UNVEILING THE FORMULATION BUILDING BLOCKS IN COSMECEUTICALS: A COMPREHENSIVE OVERVIEW

Abstract

The present review is the stepwise guide to cosmetic professionals and students to get familiar with the formulation building blocks for various creams like vanishing, cold moisturizing, toothpastes, shampoos etc. It also has insights on core ingredients like emollients, preservatives, rheological additives etc. review also give valuable insights on classification and applications as well as merits and demerits of general cosmetic ingredients. Information on factors affecting microbial preservative efficacy. Brief information about soaps and syndetbars also mentioned. Controversial ingredients like Parabens, formaldehyde liberators, dioxane have been discussed.

The book goes beyond the theoretical aspects, delving into practical examples and case studies that illustrate the application of formulation principles. Step-by-step procedures for creating various cosmetic products offer valuable insights into the hands-on process, empowering readers to bring their own creative visions to life.

Keywords: Building blocks of cosmetic formulation, Emollients, rheological additives, Perfumes, EU regulations

Authors

Dr. Kailas Madhukar Karande
Professor
Department of Pharmaceutics
SET's Arvind Gavali College of Phamracy
Satara
karandekailas@gmail.com

Dr. Jayprakash Sitaram Suryawanshi
Professor
Department of Pharmacognosy
N.N. Sattha College of Pharmacy
Ahmednagar
jay.suryawanshi79@gmail.com

I. INTRODUCTION

Cosmeceuticals have emerged as a prominent and rapidly evolving category within the beauty and skincare industry, combining elements of cosmetics and pharmaceuticals. These products offer an innovative approach to addressing various skin concerns, providing not only aesthetic enhancements but also therapeutic benefits[1]. Central to the effectiveness of cosmeceuticals are the diverse range of active ingredients they contain, carefully formulated to target specific skin issues and promote overall skin health[2].

Unlike conventional cosmetic products, cosmeceuticals are developed with a scientific foundation, incorporating biologically active compounds and cutting-edge technologies. These ingredients go beyond superficial cosmetic effects, penetrating deeper into the skin to exert more profound and lasting results. As a result, cosmeceuticals have gained significant popularity among consumers seeking solutions for a wide array of skin conditions, ranging from aging signs like wrinkles and fine lines to hyperpigmentation, acne, and other dermatological concerns[3].

In this comprehensive exploration of cosmeceutical ingredients, we will delve into the fundamental building blocks that constitute these advanced formulations.

The present review is the stepwise guide not only to students but also to cosmetic professionals to get familiar with the formulation building blocks for various creams like vanishing, cold moisturizing, toothpastes, shampoos etc. It also has insights on core ingredients like emollients, preservatives, rheological additives etc. review also give valuable insights on classification and applications as well as merits and demerits of general cosmetic ingredients. Information on factors affecting microbial preservative efficacy. Brief information about soaps and syndetbars also mentioned. Controversial ingredients like Parabens, formaldehyde liberators, dioxane have been discussed.

II. COMMON BUILDING BLOCKS:

1. **Surfactants (Classification and application):**Surfactants are compounds that have both hydrophilic (water-loving) and lipophilic (oil-loving) properties [4]. This dual nature allows them to interact with both water and oil, making them effective at reducing surface tension and facilitating the mixing of ingredients that do not naturally blend. In cosmeceutics, surfactants act as emulsifiers, detergents, solubilizers, and foaming agents. Surfactants, or surface-active agents, play a significant role in cosmeceutics, which combines elements of cosmetics and pharmaceuticals[5]. They are commonly used ingredients in skincare, haircare, and other personal care products due to their unique properties. Key roles of surfactants in cosmeceuticals are,

    - **Emulsification:** One of the primary functions of surfactants in cosmeceutics is to stabilize emulsions. Most of the emulsions in market are either cold, vanishing or foundation creams. Emulsions are mixtures of two immiscible liquids, such as oil and water, and surfactants help to disperse and stabilize the droplets of one liquid within the other, forming a stable and uniform product. This is important for

creating creams, lotions, and other formulations that contain both water and oil components[6].

- **Cleansing and Detergency:** Surfactants are commonly used in cleansers, shampoos, and body washes due to their ability to remove dirt, oils, and impurities from the skin and hair. They lower the surface tension of water, allowing it to penetrate and lift away oil-based substances. Surfactants help create foam and lather, which aids in the effective cleansing and removal of dirt and oils[7].
- **Solubilization:** Some active ingredients used in cosmeceutics have limited solubility in water or oils. Surfactants can help solubilize these ingredients by forming micelles, which are small aggregates of surfactant molecules. Micelles can encapsulate and solubilize hydrophobic (water-insoluble) ingredients, enhancing their delivery and efficacy in cosmetic formulations[8].
- **Foaming and Texture Enhancement**: Surfactants are responsible for creating foam and enhancing the texture of many cosmetic products, such as cleansers, shampoos, and shaving creams. They help to stabilize and increase the volume of foam, providing a pleasant sensory experience during product use[9].

Surfactants should be compatible with the skin and hence it is essential to choose surfactants that are gentle on the skin and do not cause irritation or disrupt the natural barrier function. Mild surfactants, such as those derived from natural sources or with low irritancy profiles, are often preferred in formulations targeting sensitive or compromised skin.

III. CLASSIFICATION OF SURFACTANTS

There are various types of surfactants used in cosmeceutics, including anionic, cationic, amphoteric, and non-ionic surfactants. Each type has different properties and functionalities, and the selection depends on the specific requirements of the formulation and desired performance characteristics. It is worth noting that some surfactants can be classified into multiple categories depending on their chemical structure and behaviour[10].

Additionally, the selection and use of surfactants in cosmetics depend on factors such as the desired cleansing, foaming, emulsifying, and solubilizing properties, as well as considerations for compatibility, skin sensitivity, and regulatory guidelines.

Surfactants, or surface-active agents, used in cosmetics can be classified into different categories based on their chemical structure, charge, and the nature of their hydrophilic (water-loving) and lipophilic (oil-loving) groups[11].

Detailed classification of surfactants commonly used in cosmetics is as follows,

1. Anionic Surfactants

- **Sulfates:** These include sodium lauryl sulfate (SLS) and sodium laureth sulfate(SLES), which are widely used in cleansing products for their excellent foaming and cleaning properties.

- **Sulfonates:** Examples include sodium dodecylbenzenesulfonate (SDBS) and sodium lauryl sulfoacetate (SLSA), often used as alternatives to sulfates due to their milder nature.

2. **Cationic Surfactants**

- **Quaternary Ammonium Compounds (Quats):** Examples include cetrimonium chloride, behentrimonium chloride, and stearalkonium chloride. These surfactants are commonly used in hair conditioners and fabric softeners due to their conditioning and anti-static properties.

3. **Nonionic Surfactants**

- **Alkyl Polyglucosides (APGs):** These surfactants are derived from natural sources, such as coconut oil and glucose. They are mild, biodegradable, and suitable for use in baby care and sensitive skin products.
- **Ethoxylated Alcohols**: Surfactants such as polysorbates (e.g., Polysorbate 20, Polysorbate 80) and laureth compounds fall into this category. They are often used as emulsifiers, solubilizers, and dispersing agents.
- **Sorbitan Esters:** Examples include sorbitan stearate and sorbitan oleate. These surfactants are used as emulsifiers and co-emulsifiers in creams, lotions, and ointments.
- **Fatty Acid Ethoxylates**: Surfactants like laureth-4 and oleth-10 belong to this group. They are used as solubilizers, emulsifiers, and mild cleansing agents in various cosmetic formulations.

4. **Amphoteric Surfactants**

- **Betaines:** Examples include cocamidopropyl betaine (CAPB) and lauryl betaine. These surfactants are mild, compatible with various skin types, and commonly used in shampoos, body washes, and facial cleansers.

5. **Zwitterionic Surfactants**

- **Sulfobetaines**: Surfactants such as cocamidopropyl hydroxysultaine and lauryl hydroxysultaine belong to this category. They exhibit both cationic and anionic characteristics, providing mildness and conditioning properties
- **Silicone Surfactants:**Dimethicone Copolyol, Dimethicone PEG-10/15 Crosspolymer.

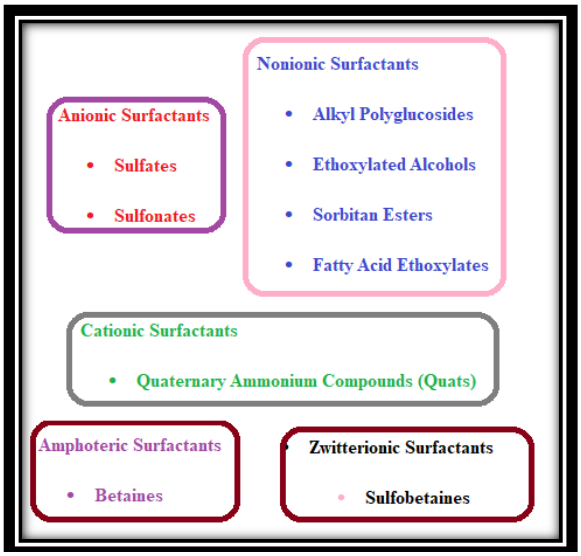

Figure1: Types of Surfactants

IV. APPLICATIONS OF SURFACTANTS

Surfactants play a vital role in the formulation of various cosmetic products. They are surface-active agents that help to reduce the surface tension between two substances, such as oil and water. This property makes surfactants versatile ingredients in cosmetics, enabling them to perform a range of functions. Most creams are emulsions and hence surfactants have crucial applicability in cosmetics. Some of common applications of surfactants in cosmetics are as follows,

1. **Cleansing:** Surfactants are widely used in cleansers, such as face washes, body washes, shampoos, and soaps. They help to remove dirt, oils, and impurities from the skin and hair by enabling the mixing of oil and water. Surfactants create micelles that encapsulate the dirt and allow it to be rinsed away.

2. **Foaming:** Surfactants are responsible for creating the foaming or lathering effect in many personal care products. They stabilize and increase the volume of the foam, enhancing the sensory experience during cleansing. Commonly used foaming surfactants include sodium lauryl sulfate (SLS) and sodium laureth sulfate (SLES).

