

COSMETOLOGY IN PRACTICE

A GUIDE FOR HEALTHCARE PROFESSIONALS

PART 1



Editor:

Bruna Galdorfini Chiari-Andréo

Bentham Books

Cosmetology in Practice: A Guide for Healthcare Professionals

(Part 1)

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Editor: Bruna Galdorfini Chiari-Andréo

ISBN (Online): 978-981-5322-25-5

ISBN (Print): 978-981-5322-26-2

ISBN (Paperback): 978-981-5322-27-9

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First published in 2026.

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FOREWORD

Welcome to an indispensable resource, designed specifically for professionals specializing in the application of cosmetic products and facial aesthetics. This comprehensive book aims to be a resource for students and professionals (dermatologists, estheticians, pharmacists, biomedical physicians, nurses, and dentists) in the fields of dermatology, cosmetology, and personal care, being an informative guide for the selection and use of cosmetic raw materials, and the guidance necessary for effective cosmetic prescription. By arming ourselves with knowledge, we can make informed decisions about the cosmetics we use.

In the ever-evolving landscape of beauty and wellness, professionals who apply and recommend cosmetic products play a crucial role in helping individuals maintain healthy, radiant skin and prevent premature aging. By understanding the intricate histology and physiology of the skin, scalp, and hair, including their appendages, professionals gain the knowledge necessary to address a wide array of skin dysfunctions and deliver optimal care to their clients.

This book serves as a comprehensive guide to unravel the complex workings of the skin and its appendages, from its cellular structure to the multifaceted processes that influence its health and appearance. By examining the interplay between physiology, environmental factors, and skincare practices, professionals can develop a comprehensive approach to skincare, tailoring their recommendations to the individual's unique needs.

Furthermore, this book delves into the realm of cosmetic raw materials, products, and routines, exploring the active ingredients that can help maintain the health and vitality of one's skin and hair while also preventing the signs of aging. From well-known substances to innovative compounds, the authors will explore the science behind these ingredients, their mechanisms of action, and their proven efficacy in various skincare and haircare formulations.

We would like to express our deepest gratitude to the researchers, scientists, and experts whose tireless efforts have contributed to the advancement of dermatology, cosmetology, and facial aesthetics. By expanding one's knowledge of skin and hair histology and physiology, exploring the science behind cosmetics, and incorporating guidance for cosmetic prescription, I believe that an individual can enhance their ability to meet the unique needs of their consumers, ultimately fostering their confidence and well-being.

May this book serve as your trusted companion, empowering you to excel in your profession and make a meaningful impact on the lives of those who seek your expertise.

Helena Margarida Ribeiro
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PREFACE

The book “Cosmetology in Practice: A Guide for Healthcare Professionals (Part 1)” was prepared to meet a demand identified by the editor: the lack of literature that brings practical information about Cosmetology for professionals working in Dermatology, Aesthetics, and Facial and Body Harmonization.

The literature for Cosmetology is currently relatively wide, however, focused on the knowledge of professionals who work in product development. Or, when aimed at professionals prescribing these products, superficially.

Thus, this book aimed to gather clear and direct information on how to apply Cosmetology in the daily lives of the professionals mentioned above.

In addition, it finds relevance in the growing demand for these professionals, who, in order to offer complete care to their patients, depend on this knowledge. Knowing cosmetic products in depth allows professionals to create an effective cosmetic prescription that satisfies the needs of their patients.

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CHAPTER 1

Histophysiology of the Skin and its Accessory Structures

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Abstract: This chapter marks the opening of this book, dedicated to the study of Cosmetology, providing in-depth information for health professionals. Thus, it is of fundamental importance to provide a basis for further discussions regarding the use of Cosmetology to act on the skin and its appendages. Thus, this manuscript aims to provide an understanding of the entire microarchitecture of the skin, as well as the functioning of the organ and its cells, thereby facilitating the understanding and learning that will occur in sequence.

Keywords: Connective tissue, Corneocytes, Epidermis, Epithelial tissue, Fibroblasts, Keratin, Melanocytes, Mitosis, Physiology, Stratum corneum, Subcutaneous tissue.

INTRODUCTION

The skin is the largest organ of the human body, accounting for approximately 15% of an adult's body weight, with an area ranging from 1.5 to 2 m², and a thickness varying from 1 to 2 mm, generally fluctuating according to individual needs of the various areas of the body that it covers [1, 2], normally being thicker in more damaged regions such as the soles of the feet and the palms of the hands. In addition to its complex composition, it has connected structures capable of ensuring the body's communication with the environment.

Its basic functions are the interaction with the external environment, since it is the first contact of the human body with the environment, protection against friction, also against excessive loss of water, possible invaders, and harmful substances; therefore, due to its extension, it is the greatest protective barrier of the organism [3]. Because it is the organ most exposed to the environment, it is also the one that suffers the most impact from external factors, including changes that are percepti-

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ble to human observation. One of the most important morphological alterations, including unsightly impacts that are “manipulated” by Cosmetology, is aging caused by intrinsic and extrinsic factors. In this condition, there is a reduction in the number of its cells, including fibroblasts, as well as a reduction in the biosynthesis of molecules that make up its architecture, such as collagen, elastin, and glycosaminoglycans. This set of changes reflects changes in its texture, the appearance of sagging, as well as the formation of wrinkles [2, 4]. In addition to the aforementioned barrier function, thermoregulation is another function of the skin, performed by hair and sweat glands that help maintain homeostasis in terms of temperature. The sensory function can also be described as the skin allowing the perception of pressure, touch, temperature, and pain [5].

This complex organ is composed of 2 layers, the epidermis and the dermis, supported by the subcutaneous tissue, previously also known as the hypodermis.

EPIDERMIS

The epidermis is the outermost layer, and as such, it is the body's primary protective barrier. It is mainly composed of cells called keratinocytes and is subdivided into five layers or strata: basal, spinous, granular, lucid, and corneal [6].

In the basal layer, also known as the germinal stratum, which is located more internally and in contact with the dermis, multiplication of keratinocytes occurs through mitosis. The mitosis of these cells in this stratum promotes the migration of cells with a longer lifespan towards the more superficial layer, as the deeper layers are occupied by new cells. As migrating cells reach the most superficial layers of the epidermis, they undergo changes that lead to cell death and the loss of their nuclei. This process is evident in the stratum corneum, where the cells are flattened, anucleated, and lack viability [3]. In contrast, cells in the deeper, more basal layers—such as the cuboidal or low columnar keratinocytes—present with basophilic cytoplasm. While keratinocytes are the predominant cell type, melanocytes are also present in these basal layers [5].

