

Transdermal Drug Delivery Systems

Theory of Transdermal Drug Delivery Systems (TDDS)

- Transdermal Drug Delivery Systems are designed to **deliver drugs through the skin into systemic circulation** at a controlled rate.

Basic Concept

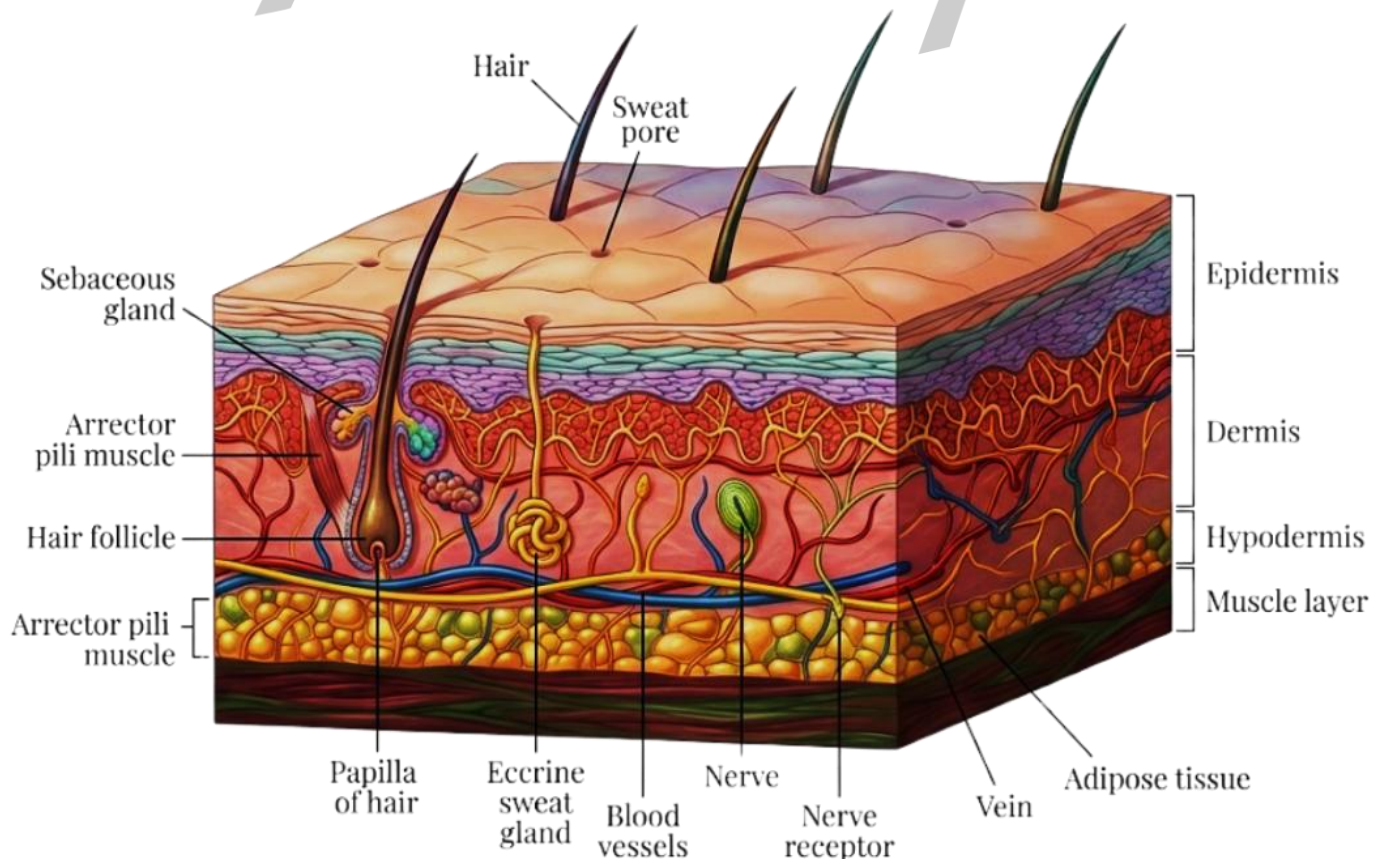
- Drug is applied on the **skin surface**
- It passes through different layers of skin
- Enters blood circulation
- Provides **systemic effect**

Why Transdermal Delivery is Used

- Avoids **first-pass metabolism** (liver metabolism)
- Maintains **constant drug levels**
- Reduces dosing frequency
- Improves patient compliance

Structure of Skin

Skin acts as a barrier, so understanding its structure is very important.



1. Stratum Corneum (Outer Layer)

- Most important barrier
- Made of dead cells (keratin)
- Highly resistant to drug penetration
- Controls drug entry

2. Epidermis

- Living cells
- No blood vessels
- Supports barrier function

3. Dermis

- Contains blood vessels
- Once drug reaches here → enters systemic circulation

Mechanism of Drug Absorption

Drug passes through skin mainly by passive diffusion.

