CODEN [USA]: IAJPBB ISSN : 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

SJIF Impact Factor: 7.187
https://zenodo.org/records/10068889

https://www.iajps.com/volumes/volume10-october-2023/32-issue-10-october-23/

Available online at: http://www.iajps.com *Review Article*

TOPICAL DRUG DELIVERY SYSTEM: AN OVERVIEW

Manjunath J[1]*, Tanushree C[2], Suma R[3]

[1]PG student, Department of Pharmaceutics, AL-Ameen College of Pharmacy, Bangalore-27, Karnataka, India.

[2 & 3]Associate Professor, Department of Pharmaceutics, AL-Ameen College of Pharmacy, Bangalore-27, Karnataka, India.

Abstract

The drug delivery systems ensure that drugs enter the body and reach their intended place. These systems must consider a variety of factors, ranging from convenience of administration to therapeutic efficacy. Several firms specialise in inventing and marketing drug delivery technologies to pharmaceutical corporations, while others design their own systems. Many of these methods are patented and one-of-a-kind. When a medicine is administered, the dose must be precisely established so that the drug can be utilized by the body, which mandates the use of a drug delivery system with precise dosing capabilities. Drug delivery systems must also consider that how the body metabolizes a drug. Some drugs are destroyed in the digestive tract and hence cannot be administered into the body this way. Others may be toxic in high dosages, necessitating the use of a time release approach to assure patient safety. The application of a medicine to the skin's surface in an absorbable formulation is one way of topical drug administration. Skin patches are one type of topical medicine administration technology. Other treatments include sprays applied to the nose's mucous membranes, inhalation aerosols, eye drops, and lotions applied on the skin. These systems are often simple to use, which appeals to patients. A main purpose of the drug delivery system is to provide the required dosage to the desired location in all situations. Many drugs are available in topical and enteral formulations that may be taken orally or applied directly to the skin because patients prefer painless and uncomplicated methods. Parenteral methods are more common in therapeutic settings, especially for restricted medications, since they provide greater control over how and when drugs are supplied.

KEYWORDS: *Skin, Creams, Gels, Pastes, Topical drug delivery system, Ointment.*

Corresponding author:

Manjunath J,

PG student, Department of Pharmaceutics,
AL-Ameen College of Pharmacy,
Opp Lalbagh main gate, Hosur road,
Bangalore-27, Karnataka, India-608002.
Email id: manjureddy364@gmail.com

QR code

Please cite this article in press Manjunath J et al, **Topical Drug Delivery System: An Overview,** *Indo Am. J. P. Sci, 2023; 10 (10).*

INTRODUCTION:

A topical drug delivery system (TDDS) is a pharmacological dose form that is applied to the skin directly to treat skin conditions. These are intended to limit the drug's pharmacological effect to the skin's surface. The TDDS offers a diverse spectrum of medicinal dosage forms, including liquids, semisolids, and spray powders. Gels, creams, and ointments, on the other hand, are the most often used semisolid formulations for topical medicine delivery. Topical formulations are applied to the skin, eyes, nose, and vaginal area to treat local problems. The administration of a drug through the skin to treat or cure skin disorders is known as topical medication delivery. These topical medicine administration methods are mainly used for local skin illnesses such as fungal infections or when traditional routes of administration are inadequate. It may penetrate deeper into the skin, improving absorption. Topical administration has no advantages over typical dosage methods. They are expected to be more effective and less harmful than standard formulations due to their bilayered composition and structure. To boost local and diminish systemic effects, or to ensure optimum Percutaneous absorption, attempts have been made in the formulation of topical dosage forms to employ drug carriers that allow adequate localization or penetration of the medicine within or through the skin. Topical preparations alleviate gastrointestinal discomfort, prevent medicine metabolism in the liver, and increase drug bioavailability. Topical medicines have an immediate effect at the site of action.[1,2]

Advantages of topical drug delivery system

- ✓ Preventing preliminary metabolism
- ✓ Improves patient compliance.
- ✓ Convenience and ease of use.
- ✓ The removal of gastrointestinal repugnant.
- ✓ Preventing the risks and hassles associated with intravenous treatment and other illnesses.
- ✓ Substitute for other administrative routes.
- ✓ Give them the choice of self-medicating.
- ✓ Dose decrease when compared to oral dosing methods.
- ✓ The capacity to quit medications as needed.
- ✓ In a practical and effective manner, employs a pharmaceutical compound with a shorter half-life.
- ✓ The drug molecule with a narrow therapeutic window is used. [3,4]