3. **Emulsification:** Surfactants act as emulsifiers, allowing the blending of oil and water-based ingredients in creams, lotions, and other emulsion-based products. They help to stabilize the mixture and prevent separation. Emulsifying surfactants include ingredients like cetearyl alcohol, polysorbates, and glyceryl stearate.

4. **Solubilization:** Surfactants can solubilize oil-soluble ingredients in water-based formulations. This property is utilized in the production of products such as makeup removers, where surfactants help dissolve and remove makeup residues from the skin.

5. **Wetting and Spreading**: Surfactants aid in the even spreading of cosmetic products on the skin or hair surface. They enhance the wetting ability of formulations, allowing for better coverage and distribution of active ingredients.

6. **Conditioning:** Certain surfactants, such as quaternary ammonium compounds like cetrimonium chloride, are used in hair conditioners to provide a softening and smoothing effect. They help to reduce static electricity, improve manageability, and enhance the overall appearance of the hair.

7. **Stabilization:** Surfactants contribute to the stability of cosmetic formulations by preventing the aggregation or separation of ingredients. They can inhibit the growth of microorganisms and enhance the shelf life of products [12].

V. EMOLLIENTS (CLASSIFICATION AND APPLICATION)

Emollients are substances that have the ability to soothe, moisturize, and soften the skin by preventing water loss and improving the skin's texture. They are typically oily or fatty substances that can be of natural, synthetic, or semi-synthetic origin.

Emollients are a class of ingredients commonly used in cosmetics and personal care products to improve the hydration, smoothness, and softness of the skin. They form a protective barrier on the skin's surface, reducing water loss and helping to maintain the skin's natural moisture balance. Emollients play a vital role in cosmetic formulations, providing hydration, protection, and sensory benefits. Their use can help improve the overall appearance, feel, and health of the skin.

Emollients are incorporated into various cosmetic products, including creams, lotions, moisturizers, lip balms, and body oils. Formulators consider factors such as the desired texture, skin compatibility, stability, and specific performance requirements when selecting and combining emollients in a formulation.

Emollients vary in their comedogenicity (tendency to clog pores) and potential for skin sensitivity or irritation. It's important for formulators to choose emollients suitable for different skin types and to conduct appropriate testing to ensure product safety[13].

1. **Classification of Emollients:** They help to maintain the skin's natural moisture balance and improve its texture and appearance. Emollients form a protective barrier on the skin's surface, preventing moisture loss and providing a smooth and supple feel. They can be derived from various sources, including plant oils, mineral oils, and synthetic compounds. Based on the nature of emollient, these are classified as follows,

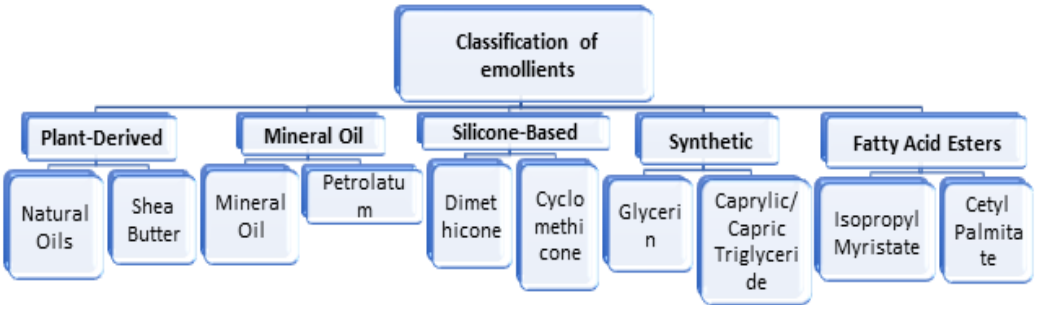

Figure 2: Classification of Emollients

2. Plant-Derived Emollients

- **Natural Oils:** These emollients are derived from plant-based oils and include oils such as almond oil, olive oil, coconut oil, jojoba oil, and avocado oil. They are rich in essential fatty acids and vitamins, providing nourishment and hydration to the skin.
- **Shea Butter:** Extracted from the nuts of the shea tree, shea butter is a popular emollient known for its rich texture and moisturizing properties. It is often used in creams, lotions, and lip balms.

3. Mineral Oil Emollients

- **Mineral Oil:** Also known as paraffin oil or liquid paraffin, mineral oil is a clear, odorless, and lightweight emollient derived from petroleum. It forms a protective barrier on the skin and helps to prevent water loss. Mineral oil is commonly found in various skincare products, including creams, lotions, and body oils.
- **Petrolatum**: Also known as petroleum jelly, petrolatum is a semi-solid emollient that provides excellent occlusive properties. It forms a protective layer on the skin's surface, preventing moisture loss and protecting the skin from external irritants. It is often used in lip balms, ointments, and body creams.

4. Silicone-Based Emollients

- **Dimethicone:** Dimethicone is a widely used silicone-based emollient that imparts a smooth, silky feel to the skin. It forms a breathable barrier, preventing moisture loss while allowing the skin to breathe. Dimethicone is commonly found in various skincare and cosmetic products, including foundations, primers, and moisturizers.
- **Cyclomethicone:**Cyclomethicone is a volatile silicone that evaporates quickly, leaving a dry, non-greasy feel on the skin. It is often used in haircare products, sunscreens, and serums.

5. Synthetic Emollients

- **Glycerin**: Glycerin is a humectant emollient that attracts water from the environment and helps to retain moisture in the skin. It is commonly used in moisturizers, serums, and facial mists.

- **Caprylic/Capric Triglyceride:** Derived from coconut oil and glycerin, caprylic/capric triglyceride is a lightweight, non-greasy emollient that penetrates easily into the skin. It provides a silky feel and is often used in lotions, creams, and sunscreens.

6. Fatty Acid Esters

- **Isopropyl Myristate:** Isopropyl myristate is a synthetic ester derived from isopropyl alcohol and myristic acid. It has excellent spreadability and is often used in cosmetic formulations to provide a smooth, non-greasy feel.
- **Cetyl Palmitate:** Cetyl palmitate is an emollient derived from cetyl alcohol and palmitic acid. It is known for its softening and smoothing properties and is commonly found in creams, lotions, and lip products.

VI. APPLICATIONS OF EMOLLIENTS

Emollients find wide-ranging applications in cosmetics due to their ability to improve the skin's texture, provide hydration, and enhance the overall feel of skincare and beauty products. Few of the core applications are as follows;

1. **As a moisturizer:** Emollients play a vital role in moisturizers as they help replenish and retain moisture in the skin, preventing dryness and maintaining its hydration. Examples of moisturizers containing emollients include facial creams, body lotions, and hand creams. These products often combine emollients like shea butter, almond oil, mineral oil, or silicone-based emollients like dimethicone or cyclomethicone to provide long-lasting hydration and a soft, supple feel.

2. **As a Lip Care Product:** Emollients are commonly used in lip balms, lipsticks, and lip glosses to moisturize and protect the delicate skin on the lips. Ingredients such as petrolatum, beeswax, shea butter, and natural oils like coconut oil or jojoba oil are frequently used as emollients in lip care products. They help to soothe dry, chapped lips, provide a smooth texture, and enhance the appearance of the lips.

3. **As Foundations and Concealers:** Emollients are incorporated into liquid foundations, tinted moisturizers, and concealers to improve the application and blendability of these products. Silicone-based emollients like dimethicone or cyclopentasiloxane help create a smooth, even application and provide a velvety finish. They also aid in the dispersion of pigments, allowing for better coverage and a more natural appearance.

4. **As body Oils:** Emollients, especially natural oils like almond oil, olive oil, or argan oil, are used in body oils to provide intense hydration and promote a luxurious, silky feel on the skin. Body oils are typically applied after showering or bathing to seal in moisture and leave the skin soft and nourished. They can also contain mineral oil or synthetic esters to provide a lightweight, non-greasy texture.

5. **As sunscreen and After-Sun Products:** Emollients are often included in sunscreens and after-sun products to provide hydration and soothe the skin. They help counteract the

drying effects of sun exposure and assist in maintaining the skin's moisture balance. Examples of emollients used in these products include glycerin, aloe vera extract, or natural oils like coconut oil or shea butter.

6. **As Hair Care Products:** Emollients are not limited to skincare but are also used in hair care products. In conditioners, hair masks, and styling products, emollients like dimethicone or cyclomethicone help to smooth frizz, improve manageability, and enhance the shine of the hair strands. They provide a protective coating, preventing moisture loss and adding a silky touch to the hair.

VII. RHEOLOGICAL ADDITIVES

Rheological additives are substances used in cosmetics to control the flow behavior and texture of formulations. They help improve product stability, enhance application properties, and provide desirable sensory attributes [15]. Here are some commonly used rheological additives in cosmetics along with their details:

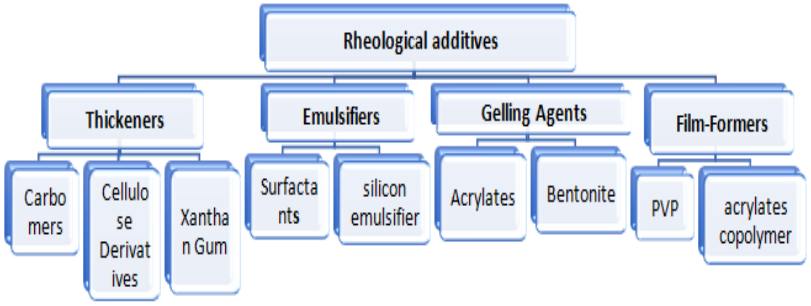

Figure 3

1. **Thickeners:** Thickeners increase the viscosity or thickness of cosmetic products, giving them a desirable texture and consistency. They help prevent product separation, improve spreadability, and enhance the suspension of ingredients. Examples of thickeners include:

   - **Carbomers:** Carbomers are synthetic polymers that can absorb large amounts of water and create a gel-like consistency. They are commonly used in creams, lotions, and gels to provide viscosity and stabilize emulsions.
   - **Cellulose Derivatives:** Cellulose derivatives such as hydroxyethyl cellulose (HEC), hydroxypropyl cellulose (HPC), and methylcellulose (MC) are frequently used as thickeners in cosmetic formulations. They provide viscosity control and improve the texture of products like creams, shampoos, and body washes.
   - **Xanthan Gum:** Xanthan gum is a natural polysaccharide derived from fermentation processes. It acts as a thickener and stabilizer, imparting a smooth and creamy texture to cosmetic products. Xanthan gum is commonly used in lotions, creams, and facial masks.

