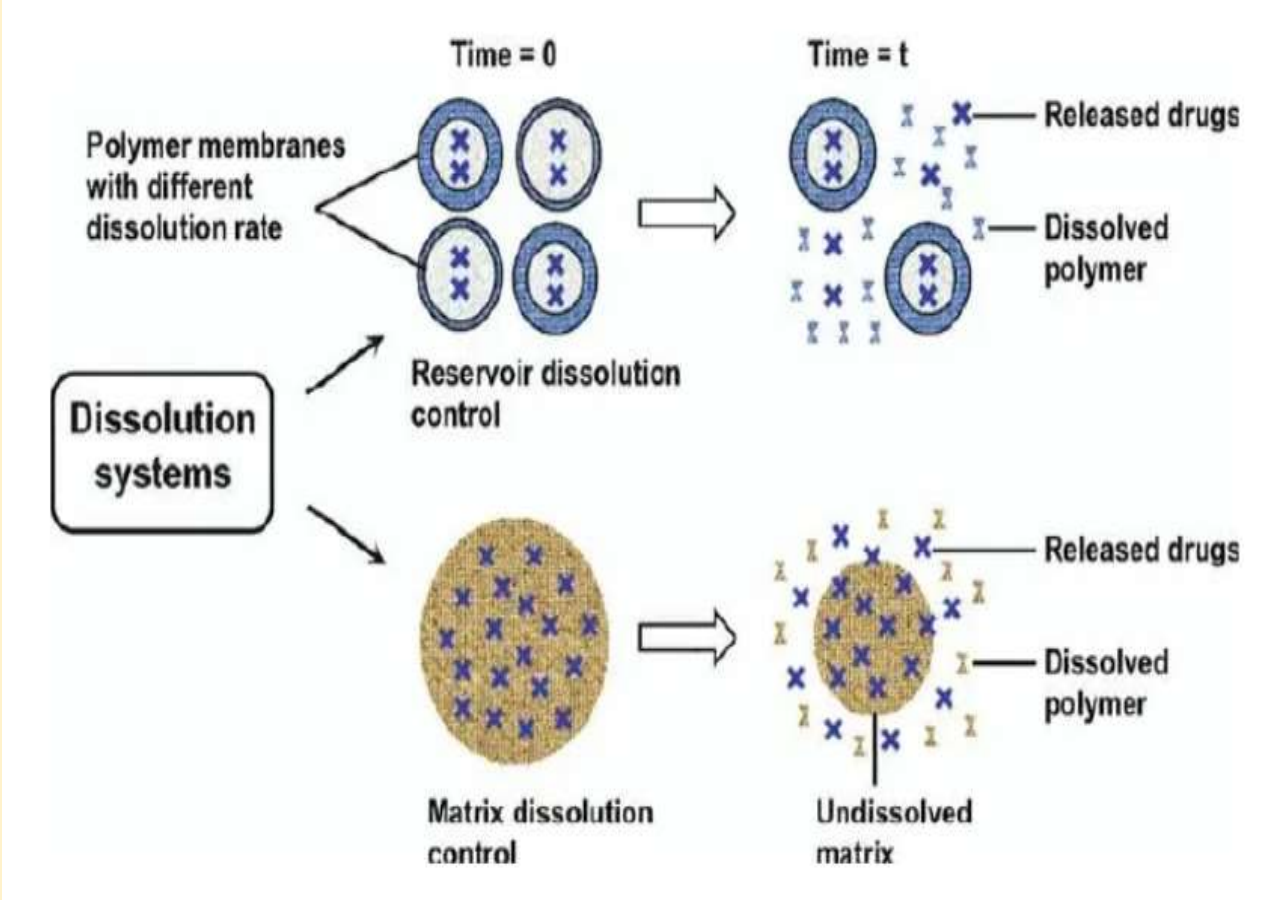
Prototype

- Refers to a mechanism where the drug is enclosed within an encapsulating material, such as a capsule or coating, that controls its release through dissolution.
- The encapsulating material dissolves gradually in the presence of body fluids, allowing the drug to be released over time.



MATRIX DISSOLUTION-CONTROLLED SYSTEMS

- The drug is embedded with in a matrix that dissolves slowly, releasing the drug gradually.
- This approach is often used for water-soluble drugs where the matrix material controls the release rate.