The process of multiplication of keratinocytes in the basal layer, with transformation into corneocytes (anucleated, keratinized cells) until their desquamation in the outermost layer, called the stratum corneum, lasts approximately 30 days in a healthy adult [3]. Pathological conditions such as psoriasis affect this multiplication rate.

The keratinization mechanism involves the synthesis phase, in which the differentiating cell accumulates keratin in its cytoplasm, serving as a stabilizer of its cytoskeleton. It emits keratin filaments that bind to the basement membrane,

stabilizing and forming desmosomes. During the degradation phase, terminal differentiation occurs, resulting in the formation of corneocytes, which are keratinized cells lacking a nucleus [7].

The keratinocytes are found not only in the stratum basale, but also in the other strata. The innermost layer is the aforementioned basal layer, which is connected to the basement membrane and is composed of stem cells, thus initiating the proliferative activity of epidermal cells. After this process, these cells move to the layer above, called the stratum spinosum, losing their ability to proliferate and assuming a non-regular (polyhedral) morphology depending on the region they cover, in addition to containing compounds such as glycoproteins, glycolipids, and hydrolytic enzymes, which favors the barrier function [8]. Among the keratinocytes of the stratum spinosum, there are desmosomes, specialized structures of the plasma membrane of these cells, responsible for ensuring firm attachment between them. This structure is anchored in the keratin filaments of the cytoskeleton of such cells, making the fixation more efficient. Due to the presence of such desmosomes, microscopy reveals the presence of spines between cells [5].

The cells located in the stratum spinosum follow and reach the stratum granulosum, where they begin to produce granules of keratohyaline, accumulated in the cytoplasm, and, when visualized in optical microscopy, appear as basophilic spots. These granules are precursors for the formation of keratin. Keratin corresponds to the main protein present in the composition of the skin and its appendages (hair and nails, mainly). In addition, filaggrin is also mentioned, one of the main proteins associated with keratin filaments in the skin. Its precursor form, called profilaggrin, accumulates in the cytoplasmic granules of the granulosum layer, as mentioned above, in the form of keratohyalin granules. This protein's primary function is the reticulation of keratin filaments, which is crucial for forming a barrier and providing the body with an impermeable layer that protects it [9].

These cells begin to lose their nuclei and reach the stratum corneum, the most superficial layer of the skin, composed of an aggregate of anucleated cells, full of keratin, called corneocytes, permeated by a lipid matrix and closely connected, making this biochemically resistant layer with a hydrophobic capacity for protection [10]. Under optical microscopy, this region shows marked acidophilia [5].

This ability to migrate from the basal layer to the surface layer of the epithelium, which makes this tissue resistant and rigid, forms networks of filament connections through desmosomes and hemidesmosomes. Furthermore, the

CHAPTER 2

Pillars of Facial Aging

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Abstract: Facial aging is a complex, multifactorial, and interrelated process of changes occurring in the facial skeleton, ligaments, muscles, adipose tissue, and skin. The aging process is similar, regardless of ethnicity or gender; however, facial changes vary between people. Although each anatomical layer goes through its own process, a change in one layer can trigger alterations in nearby layers. Bony skeleton provides stability, structure, and definition to the overlying Soft Tissue (ST). Its support diminishes as bones remodel with age, causing the ST to deflate and reposition. Adipose tissue promotes skin health, elasticity, and structure. Over time, several factors undermine the metabolic and structural support it provides to the face. Muscles provide suspension and structural integrity to the ST, affecting volume and facial contour. Repetitive contraction and loss of muscle tone are responsible for the signs of senescence. Retaining ligaments are anchor points that retain and stabilize the ST. Its laxity and the hypertrophy of the fat pads cause ST descent. The skin is subject to intrinsic and extrinsic aging processes, resulting in a progressive loss of function and regeneration potential. Facial ageing is characterized by deflation and descent of soft tissues due to loss of bone, fat, and muscle tone, loss of balance between interacting muscles, weakening of retaining ligaments and skin elasticity, deterioration of skin tone and texture, disproportion as hypotrophy and hypertrophy happen at different rates, facial areas, and chronological times. Clinicians can promote more precise and effective treatment when they better understand the facial aging process in its five structural planes.

Keywords: Anatomy, Collagen, Facial muscles, Facial retaining ligaments, Facial aging, Fasciocutaneous, Genetic alterations, Gravitational wrinkles, Intrinsic aging, Ptosis, Superficial fat compartments.

INTRODUCTION

The anatomy of the human face has received intensive attention over the last decade, as procedures for facial rejuvenation are increasingly being performed

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with a variety of techniques [1]. Studies on the etiology of facial aging have evolved considerably; it is now known that this process is complex and integrated, affecting all layers of the face, and has progressed beyond a simple approach that focuses on the effects of gravity and skin laxity [2, 3]. Facial aging is a multifactorial process of the facial skeleton, ligaments, muscles, adipose tissue, and skin [1]. The aging process is similar, regardless of ethnicity or gender; however, the extent and rate of facial changes vary between people [2, 3].

Facial aging is a composite, interrelated, three-dimensional process [4]. While each anatomical layer undergoes an aging process of its own, a dependency also exists between the more superficial structures and the deeper layers. It is a complex, multifaceted process wherein a change in one layer often causes a cascade of changes to adjacent layers [5].

AGE-RELATED CHANGES

Facial Bones

The bony skeleton of the face serves as a pillar for the overlying soft tissue, providing stability, structure, and definition [1, 5].

It is currently accepted that the facial skeleton undergoes lifelong and continuous changes that affect the appearance of the face and its expressions [6 - 8]. As bones recede and remodel over time, support from this foundation is reduced, causing a recession and repositioning of the ST above. Consequently, there is a repositioning of the muscles and fat pads inferiorly and medially as they relocate over the shifting bony platform [9, 10].

Remodeling of the craniofacial skeleton occurs between adolescence and middle adulthood, and beyond [11]. The changes noted in the descriptions that follow occur among both sexes; however, men have a larger pyriform aperture, differently shaped orbital rims, more prominent brow ridges, and a larger jaw than women [12]. Furthermore, with the aging process, both genders vary in the extent and rate of facial bony changes [13].

Selective resorption occurs in specific areas of the adult facial bone (Fig. 1). Contrary to conventional beliefs, remodeling of the facial skeleton occurs unabated regardless of the state of the dentition. However, the loss of dentition significantly accelerates bony resorption of the alveolar and skeletal portions of the maxilla and mandible [14].