Disadvantages

- ✓ Skin irritation or contact dermatitis may be brought on by the medication and/or excipients.
- ✓ Allergic responses are possible.
- ✓ Can only be used for medications that require very low plasma concentrations to act.
- ✓ The medications may be denatured by an enzyme in the epidermis.
- ✓ Some medications do not penetrate the skin well.[3,5]

ANATOMY AND PHYSIOLOGY OF SKIN

The human body has two mechanisms in place to protect itself against potentially hazardous microorganisms in the environment. Microorganisms and germs that have already penetrated the body are destroyed by the internal defence system. The external defence system keeps germs out of the body. Depending on the surroundings, the skin temperature ranges between 30-40^{0}C. The largest organ in our body is the skin. It is made up of 3 layers. They are

Epidermis – outermost layer

Dermis – intermediate layer

Hypodermis – deepest layer

Skin covers the outside of the body, although it has several functions other than defense. It acts as a mechanical barrier between the interior and exterior of the body. The anatomy of the skin is shown in figure 1.[4]

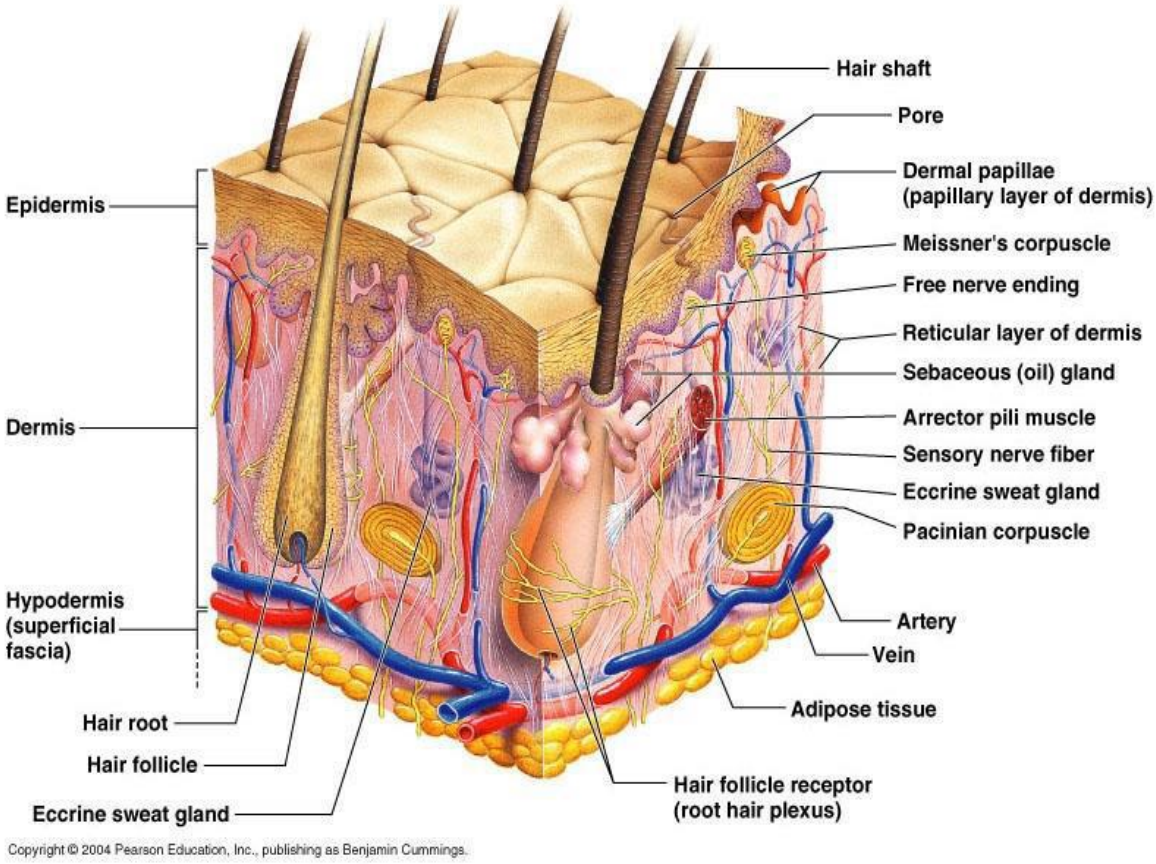

Fig 1: Anatomy of skin

Epidermis: Epithelial cells make up the epidermis. A living cell as well as a dead cell can be found among these cells. New cells proliferate swiftly at the base of the epidermis, pushing older cells upward. The epidermis lacks a direct supply of blood vessels for nutrition delivery. It is fed by the flow of necessary chemicals from the extensive circulatory network of the underlying dermis. Desmosomes have a strong affinity for epidermal cells. Within the cell, desmosomes are in contact with keratin filaments. Keratin filaments produce keratin. During maturation, keratin cells cluster and crosslink with other keratin cells in the cytosol. When the older cells die, the keratin fibrosis network persists, forming the protective keratinized layer, a stiff and rigid protective layer in the epidermis. This layer is both water and airtight. It keeps most chemicals from entering or leaving the body. In unhealthy skin, particularly burns this layer is damaged, resulting in significant fluid loss and increased susceptibility to microbial infections, which can be deadly if left untreated.

Dermis: This layer is present underneath the epidermis and is differentiated by numerous elastin fibers that allow for stretching and numerous collagen fibers that offer skin strength. Dermal blood vessels hydrate both the dermis and the epidermis. The dermis is also involved in temperature control. The existence of nerves cause's pressure and discomfort feelings. The dermis measures 3-5 mm thick. The dermis has an interfibrillar gel that contains salt, glycosaminoglycan, water, sweat glands and lymphatic cells, in addition to elastin fibres, blood arteries, and nerves.