DIFFUSION-CONTROLLED SYSTEMS

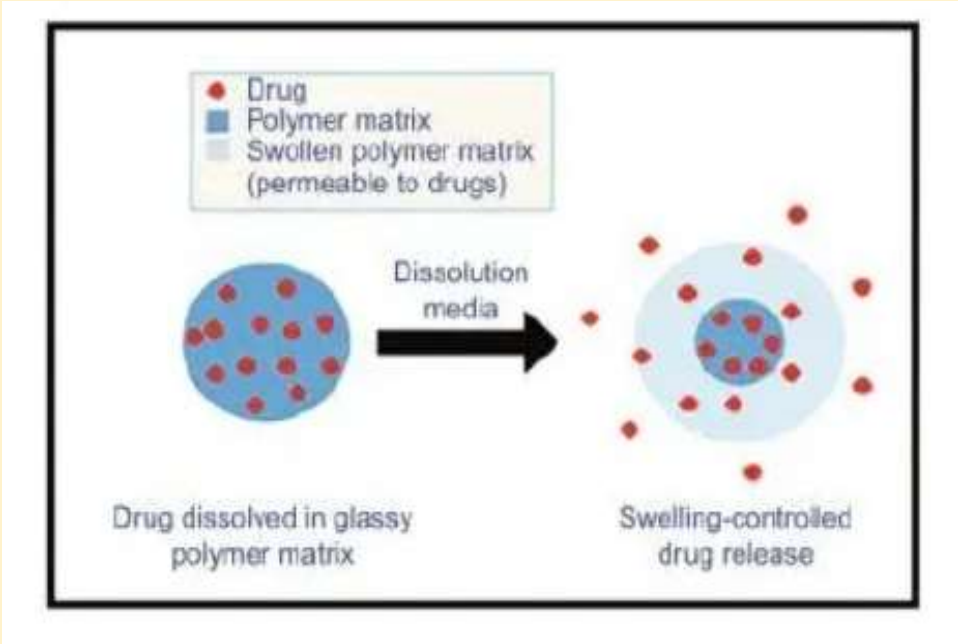
- This involves the movement of drug molecules from a region of higher concentration (within the delivery system) to a region of lower concentration (the surrounding environment, such as bodily fluids) through a rate-limiting barrier, such as a polymer matrix or membrane.
- The rate of release depends on factors like the drug's concentration gradient, the properties of the barrier (e.g., porosity, thickness), and the diffusion coefficient of the drug.

RESERVOIR SYSTEMS

In these systems, the drug is enclosed within a core surrounded by a rate-controlling polymeric membrane. Examples include transdermal patches

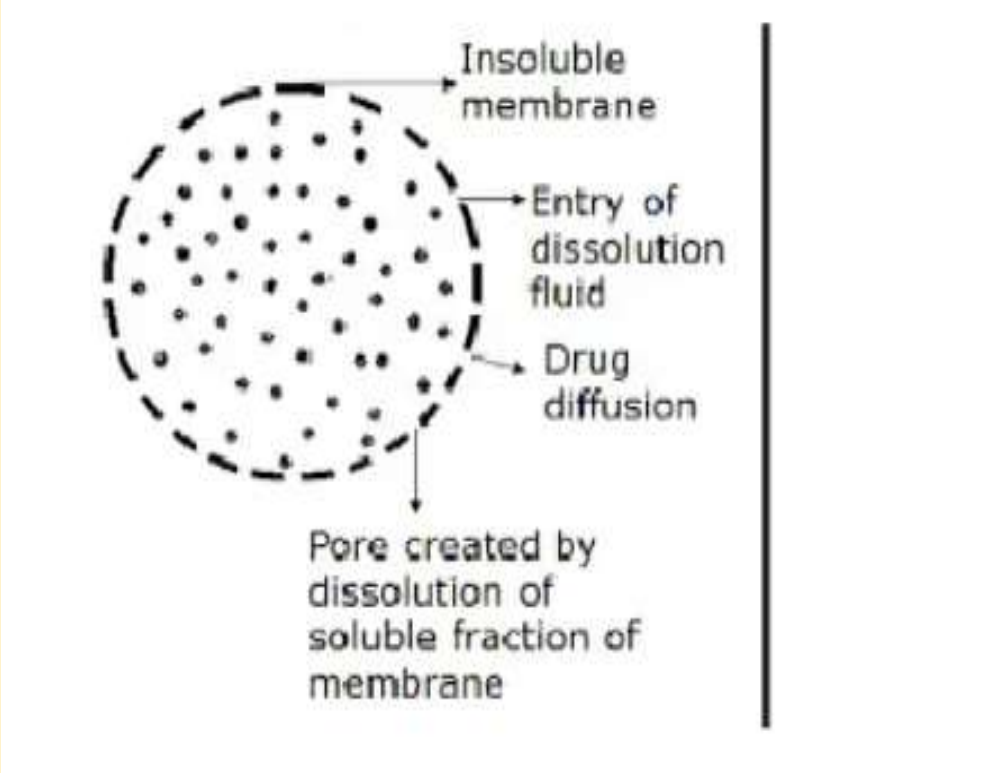
(e.g., Nitro-Dur for nitro-glycerine) and ocular inserts

(e.g., Ocusert for pilocarpine).