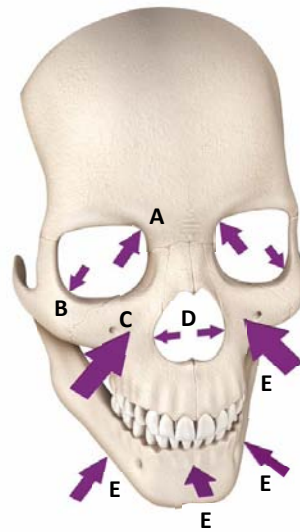


Fig. (1). Specific locations of the facial bones susceptible to resorption with aging. The *size of the arrows* corresponds to the quantity of resorption. Superomedial (**A**) and Inferolateral (**B**) aspects of the orbit. Suborbital (**C**) and medial pyriform (**D**) areas of the maxilla. Mandible area (**E**) [8]. *Image courtesy of Napoleão do Brasil Publisher.*

The main sites of age-related bone alterations include:

Periorbital Region

With age, the orbital aperture increases in both width and area. Yet, resorption is site-specific and uneven [15].

The inferolateral and superomedial sides of the orbital bone are resorbed, increasing the eyelid-cheek junction, prominence of the medial brow, and fat pad; this way, the eyes appear rounder and smaller (senile enophthalmos) with deeper tear ducts [8, 9, 16, 17].

Those changes occur at different ages. The inferolateral orbital rim changes manifest earlier, by middle age, whereas in the superomedial quadrant, recession may be noted only in old age [15]. The inferomedial quadrant of the orbit also tends to recede in old age, especially in males [15]. In contrast, the central parts of the superior and inferior orbital rims are more stable, with little if any resorption occurring with age [18] (Fig. 2).

CHAPTER 3

Skin Functioning Disorders and Main Pathologies

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Abstract: The skin is an incredibly complex and multifaceted organ that performs vital bodily functions. It protects the body from harm, regulates temperature, and helps maintain its immune system. Understanding the structure and function of the skin, the human body's largest organ, is vital to effectively identifying and treating skin disorders or pathologies. The skin comprises three layers: the epidermis, dermis, and hypodermis. The skin also plays a vital role in the immune system. It contains immune cells that help to fight off infections and diseases. These immune cells recognize and attack foreign invaders, such as viruses and bacteria, that can cause skin infections. Various factors can affect the skin's health, including genetics, environmental factors, and lifestyle choices. Exposure to harmful UV rays, pollution, stress, smoking, and poor nutrition can all lead to skin disorders and pathologies. Common skin disorders and pathologies include acne, eczema, psoriasis, and skin cancer. These conditions can range from mild to severe, significantly impacting a person's quality of life. In summary, the skin is a complex and multifaceted organ that performs essential bodily functions. Understanding the structure and function of the skin is vital to maintaining its health and preventing skin disorders and pathologies.

Keywords: Acne, Barrier, Eczema, Genetic factors, Hair disorders, Hypersensitivity reaction, Inflammation, Irritants, Lifestyle factors, Pathologies, Prevention, *Propionibacterium acnes*, Psoriasis, Quality of life, Skin cancer, Skin diseases, Skin health, Skin infections, Skin disorders.

INTRODUCTION

The skin is a vital organ that performs various crucial bodily functions. As the largest organ, it covers the entire body and acts as a protective barrier, shielding it from the external environment. It provides a barrier that prevents harmful substances and microorganisms from entering the body and helps regulate body temperature [1]. The skin also helps detect various external stimuli such as touch, pressure, temperature, and pain through sensory receptors present in the skin.

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The human skin comprises three main layers: the epidermis, dermis, and hypodermis [2]. The epidermis is the outermost layer of the skin, providing an excellent protective barrier to the body. The epidermis also contains melanocytes that produce melanin, a pigment that protects the skin from the harmful effects of UV radiation from the sun [3]. The dermis is the second layer of the skin, providing structural support to the skin. It contains blood vessels, nerves, and other structures that help maintain the skin's elasticity, strength, and flexibility. The dermis also contains various appendages, such as hair follicles, sweat glands, and sebaceous glands, that help regulate body temperature and secrete oils and sweat, which lubricate and protect the skin [4, 5]. The hypodermis is the deepest layer of the skin and comprises adipose tissue and connective tissue. It helps insulate the body and stores energy [4]. The skin also plays an essential role in the immune system. It contains various immune cells, such as Langerhans and T-cells, that help protect the body against infections and diseases. These cells help detect and respond to foreign invaders such as bacteria, viruses, and fungi and initiate an immune response to eliminate them [6].

Despite its importance, the skin can be affected by various factors, leading to dysfunction and the development of skin disorders and pathologies. They can range from mild to severe and affect people of all ages and skin types. These factors can be genetic, environmental, or related to lifestyle. Genetic factors significantly determine the skin's structure, function, and susceptibility to various skin diseases [7]. Environmental factors such as exposure to UV radiation, pollutants, and chemicals can damage the skin and compromise its protective function, leading to various skin disorders. Lifestyle factors such as diet, stress, and smoking can also affect the skin's health and increase the risk of developing skin diseases [8 - 10]. Understanding the skin's anatomy and physiology is crucial in diagnosing and treating various skin conditions and diseases.

In conclusion, the skin is a complex organ that can be affected by various factors, leading to dysfunction and the development of skin disorders and pathologies. This chapter will discuss some of the most common skin functioning disorders and their main pathologies.

MAIN SKIN DISORDERS

Acne Vulgaris

Acne vulgaris is a common skin condition affecting a significant proportion of adolescents and young adults, with an estimated prevalence of approximately 85% [11]. It is a chronic inflammatory disorder of the pilosebaceous unit, which consists of hair follicles and sebaceous glands, primarily located on the face, chest, and back [12].

The pathogenesis of acne is multifactorial, involving several factors, including genetics, hormonal changes, inflammation, and microbiota. The overproduction of sebum by the sebaceous glands is a crucial factor in the development of acne. The excess sebum mixes with keratinocytes and forms a plug, resulting in microcomedones [12]. The abnormal follicular keratinization process also contributes to the development of comedones, non-inflammatory lesions that can progress into inflammatory lesions, such as papules, pustules, and nodules [13].