2. **Emulsifiers:** Emulsifiers help to blend and stabilize oil and water-based ingredients in cosmetic formulations. They ensure proper dispersion of immiscible components,

preventing separation and maintaining the stability of emulsions. Examples of emulsifiers include:

- **Surfactants:** Surfactants, such as polysorbates, glyceryl stearate, and cetearyl alcohol, are commonly used as emulsifiers in cosmetics. They lower the surface tension between oil and water phases, enabling the formation of stable emulsions in products like creams, lotions, and serums.
- **Silicone Emulsifiers**: Silicone emulsifiers, such as dimethicone copolyol and cyclomethicone, are used to create silicone-in-water emulsions. They allow for the incorporation of silicone oils into water-based formulations, providing a smooth and non-greasy feel.

3. **Gelling Agents:** Gelling agents are rheological additives that help transform liquid formulations into gels or semi-solid forms. They contribute to the stability, viscosity, and texture of the product. Examples of gelling agents include:

- **Acrylates/C10-30 Alkyl Acrylate Cross polymer**: This gelling agent is commonly used in gel-based skincare products, such as moisturizers and serums. It helps create a gel-like texture while imparting a smooth and silky feel.
- **Bentonite:** Bentonite is a natural clay mineral that can form a gel-like consistency when hydrated. It is often used in masks, cleansers, and scrubs to provide thickening and suspending properties.

4. **Film-Formers:** Film-forming agents create a thin, continuous film on the skin or hair surface, providing a protective barrier, enhancing adhesion, and improving the longevity of cosmetic products. Examples of film-formers include:

- **Polyvinylpyrrolidone (PVP):** PVP is a synthetic polymer that forms a clear film when applied to the skin or hair. It is commonly found in hairsprays, mousses, and styling products to provide hold and manageability.
- **Acrylates Copolymer**: Acrylates copolymer is a versatile film-forming agent used in a wide range of cosmetic products, including mascaras, eyeliners, and nail polishes. It helps create long thin film [16].

Real Life Example of Rheological Additive in Cosmetics

Set Wet is a popular brand of hair gel that offers various styling products, including hair gels. Set Wet hair gel exhibits thixotropic behaviour, allowing for easy application and styling. Its viscosity decreases under shear stress, making it more fluid and spreadable when agitated or applied with force. This property enables smooth application, even distribution, and long-lasting hold without compromising on flexibility and manageability.

Thixotropic behavior refers to the property of certain substances to exhibit a decrease in viscosity under shear stress, meaning they become less viscous and flow more easily when agitated or applied with force. This characteristic is particularly beneficial for hair gels as it allows for easy application and styling while maintaining the desired hold and shape.

Set Wet hair gel can be considered a thixotropic application because of its unique formulation and rheological properties. When at rest, the gel has a higher viscosity, providing structure and hold to the hair. However, when the gel is agitated by rubbing it between the palms or applied to the hair, it undergoes shear stress, causing it to become less viscous and easier to spread and manipulate.

The thixotropic behavior of Set Wet hair gel allows for smooth and effortless application onto the hair. The gel is initially thick and gel-like, ensuring it stays in place and holds the desired style. However, as it is worked into the hair or spread with fingers or a comb, it thins out and becomes more fluid, allowing for easy distribution and styling.

Once the desired style is achieved, the gel reverts back to its higher viscosity state, maintaining the hold and shape of the hair throughout the day. This thixotropic behavior ensures that the hair gel stays in place, providing a long-lasting hold, without becoming overly sticky or rigid.

VIII. APPLICATIONS OF RHEOLOGICAL ADDITIVES:

Rheological additives play crucial roles in the formulation of cosmetics, providing desirable texture, stability, and sensory attributes to various products.

Common applications of rheological additives in cosmetics:

1. **Creams and Lotions:** Rheological additives are used in creams and lotions to control their viscosity, texture, and spreadability. Thickeners such as carbomers, cellulose derivatives, or natural gums are incorporated to create a smooth, creamy consistency and prevent phase separation. These additives ensure easy application, enhance product stability, and improve the overall sensory experience
.
2. **Emulsions:** Rheological additives are essential in emulsions, which are formulations containing both oil and water phases. Emulsifiers, which act as rheological additives, help stabilize the emulsion, preventing phase separation and maintaining a uniform texture. They enhance the product's ability to mix, spread, and absorb into the skin. Common emulsifiers include surfactants, such as polysorbates or glyceryl stearate.

3. **Gels:** Rheological additives are used to create gels in cosmetic products such as hair gels, face masks, or body gels. Gelling agents, such as acrylates/C10-30 alkyl acrylate crosspolymer or natural gums like xanthan gum, are added to provide structure, thicken the product, and control its flow properties. Gels offer better control during application and provide enhanced adherence to the skin or hair, ensuring effective delivery of active ingredients.

4. **Sunscreens:** Rheological additives are employed in sunscreen formulations to improve their texture, spreadability, and film-forming properties. They help achieve even distribution and ensure proper coverage on the skin. Thickeners, such as cellulose derivatives or acrylates copolymers, are commonly used to provide stability and enhance the product's ability to adhere to the skin.

5. **Mascara and Eyeliners:** Rheological additives play a crucial role in mascara and eyeliner formulations to provide appropriate texture and application properties. They help control the flow and viscosity of the product, ensuring smooth and precise application. Film-forming agents, such as acrylates copolymers, create a flexible film on the lashes or eyelids, enhancing adhesion and longevity.

6. **Nail Polishes:** Rheological additives are used in nail polish formulations to control their viscosity, flow, and leveling properties. They help prevent settling of pigments, enhance brushability, and promote an even application. Thickeners and suspending agents, such as bentonite clay or acrylic resins, are employed to maintain uniform dispersion of colorants and other ingredients.

7. **Hair Styling Products:** Rheological additives are widely used in hair styling products, including hair gels, mousses, and waxes. They contribute to the desired texture, hold, and manageability of the hair. Thickeners, film-formers, and gelling agents are incorporated to provide structure, long-lasting hold, and flexibility while enabling easy application and styling[17].

IX. ANTIMICROBIAL AGENTS IN COSMETICS (PRESERVATIVE APPLICATION IN COSMETICS)

Antimicrobial preservatives play a crucial role in cosmetics by preventing the growth of microorganisms and ensuring product safety and stability. These preservatives are added to various cosmetic formulations to extend their shelf life, protect against contamination, and maintain product quality. Use of preservatives in cosmetics is strictly regulated by regulatory bodies such as the U.S. Food and Drug Administration (FDA) and the European Union's Cosmetics Regulation. Cosmetic manufacturers must comply with the permitted limits and safety assessments for preservatives to ensure consumer safety. Additionally, consumers with specific sensitivities or allergies should carefully read product labels and consult with healthcare professionals if needed[18].

Commonly used antimicrobials in cosmetics:

1. **Parabens:** Parabens are a group of preservatives that have been widely used in cosmetics for several decades. They are effective against a broad spectrum of microorganisms and are used in a variety of personal care products such as creams, lotions, shampoos, and makeup. However, there have been concerns about their potential hormonal activity and their possible link to health issues. As a result, some cosmetic manufacturers have started to use alternative preservatives.

   - **Merits of Parabens in Cosmetics**

     - **Preservative Properties:** Parabens are effective preservatives, inhibiting the growth of bacteria, yeast, and mold in cosmetics. This helps to extend the shelf life of products, preventing microbial contamination and ensuring consumer safety.
     - **Wide Usage:** Parabens have been extensively used in the cosmetics industry due to their broad-spectrum antimicrobial activity and affordability. They are versatile

preservatives, found in a wide range of products such as moisturizers, shampoos, makeup, and lotions.

- **Stability:** Parabens are chemically stable compounds, meaning they do not easily degrade or lose their effectiveness over time. This stability allows for long-lasting preservation of cosmetic products, reducing the risk of spoilage or deterioration.

- **Demerits of Parabens in Cosmetics**

  - **Allergic Reactions:** Some individuals may develop allergic reactions to parabens, including skin irritations, rashes, or dermatitis. These reactions can be more pronounced in people with sensitive skin or pre-existing skin conditions, such as eczema.
  - **Endocrine Disruption Concerns**: Parabens have been reported to possess weak estrogenic activity, meaning they can mimic the hormone estrogen in the body. This has raised concerns about their potential to disrupt the endocrine system, which regulates various bodily functions. However, the extent and significance of this effect in humans are still under debate and require further research.
  - **Bioaccumulation:** Parabens have been detected in human breast tissue, urine, and blood samples, indicating that they can accumulate in the body over time. This has led to concerns about their potential long-term effects, particularly regarding their cumulative exposure and possible links to certain health issues, such as hormone-related cancers. However, more research is needed to establish a clear causal relationship.
  - **Environmental Impact:** Parabens are not readily biodegradable and can persist in the environment. When washed off during use or disposed of improperly, they can enter water bodies and potentially have adverse effects on aquatic organisms.
  - **Regulatory Restrictions:** Due to the aforementioned concerns, some countries and regulatory bodies have implemented restrictions or bans on certain types of parabens in cosmetics. For instance, the European Union has banned the use of certain parabens in leave-on products for children under three years of age.

2. **Phenoxyethanol:** Phenoxyethanol is a widely used antimicrobial preservative in cosmetics. It has broad-spectrum activity against bacteria, yeasts, and molds. Phenoxyethanol is considered a safe alternative to parabens and is commonly found in skincare products, makeup, and hair care formulations. However, it is important to use it within the recommended concentration limits, as excessive amounts can cause skin irritation.