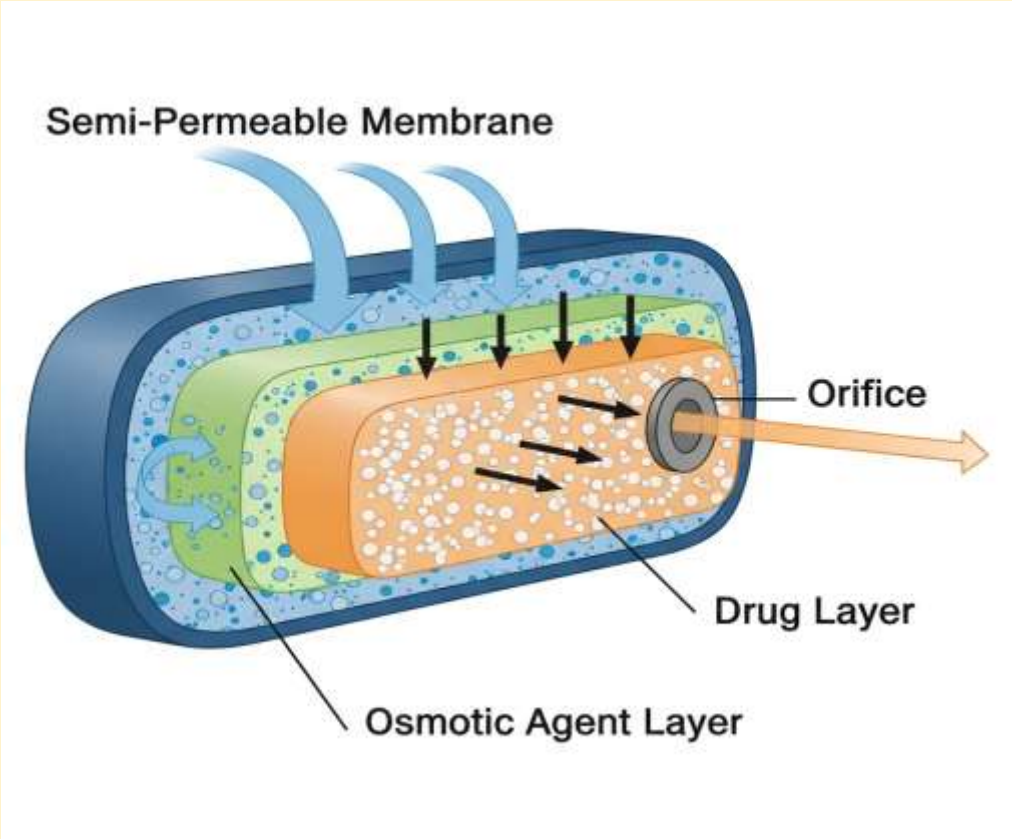
MATRIX SYSTEMS

In matrix systems, the drug is dispersed uniformly throughout a polymeric matrix. The drug release occurs as it diffuse out of the matrix. (e.g., Theophylline in Theo-24)