Steps:

- Drug is released from formulation
- Penetrates stratum corneum
- Passes through epidermis
- Reaches dermis
- Enters blood circulation

Pathways of Drug Absorption

Drug can penetrate skin by:

1. Transcellular Route

- Through skin cells
- Requires drug to cross cell membranes

2. Intercellular Route

- Between cells
- Most common pathway

3. Appendageal Route

- Through hair follicles and sweat glands

Factors Affecting Drug Permeation

1. Drug Properties

- Molecular weight (<500 Da preferred)
- Lipophilicity (balance required)
- Solubility

2. Skin Condition

- Hydration increases permeability
- Damaged skin → increased absorption

3. Factors of formulation

- Type of vehicle
- Use of enhancers

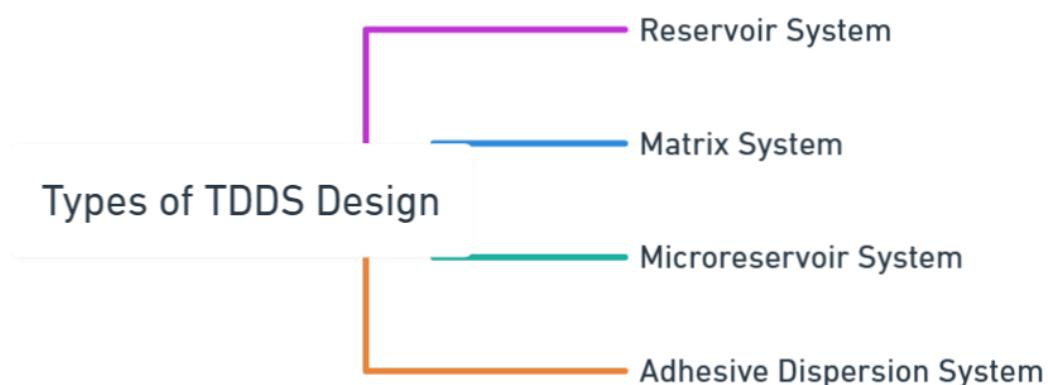
Design of Transdermal Drug Delivery Systems

- Design of TDDS focuses on achieving **controlled and predictable drug release through skin.**

Key Design Requirements

- Deliver drug at constant rate
- Ensure adequate skin penetration
- Maintain drug stability
- Provide patient comfort

Types of TDDS Design



1. Reservoir System

- Drug stored in a reservoir compartment
- Surrounded by rate-controlling membrane

Structure:

- Backing layer
- Drug reservoir
- Rate-controlling membrane
- Adhesive layer

Mechanism:

- Drug diffuses through membrane at controlled rate

2. Matrix System

- Drug is **uniformly dispersed in polymer matrix**

Types:

- Drug-in-adhesive system
- Matrix-dispersion system

Mechanism:

- Drug diffuses out of matrix

3. Microreservoir System

- Combination of reservoir and matrix systems

4. Adhesive Dispersion System

- Drug mixed in adhesive

Basic Components of TDDS

1. Drug

- Should be potent
- Low dose required
- Suitable physicochemical properties

2. Polymer Matrix

- Holds drug
- Controls release

3. Permeation Enhancers

- Increase drug penetration
- **Examples:**
 - Alcohol
 - Fatty acids

4. Backing Membrane

- Protects system
- Prevents drug loss

5. Adhesive Layer

- Keeps patch attached to skin

6. Release Liner

- Removed before application

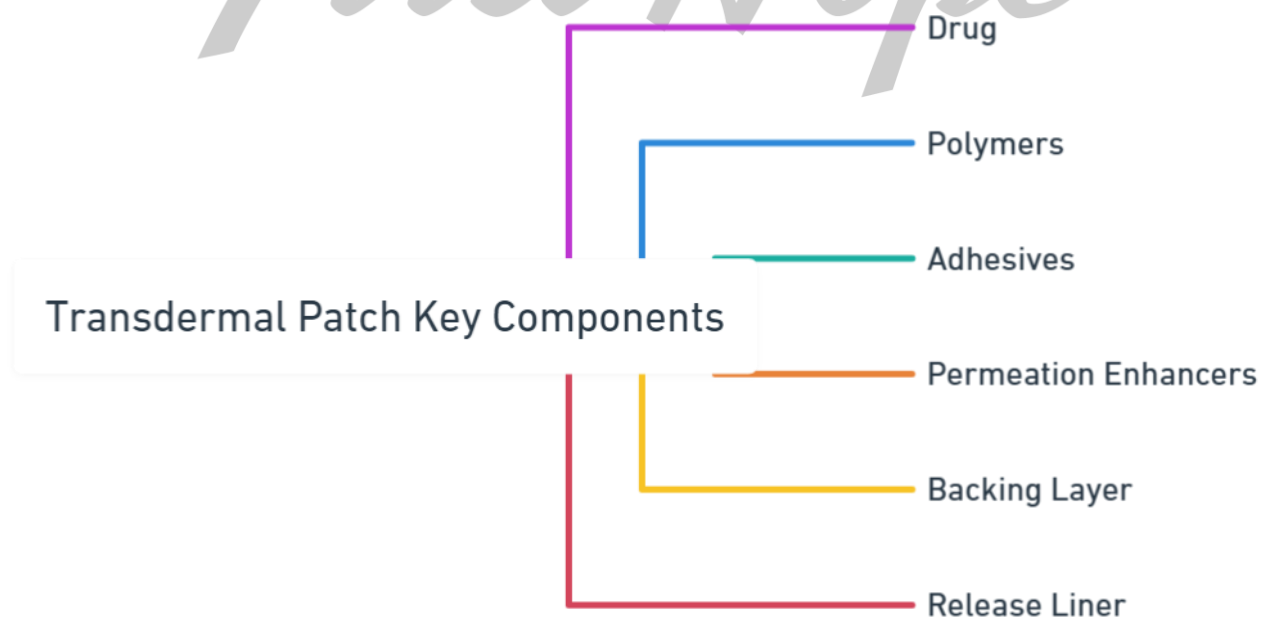
Selection Criteria for Drug

- Potent (small dose required)
- Short half-life
- Suitable solubility
- Non-irritant to skin

Formulation of Transdermal Drug Delivery Systems

- Formulation involves selecting suitable **materials and methods** to prepare effective patches or systems.

Key Components



1. Drug

- Must be stable and effective at low dose

2. Polymers

- Used to control drug release.

Examples:



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