

Concept & Models for NDDS

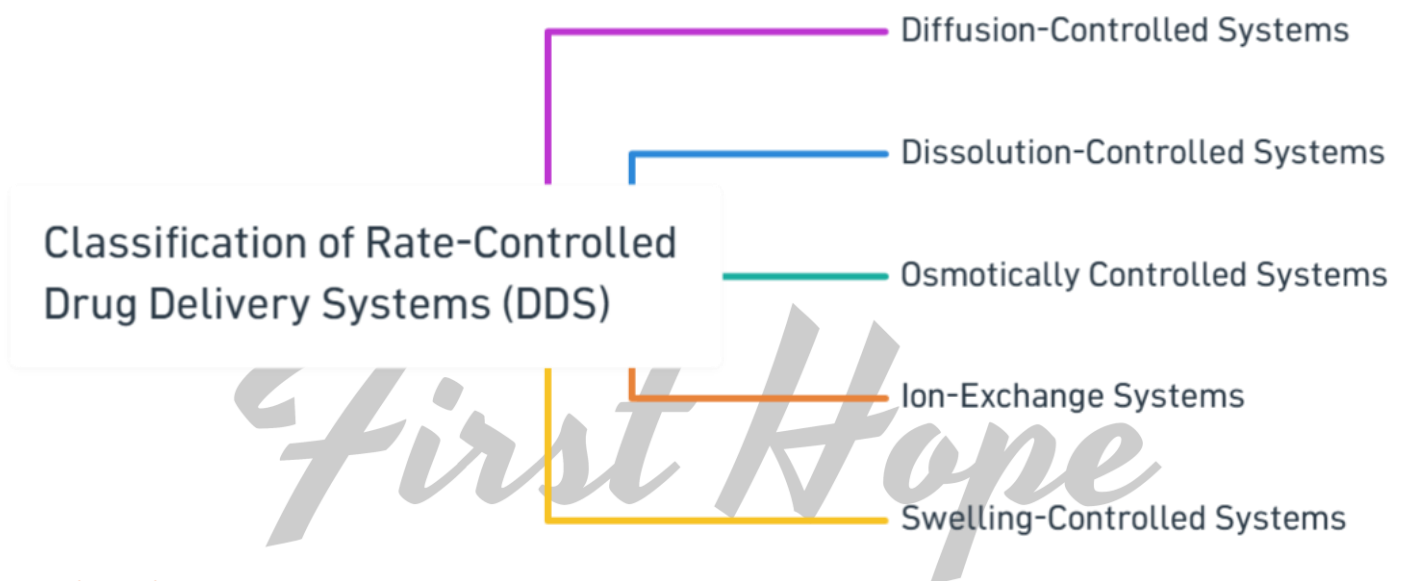
Classification of Rate-Controlled Drug Delivery Systems (DDS)

- Rate-controlled drug delivery systems are designed to release a drug into the body at a controlled speed (rate) over time, instead of releasing it all at once.

Main Goal

- Maintain drug concentration within the therapeutic range for a long time
- Avoid peaks (toxicity) and troughs (ineffectiveness)

Classification



1. Diffusion-Controlled Systems

- Drug release occurs by movement (diffusion) from high concentration to low concentration.

Types:

A. Reservoir System

- Drug is stored in a core
- Surrounded by a polymer membrane
- Drug diffuses through the membrane slowly
- **Key Points:**
 - Release rate depends on membrane thickness and permeability
 - Can achieve near constant release
 - Risk of dose dumping if membrane breaks

B. Matrix System

- Drug is uniformly mixed in a polymer matrix
- Drug diffuses out through pores or polymer

- **Key Points:**

- Simple and widely used
- Release rate decreases over time
- Hard to achieve constant release

2. Dissolution-Controlled Systems

- Drug release depends on how fast the drug or coating dissolves.

Types:

A. Encapsulated Dissolution

- Drug coated with a dissolving layer
- Coating dissolves → drug released

B. Matrix Dissolution

- Drug embedded in dissolving matrix
- Matrix dissolves slowly → drug released
- **Key Points:**
 - Controlled by solubility of drug or coating
 - Used in oral sustained-release tablets

3. Osmotically Controlled Systems

- Drug release driven by osmotic pressure.

Mechanism:

- Water enters system through semi-permeable membrane
- Pressure builds inside
- Drug pushed out through a small hole
- **Key Points:**
 - Very precise control
 - Independence of pH and GI conditions
 - Example: Osmotic pump tablets

4. Ion-Exchange Systems

- Drug bound to ion-exchange resin
- Drug released when exchanged with ions in body fluids
- **Key Points:**
 - Controlled by ionic environment

- Used in liquid formulations

5. Swelling-Controlled Systems

- Polymer swells when it absorbs water
- Drug diffuses out through swollen gel
- **Key Points:**
 - Release depends on swelling rate
 - Used in hydrophilic matrices

Rate Programmed Release DDS

- These systems are designed so that the drug release rate is pre-determined and controlled by the formulation itself.

Definition

- Drug is released at a fixed, predictable rate based on system design, not external factors.

Types



1. Zero-Order Release Systems

- Drug released at a constant rate over time

Example:

- Transdermal patches
- Osmotic pumps

Graph:

- Straight line (constant slope)

Advantages:

- Maintains steady drug levels
- Ideal for chronic conditions

2. First-Order Release Systems

- Drug release rate depends on concentration remaining

Behavior:

- Faster release initially
- Slower release later

Example:

- Matrix tablets

3. Time-Controlled (Pulsatile) Systems

- Drug released after a lag time

Example:

- Coated tablets that dissolve after delay

Use:

- Diseases with circadian rhythm (e.g., asthma, arthritis)

Factors Controlling Rate Programming

- Polymer type
- Drug solubility
- Surface area
- Thickness of coating
- Diffusion coefficient

Advantages

- Predictable drug delivery
- Reduced dosing frequency
- Better patient compliance

Activation Modulated Drug Delivery Systems

- These systems release drugs **only when triggered by some external or internal stimulus.**

Key Concept

- Drug release is **activated by a specific signal**
- No release (or minimal release) until trigger is applied

Types of Activation

1. Physical Stimuli

a) **Temperature**

- Drug released when temperature changes

b) Light

- Light-sensitive systems release drug when exposed

c) Magnetic field

- Magnetic particles help trigger release

d) Ultrasound

- Sound waves increase drug release

2. Chemical Stimuli

- pH changes (e.g., stomach vs intestine)
- Presence of specific ions or molecules

3. Biological Stimuli

- Enzymes
- Glucose levels (important in insulin delivery)

Examples

- Insulin pumps responding to glucose
- Tumor-targeted drug systems activated by tumor environment

Advantages

- Site-specific delivery
- Reduced side effects
- Better therapeutic control

Feedback Regulated Drug Delivery Systems

- These are **self-regulating systems** that adjust drug release automatically based on the body's needs.

Key Concept

- System monitors a **biological signal**
- Adjusts drug release accordingly
- Works like a **closed-loop system**

How It Works

1. A **sensor detects** a biological parameter (e.g., glucose level)
2. System processes the signal
3. Drug release is increased or decreased

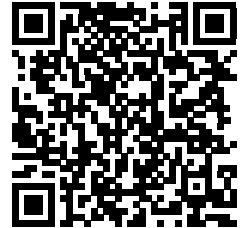


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