- **Merits of Phenoxyethanol in Cosmetics**

  - **Broad-Spectrum Antimicrobial Activity**: Phenoxyethanol is effective against a wide range of microorganisms, including bacteria, yeast, and mold. It helps prevent microbial growth, ensuring the safety and shelf life of cosmetic products.
  - **Low Skin Irritation Potential**: Phenoxyethanol has a relatively low skin irritation potential compared to some other preservatives. This makes it suitable for use in formulations intended for individuals with sensitive skin.

- **Stability and Compatibility**: Phenoxyethanol is a stable compound that remains effective over time. It is compatible with various cosmetic ingredients and formulations, making it a versatile choice for product preservation.
- **Approved by Regulatory Authorities:** Phenoxyethanol has been approved for use in cosmetics by regulatory authorities in many countries. It meets safety standards when used within recommended concentration limits.

- **Demerits of Phenoxyethanol in Cosmetics**

  - **Potential Skin Sensitization**: While phenoxyethanol is generally well-tolerated, there have been reports of skin sensitization and allergic reactions in some individuals. People with sensitive skin or a history of allergies may be more prone to developing adverse reactions.
  - **Controversial Safety Profile:** There have been debates and concerns regarding the safety of phenoxyethanol. Some studies have raised questions about its potential toxicity, especially when used in high concentrations or in specific formulations. However, the overall consensus is that phenoxyethanol is safe for use in cosmetics at the approved levels.
  - **Environmental Impact:** Like many preservatives, phenoxyethanol can have negative environmental impacts if not properly disposed of. It can accumulate in water bodies and has the potential to be toxic to aquatic organisms. Proper waste management and disposal practices are necessary to minimize its environmental impact.
  - **Regulatory Restrictions:** In certain regions, there are restrictions on the maximum allowable concentration of phenoxyethanol in cosmetics. For example, the European Union has set limits on its concentration in cosmetic products due to safety concerns.

3. **Benzalkonium Chloride**: Benzalkonium chloride is a quaternary ammonium compound used as an antimicrobial agent in cosmetics. It exhibits strong antimicrobial activity against bacteria and fungi. Benzalkonium chloride is often used in products such as creams, lotions, and wipes. However, it can be irritating to the skin and eyes, especially at higher concentrations.

- **Merits of Benzalkonium Chloride in Cosmetics**

  - **Effective Antimicrobial Activity**: Benzalkonium chloride exhibits strong antimicrobial properties, effectively inhibiting the growth of bacteria, viruses, and fungi. It helps prevent contamination and extends the shelf life of cosmetic products, ensuring consumer safety.
  - **Versatility:** Benzalkonium chloride is compatible with a wide range of cosmetic ingredients and formulations, making it a versatile preservative choice. It is used in various products, including shampoos, cleansers, moisturizers, and ointments.
  - **Long-Lasting Preservation**: Benzalkonium chloride is a stable compound that can provide long-lasting preservation of cosmetic products. It is not easily degraded, ensuring the maintenance of its antimicrobial effectiveness over time.

- **Demerits of Benzalkonium Chloride in Cosmetics**

  - **Skin Irritation and Sensitization**: Benzalkonium chloride has the potential to cause skin irritation and sensitization, particularly in individuals with sensitive skin or pre-existing skin conditions. Prolonged or repeated exposure to high concentrations can increase the risk of adverse reactions.
  - **Potential Allergic Reactions:** Some individuals may develop allergic reactions to Benzalkonium chloride, resulting in symptoms such as itching, redness, or swelling. People with a history of allergies or known sensitivities should be cautious when using products containing this ingredient.
  - **Environmental Concerns:** Benzalkonium chloride is not easily biodegradable and can have adverse effects on aquatic life when released into the environment. It is important to ensure proper disposal and waste management practices to minimize its impact on ecosystems.
  - **Regulatory Restrictions**: In certain regions, there are restrictions on the maximum allowable concentration of Benzalkonium chloride in cosmetics. For example, the European Union has set limits on its concentration in certain product categories due to safety concerns.
  - **Potential Development of Antimicrobial Resistance:** Overuse or misuse of products containing Benzalkonium chloride may contribute to the development of antimicrobial resistance in microorganisms. This can have implications for the effectiveness of antimicrobial agents in medical and healthcare settings.

4. **Chlorhexidine:** Chlorhexidine is an effective antimicrobial preservative commonly used in oral care products, such as mouthwashes and toothpaste. It has broad-spectrum activity against bacteria and fungi. Chlorhexidine is known for its persistent antimicrobial effect and is used to control oral bacteria and prevent dental plaque formation. However, it can cause tooth staining and taste alteration when used for an extended period.

   - **Merits of Chlorhexidine in Cosmetics**

     - **Strong Antimicrobial Activity:** Chlorhexidine exhibits potent antimicrobial properties against a wide range of microorganisms, including bacteria, fungi, and viruses. It effectively inhibits their growth and helps prevent contamination in cosmetic products.
     - **Persistence and Long-Lasting Effectiveness**: Chlorhexidine has a residual effect, meaning it remains active on the skin or surfaces for an extended period. This property ensures long-lasting antimicrobial protection and reduces the risk of microbial proliferation.
     - **Broad-Spectrum Efficacy**: Chlorhexidine is effective against both Gram-positive and Gram-negative bacteria, making it a versatile choice for controlling bacterial growth in cosmetics. It can also target certain viruses and fungi, contributing to the overall safety and stability of cosmetic products.
     - **Skin-Friendly Formulations**: Chlorhexidine can be formulated in various ways to make it less irritating and more suitable for use in cosmetic products. For instance, it can be combined with conditioning agents or emollients to minimize skin dryness or irritation.

- **Demerits of Chlorhexidine in Cosmetics**

  - **Skin Irritation and Allergic Reactions**: Some individuals may experience skin irritation, redness, or allergic reactions when exposed to Chlorhexidine. People with sensitive skin or a history of allergies should be cautious when using products containing this ingredient.
  - **Discoloration and Staining**: Chlorhexidine has the potential to cause discoloration or staining on certain surfaces or fabrics. This effect can be undesirable in cosmetic products that come into contact with clothing, towels, or other fabrics.
  - **Potential for Sensitization**: Prolonged or repeated use of products containing Chlorhexidine may lead to sensitization in some individuals. This means that the body can develop an allergic response to Chlorhexidine over time, resulting in adverse reactions upon subsequent exposure.
  - **Limited Solubility:** Chlorhexidine has limited solubility in water, which can pose challenges in formulating cosmetic products. Proper formulation techniques and compatibility with other ingredients are required to ensure the optimal dispersion and stability of Chlorhexidine in cosmetic formulations.
  - **Environmental Impact:** Chlorhexidine can have negative impacts on the environment when released into water bodies. It is important to properly dispose of products containing Chlorhexidine and adhere to environmental regulations to minimize its ecological footprint.

5. **Ethanol:** Ethanol, also known as ethyl alcohol, is a commonly used antimicrobial agent in cosmetics. It has broad-spectrum activity against bacteria, viruses, and fungi. Ethanol is often used in hand sanitizers, antiperspirants, and fragrances. It helps to kill microorganisms on the skin and evaporates quickly, leaving a dry and clean feeling. However, it can be drying to the skin with prolonged use.

   - **Merits of Ethanol in Cosmetics**

     - **Antimicrobial Properties:** Ethanol possesses antimicrobial activity and can effectively kill or inhibit the growth of certain bacteria and fungi. It helps to prevent microbial contamination in cosmetic products, contributing to their safety and shelf life.
     - **Solvent Properties:** Ethanol is a versatile solvent that can dissolve a wide range of cosmetic ingredients. It aids in the blending and dispersion of various substances, allowing for the creation of stable and homogeneous formulations.
     - **Rapid Evaporation:** Ethanol has a relatively low boiling point, which means it evaporates quickly upon application. This rapid evaporation can provide a cooling sensation on the skin and contribute to the quick drying of cosmetic products.
     - **Enhanced Absorption of Ingredients:** Ethanol can help improve the absorption and penetration of certain cosmetic ingredients into the skin. This property is particularly beneficial for products that aim to deliver active ingredients or therapeutic benefits.

- **Demerits of Ethanol in Cosmetics**

  - **Skin Irritation and Sensitization:** Ethanol can be drying and irritating to the skin, especially when used in high concentrations or by individuals with sensitive skin. Prolonged or repeated exposure to ethanol may disrupt the skin's natural moisture balance and lead to dryness or irritation.
  - To evaporate quickly, potentially reducing their effectiveness over time. This can be a concern for products where a longer shelf life or extended contact on the skin is desired.
  - **Potential for Overuse or Misuse:** Ethanol-containing cosmetics, particularly those with high alcohol content, may be misused or overused by individuals. Excessive or frequent use can strip the skin of its natural oils, disrupt the skin barrier function, and contribute to skin dryness and sensitivity.
  - **Flammability:** Ethanol is highly flammable, which presents safety concerns during the manufacturing, storage, and usage of cosmetic products. Proper precautions and adherence to safety guidelines are necessary to mitigate the risk of fire hazards.
  - **Regulatory Considerations:** Ethanol is regulated by various authorities, and there may be specific concentration limits or restrictions on its use in cosmetic products. Compliance with applicable regulations is essential to ensure product safety and regulatory compliance[19].

X. FACTORS AFFECTING MICROBIAL PRESERVATIVE EFFICACY

The efficacy of microbial preservatives in cosmetic products can be influenced by various factors. These factors can affect the ability of preservatives to inhibit the growth of microorganisms and prevent microbial contamination. Proper selection, formulation, and testing of preservatives in cosmetic products are essential to ensure effective microbial preservation and product safety throughout its shelf life. Key factors that can impact the microbial preservative efficacy in cosmetics are;

1. **pH**: The pH of a cosmetic product plays a crucial role in determining the effectiveness of preservatives. Microorganisms have different pH requirements for growth, and certain preservatives are more effective in specific pH ranges. Therefore, maintaining an appropriate pH range in the product formulation is important to ensure optimal preservative efficacy.

2. **Concentration:** The concentration of preservatives in a cosmetic product directly impacts their antimicrobial activity. Preservatives should be used at concentrations that are effective against a broad spectrum of microorganisms without causing irritation or other adverse effects on the skin. It is crucial to follow recommended usage levels to achieve the desired antimicrobial efficacy.