The colonization of *Propionibacterium acnes* (*P. acnes*) bacteria is also implicated in the development of acne. *P. acnes* is a commensal bacterium that resides in the pilosebaceous unit and regulates sebum production. However, under certain conditions, such as an increase in sebum production and inflammation, *P. acnes* can contribute to the development of acne by inducing an inflammatory response [12].

In summary, acne vulgaris is a chronic inflammatory disorder of the pilosebaceous unit that results from the interplay between sebum production, abnormal follicular keratinization, and colonization of *P. acnes* bacteria. Understanding the pathogenesis of acne is crucial for developing effective treatment strategies for this common skin condition.

Alopecia

Alopecia, also known as hair loss, is a common skin disorder that affects many people worldwide. It can occur in different forms and affect various body parts, including the scalp, face, and body [14]. It can occur in different patterns and severities, ranging from patchy hair loss (alopecia areata) to complete hair loss (alopecia universalis) [14].

Some of the most common types of alopecia include [14 - 17]:

Androgenetic Alopecia: This is also known as male pattern baldness or female pattern hair loss.

Alopecia Areata: An autoimmune disorder that causes patchy hair loss in various areas of the body.

Telogen Effluvium: This occurs when a large number of hair follicles prematurely enter the resting (telogen) phase of the hair growth cycle.

Traction Alopecia: This is caused by repeated pulling or tension on the hair follicles.

Cicatricial Alopecia: A rare form of hair loss where inflammation damages hair follicles and replaces them with scar tissue.

CHAPTER 4

Skin Health as a Reflection of Body Health

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Abstract: Vitamins are essential organic components in the regulation of various metabolic processes, and their presence is indispensable for the maintenance of dermal homeostasis. Initially, vitamin A is essential for the synthesis of new collagen fibers and cell renewal, as well as for its antioxidant effects, which help avoid dermatological pathologies and photoaging. In deficiency, it affects human growth and development, causing an imbalance in the immune system. Among the B vitamins, the ones most closely related to dermatological aspects are vitamin B3 and vitamin B12. Vitamin B3 is associated with antipruritic, whitening, and antimicrobial effects. Vitamin B12 is essential as a cofactor for several enzymatic reactions, and its deficiency can lead to cutaneous and oral manifestations. Vitamin C is effective in its antioxidant role, in hormonal and collagen synthesis, and in the induction of fibroblast migration and proliferation in the skin, making it a target of great interest for dermatology. Vitamin D can be obtained through diet or exposure to UV light and is involved in increasing intestinal absorption of calcium. Finally, vitamin E plays a crucial role in the blood clotting cascade and antioxidant potential, making it a valuable tool for preventing photoaging.

Keywords: Aging, Antioxidant, Collagen, Deficiency, Dermatology, Dermocosmetics, Homeostasis, Photoaging, Retinol, Skin health, Tretinoin, Vitamin A, Vitamin B, Vitamin B3, Vitamin B12, Vitamin C, Vitamin D, Vitamin E.

INTRODUCTION

Vitamins are conceptualized as organic molecules that act in a wide variety of organic processes. Its most common function is to act as intrinsic cofactors in enzymatic and metabolic reactions. As differentiable characteristics, it is known that vitamins are generally not synthesized by the cells of mammalian species; therefore, their obtainment occurs through the consumption of foods such as

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fruits, milk, and leafy greens. We can classify them into two distinct types. Water-soluble vitamins (Thiamine, Riboflavin, Niacin, Pantothenic Acid, Pyridoxine, Biotin, Cobalamin, Folic Acid, and Ascorbic Acid) and fat-soluble (vitamin A, vitamin D, vitamin E, and vitamin K) [1, 2].

To maintain healthy skin, vitamins play a crucial role in our body, as they are essential for regulating dermal homeostasis. However, for aesthetic purposes, such substances can be replaced topically by applying them directly to the skin layer through dermocosmetics, or orally. Thus, they assist in processes such as cell renewal, the production of new collagen fibers, increasing the natural resistance of the skin, controlling the production of sebum in oily skin, and assisting in the reduction of acne lesions. They act against sagging, premature photoaging, and fine lines of expression [2].

Generally speaking, each of these nutrients has a specific life cycle and optimal levels that meet the body's needs, allowing symptoms to manifest uniquely. The lack and low consumption of these nutrients, associated with cultural factors and eating habits, can cause numerous undesirable and harmful organic manifestations in the human body, which can lead to a vitamin deficiency. Thus, the symptoms present themselves in varied ways, as they depend on the missing vitamin and the intensity of its deficiency [1, 2].

With this, some dermatological signs and symptoms present themselves, including dry, flaking skin, papules, a rough texture, and weakness of nails and hair. To target regions such as elbows, knees, arms, and buttocks more frequently.

However, hypovitaminosis is considered a disease that happens when a person has low or total levels of vitamins in the body [2].

VITAMIN A

Vitamin A, also known as retinol, has a molecular formula of $C_{20}H_{30}O$. It belongs to the family of essential micronutrients, to compose the group of fat-soluble vitamins, which is found in animal tissue as retinoid or in plant tissues, as provitamin A (carotenoid) [3, 4]. This is available as a food source and can be divided into preformed vitamin A and provitamin A. Preformed vitamin A is found in animal foods such as liver, butter, cheese, whole milk, eggs, and fish. It may be presented under different names, including retinol, retinal, and retinoic acid. In contrast, only provitamins A (specifically β -carotene and β -cryptoxanthin) are found in plant-based sources. These sources include leafy greens (such as spinach and kale), yellow vegetables (like pumpkin and carrot), yellow-orange fruits (like mango and papaya), and certain oils (such as buriti and palm oil). The body transforms these provitamins into vitamin A through a process called hepatic

metabolization, where the cleavage of a single β -carotene molecule yields two molecules of vitamin [4].

It is known that carotenoids comprise a group of natural pigments with colorations that transition from yellow to red, and these are present in all photosynthetic and non-photosynthetic tissues. Furthermore, they can be absorbed in their intact conformation and deposited in the tissues of the organism (skin, fat, and blood) [5].

Hepatic metabolism of vitamin A involves liver parenchymal cells and Ito cells (also known as hepatic stellate cells). Significant portions of ingested retinol are absorbed by the lymphatic pathway and transported by lipoproteins called chylomicrons, such as retinyl esters, destined to the cells of the hepatic parenchyma; where they will be hydrolyzed and give conformation again to retinol, which will bind the Retinol-Binding Protein (RBP) and thus transported to the hepatic stellate cells [5].

