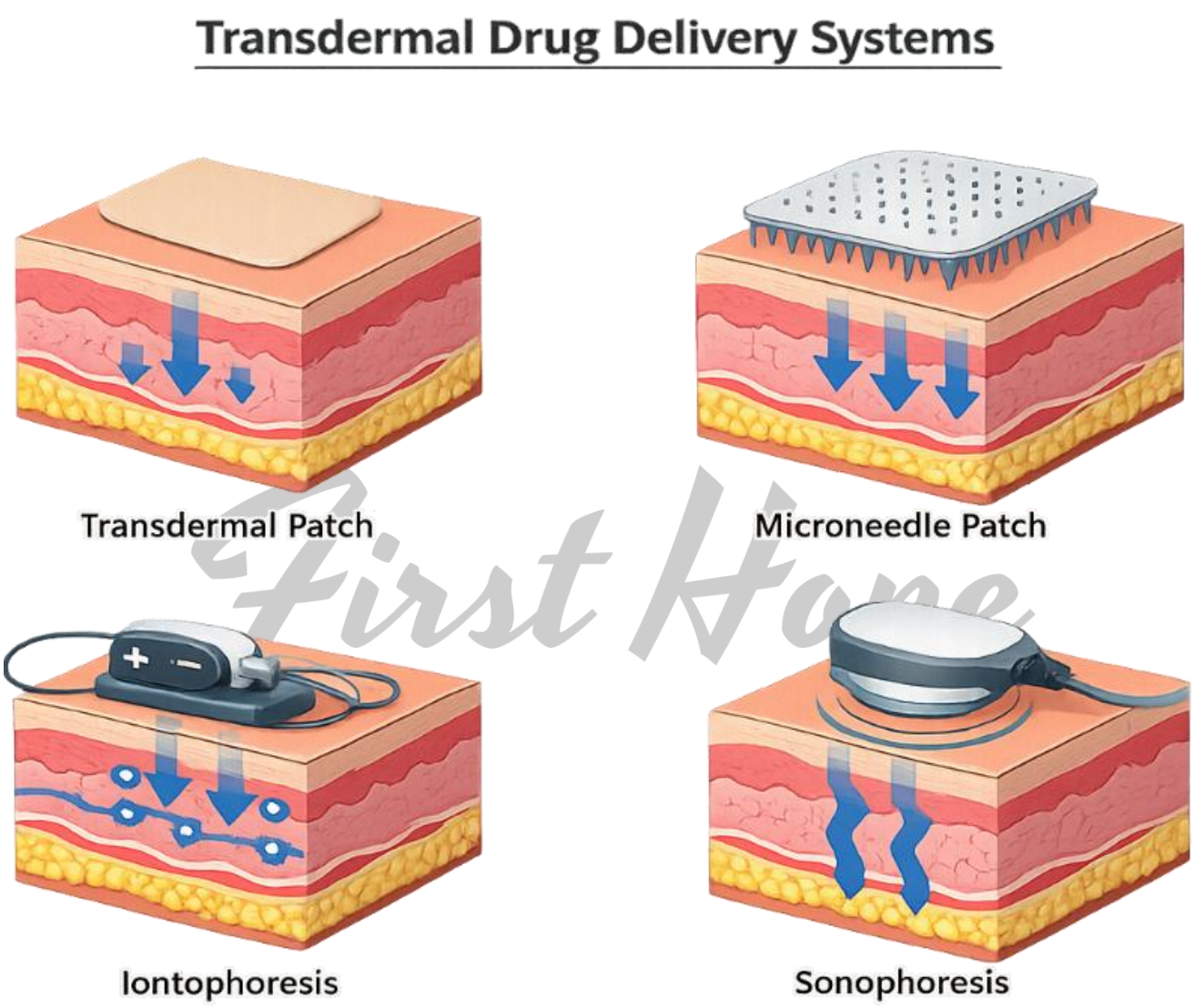
Transdermal Drug Delivery Systems

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.