3. **Interactions with other Ingredients**: Some cosmetic ingredients can interact with preservatives, potentially reducing their effectiveness. For example, certain surfactants or chelating agents can bind to preservatives and render them less available to inhibit microbial growth. Compatibility studies should be conducted to ensure that preservatives remain active and effective in the presence of other ingredients.

4. **Formulation Factors**: The overall formulation of a cosmetic product can impact preservative efficacy. Factors such as water activity, oil content, presence of emulsifiers, and texture can influence the ability of preservatives to distribute evenly and contact microorganisms. The formulation should be optimized to maximize the preservative's ability to reach and act on target microorganisms.

5. **Packaging and Storage**: The packaging and storage conditions of cosmetic products can also affect the efficacy of preservatives. Airtight and properly sealed containers can prevent the entry of contaminants and maintain the integrity of the product. Additionally, exposure to extreme temperatures or sunlight can degrade preservatives and compromise their efficacy.

6. **Microbial Load:** The initial microbial load in a cosmetic product can influence the efficacy of preservatives. Higher levels of microbial contamination can challenge the preservative system and potentially overwhelm its ability to control microbial growth. Good manufacturing practices and appropriate hygiene measures should be followed to minimize the microbial load during production.

7. **Time:** Preservatives need sufficient contact time to exert their antimicrobial activity. The duration of product use, including how long the product is exposed to air or the skin, can impact the preservative's ability to maintain microbial control. It is important to consider the expected duration of product usage and shelf life when formulating with preservatives [20].

XI. BUILDING BLOCKS FOR FORMULATION OF A MOISTURIZING

Moisturizing creams are widely used in cosmetics to provide hydration, nourishment, and protection to the skin. These creams are formulated with specific ingredients that help improve the skin's moisture levels, restore its natural barrier, and keep it soft and supple.

The primary purpose of moisturizing creams is to replenish and lock in moisture. They are particularly beneficial for individuals with dry, dehydrated, or sensitive skin, as well as those exposed to environmental factors that can cause skin dryness, such as cold weather or air conditioning.

1. Functions of Moisturizing Cream

- **Hydration:** The primary function of moisturizing creams is to provide hydration to the skin. They contain water and humectants that attract and retain moisture, preventing dryness and promoting a healthy, plump appearance.
- **Skin Barrier Protection**: Moisturizing creams help strengthen the skin's natural barrier function. They contain occlusive ingredients that create a protective layer on the skin's surface, preventing water loss and shielding it from external aggressors like pollution or harsh weather conditions.
- **Soothing and Calming**: Some moisturizing creams include ingredients with soothing properties, such as aloe vera or chamomile extract. These ingredients help calm and reduce inflammation, making them suitable for sensitive or irritated skin.

- **Anti-Aging Effects**: Many moisturizing creams incorporate active ingredients like peptides, antioxidants, or vitamins that provide anti-aging benefits. These ingredients help diminish the appearance of fine lines, wrinkles, and age spots, promoting a more youthful complexion.
- **Softness and Smoothness**: Emollients present in moisturizing creams, such as oils and butters, help soften and smooth the skin's texture. They create a barrier that locks in moisture and prevents the skin from feeling rough or dry.

2. Building Blocks for Formulation of a Moisturizing Cream

When formulating a moisturizing cream, several key building blocks are typically considered to achieve the desired product characteristics. These building blocks include:

- **Water:** Water is the primary component of moisturizing creams and serves as the base. It provides hydration to the skin and helps deliver other ingredients.
- **Emollients:** Emollients are ingredients that help soften and smooth the skin by forming a protective barrier. Examples of emollients include oils, butters (such as shea butter or cocoa butter), and fatty acids.
- **Humectants:** Humectants are substances that attract and retain moisture from the environment or deeper layers of the skin. Common humectants used in moisturizing creams include glycerin, hyaluronic acid, and sorbitol.
- **Occlusives:** Occlusives create a barrier on the skin's surface to prevent moisture loss by reducing water evaporation. Common occlusive ingredients include petrolatum, lanolin, and dimethicone.
- **Emulsifiers**: Emulsifiers help blend the water and oil-based ingredients in a moisturizing cream to create a stable, homogeneous product. They allow the cream to have a smooth and consistent texture. Examples of emulsifiers include cetearyl alcohol, glyceryl stearate, and lecithin.
- **Thickeners:** Thickeners are used to give the moisturizing cream a desirable consistency and texture. They provide stability and prevent separation of the ingredients. Common thickeners include carbomer, xanthan gum, and cellulose derivatives.
- **Preservatives:** Preservatives are necessary to prevent microbial growth and extend the shelf life of the moisturizing cream. Common preservatives include parabens, phenoxyethanol, and benzyl alcohol.
- **Active Ingredients**: Active ingredients are added to provide specific benefits to the skin, such as anti-aging, soothing, or brightening properties. Examples of active ingredients in moisturizing creams are vitamins (e.g., vitamin E), botanical extracts, peptides, or hyaluronic acid.
- **Fragrance and Colorants (optional)**: Fragrance and colorants are sometimes added to enhance the sensory experience of using the moisturizing cream. However, they may also cause irritation in some individuals, so fragrance-free and colorant-free options are available for sensitive skin.

Example:

Table 1

Ingredient	Composition	Use
Water	70%	Solvent
Cetyl Alcohol/ Cetearyl Alcohol/ Shea Butter/ Coconut Oil	15%	Emollient
Glycerin/Hyaluronic Acid	05%	Humectant
Petrolatum/Dimethicone	05%	Occlusive
Cetearyl Glucoside/Glyceryl Stearate	03%	Emulsifier
Carbomer/Xanthan Gum	01%	Thickener
Phenoxyethanol/Ethylhexylglycerin	0.5%	Preservative
Vitamin E/Aloe Vera Extract	0.5%	Active Ingredient (optional)
Floral	qs	Fragrance (optional, to desired strength)
Colorant	qs	(optional, to desired intensity)

Process

1. In a heat-resistant container, combine water and the emollient (such as coconut oil) and heat the mixture to around 70°C (158°F) using a water bath or microwave.
2. In a separate container, combine the humectant (such as glycerin) and occlusive (such as dimethicone) and mix well.
3. Add the emulsifier (such as cetearyl alcohol) to the water and emollient mixture and stir until it dissolves completely.
4. Slowly pour the humectant and occlusive mixture into the water and emollient mixture while continuously stirring. Continue stirring until the mixture becomes uniform and well-emulsified.
5. Sprinkle the thickener (such as carbomer) into the mixture while stirring gently to avoid clumps. Continue stirring until the cream thickens and reaches the desired consistency.
6. Add the preservative (such as phenoxyethanol) to the mixture and stir well to ensure proper preservation of the cream.
7. If desired, add the optional active ingredient (such as hyaluronic acid) and mix thoroughly.
8. Optional: Add fragrance and colorant to the cream, adjusting the amounts to achieve the desired scent and color.
9. Allow the cream to cool down to room temperature while stirring occasionally to prevent separation.
10. Once the cream has cooled, transfer it to suitable containers, such as jars or tubes, and store in a cool, dry place .

3. **Vanishing Cream:** Vanishing cream, also known as vanishing lotion or vanishing ointment, is a type of cosmetic product that has gained popularity for its light and non-greasy texture. It is designed to quickly absorb into the skin upon application, leaving

little to no residue behind. Vanishing creams are commonly used in skincare and makeup routines, offering several benefits to the skin.

The basic ingredients of a vanishing cream provide the foundational properties of the formulation. These typically include water (aqua) as the primary component, which provides hydration to the skin. Other base ingredients may include oils, waxes, or silicones that contribute to the cream's texture and spreadability.

- **Building Blocks of Vanishing Cream**

  - **Stearic Acid:** Stearic acid is a saturated fatty acid derived from vegetable or animal sources. It acts as an emulsifier and thickening agent in the cream, contributing to its texture and stability.
  - **Emollients:** Emollients are ingredients that help soften and soothe the skin, preventing moisture loss. Examples of emollients used in stearic acid-based creams include:
    - **Coconut Oil:** Coconut oil is a natural emollient that provides hydration and helps to retain moisture in the skin.
    - **Shea Butter:** Shea butter is a rich emollient derived from the nuts of the shea tree. It has moisturizing and nourishing properties.

- **Humectants:** Humectants attract and retain moisture from the environment, enhancing the cream's moisturizing properties. Examples of humectants commonly used are:
  - **Glycerin:** Glycerin is a widely used humectant that helps to hydrate and soften the skin.
  - **Sodium Hyaluronate**: Sodium hyaluronate is a form of hyaluronic acid known for its exceptional ability to retain moisture, promoting hydration in the skin.
- **Water (Aqua):** Water is an essential component in the formulation of creams, serving as a solvent and providing a medium for the incorporation of other ingredients.

- **Emulsifiers:** Emulsifiers are crucial in forming a stable cream by allowing the mixture of oil and water-based ingredients. Common emulsifiers used in stearic acid-based creams include:

- **Glyceryl Stearate:** Glyceryl stearate acts as an emulsifier, assisting in the mixing of oil and water phases to create a stable emulsion.

- **Cetearyl Alcohol**: Cetearyl alcohol is a fatty alcohol that helps to stabilize the cream's consistency and promote a smooth texture.

- **Preservatives:** Preservatives are added to prevent microbial growth and ensure the cream remains safe for use. Examples of preservatives commonly used in creams are:
  - **Phenoxyethanol:** Phenoxyethanol is a broad-spectrum preservative effective against various microorganisms.
  - **Parabens**: Parabens, such as methylparaben and propylparaben, are commonly used preservatives with antimicrobial properties.

- **Fragrance (optional**): Fragrances may be added to enhance the sensory experience of the cream, providing a pleasant scent.

- **Colorants (optional):** Colorants may be added to give the cream a desired color or adjust its appearance.