Once ingested, retinol is released by the proteins in the stomach through enzymatic actions, resulting in the formation of retinyl esters. In the small intestine, these esters are hydrolyzed again, allowing for the formation of retinol, which is then absorbed more easily than the esters. Concomitantly, carotenoids are cleaved inside the cells of the intestinal mucosa, yielding the retinaldehyde molecule, which is subsequently reduced to retinol. During the absorption process, retinol undergoes conjugation with glucuronic acid, facilitating its entry into the enterohepatic circulation and resulting in the formation of two products: the esterification of retinol, yielding retinyl esters, and the oxidation of retinol, producing retinoic acid, both of which can be transported in plasma [4].

The storage of vitamin A occurs in the form of retinyl esters; thus, 50-80% of vitamin A is stored in the liver, where it binds with Retinol-Binding Protein (RBP) and is subsequently transported to the hepatic stellate cells. Such storage can regulate the dietary variability of vitamin A, preventing vitamin A deficiency during periods of low intake [3, 6].

When there is a need for vitamin supply, vitamin A is mobilized from the hepatic system to the peripheral tissues, under conditions of integral reserves. In cases of reduced reserves, the body must perform hydrolysis of retinyl esters, a metabolic event that maintains the constant concentration of circulating active forms. Thus, the interaction of retinol with the Retinol-Binding Protein (RBP) circulating in plasma and associated with a complex with transthyretin (prealbumin), promotes conditions that prevent the excretion of the retinol-RBP complex in the urine [4, 6].

CHAPTER 5

Importance of Cosmetics in Maintaining Health and Preventing Skin Aging

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Abstract: Among all human organs, the skin stands out in terms of size and structural complexity. It comprises multiple strata, each with distinct characteristics, including differences in embryonic origin, cellular composition, and vascularization. The skin plays a critical role in protecting the internal environment from external stressors such as solar radiation and dehydration. Although the human body possesses an intrinsic antioxidant system, it is insufficient to counteract oxidative stress entirely. As a result, oxidative damage accumulates, with aging being the most evident manifestation. While aging is a natural biological process, it underscores the need to develop cosmetic formulations containing active ingredients that mitigate its effects. Additionally, the development of products that support skin hydration is essential to maintaining healthy, resilient skin.

Keywords: Air pollution, Antioxidant, Ascorbic acid, Beauty, Chronological aging, Dehydration, Dermis, Embryology, Epidermis, Free radicals, Glycation, Hydroxy acids, Moisturizer, Oxidative stress, Premature aging, Rejuvenation, Skin aging, Solar radiation, Tocopherol.

INTRODUCTION

The skin is the body's most exposed organ and, as such, is particularly vulnerable to environmental insults. Factors such as pollution, dehydration, and excessive exposure to solar radiation contribute significantly to the overproduction of free radicals and the initiation of other deleterious reactions in the skin.

Free radicals arise from both endogenous metabolic processes and exogenous sources, and an imbalance in the antioxidant defense system can lead to oxidative stress. One of the most visible consequences of this imbalance is premature skin

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aging. Due to its external location and visibility, the skin readily displays signs of both chronological and premature aging, including decreased elasticity, the formation of wrinkles, and the appearance of pigmentation disorders.

Aging involves a series of physiological, biochemical, and genetic changes in the skin, many of which are inevitable. However, a wide range of exogenous factors can accelerate these changes. Poor nutrition, dehydration, excessive production of free radicals and advanced glycation end products, and impaired skin barrier function all contribute significantly to skin aging.

Premature aging is among the most frequently reported aesthetic concerns. Many individuals are troubled by the visible signs of skin aging and seek interventions to rejuvenate the skin and maintain a healthy appearance.

Advances in dermatological and cosmetic research have led to the development of numerous strategies aimed at mitigating the effects of premature aging. These include the use of cosmetic formulations containing active compounds such as phenolic compounds and ascorbic acid, which possess antioxidant and antiglycation properties; hyaluronic acid, fatty acids, and glycerin, which support skin hydration; and retinoids, which enhance barrier function. While it is not possible to reverse the aging process, these interventions can improve skin appearance and delay the onset of visible signs of aging.

This guide will outline the classical mechanisms underlying skin aging and highlight active ingredients that effectively target these pathways, offering both functional and aesthetic benefits.

GENERAL ASPECTS OF SKIN AGING

Aging is a multifactorial and interconnected biological process, with Reactive Oxygen Species (ROS) playing a central role. ROS activate signaling pathways such as Mitogen-Activated Protein Kinases (MAPKs) and Nuclear Factor-kappa B (NF- κ B), which contribute to decreased extracellular matrix synthesis and increased expression of matrix-degrading enzymes, including matrix metalloproteinases. As a result, collagen production declines by approximately 1% annually, and existing collagen fibers become increasingly irregular and disorganized. Moreover, MAPK and NF- κ B signaling enhance the production of pro-inflammatory cytokines, which in turn amplify ROS generation *via* the Fenton reaction [1 - 3]. Photoaging, skin aging induced by chronic and cumulative exposure to ultraviolet radiation, represents another key contributor to cutaneous aging. This exposure results in DNA damage, mutations, and elevated ROS production, all of which accelerate the aging process [4].

MicroRNAs (miRNAs), a class of non-coding RNAs that regulate gene expression post-transcriptionally, also play significant roles in skin aging. By targeting messenger RNAs for degradation or translational repression, miRNAs influence various physiological processes, including cell proliferation, differentiation, and apoptosis. Differential miRNA expression patterns have been observed during aging, and elevated miRNA levels are considered hallmarks of cellular senescence [4]. Senescent cells express genes encoding immunomodulatory and proteolytic mediators associated with either tissue maintenance or degeneration. Notably, senescent fibroblasts produce surface molecules that inhibit their clearance by Natural Killer (NK) cells and CD8⁺ T lymphocytes. These fibroblasts can also communicate with neighboring cells *via* extracellular vesicles, transferring miRNAs to keratinocytes in organotypic models and inducing senescent phenotypes in recipient cells [5].

Other critical markers of aging include telomere shortening and the accumulation of Advanced Glycation End-products (AGEs). Telomeres are repetitive nucleotide sequences that protect chromosomal integrity, but they progressively shorten with each cell division, signaling cellular aging. In keratinocytes, two classical signs of senescence have been identified: telomere attrition and a proliferation plateau accompanied by increased expression of the *p21* gene, though this latter signal may be reversible. Despite advances, the mechanisms underlying senescence in keratinocytes and fibroblasts remain incompletely understood, with emerging evidence suggesting an unexpected degree of cellular plasticity.