Hypodermis: The skin's innermost layer is the hypodermis. This layer is linked to the body's deeper tissues, including the muscles and bones. Although sebaceous glands, sweat glands, and hair follicles are visible on the epidermis, their origins are in the dermis. A thin salt solution is secreted onto the skin's surface by sweat glands. To regulate body and skin temperatures, this fluid evaporates and cools the skin. Sweat glands may be located all over the body. Ambient temperature, heat generated by skeletal muscle movement and various emotional aspects all influence the quantity of dilutions (sweat) produced. Sebum is produced by the sebaceous glands. The oily substance sebum is produced by the hair follicles before being released onto the skin's surface. The sebum on the surface of the skin and hair acts as a

waterproof barrier to prevent them from drying out.[1,6]

CHALLENGES IN DEVELOPING TOPICAL DRUG DELIVERY SYSTEM

The difficulty in designing a good topical medication stem from the several conditions that a composition must fulfill:

1. Choice of Containers and Product Stability

A dispensing container (such as a tube, jar, can, etc.) will be chosen based on the properties of the combined ingredients in order to protect the therapeutic compound(s) from chemical deterioration. The therapeutic ingredient(s) and the skin condition to be treated primarily decide whether the formulation is liquid, semi-solid, monophasic, or multiphasic (for example, oil-in-water or water-in-oil).

2. Skin Penetration

The formulation, the active chemicals, and the skin interact intricately when the product is applied to the skin. According to Fick's first law of diffusion, which describes the rate of solute transfer as a function of component concentration, treatment surface area size, and skin permeability, the active compound(s) penetrate the skin. In spite of this, a variety of factors, such as drying, moisturizing, or occluding effects of the formulation's excipients, which, when added together, can affect the product's release at the treatment site, can affect skin permeability. Because the pilosebaceous unit is the site of action in acne, a good anti-acne formulation should allow the therapeutic compound(s) to penetrate into this extremely lipophilic environment.

3. Cosmetic Acceptability

Patients now want topical drugs that are not only safe and effective, but also visually appealing and easy to use. This is especially true in the case of acne, where cosmetic motives are one of the most prevalent reasons individuals seek dermatological help. Furthermore, because the majority of acne patients are teens or young adults, therapies that are easy to apply and less disruptive to daily routines boost compliance and, as a result, topical therapeutic efficacy. Concerns about prescription vehicles, for example, should account for the drug's administration on big, hairy places like the chest and back. In the case of face acne, this may necessitate quick-spreading formulations or an optimum composition that leaves no residue or oiliness.[2,3,7]

CLASSIFICATION OF TOPICAL DRUG DELIVERY SYSTEMS:

