

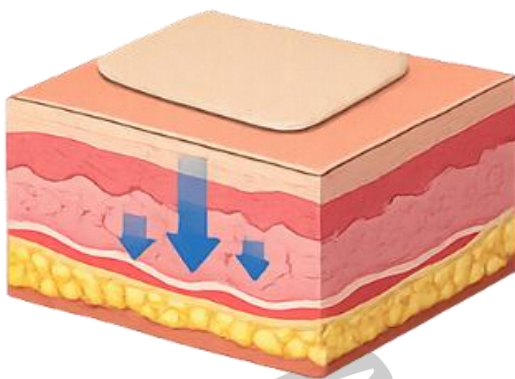
Transdermal Drug Delivery Systems

Introduction: Transdermal Drug Delivery Systems (TDDS)

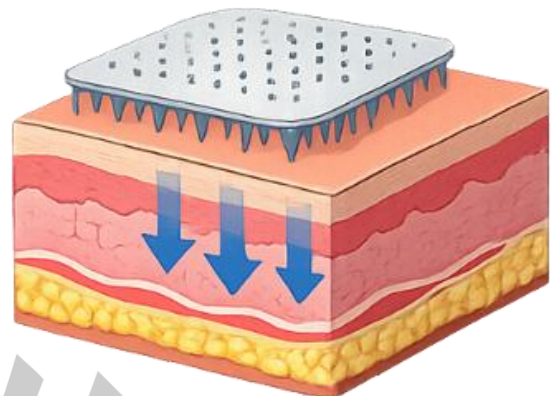
Introduction

- Transdermal Drug Delivery Systems (TDDS) are drug delivery systems designed to deliver drugs through the skin into systemic circulation.

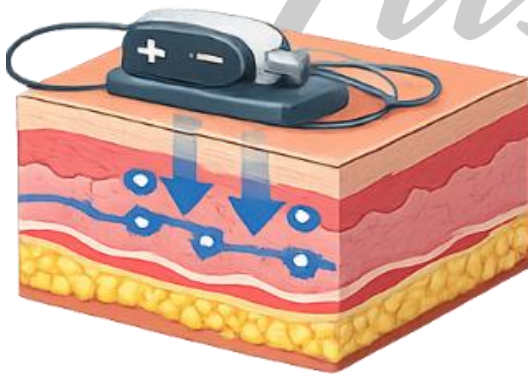
Transdermal Drug Delivery Systems



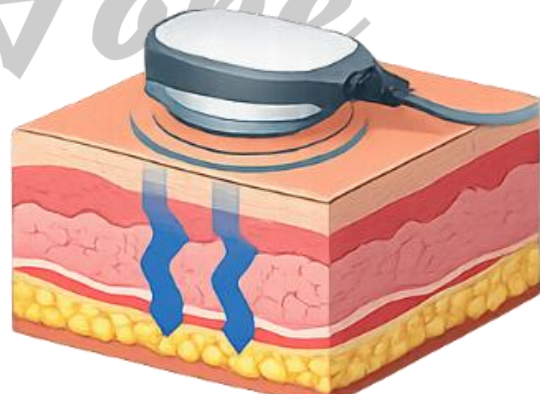
Transdermal Patch



Microneedle Patch



Iontophoresis



Sonophoresis

- In this system, the drug is **applied on the skin surface** in the form of:
 - Patches
 - Gels
 - Creams
 - Ointments
- From the skin surface, the drug penetrates through the skin layers and enters the bloodstream.
- TDDS provides controlled and sustained release of drugs over a prolonged period of time.