AGEs are formed through non-enzymatic glycation reactions in which sugars (*e.g.*, glucose or fructose) covalently bind to proteins, lipids, or nucleic acids, impairing their normal functions. In the skin, AGEs contribute to tissue stiffening and reduced elasticity, while also activating MAPK and NF- κ B signaling pathways [1, 4, 5].

In summary, skin aging is a complex and multifactorial process. Although considerable progress has been made, further research is needed to fully elucidate the underlying mechanisms and integrate the diverse molecular pathways involved.

Glycation and Aging

Glycation accelerates skin aging through a non-enzymatic reaction known as the Maillard reaction, wherein glucose binds to proteins, leading to the formation of glycotoxins that impair physiological function. The initial glycation products, known as Amadori compounds, can undergo structural rearrangement and dehydration to form AGEs [6]. AGEs are a heterogeneous group of compounds that adversely affect various biological structures, including collagen and elastic

CHAPTER 6

Basic Cosmetic Raw Materials: Products for Use on the Skin

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Abstract: The knowledge of the raw materials in a cosmetic product is essential for the formulator to select, rationally, the ingredients and process steps to obtain an efficient, stable and safe cosmetic for the consumer. In this chapter, we present the main components required to compose a cosmetic, as well as trends utilizing sustainable compounds. It is organized in the main groups of ingredients and their specific subgroups: surfactants (anionic, cationic, nonionic, amphoteric), rheological additives, preservatives (antimicrobial, antioxidant), moisturizers (humectant, emollient, occlusive), and sustainable strategies in raw materials. Information regarding cosmetic chemistry must be reviewed in each case to guarantee better interaction among the components. Safety and efficacy of cosmetics must be evaluated with all ingredients combined at the final formulation, along with package design.

Keywords: Antioxidants, Clean beauty, Cosmetic, COVID-19, Cruelty free, Emollients, Essential oils, Formulations, Green beauty, Humectants, Minimalist formulation, Moisturizers, Multifunctional ingredients, Occludents, Organic cosmetics, Preservatives, Raw materials, Rheological additives, Surfactants, Sustainable ingredients.

INTRODUCTION

The raw material in cosmetic formulations can be composed of one or more components of vegetable, animal, mineral, or synthetic origins. This chapter approaches the main ingredients of a cosmetic formulation with basic information

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regarding definition, uses and examples. Nonetheless, the association of these components and possible incompatibilities among them are case-specific and require prior knowledge of cosmetic chemistry [1].

This chapter is organized sequentially into five sections: surfactants, rheological additives, preservatives, moisturizers, and sustainable strategies in raw materials. We present up-to-date basic ingredients that must compound a cosmetic formulation, their impact on health and environmental issues and recent advances after the COVID-19 pandemic.

SURFACTANTS

Surfactants are represented by molecules capable of modifying the surface tension of liquids due to the presence of a polar group bonded to a weakly polar or non-polar one in their structure. By being compatible with both oil and water, surfactants act as emulsifiers, wetting and foaming agents, penetration enhancers, solubilizers and dispersants [2 - 5].

Due to their affinity for both polar and nonpolar molecules, surfactants are widely used in cleansing and emulsified formulations. The human skin can get dirty by oily deposits (natural sebum) and solid particulates (such as pollution particles and other particles from the environment). Water alone is not capable of removing all the skin dirtiness, particularly oily deposits. In this case, surfactants act as detergents, where the lipophilic part of the molecule is attracted to the lipids on the surface of skin, and the hydrophilic part of the molecule is attracted by the aqueous moiety, providing cleaning at the time of rinsing with water. Consumers usually associate the foaming formation with cleaning, although foam does not provide dirt removal itself. Surfactants can stabilize air bubbles, contributing to the maintenance of foam [3].

Another interesting application for surfactants is as wetting agents. They reduce the contact angle between surfaces, facilitating the interaction between the product and the skin, for example, providing better spread. Surfactant molecules align themselves in micelles. These are responsible for the thickening and emulsifying properties of surfactants. For this reason, they are used in the composition of creams and lotions, by forming a thermodynamically metastable dispersion of two immiscible liquids [2 - 4].

Surfactants are classified as anionic, cationic, nonionic, or amphoteric, according to the presence of electrolytic dissociation in aqueous medium, due to the group present in the polar portion of the molecule.

Anionic surfactants have a negatively charged ion. They are widely used for cleaning products. On the other hand, cationic surfactants are positively charged and are represented by amine salts or quaternary ammonium salts linked to hydrocarbon groups. They are not used for cleansing formulations since they do not clean, foam, or rinse efficiently. Also, they are known for being irritant to the skin and incompatible with anionic surfactants. In the cosmetic industry, cationic surfactants are used as conditioning agents for skin and hair in cosmetics, presenting antiseptic and disinfectant properties, and also used as preservatives [2, 3, 5]

Amphoteric surfactants are medium pH dependent, meaning that they can present negative and/or positive charges. They exhibit excellent cleansing properties, being less irritating than anionic surfactants, and for this reason, they are usually used in combination. They present low toxicity, good stability and chemical compatibility. Additionally, they serve as effective foam enhancers when combined with anionic surfactants, promoting formulation thickness and facilitating the solubilization of oils. This class of surfactants is represented by glycol and glycerol esters, sorbitan esters, polysorbates, ethoxylated fatty alcohols, fatty alkanolamides, including lauramide diethanolamine (DEA) and cocamide DEA, as well as amine oxides such as lauramine oxide or stearamine oxide [2 - 5].

Skin care products that contain both water and oil-based ingredients are usually commercialized as emulsions, such as creams and lotions. Emulsifiers are also being used to help deliver certain ingredients, such as vitamins and antioxidants, deeper into the skin layers. Some of the most commonly used emulsifiers in cosmetic products include cetostearyl alcohol derivatives, glyceryl stearate derivatives, and polyglyceryl oleate (used as a co-emulsifier), as well as stearic acid derivatives (when partially neutralized), polyoxyethylene alkyl ethers, and polysorbates [2, 3, 6 - 8].