Example:

Ingredient	Composition	Use
Stearic Acid:	10%	Emulsifier, thickening agent
Water	60%	Solvent
Cetyl Alcohol/ Cetearyl Alcohol/ Shea Butter/ Coconut Oil	15%	Emollient
Glycerin/Hyaluronic Acid	05%	Humectant
Petrolatum/Dimethicone	05%	Occlusive
Cetearyl Glucoside/Glyceryl Stearate	03%	Emulsifier
Phenoxyethanol/Ethylhexylglycerin	0.5%	Preservative
Floral	qs	Fragrance (optional, to desired strength)
Colorant	qs	(optional, to desired intensity)

➢ **Process**

- In a heat-resistant container, combine stearic acid, emollient (coconut oil), and water.
- Heat the mixture using a water bath or microwave until the stearic acid and emollient melt completely. Stir occasionally to ensure proper blending.
- In a separate container, combine glycerin, glyceryl stearate, and cetearyl alcohol. Heat them until melted and well-mixed.
- Slowly pour the glycerin, glyceryl stearate, and cetearyl alcohol mixture into the heated stearic acid, emollient, and water mixture. Stir continuously until the emulsion is fully incorporated, and the cream begins to thicken.
- Add phenoxyethanol to the cream as a preservative, stirring well to ensure even distribution.
- Optional: Add fragrance to the cream, adjusting the amount to achieve the desired scent. Stir thoroughly to ensure proper dispersion.
- Allow the cream to cool down to room temperature while stirring occasionally to prevent separation.
- Once cooled, transfer the vanishing cream into suitable containers, such as jars or tubes, ensuring they are clean and airtight.

4. Beeswax Borax Cream/Cold Cream

Beeswax borax cream, also known as beeswax emulsion or cold cream, is a type of moisturizing cream that incorporates the natural ingredients of beeswax and borax. This cream has been used for centuries as a skincare product due to its emollient and protective properties. Beeswax borax cream is typically applied to the face, hands, or body as a moisturizer. It can be used during the day or as a night cream, depending on personal

preference. A small amount of the cream is usually sufficient, as it spreads easily on the skin.

- **Functions:**

  - **Moisturization**: Beeswax and emollients in the cream help to moisturize and hydrate the skin, making it softer and smoother.
  - **Protection:** The protective barrier created by beeswax helps to shield the skin from environmental factors, such as harsh weather conditions or pollutants.
  - **Soothing and Healing**: Beeswax has soothing properties that can help calm irritated or sensitive skin. It may also support the healing process of minor skin irritations.

- **Building Blocks**

- **Beeswax:** Beeswax is a natural wax produced by honeybees. It is known for its emollient, moisturizing, and protective properties. Beeswax helps to create a protective barrier on the skin, preventing moisture loss and providing a soothing effect.
- **Borax:** Borax, also known as sodium borate, is a naturally occurring mineral salt. It acts as an emulsifier, helping to stabilize the mixture of oil and water in the cream.
- **Emollients:** Emollients like oils or butters, such as coconut oil, almond oil, or jojoba oil, are often added to provide additional moisturization and nourishment to the skin.
- **Water**: Water is used as a base and a solvent in the cream.
- **Essential Oils** (optional): Essential oils may be added for fragrance and potential additional skin benefits.

Example:

Ingredient	Composition	Use
Beeswax:	10%	Emulsifier
Borax: 0.2%	1%	Emulsifier
Emollient (e.g., Coconut Oil): 60%	30%	Emollient
Water (Aqua): 15%	60%	Solvent
Essential Oil (optional): To desired strength (Lavender Oil/rose oil)	qs	Essence/flavour

- **Manufacturing process:**

- Weigh out 10 grams of beeswax and 1 gram of borax.
- In a double boiler or a heat-resistant container placed in a water bath, melt the beeswax and borax together.
- Separately, measure out 30 grams of your chosen emollient (such as coconut oil) and add it to the melted beeswax and borax mixture. Stir gently to combine.
- Heat 58.9 grams of water until warm (not boiling). Slowly add the warm water to the melted wax and oil mixture while stirring continuously to form an emulsion.
- Continue stirring the mixture until it starts to cool down and thicken. At this point, you can add 0.1 grams (a few drops) of your preferred essential oil for fragrance, if desired. Stir well to evenly distribute the fragrance.

- Once the cream has cooled down to room temperature, transfer it into clean and airtight containers, such as jars or tubes.
- Allow the cream to cool and solidify completely before use.

5. **Building blocks for formulation of a shampoo:** Formulating a shampoo involves combining different ingredients to create a cleansing and conditioning product for the hair and scalp**.** Essential building blocks commonly used in shampoo formulations are;

   - **Surfactants:** Surfactants are the primary cleansing agents in shampoos. They help to remove dirt, oil, and other impurities from the hair and scalp. Common surfactants used in shampoos include sodium lauryl sulfate (SLS), sodium laureth sulfate (SLES), cocamidopropyl betaine, and decyl glucoside.
   - **Conditioning Agents:** Conditioning agents are added to improve the manageability, softness, and overall appearance of the hair. They help to reduce tangling, improve combability, and enhance shine. Examples of conditioning agents used in shampoos include cationic surfactants (e.g., behentrimonium chloride), silicones (e.g., dimethicone), and natural oils (e.g., argan oil).
   - **Thickeners:** Thickeners are used to give the shampoo its desired viscosity and texture. They help to stabilize the formulation and improve its ability to spread and cling to the hair. Common thickeners include sodium chloride (salt), cocamide DEA, guar gum, and xanthan gum.
   - **pH Adjusters:** pH adjusters are added to maintain the optimal pH range for the shampoo, which is typically around pH 5.5 to 6.5. This pH range is considered more compatible with the hair and scalp. Common pH adjusters include citric acid, lactic acid, and sodium hydroxide.
   - **Preservatives:** Preservatives are necessary to prevent the growth of microorganisms and maintain the shelf life of the shampoo. They help ensure product safety and stability over time. Common preservatives used in shampoos include phenoxyethanol, sodium benzoate, and potassium sorbate.
   - **Fragrances:** Fragrances are added to provide a pleasant scent to the shampoo. They help enhance the sensory experience and leave a fresh aroma on the hair. Fragrances can be a blend of natural and synthetic compounds.
   - **Conditioning Agents:** In addition to conditioning agents mentioned earlier, shampoos may contain other ingredients specifically designed to provide additional conditioning benefits, such as hydrolyzed proteins (e.g., hydrolyzed keratin, silk protein), panthenol (provitamin B5), and plant extracts (e.g., aloe vera, chamomile).
   - **Antioxidants:** Antioxidants are incorporated to help protect the shampoo from oxidation and maintain the stability of its ingredients. They help prevent degradation and maintain the effectiveness of active components. Common antioxidants used in shampoos include tocopherol (vitamin E) and ascorbic acid (vitamin C).
   - **Colorants:** Colorants may be added to give the shampoo its desired color or to match the brand's visual identity. These can include dyes or pigments approved for cosmetic use.
   - **Water:** Water serves as the primary solvent and base for the shampoo formulation. It helps to dissolve and disperse other ingredients, making them easier to mix and apply to the hair and scalp.

Example:

Ingredient	Composition	Use
Water (Aqua)	60%	Solvent
Surfactants 30%: Sodium Laureth Sulfate (SLES): Cocamidopropyl Betaine: Cocamide DEA:	 15% 10% 5%	Cleansing and foaming agent
Conditioning Agent: 5% Cetyl Alcohol: Behentrimonium Chloride:	 3% 2%	Conditioning agent
Preservatives: 0.5% Phenoxyethanol: Sodium Benzoate:	 0.3% 0.2%	
Fragrance(optional): desired strength **Citric Acid (optional): To adjust pH**	Qs Qs	

- **Process of Manufacturing**

  - Measure out 60 grams of water.
  - In a separate container, combine the surfactants: 15 grams of Sodium Laureth Sulfate (SLES), 10 grams of Cocamidopropyl Betaine, and 5 grams of Cocamide DEA. Mix well to ensure uniform distribution.
  - Add the surfactant mixture to the water while stirring gently.
  - In another container, combine the conditioning agents: 3 grams of Cetyl Alcohol and 2 grams of Behentrimonium Chloride. Heat them until melted and well-mixed.
  - Slowly add the melted conditioning agents to the surfactant and water mixture while stirring continuously.
  - Add the preservatives: 0.3 grams of Phenoxyethanol and 0.2 grams of Sodium Benzoate. Stir well to ensure proper distribution.
  - Optional: Add fragrance to the shampoo, adjusting the amount to achieve the desired scent. Stir thoroughly to ensure proper dispersion.
  - Optional: If needed, adjust the pH of the shampoo by adding small amounts of citric acid while monitoring the pH level. The recommended pH for shampoos is typically around 5.5.
  - Allow the shampoo to cool down to room temperature while stirring occasionally to prevent separation.
  - Once cooled, transfer the shampoo into suitable containers, such as bottles, ensuring they are clean and tightly sealed.

6. Building blocks for formulation of a toothpaste

Formulating a toothpaste involves combining various ingredients to create a product that effectively cleans and maintains oral hygiene. Essential building blocks commonly used in toothpaste formulations are;

- **Abrasives:** Abrasives are used to help remove plaque, surface stains, and debris from the teeth. They assist in the mechanical cleaning action of toothbrushing. Common abrasives used in toothpaste include calcium carbonate, hydrated silica, and dicalcium phosphate.

- **Humectants:** Humectants help to retain moisture in the toothpaste and prevent it from drying out. They also contribute to the smooth texture and flowability of the product. Common humectants used in toothpaste include glycerin, sorbitol, and propylene glycol.

- **Surfactants**: Surfactants are added to toothpaste to create foam and assist in spreading the toothpaste across the teeth and gums. They help in the removal of debris and enhance the overall cleaning action. Sodium lauryl sulfate (SLS) and sodium lauroyl sarcosinate are commonly used surfactants in toothpaste.

- **Binders and Thickeners:** Binders and thickeners help to give toothpaste its desired consistency, texture, and stability. They help maintain the shape of the toothpaste and prevent it from separating. Common binders and thickeners used in toothpaste include carboxymethylcellulose (CMC), carrageenan, and xanthan gum.