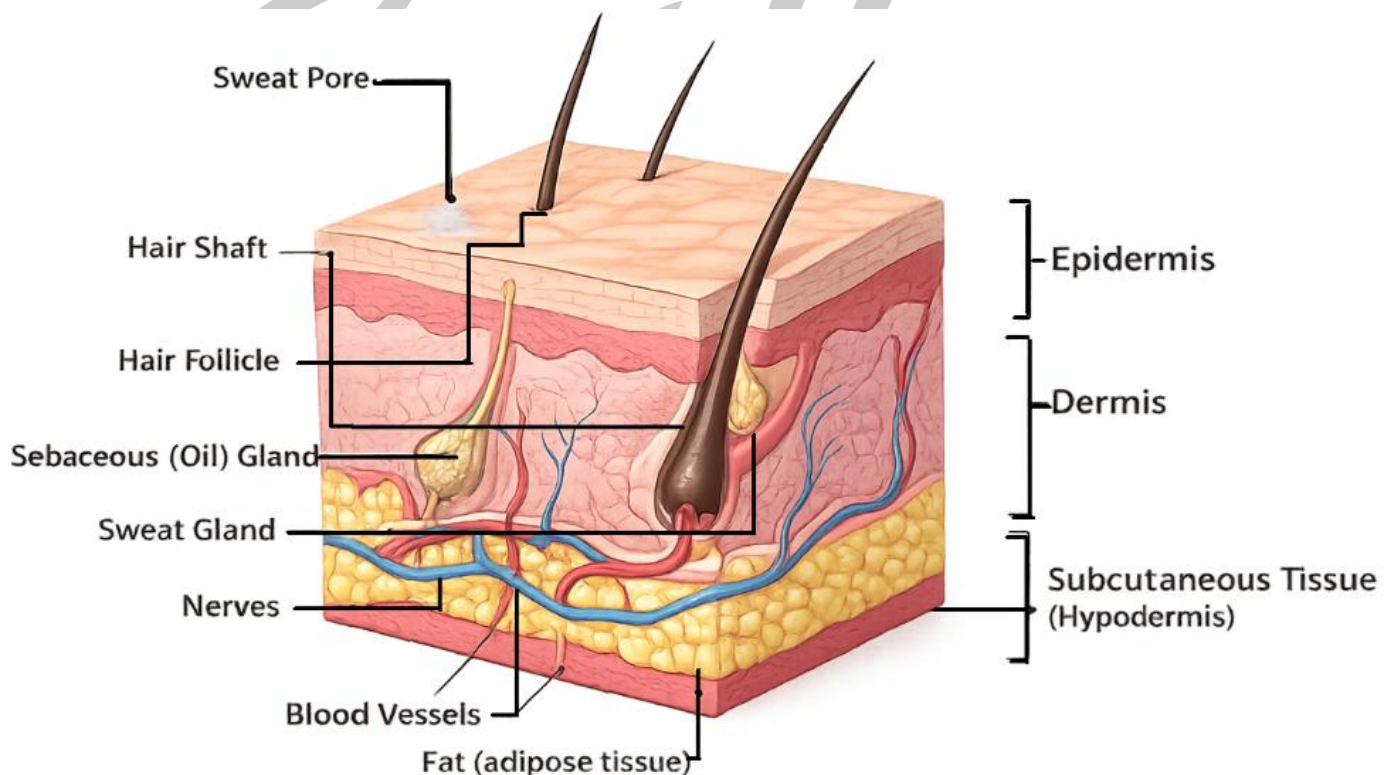
- The concept of transdermal delivery is based on the ability of certain drugs to diffuse through the skin layers and enter systemic circulation without passing through the gastrointestinal tract.
- This helps in maintaining constant drug levels in the body.

Examples of Drugs Delivered Through TDDS

- Nitroglycerin
- Nicotine
- Fentanyl
- Estradiol
- Scopolamine
- Clonidine

Structure of Skin

- The skin is the largest organ of the human body and acts as a protective barrier between the body and the external environment.



- The average thickness of skin is about 2–3 mm.
- The skin is composed of **three main layers**:
 - Epidermis
 - Dermis
 - Hypodermis (Subcutaneous tissue)

1. Epidermis

- The epidermis is the outermost layer of the skin.
- It acts as the primary barrier to drug penetration.
- **The epidermis consists of several sublayers:**

A. Stratum Corneum

- Outermost layer of the epidermis
- Consists of dead keratinized cells
- Thickness: about 10–20 µm
- Acts as the main barrier for drug permeation
- **Brick and Mortar Model:**
 - The structure of the stratum corneum is often described as the "brick and mortar" model:
 - Bricks → Corneocytes (dead cells)
 - Mortar → Lipid matrix surrounding the cells

B. Stratum Lucidum

- Present mainly in **thick skin**, such as **palms and soles**.

C. Stratum Granulosum

- Cells begin the **keratinization process**.

D. Stratum Spinosum

- Provides **structural strength** to the skin.

E. Stratum Basale

- Deepest layer of the epidermis
- Cells actively divide to produce new skin cells.

2. Dermis

- The dermis lies below the epidermis.
- **It contains:**
 - Blood vessels
 - Nerves
 - Sweat glands
 - Sebaceous glands
 - Hair follicles
- **Characteristics**

- Has a rich blood supply.
- Once a drug reaches the dermis, it can enter systemic circulation.

3. Hypodermis (Subcutaneous Layer)

- This is the innermost layer of the skin.
- **Composition**
 - Fat tissue
 - Connective tissue
- **Functions**
 - Insulation
 - Energy storage
 - Protection of underlying organs

Barriers to Drug Penetration Through Skin

- The skin acts as a protective barrier that limits drug absorption.
- The major barrier in transdermal drug delivery is the stratum corneum.
- Drug molecules must pass through several barriers before entering systemic circulation.



1. Stratum Corneum Barrier

- This is the most significant barrier to drug penetration in transdermal drug delivery.
- Reasons
 - Highly organized lipid structure
 - Dense keratinized cells
 - Low hydration
 - Low permeability
- Only drugs with specific physicochemical properties can penetrate this layer effectively.

2. Skin Lipid Barrier

- Lipids present between **corneocytes** form a **hydrophobic barrier** that limits drug penetration.
- **These lipids include:**
 - Ceramides
 - Cholesterol
 - Free fatty acids
- These lipids mainly **prevent penetration of hydrophilic drugs.**

3. Epidermal Barrier

- Even after crossing the stratum corneum, drugs must pass through the remaining epidermal layers.
- These layers further slow drug diffusion.

4. Dermal Barrier

- The dermis contains blood vessels, but drugs must first diffuse through connective tissue before entering systemic circulation.
- This process can delay drug absorption.

5. Skin Thickness

- The thickness of skin varies in different parts of the body, which affects drug diffusion.
- **Examples**
 - **Thin skin** → Eyelids
 - **Thick skin** → Palms and soles
 - **Thicker skin slows drug diffusion.**

6. Skin Hydration

- Hydration of the skin affects permeability.
- **Hydrated Skin**



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