- 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.

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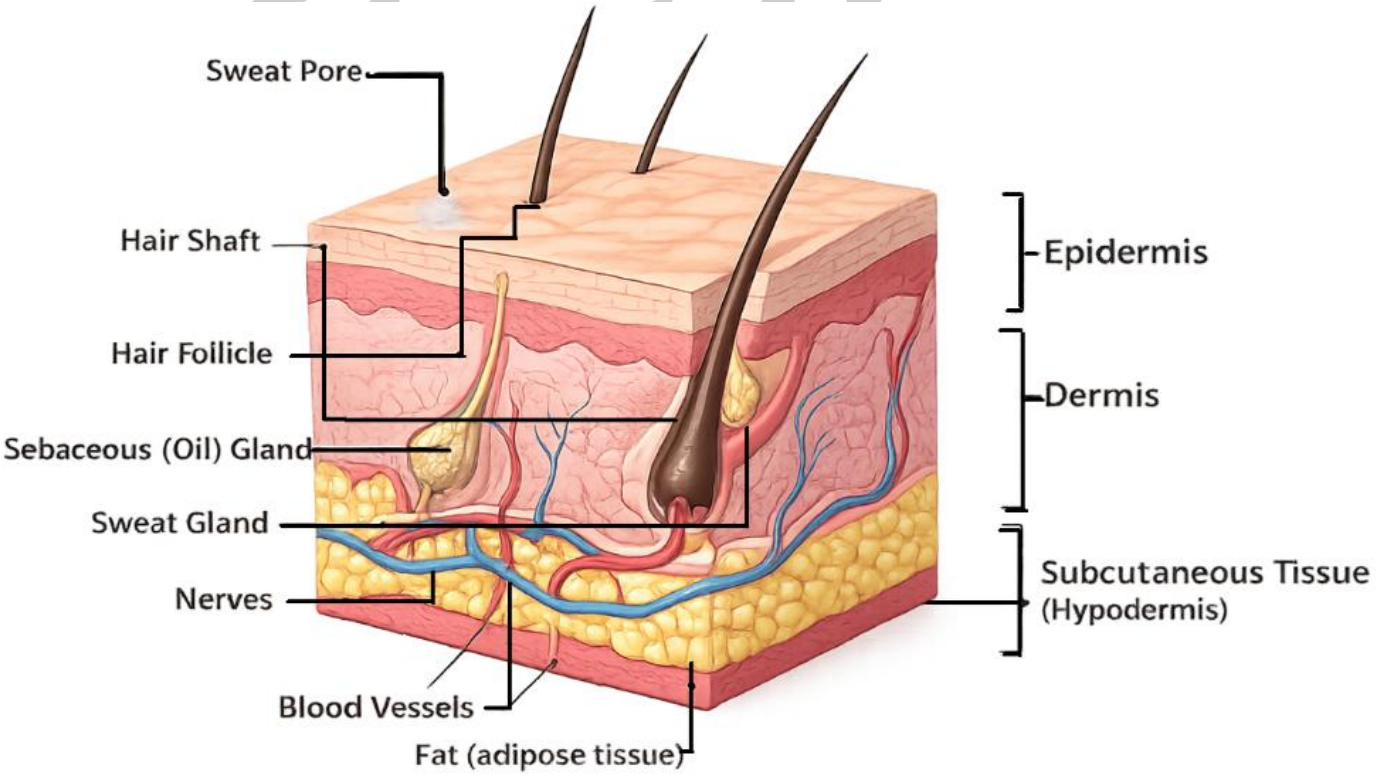
- The concept of transdermal delivery is based on the ability of certain drugs to diffuse through the skin layers and enter systemic circulation without passing through the gastrointestinal tract.
- This helps in maintaining constant drug levels in the body.

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)

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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**

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- 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

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- 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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