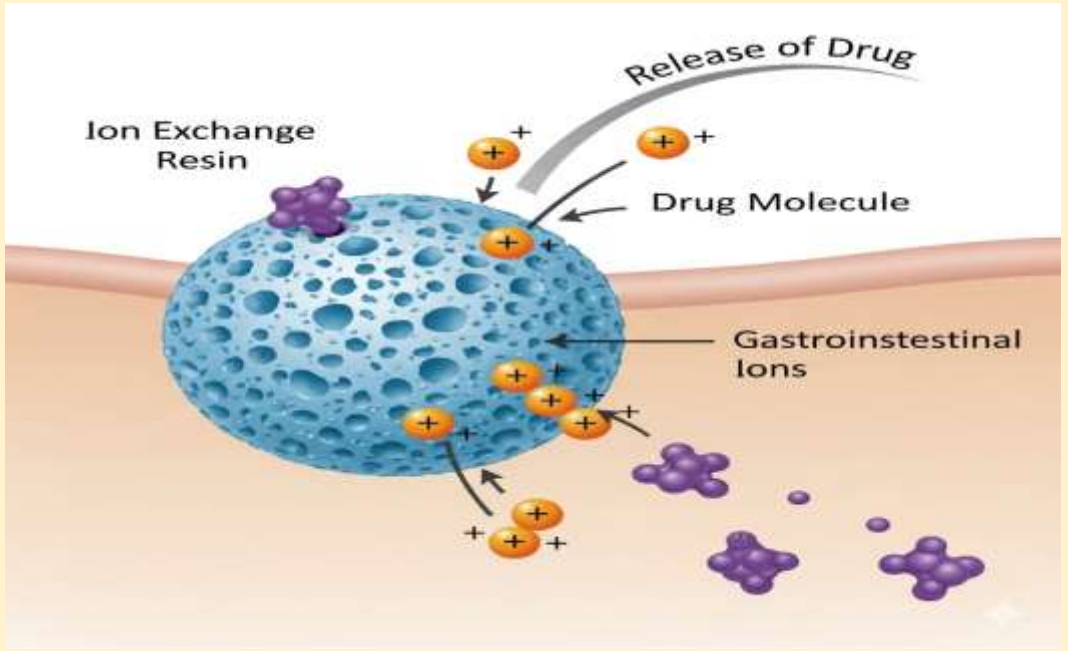
OSMOTIC-CONTROLLED SYSTEMS

Utilize osmotic pressure to control drug release. The system typically consists of a core containing the drug and osmotic agents surrounded by a semi-permeable membrane with a laser-drilled orifice..



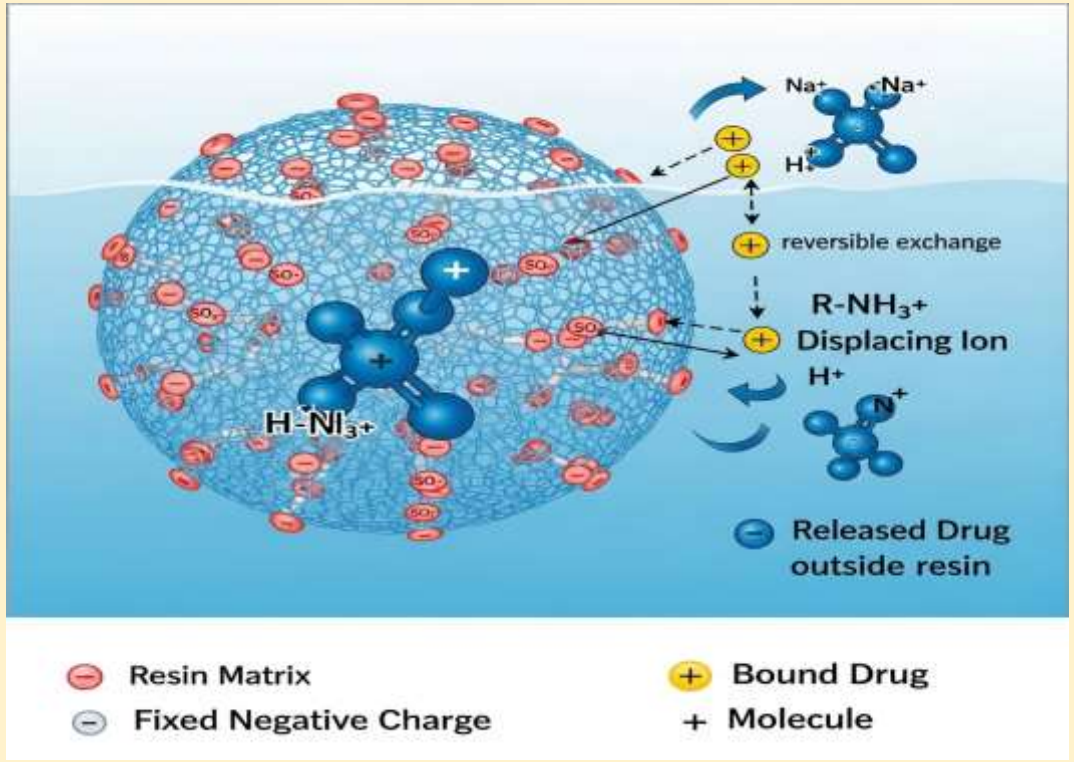
ION EXCHANGE SYSTEMS

- The drug is bound to an ion exchange resin, and release occurs when ions in the gastrointestinal tract exchange with the drug ions, causing a controlled release