It is known that surfactants can cause environmental problems in the long-term. For this reason, several investigations have been conducted on non-toxic and biodegradable alternatives, such as biosurfactants and bioemulsifiers, due to their biocompatibility, biodegradability, physicochemical properties, and biological activities. Biosurfactants exhibit multifunctional activities, with sophorolipids and rhamnolipids being the most commonly used in cosmetics and belonging to the glycolipid group. Sophorolipids exhibit moisturizing and bactericidal activities, making them suitable for use in cosmetics aimed at treating acne and body odor. Also, they are used in formulations as detergents, foaming and wetting agents, emulsifiers and solubilizers. Rhamnolipids are also effective surfactants; skin-compatible, and exhibit excellent antimicrobial activity. Besides, cosmetics

CHAPTER 7

Basic Cosmetic Raw Materials: Hair Care Products

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Abstract: Same as other aspects of the cosmetics market, in the field of hair aesthetics, there is a wide array of formulations. The products, such as shampoos, conditioners, and hair tonics, are produced all over the world, and it is not always easy even for professionals to make proper recommendations according to specific hair types and scalp disorders. This chapter introduces the background of the hair follicle (sebaceous glands, arrector pili muscle, dermal papilla, and bulge) and hair shaft (cuticle, cortex, and medulla), providing a simplified yet efficient description of the physiology of these regions, which are key for trichology. The understanding of the hair follicle is important because cosmetic formulations are used to maintain these structures. In the case of shampoos, we give a comprehensive review of those that contain certain quantities of fatty alcohol in their compositions, to those formulated as powders, ranging from gels, sprays, fluids, and viscous solutions. With all these differences in ingredients, it is reasonable to speculate that their effectiveness will also vary, with some having a more pronounced while others having a milder cleaning effect. A similar rationale also applies to conditioners and tonics. This shows us the importance of studying cosmetology to make informed choices on cosmetics for personal care.

Keywords: Arrector pili muscle, Conditioner, Cortex, Cosmetics, Cosmetic, Cuticle, Dermal papilla, Gel, Hair, Hair care, Hair follicle, Medulla, Rinse-off, Scalp, Sebaceous glands, Shampoo.

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INTRODUCTION

Human hair demonstrates, on a daily basis, its social, economic, political, and most importantly, self-image significance. Even minor dissatisfaction with one's hair can lead a person to develop depressive symptoms, causing inhibition, shyness, and significant psychological distress. All body hair strands grow from hair follicles, which are small yet highly significant structures on the skin. The hair follicles are referred to as a “mini organ” due to their complexities. The sebaceous glands are part of the hair follicle and, by releasing sebum, they have important roles in maintaining the hydro-lipid barrier and controlling the microbiota, which contributes to the soft and shiny appearance of the hair. Some hair disorders, including alopecias, are due to metabolic disorders within the follicle. The in-depth understanding of the physiology of hair follicles enables cosmetic developers to improve the formulations of their products that help mitigate hair abnormalities such as hair loss, dandruff, seborrheic dermatitis, psoriasis, and other conditions.

THE HAIR FOLLICLE

Hair is a primary characteristic of mammals, which has a plethora of physiological roles including protection, body temperature, control, sensation, and social identification (including religious, sexual, and political) [1, 2]. The human body has approximately 100 to 150,000 hair follicles sporadically distributed, which give rise to terminal and vellus hairs. The density of the hair follicles varies in a wide range, but their number is determined at the stage of fetal gestation [3, 4].

The hair follicle is a highly complex skin appendage structure, often described as a mini-organ. The hair follicle is divided into four parts, which are the infundibulum, isthmus, suprabulbar area, and bulb. All the hair follicle structures work coordinately, and the body hair follows the cyclical system called the capillary cycle [2, 5].

Signal transduction between the epidermis and the dermis is essential for the development of the hair follicle as well as the production of attachments such as feathers, teeth, scales, and hair. The coordination of different signaling pathways, including Transforming Growth Factor-beta (TGF- β)/Bone Morphogenic Protein (BMP), FGF (fibroblast growth factor), and TNF (Tumor Necrosis Factor), plays an essential role in this process [2]. These signaling molecules are produced by the sebaceous gland, arrector pili muscle, dermal papilla, and bulge [6, 7].

Sebaceous Glands

The sebaceous glands are distributed throughout most parts of the body but concentrated especially on the scalp, face, and forehead, with up to 400-900 glands/cm² in these areas. Most of the sebaceous glands are associated with the hair follicle and, therefore, known as pilosebaceous glands. The development of sebaceous glands occurs between the 13th and 16th week of gestation in humans. The role of sebaceous glands is to produce and excrete sebum by the manner of holocrine secretion. In the fetal stage, the development of the sebaceous glands is modulated by maternal hormones (androgens) and by fetal endogenous steroid synthesis. In some periods of life, there are significant increases in the release of sebum, including the post-birth and puberty, and the level of sebum reaches the adult level at around the age of 17 years [8 - 11].

Arrector Pili Muscle

The arrector pili muscle belongs to the smooth muscles, which is a small band connecting the hair follicle to the basal membrane and the connective tissues. The role of the arrector pili muscle is to promote air trapping and temperature control, and new studies further unravel its importance in maintaining the follicular system. The arrector pili muscle is formed by bundles of parallel muscle fibers composed of fusiform cells with centralized nuclei and contains nerve fibers. Each follicular unit (made up of 1 or more hairs) has a single muscle [1, 7].

Dermal Papilla

The dermal papilla is at the base of the hair follicle, which is close to the germ cells and is highly important in the regulation of the hair cycle and pigmentation of the shaft. It is formed by a set of mesenchymal cells organized in a complex manner, serving as a source of growth factors that stimulate and nourish keratinocytes and melanocytes. The cellular signal transduction in the dermal papilla is yet to be fully elucidated. Different research groups are actively working on the regulation of these cells *in vivo*, in addition to the research on using chemical and electrical stimuli to facilitate capillary growth [6, 13 - 16].