1. Solid preparation includes poultices, plasters, and topical powders

2. Preparations that are semi-solid: creams, suppositories, gels, pastes, and ointments.

3. Liquid preparations include tinctures, liniments, lotions, solutions, suspension and emulsions.

4. Other preparations: Topical aerosol, Tapes and Gauzes, Rubbing Alcohols, Liquid Cleansers, and Transdermal Drug Delivery Systems.[1,2]

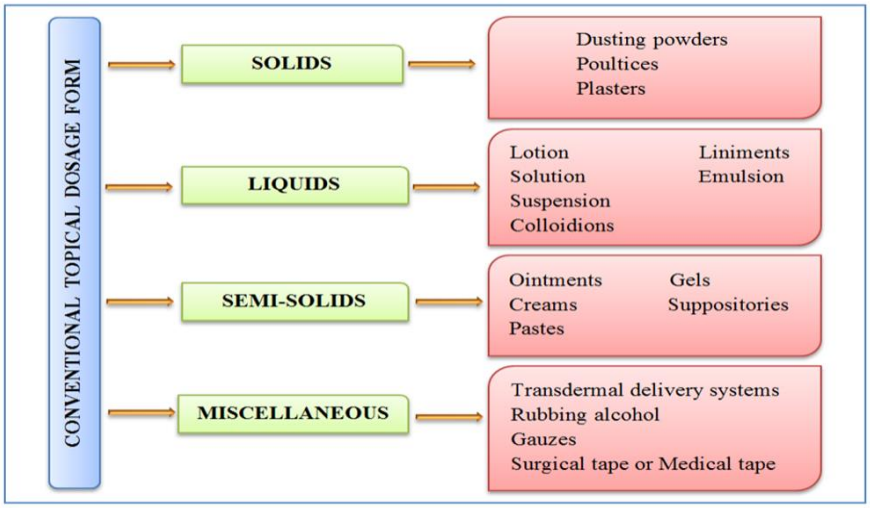

Fig 2: Classification of conventional dosage form

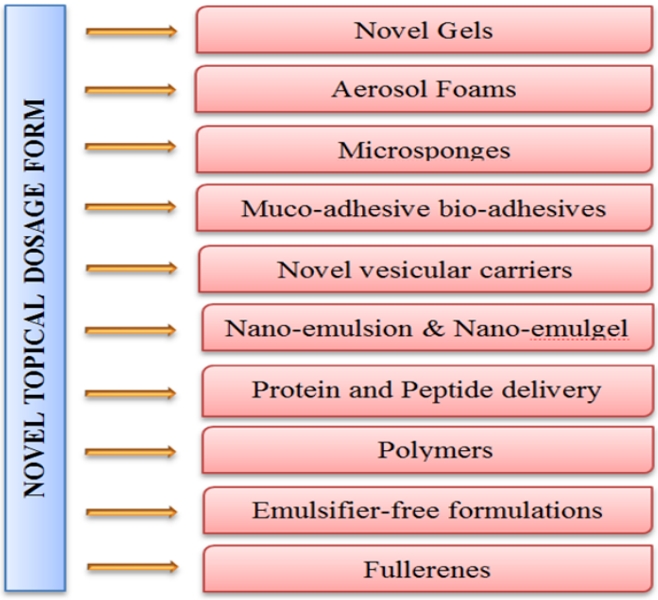

Fig 3: Classification of novel dosage form

Jellies (gels)

Pharmaceutical gels are semisolid preparations composed of a gelled dispersion of tiny or large molecules in an aqueous liquid media. Aqueous, hydroalcoholic, alcohol-based, or non-aqueous vehicles are all possible.

Gel varieties, based on the continuous phase

1. Organic gels
2. Hydrogels
3. Xerogels [4,8]

Creams

Creams are semi-solid oil-and-water emulsions that include one or more medicinal ingredients that have been dissolved or distributed in a suitable base. They are softer and easier to distribute than ointments. Types of creams,

1. Oil- in- water cream: E.g., Vanishing cream
2. Water –in- oil cream: E.g., Cold cream [9]

Ointments

Ointment is derived from the Latin word ungere, which means to anoint with oil. Ointments are semi-solid formulations that have a protective and emollient effect when applied topically to the skin or mucous membrane. When exposed to shear stress, it behaves similarly to viscoelastic materials. They are typically made up of a medicine or drugs that have been dissolved, suspended, or emulsified in an ointment base (vehicles). These ointments are topically applied to the skin's surface and are classed based on skin penetration. These are classified into three types.