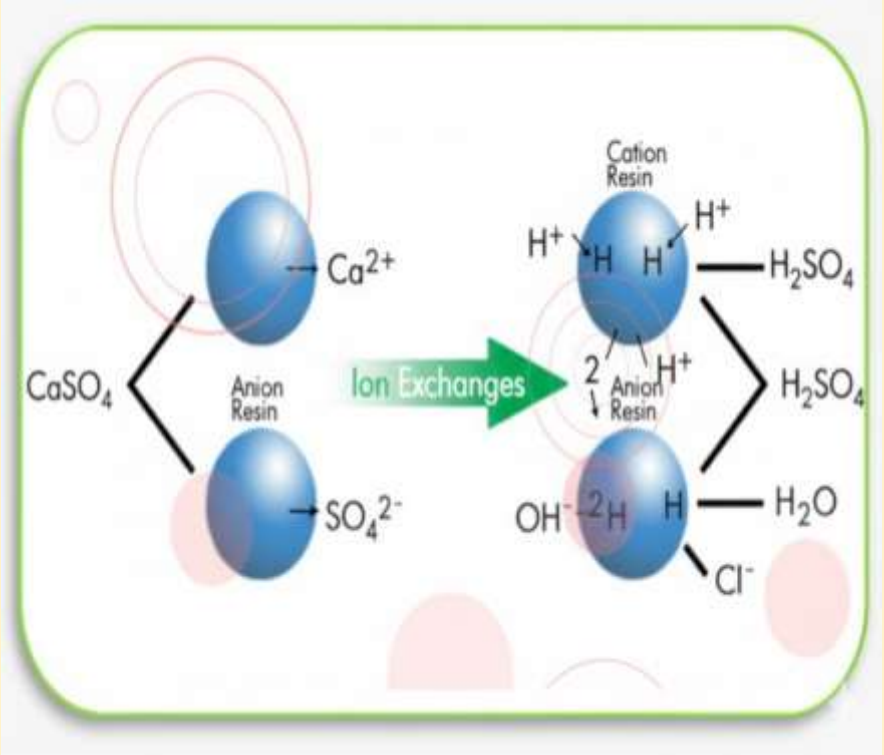
MECHANISM OF ION EXCHANGE RESINS

- The basic principle of ion exchange resins involves the reversible exchange of ions between the resin and the surrounding medium.



CATION EXCHANGE RESINS :

These resins contain acidic functional groups (e.g., sulfonic acid or carboxylic acid) and exchange their positively charged counter-ions (usually hydrogen ions) with cationic drugs

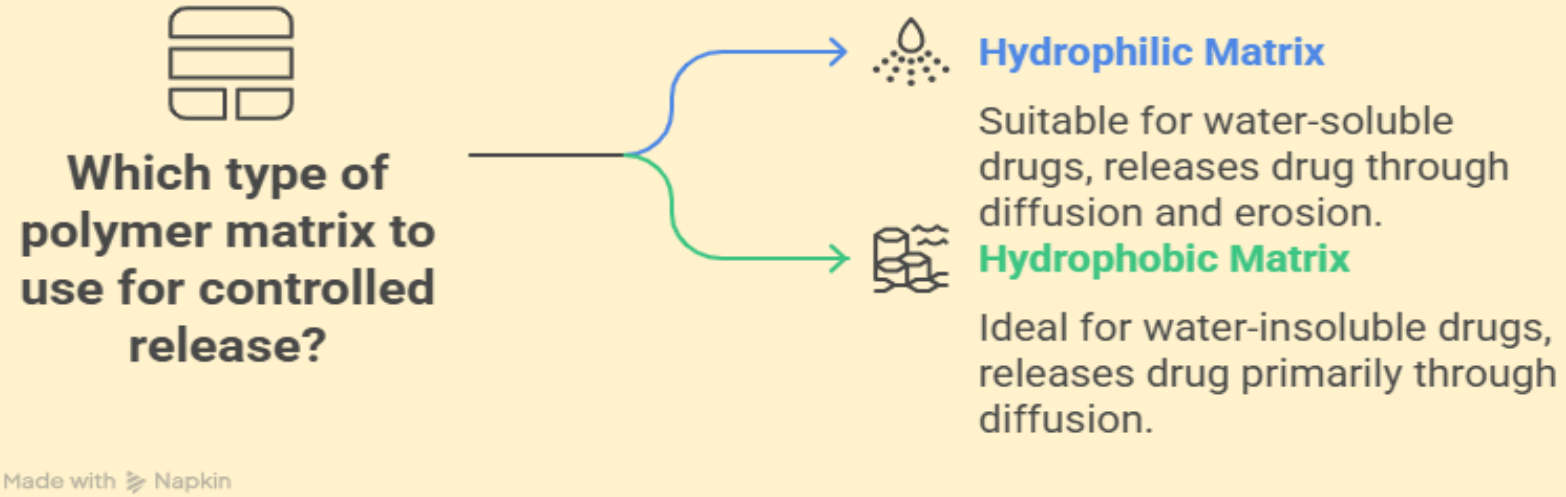


ANION EXCHANGE RESINS :