- **Fluoride:** Fluoride is an essential ingredient in toothpaste for its anticavity properties. It helps to strengthen tooth enamel, prevent tooth decay, and remineralize the teeth. Sodium fluoride, sodium monofluorophosphate, and stannous fluoride are commonly used fluoride compounds in toothpaste.

- **Flavoring Agents**: Flavoring agents are added to toothpaste to provide a pleasant taste and freshen breath. They help mask the natural taste of other ingredients and enhance the overall user experience. Common flavoring agents used in toothpaste include mint, spearmint, peppermint, and fruit flavors.

- **Sweeteners:** Sweeteners are used to enhance the taste of toothpaste and make it more appealing to users. They provide a pleasant flavor while being non-cariogenic (non-tooth-decaying). Common sweeteners used in toothpaste include saccharin, sorbitol, and xylitol.

- **Anti-Calculus Agents**: Anti-calculus agents help to prevent the formation of tartar or calculus on the teeth. They inhibit the mineralization of plaque and aid in maintaining oral hygiene. Pyrophosphates and zinc citrate are commonly used anti-calculus agents in toothpaste.

- **Desensitizing Agents**: Desensitizing agents are used in toothpaste to help reduce tooth sensitivity to hot, cold, or sweet stimuli. They work by blocking the nerve signals and providing relief from sensitivity. Potassium nitrate and strontium chloride are commonly used desensitizing agents in toothpaste.

- **Preservatives:** Preservatives are necessary to prevent microbial growth and maintain the stability and safety of toothpaste. They help to prolong the shelf life of the product.

Common preservatives used in toothpaste include sodium benzoate, potassium sorbate, and parabens.

Example:

Ingredient	Composition	Use
Calcium Carbonate: 50%	50%	
Glycerin: 20%	20%	
Water (Aqua): 20%	20%	
Sorbitol: 5%	5%	
Sodium Lauryl Sulfate: 1%	1%	
Sodium Saccharin: 0.2%	0.2%	
Preservatives: 0.3%	0.3%	
Sodium Benzoate: 0.2%	0.2%	
Potassium Sorbate: 0.1%	0.1%	
Flavor:	To desired taste and strength	

- **Manufacturing Process**

  - Measure out 50 grams of Calcium Carbonate.
  - In a separate container, combine 20 grams of Glycerin and 20 grams of Water (Aqua). Mix well to ensure uniform distribution.
  - Slowly add the Calcium Carbonate to the Glycerin and Water mixture while stirring continuously to form a smooth paste.
  - Add 5 grams of Sorbitol to the paste and mix well.
  - Incorporate 1 gram of Sodium Lauryl Sulfate into the mixture and stir until well combined. Sodium Lauryl Sulfate helps in foaming and cleansing action.
  - Add the desired amount of Flavor (such as mint or spearmint) to achieve the desired taste and strength. Stir thoroughly to ensure proper dispersion.
  - Include 0.2 grams of Sodium Saccharin as a sweetener and mix well.
  - Add the preservatives: 0.2 grams of Sodium Benzoate and 0.1 grams of Potassium Sorbate. Stir well to ensure proper distribution and to maintain the shelf life of the toothpaste.
  - Allow the toothpaste to sit for a few hours, giving it time to stabilize and thicken.
  - Once the toothpaste has reached the desired consistency, transfer it into suitable containers, such as tubes or jars, ensuring they are clean and tightly sealed [21].

XII. PERFUMES

Perfumes play a significant role in cosmetics as they provide a pleasant and appealing scent to various personal care products. They are used to enhance the sensory experience and create a positive emotional response in consumers. Perfumes in cosmetics can be found in a wide range of products, including perfumes and colognes, body lotions, creams, soaps, shampoos, conditioners, and more.perfumes in cosmetics add an element of luxury, personalization, and sensory delight to a wide range of personal care products, enhancing the overall user experience and leaving a lasting impression.The primary purpose of adding

perfumes to cosmetics is to impart a specific fragrance that aligns with the brand identity or the intended user experience. The scent of a product can evoke different emotions, create associations, and enhance the overall enjoyment of using the cosmetic item.

Perfumes in cosmetics are created using a combination of aromatic compounds, which can be derived from natural sources (such as essential oils or plant extracts) or created synthetically. These aromatic compounds contribute to the distinct scent profile of the perfume.Formulating perfumes involves selecting and blending different fragrance notes, which are classified into three categories:

- **Top Notes**: Top notes are the initial scents that are immediately perceived upon application of the cosmetic product. They provide the first impression and tend to be lighter, more volatile, and refreshing. Common top notes include citrus fruits, herbs, and aromatic spices.

- **Middle Notes or Heart Notes**: Middle notes emerge once the top notes have evaporated. They are the main body of the fragrance and provide the characteristic scent that lasts for several hours. Middle notes are often floral, fruity, or herbal in nature and contribute to the overall theme of the perfume.

- **Base Notes**: Base notes are the final and longest-lasting scents in the perfume. They provide depth and richness to the fragrance and can persist for several hours or even days. Base notes are usually derived from woods, resins, musk, or vanilla, and they help anchor the entire fragrance composition.

Perfumes in cosmetics are carefully formulated to achieve a harmonious and balanced blend of fragrance notes. The selection and combination of these notes are based on the desired scent profile, target audience, and the overall concept of the cosmetic product.

Sometimes individuals may have sensitivities or allergies to certain fragrance ingredients. Cosmetic manufacturers often list the ingredients used in the perfume on the product packaging, allowing consumers to make informed choices and avoid potential allergens.

1. **Classification of perfumes based on Fragrance Families, Concentration Levels, Gender Categories and Specialty:**

   Perfumes can be classified into different categories based on their scent profile, concentration of aromatic compounds, or target audience.

- **Fragrance Families/Groups**

  - **Floral:** Fragrances dominated by floral notes, such as rose, jasmine, or lily.
  - **Oriental:** Rich, warm, and exotic fragrances with notes of spices, vanilla, amber, or musk.
  - **Woody:** Fragrances characterized by woody or earthy notes, like sandalwood, cedarwood, or patchouli.

- **Citrus:** Refreshing and vibrant fragrances featuring citrus notes, such as lemon, bergamot, or orange.
- **Aromatic:** Fragrances with herbal, green, or aromatic notes like lavender, rosemary, or mint.
- **Fresh:** Clean, crisp, and invigorating scents reminiscent of freshly laundered clothes or aquatic notes.

- **Concentration Levels**

  - **Perfume/Parfum:** The highest concentration of fragrance, typically containing 20-30% aromatic compounds.
  - **Eau de Parfum (EDP):** A slightly lighter concentration than perfume, usually around 15-20% aromatic compounds.
  - **Eau de Toilette (EDT**): A lighter fragrance concentration with around 5-15% aromatic compounds.
  - **Eau de Cologne (EDC**): Lighter and less concentrated than EDT, typically containing 2-5% aromatic compounds.
  - **Eau Fraiche**: The lightest concentration with 1-3% aromatic compounds.

- **Gender Categories**

  - **Women's Perfume:** Fragrances marketed primarily for women, often featuring floral, fruity, or gourmand notes.
  - **Men's Cologne**: Fragrances marketed primarily for men, typically with woody, citrus, or aromatic notes.
  - **Unisex/Shared**: Fragrances designed to be suitable for both men and women, with neutral or diverse scent profiles.

- **Specialty Perfumes**

  - **Niche Perfumes**: Unique and artistic fragrances produced by independent or niche perfume houses, often with unconventional scent compositions.
  - **Designer Perfumes**: Fragrances associated with fashion or luxury brands, created in collaboration with renowned perfumers.
  - **Celebrity Perfumes:** Fragrances endorsed or created by celebrities, reflecting their personal style or brand image.

- **Perfume ingredients listed as allergens in EU regulation:**

In the European Union, fragrance ingredients that are known to cause allergies must be listed on the product packaging when their concentration exceeds certain thresholds. The EU regulation regarding the labeling of allergenic fragrance ingredients is outlined in Annex III of the European Cosmetics Regulation (EC) No. 1223/2009 [22,23].

The following is a list of 26 fragrance ingredients that are designated as potential allergens and require specific labelling when their concentration exceeds

0.001% in leave-on products (such as perfumes) or 0.01% in rinse-off products (such as shampoos):

• Amyl cinnamal • Benzyl alcohol • Cinnamal • Cinnamyl alcohol • Citral • Coumarin • Eugenol • Geraniol • Hydroxycitronellal • Isoeugenol • Anisyl alcohol • Benzyl cinnamate • Benzyl salicylate	• Butylphenyl methylpropional • Evernia prunastri extract • Everniafurfuracea extract • Farnesol • Hexyl cinnamal • Hydroxyisohexyl3-cyclohexene carboxaldehyde	• Limonene • Linalool • Methyl 2-octynoate • Alpha-isomethyl ionone • Benzyl benzoate • Citronellol • Geraniol citronellol

XIII. PARABENS AS A CONTROVERSIAL INGREDIENT

Parabens are a group of synthetic preservatives commonly used in cosmetics, pharmaceuticals, and personal care products to prevent the growth of bacteria, fungi, and other microorganisms. They have been widely used since the 1950s due to their effectiveness, low cost, and broad-spectrum antimicrobial properties. However, parabens have also been a subject of controversy and concern in recent years. Regulatory bodies, such as the U.S. Food and Drug Administration (FDA) and the European Union's Scientific Committee on Consumer Safety (SCCS), have evaluated the safety of parabens and set maximum concentration limits for their use in cosmetics. These limits are based on the available scientific evidence and aim to ensure that parabens do not pose significant risks to human health when used as directed.

In response to the controversies and consumer preferences, many cosmetic manufacturers have started to produce paraben-free or reduced-paraben formulations. scientific consensus on the safety of parabens is mixed, and further research is ongoing. The available evidence does not definitively establish that parabens are harmful when used in typical cosmetic concentrations. As with any cosmetic ingredient, individual sensitivities and personal preferences should be considered when choosing products. If you have specific concerns or sensitivities, consulting with a healthcare professional or dermatologist is advisable.Alternative preservatives and natural ingredients are often used as substitutes to maintain the microbial safety of cosmetic products.It caught in controversies due to following reasons;

- **Endocrine Disruption**: One of the main concerns associated with parabens is their potential to act as endocrine disruptors. Some studies have suggested that parabens, when absorbed into the body, can mimic or interfere with the hormone estrogen. Estrogen disruption has been linked to various health issues, including reproductive disorders, hormonal imbalances, and an increased risk of certain cancers.