1. Epidermic ointments
2. Endodermic ointments
3. Diadermic ointments [2,9]

Pastes

Pastes are semisolid therapies made up of insoluble particle components and ointment that are intended for cutaneous application. Pastes are classified into two types: fatty paste and non-greasy paste. There are two processes for creating pastes: trituration and fusing. They have less penetration, maceration, and heat than ointment. They are less oily than ointments, penetrate less deeply, macerate less, heat less, and are stiffer. They produce very efficient protective barriers when applied to the skin. Furthermore, because it forms an unbroken film, it acts as an excellent protective barrier. It contains a material that absorbs and neutralizes potentially dangerous substances before they reach the skin. Unlike gels, paste, like ointments, generates an unbroken somewhat water-impermeable layer.

E.g., Zinc oxide paste; Anthralin paste. [9]

FACTORS AFFECTING TOPICAL ABSORPTION OF DRUGS:

For medication absorption in topical locations, physiological and physicochemical variables are taken into account.

Physiological aspects:
1. Skin thickness.
2. The amount of lipids.
3. Hair follicle density.
4. Sweat gland density.
5. The skin's pH.
6. Blood circulation.
7. Hydration of the skin.
8. Skin inflammation.

Physicochemical aspects:
1. Coefficient of partition.
2. Molecular mass (< 400 Dalton)
3. Ionization degree
4. The impact of vehicle. [6]

CONCLUSION:

Topical medications are used for localised effects at the application site due to pharmacological penetration into the deeper layers of skin or mucous membranes. The fact that topical treatment avoids first-pass metabolism is its main advantage. Topical formulations also provide the benefit of avoiding the risks and inconveniences associated with intravenous therapy as well as the range of absorption conditions, including pH changes, the presence of enzymes, and stomach emptying time. Furthermore, because it is non-invasive, it has a higher patient acceptance rate than other medicine delivery methods. When all other methods of pharmaceutical administration fail, the topical drug delivery route is adopted. Drug delivery formulations have become more popular via gels due to their biocompatibility, network structure, and molecular stability. The optimization of gel formulations is critical because it has the potential to increase effectiveness, tolerability, and patient compliance.

REFERENCE:

1. Bani KS, Bhardwaj K, Topical Drug Delivery Therapeutics, Drug Absorption and Penetration Enhancement Techniques, Journal of Drug Delivery and Therapeutics. 2021; 11(4):105-110 DOI: http://dx.doi.org/10.22270/jddt.v11i4.4864.
2. Debjit Bhowmik, Harish Gopinath, B. Pragati Kumar, S. Duraivel, K.P. Sampath Kumar, Recent Advances In Novel Topical Drug Delivery System, THE PHARMA INNOVATION, Vol. 1, No. 9, 2012.
3. Dhanshree Kanawade, Dr. Narendra Gowekar, Review: Topical Drug Delivery System, International Journal of Pharmaceutical Research and Applications, Volume 6, Issue 3 May - June 2021, pp: 514-518.
4. Ashni Verma, Sukhdev Singh, Rupinder Kaur, Upendra K Jain, Topical Gels as Drug Delivery Systems: A Review, International Journal of Pharmaceutical Sciences Review and Research, 23(2), Nov – Dec 2013.
5. Monisha Bansal, Shahid Jamil, Micellar Microparticles: A Novel Approach To Topical Drug Delivery System, International journal of applied pharmaceutics, Vol 10, Issue 5, 2018.
6. Patil PB, Datir SK, Saudagar RB, A Review on Topical Gels as Drug Delivery System, Journal of Drug Delivery and Therapeutics. 2019; 9(3-s):989-994 http://dx.doi.org/10.22270/jddt.v9i3-s.2930.
7. M.S. Roberts, H.S. Cheruvu, S.E. Mangion et al., Topical drug delivery: History, percutaneous absorption, and product development, Advanced Drug Delivery Reviews 177 (2021).
8. Choudhury H, Gorain B, Pandey M, Chatterjee LA, Sengupta P, Das A, Molugulu N, Kesharwani P, Recent update on nanoemulgel as topical drug delivery system, Journal of Pharmaceutical Sciences (2017), doi: 10.1016/j.xphs.2017.03.042.
9. Sharadha M, Gowda D V*, Vishal Gupta N, Akhila A R, An overview on topical drug delivery system – Updated review, International Journal of Research in Pharmaceutical Sciences, 2020, 11(1), 368-385.