These resins contain basic functional groups(e.g., quaternary ammonium) and exchange their negatively charged counter-ions (usually chloride or hydroxide ions) with anionic drugs

MATRIX-BASED SYSTEMS

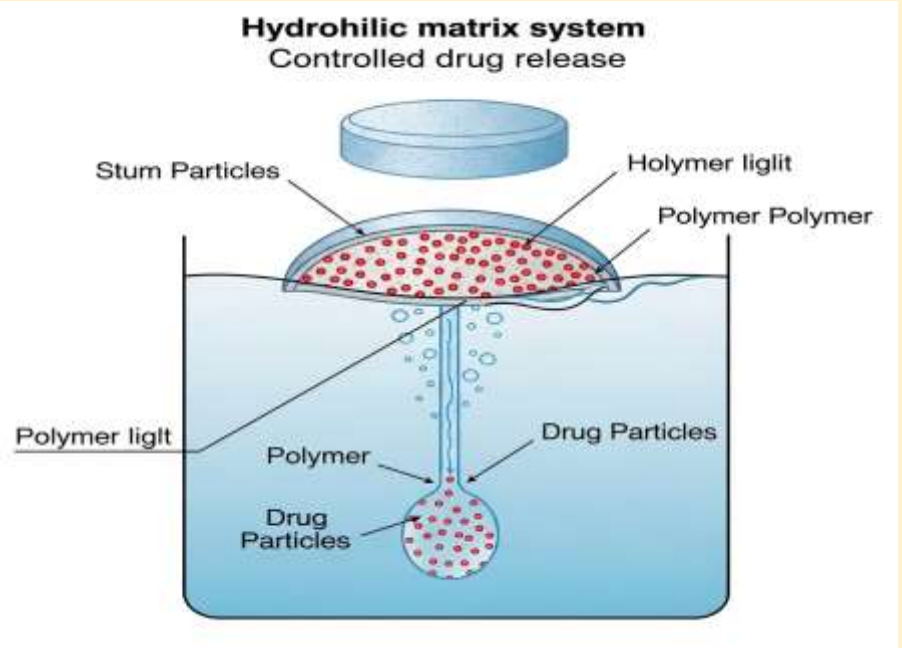
- They are versatile and widely used in controlled release formulations. In these systems, the drug is embedded in a polymer matrix that controls the release rate.
- The matrix can be designed to release the drug by diffusion, erosion, or a combination of both.



HYDROPHILIC MATRIX

- The drug is dispersed in a hydrophilic matrix

(e.g., hydroxypropyl methylcellulose). When exposed to water or gastrointestinal fluids, the matrix swells, forming a gel barrier that control drug release