- **Breast Cancer:** Parabens have been detected in breast tumors, which led to concerns about their potential link to breast cancer. However, the presence of parabens in breast tissue does not necessarily imply that they cause cancer. The research conducted so far has not provided conclusive evidence of a direct causal relationship between parabens and breast cancer.

- **Skin Irritation and Sensitization**: Parabens have the potential to cause skin irritation and allergic reactions in some individuals. People with sensitive skin or existing skin conditions may experience redness, itching, or dermatitis when using products containing parabens.

- **Accumulation in the Environment**: Parabens are not effectively removed by wastewater treatment systems and can enter the environment. There have been concerns about their potential accumulation in water bodies and their impact on aquatic ecosystems [24].

XIV. FORMALDEHYDE LIBERATORS AS A CONTROVERSIAL INGREDIENT:

Formaldehyde liberators are a group of chemical compounds commonly used in cosmetics and personal care products as preservatives. These substances slowly release small amounts of formaldehyde over time to inhibit the growth of bacteria and other microorganisms. However, formaldehyde and its releasing compounds have been the subject of controversy and concern due to their potential health risks.

1. Controversies surrounding formaldehyde liberators

- **Formaldehyde as a Carcinogen:** Formaldehyde is classified as a known human carcinogen by several authoritative bodies, including the International Agency for Research on Cancer (IARC) and the U.S. National Toxicology Program (NTP). Prolonged or excessive exposure to formaldehyde has been associated with an increased risk of certain cancers, particularly nasopharyngeal cancer and leukemia.

- **Allergic Contact Dermatitis:** Formaldehyde and its releasing compounds are known to cause allergic contact dermatitis, a skin condition characterized by redness, itching, and inflammation. Some individuals may develop sensitization to formaldehyde liberators over time, resulting in allergic reactions upon contact with products containing these ingredients.

- **Respiratory Sensitization and Irritation**: Formaldehyde exposure can also cause respiratory sensitization and irritation, leading to symptoms such as coughing, wheezing, and shortness of breath. Individuals with pre-existing respiratory conditions, such as asthma, may be particularly susceptible to the respiratory effects of formaldehyde.

- **Occupational Exposure:** Formaldehyde is a concern for workers in industries where it is used, such as hair salons, nail salons, and manufacturing facilities. Occupational exposure to formaldehyde has been associated with adverse health effects, including respiratory problems and an increased risk of certain cancers.

In response to above mentioned controversies, regulatory bodies and industry organizations have imposed restrictions and guidelines on the use of formaldehyde-releasing compounds in cosmetics. For example, the European Union's Cosmetic Regulation (EC) No. 1223/2009 restricts the concentration of formaldehyde in cosmetic products and requires proper labeling when it exceeds certain limits.
Many cosmetic manufacturers have also reformulated their products to be formaldehyde-free or use alternative preservatives to reduce the potential health risks associated with formaldehyde liberators.

It's important for consumers to be aware of the potential risks and read product labels for ingredients that may release formaldehyde, such as DMDM hydantoin, diazolidinyl urea, imidazolidinyl urea, and quaternium-15. If you have known sensitivities or concerns about formaldehyde exposure, it's advisable to choose formaldehyde-free products or consult with a healthcare professional for personalized advice [25].

2. Dioxane as a Controversial Ingredient

Dioxane is a chemical compound that is considered controversial in the cosmetic industry due to its potential health risks. It is not intentionally added to cosmetics but can be present as a byproduct or impurity in certain cosmetic ingredients. Regulatory bodies, such as the U.S. Food and Drug Administration (FDA) and the European Union's Scientific Committee on Consumer Safety (SCCS), have established guidelines and limits for dioxane levels in cosmetics. For example, the FDA recommends that the concentration of dioxane in cosmetic products should not exceed 10 parts per million (ppm).It's important for consumers to be aware of the potential risks associated with dioxane and to choose products from reputable brands that prioritize safety and comply with regulatory standards. Reading product labels and being informed about the ingredients used in cosmetics can help individuals make informed choices based on their personal preferences and concerns.

To minimize dioxane exposure, cosmetic manufacturers often employ purification processes and conduct quality control tests to ensure that dioxane levels in their ingredients and finished products are within acceptable limits. Additionally, there are alternative ingredients and manufacturing methods available to reduce the potential presence of dioxane in cosmetics.

3. Controversies Surrounding Dioxane

- **Carcinogenic Potential**: Dioxane is classified as a possible human carcinogen by the International Agency for Research on Cancer (IARC) and the U.S. Environmental Protection Agency (EPA). Animal studies have shown that high doses of dioxane can cause tumors in various organs, including the liver and lungs. However, the level of dioxane found in cosmetic products is typically low, and the actual risk to human health is still under debate.

- **Skin Irritation and Sensitization**: Dioxane can cause skin irritation and sensitization in some individuals. Prolonged or repeated exposure to high concentrations of dioxane

can lead to dryness, redness, and dermatitis. People with sensitive skin or pre-existing skin conditions may be more susceptible to these effects.

- **Environmental Concerns:** Dioxane is persistent in the environment and can contaminate water sources. It is not easily biodegradable and can bioaccumulate in aquatic organisms. Consequently, dioxane has raised concerns about its potential impact on ecosystems and aquatic life [26].

REFERENCES

[1] Gupta, Vaibhav, et al. "Nanotechnology in cosmetics and cosmeceuticals—A review of latest advancements." Gels 8.3 (2022): 173.
[2] Chen, Fa-Ming, and Xiaohua Liu. "Advancing biomaterials of human origin for tissue engineering." Progress in polymer science 53 (2016): 86-168.
[3] Javaid, Ayesha, et al. "Multifunctional attributes of nanostructured materials, toxicology, safety considerations, and regulations." Journal of Materials Science 57.36 (2022): 17021-17051.
[4] Saad, M. A., et al. "Surfactant for petroleum demulsification, structure, classification, and properties. A review." IOP Conference Series: Materials Science and Engineering. Vol. 991. No. 1. IOP Publishing, 2020.
[5] Moldes, Ana B., et al. "Synthetic and bio-derived surfactants versus microbial biosurfactants in the cosmetic industry: An overview." International Journal of Molecular Sciences 22.5 (2021): 2371.
[6] Panda, H. Herbal cosmetics hand book. National Institute of Industrial Re, 2000.
[7] Gubitosa, Jennifer, et al. "Hair care cosmetics: From traditional shampoo to solid clay and herbal shampoo, a review." Cosmetics 6.1 (2019): 13.
[8] Müller-Goymann, C. C. "Physicochemical characterization of colloidal drug delivery systems such as reverse micelles, vesicles, liquid crystals and nanoparticles for topical administration." European Journal of Pharmaceutics and Biopharmaceutics 58.2 (2004): 343-356.
[9] Rieger, Martin. "Foams in personal care products." Foams. Routledge, 2017. 381-412.
[10] Knepper, Thomas P., and José Luis Berna. "Surfactants: properties, production, and environmental aspects." Comprehensive Analytical Chemistry 40 (2003): 1-49.
[11] Somasundaran, P., Somil C. Mehta, and Parag Purohit. "Silicone emulsions." Advances in colloid and interface science 128 (2006): 103-109.
[12] Rieger, Martin, ed. Surfactants in cosmetics. Routledge, 2017.
[13] Nacht, Sergio, et al. "Skin friction coefficient: changes induced by skin hydration and emollient application and correlation with perceived skin feel." J. Soc. Cosmet. Chem 32.2 (1981): 55-65.
[14] Alander, Jari T. "Chemical and physical properties of emollients." Treatment of Dry Skin Syndrome: The Art and Science of Moisturizers. Berlin, Heidelberg: Springer Berlin Heidelberg, 2012. 399-417.
[15] Clarke, Mary T. "Rheological additives." COSMETIC SCIENCE AND TECHNOLOGY SERIES (1993): 55-55.
[16] Laba, Dennis, ed. Rheological properties of cosmetics and toiletries. CRC Press, 1993.
[17] Sherman, Philip. "Industrial rheology with particular reference to foods, pharmaceuticals, and cosmetics." Industrial rheology with particular reference to foods, pharmaceuticals, and cosmetics. (1970).
[18] Halla, N., Fernandes, I. P., Heleno, S. A., Costa, P., Boucherit-Otmani, Z., Boucherit, K., ... & Barreiro, M. F. (2018). Cosmetics preservation: a review on present strategies. Molecules, 23(7), 1571.
[19] Herman, Anna. "Antimicrobial ingredients as preservative booster and components of self-preserving cosmetic products." Current microbiology 76.6 (2019): 744-754.
[20] Cowen, R. A., and B. Steiger. "Antimicrobial activity—a critical review of test methods of preservative efficiency." Journal of the Society of Cosmetic Chemists 27 (1976): 467-481.
[21] Flick, Ernest W. Cosmetic and Toiletry Formulations, Vol. 3. Vol. 3. Elsevier, 2014.
[22] Teixeira, Miguel A., et al. "Perfumery radar 2.0: A step toward fragrance design and classification." Industrial & Engineering Chemistry Research 53.21 (2014): 8890-8912.

[23] UNION, PEAN. "Regulation (EC) No 1223/2009 of the european parliament and of the council." Official Journal of the European Union L 342 (2009): 59.
[24] Kirchhof, Mark G., and Gillian C. de Gannes. "The health controversies of parabens." Skin Therapy Lett 18.2 (2013): 5-7.
[25] Sondossi, Mohammad. Role of formaldehyde in mode of action of formaldehyde-adduct biocides. Wayne State University, 1988. Begum, Ghausia, et al. "A STUDY OF POTENTIAL CYTOTOXIC EFFECT OF 1, 4 DIOXANE ON HUMAN HEPATIC CELL LINE (HEP10)." (2016).