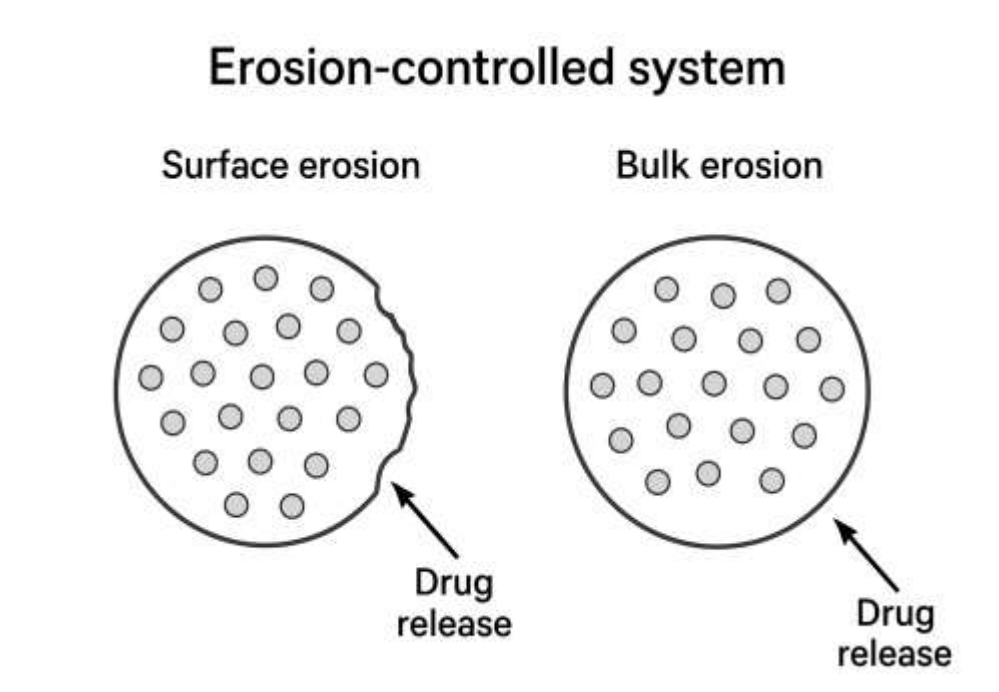
HYDROPHOBIC MATRIX SYSTEMS

- The drug is dispersed in a hydrophobic matrix (e.g., ethyl cellulose) that remains intact in the gastrointestinal tract and the drug is released by diffusion through the matrix.

Example : Ferro-Sequels (ferrous fumarate) uses a hydrophobic matrix to control iron release for the treatment of anaemia.

EROSION-CONTROLLED SYSTEMS

- Erosion-controlled systems rely on the gradual degradation or erosion of the matrix material to control drug release.



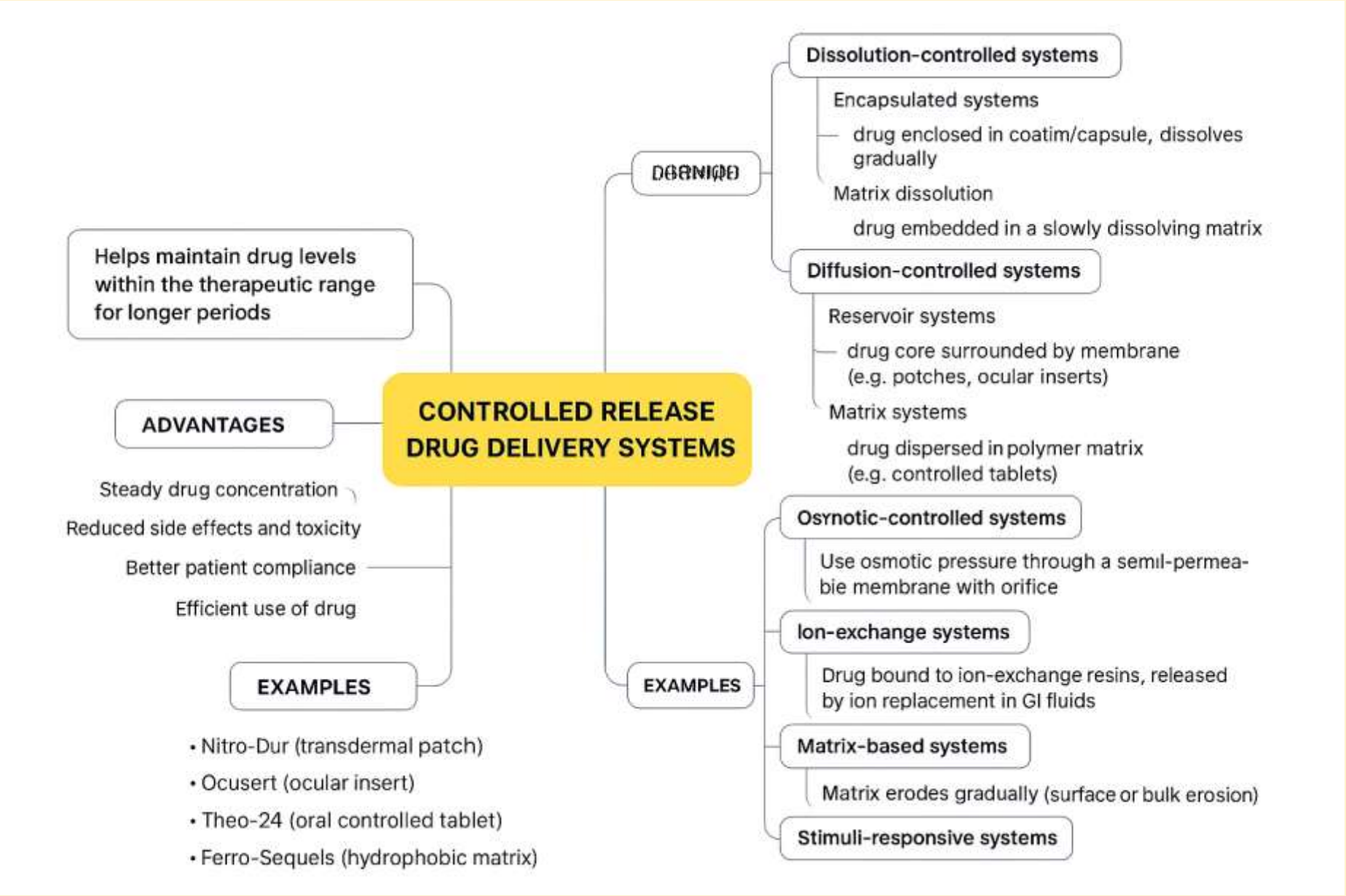
pH-RESPONSIVE SYSTEMS

- These systems release drugs in response to pH changes in the environment. They are particularly useful for targeting specific regions in the gastrointestinal tract

THERMO-RESPONSIVE SYSTEMS

- These systems release drugs in response to temperature changes. For example, hydrogels that become more permeable at body temperature can be used for localized delivery

SUMMARY


CONTROLLED RELEASE DRUG DELIVERY SYSTEMS
ADVANTAGES
Helps maintain drug levels within the therapeutic range for longer periods
Steady drug concentration
Reduced side effects and toxicity
Better patient compliance
Efficient use of drug
EXAMPLES
• Nitro-Dur (transdermal patch)
• Ocusert (ocular insert)
• Theo-24 (oral controlled tablet)
• Ferro-Sequels (hydrophobic matrix)
DOSAGE FORMS
Dissolution-controlled systems
Encapsulated systems
drug enclosed in coatim/capsule, dissolves gradually
Matrix dissolution
drug embedded in a slowly dissolving matrix
Diffusion-controlled systems
Reservoir systems
drug core surrounded by membrane (e.g. potches, ocular inserts)
Matrix systems
drug dispersed in polymer matrix (e.g. controlled tablets)
EXAMPLES
Osmotic-controlled systems
Use osmotic pressure through a semi-permeable membrane with orifice
Ion-exchange systems
Drug bound to ion-exchange resins, released by ion replacement in GI fluids
Matrix-based systems
Matrix erodes gradually (surface or bulk erosion)
Stimuli-responsive systems

CLASS ASSESMENTS

1. **What is the primary advantage of Controlled Release Drug Delivery Systems (CRDDS) over conventional drug delivery?**

a. They require more frequent administration.

b. They maintain drug levels within a desired range for an extended period.

c. They reduce patient compliance.

d. They are only suitable for drugs with a narrow therapeutic index.

2**. In an osmotic-controlled system, what is the key mechanism for drug release?**

a. Gradual dissolution of the polymer matrix.

b. Diffusion of the drug through a polymeric membrane.

c. The gradual degradation or erosion of the matrix material.

d. Osmotic pressure pushes the drug out through a laser-drilled orifice.

3.**Which type of system relies on the reversible exchange of ions between the resin and the surrounding medium to release the drug?**

a. Diffusion-controlled system

b. Ion-exchange system.

c. Erosion-controlled system.

d. Dissolution-controlled system.

4. **According to the presentation, a drug dispersed in a hydrophilic matrix, such as hydroxypropyl methylcellulose, is released when:**

a. The matrix erodes completely.

b. The matrix swells and forms a gel barrier.

c. The drug diffuses through a hydrophobic membrane.

d. The drug is pushed out by osmotic pressure.

5.**What is the main difference between an anion exchange resin and a cation exchange resin?**

a. Anion resins exchange positively charged ions while cation resins exchange negatively charged ions.

b. Anion resins release drugs through surface erosion while cation resins release drugs through bulk erosion.

c. Anion resins contain basic functional groups and exchange their negatively charged counter-ions, while cation resins contain acidic functional groups and exchange their positively charged counter-ions.

d. There is no difference; they are two terms for the same mechanism.

REFERENCES

1.Yie W. Chien: Novel Drug Delivery Systems, Second Edition, Marcel Dekker, Inc, 1992 Pg no.816.

2. Joseph R. Robinson: Sustained and Controlled Release Drug Delivery Systems, First edition, Volume 6, Marcel Dekker, Inc,1986,pg.618.

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5. https://www.scribd.com/document/668313752/Controlled-and-Novel-Drug-Delivery-by-N-K-Jain-1st-Editn-Reprint


Thank You