Bulge

It is known that in the hair follicle, different cellular processes coordinate to achieve the physiological homeostasis; for example, nutrition and the immunological microenvironment are both regulated at the bulge region. The bulge is composed of compacted and agglomerated epithelial cells, representing the only part that joins the dermal papilla to the hair follicle during the transition of the telogen and telogen-anagen phase. The arrector pili muscle attaches to the

CHAPTER 8

Polymers: A Perspective on their Classifications and Contributions in the Cosmetics Industry

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Abstract: Cosmetics are substances made to be used on the external area of the body. Its applications date back to ancient civilizations, with several materials used in its production, some of which are toxic. With the advancement of the cosmetic industry, the use of polymers is highlighted in the production of cosmetics, such as lipstick, mascara, nail polish, scrubs, creams, and gels, among others, that can be chemically classified as natural, semi-synthetic, or synthetic. Polymers also have important functions in the production of moisturizers, emollients, emulsifiers, thickeners, and antioxidants. In this sense, the objective of this chapter was to evaluate different polymers used in cosmetics, highlighting their importance mainly in the physicochemical characteristics of these products as well as toxicity. To this end, a systematic literature review was performed by searching the databases and portals such as “PubMed”, “Science Direct”, “Google Scholar,” and “CAPES Periodicals” using descriptors including “Polymers,” “Cosmetics,” and “Applications”, with a time filter of 10 years in English. 3.532 references were found, of which 79 were used for presenting results regarding the applications of polymers researched in the cosmetic area and toxicity. The results showed that the use of polymers in cosmetic preparation is fundamental to guarantee and stabilize the physicochemical characteristics of formulations (emollient, emulsifier, humectant, exfoliant, among others), most of which are non-toxic. Besides, the preference for biodegradable and biocompatible products in the cosmetic industry is evident.

Keywords: Aliphatic polyesters, Biocompatible, Biodegradable, Carbomer, Cellulose, Chitosan, Natural polymers, Polyethylene glycols, Semisynthetic polymers, Synthetic polymers.

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INTRODUCTION

According to the European Commission (2015), a cosmetic is any substance or preparation intended to be placed in contact with various external parts of the body (epidermis, lips, external genital organs, hair system, and nails), teeth, mucous membranes, and oral cavity. This definition includes a number of products, such as powders and sprays, face creams, perfumes, lipsticks, deodorants, sunscreens, and lotions, among others [1]. Regarding its market, the cosmetic industry has an average annual growth of 4.5% per year over the last 20 years, and is worth around 425 billion euros worldwide. In 2016, the European cosmetic market was the largest in the world, moving 77 billion euros, followed by the United States (64 billion euros) and Brazil (24 billion euros) [2].

Cosmetics have been present since ancient civilizations with an aesthetic function, cultural representation, and health, as is known through the history of Ancient Egypt, as they used lead-based mascara, galena, malachite, and honey for these purposes. In some of those cases, cosmetics had not only an aesthetic function, but also prevented infections, such as eye infections. However, because it contained a high concentration of heavy metals, it could cause toxicity in those who used it [3]. Currently, Article 2 of Directive 76/768/EEC states that all cosmetics and their components present must be safe under normal conditions of use without causing harm to human health, and the use of more than 1000 chemical substances in the production of the chemicals is prohibited due to their toxicological properties such as lead, arsenic, cobalt, cadmium and other heavy metals in the production of cosmetic products in the European union [4].

Despite the restrictions, there are a number of allowed polymers that are used in the cosmetics industry to compose products that have various functions and applications. These polymers are an important class of raw material for cosmetic formulations, and are classified as macromolecules of synthetic, semi-synthetic, and natural origin composed of repetitive units (monomers) that are usually arranged in the form of a chain. Once in the formulations, polymers could present several functions such as emulsifier, gelling agent, antioxidant, moisturizer, stabilizer, among others, that will be addressed throughout the chapter [5]. In the market, the main representatives of these classes are: synthetic-acrylic acid-based polymers, polyacrylamides, silicon and alkylene oxide-based homopolymers and copolymers, aliphatic polyesters and the polyethylene glycols, semi-synthetic - methylcellulose (MC), ethylcellulose (EC), hydroxyethylcellulose (HEC), hydroxypropylcellulose (HPC), hydroxypropylmethylcellulose (HPMC), carboxymethylcellulose (CMC) and sodium carboxymethylcellulose (NaCMC), cellulose acetate (AC), cellulose acetate phthalate (FAC), cellulose acetate butyrate (BAC), cellulose acetate trimellitate (TAC),

hydroxypropylmethylcellulose phthalate (HPMCP), and inorganics: cellulose nitrate (NC) and cellulose sulfate (SC) - and natural - starch, xanthan gum, guar gum, carrageenan, alginate, pectin, gelatin, agar, collagen, hyaluronic acid, chitosan, ulvan and sericin [6 - 12].

Considering the relevance of this topic, this chapter will address the main polymeric materials used in the cosmetic area, highlighting the physical-chemical characteristics of these materials, their functions in formulations, toxicity, and the main products in which these materials are found, among other important aspects. Fig. (1) represents the main polymers of the natural, semi-synthetic, and synthetic classes used in cosmetics.

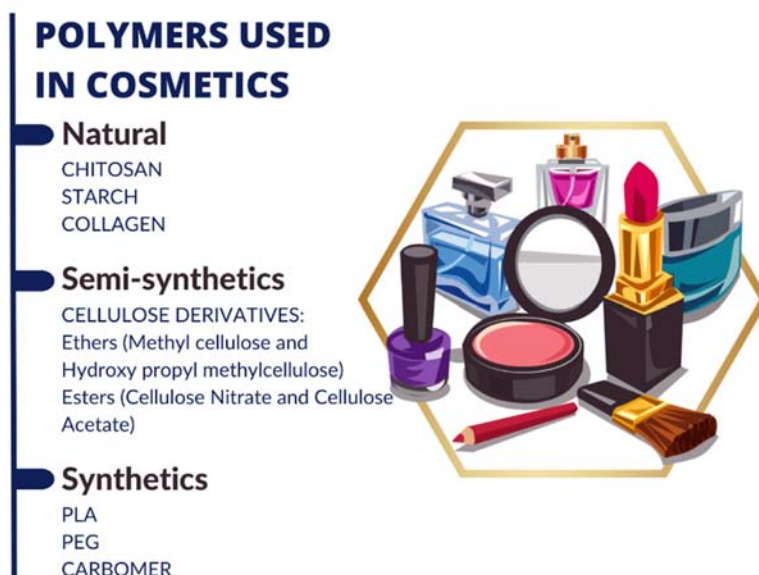


Fig.(1). Representation of the main polymers in the classes of natural, semi-synthetic, and synthetic.

NATURAL POLYMERS

The use of natural polymers in cosmetic formulations has been growing mainly because they are safe, biodegradable, biocompatible, economical, and have sustainable potential, and are well accepted by consumers. With several properties, among them antimicrobial and anti-inflammatory actions, this type of polymer enables a range of applications for health, hair, and skin care. Natural polymers include proteins, polysaccharides, polynucleotides, polyisoprene, polyesters, as well as lignin, and can be derived from plants, microorganisms, or animals. Among those used for cosmetic applications, polysaccharides, starch,

CHAPTER 9

Traditional Cosmetic Forms**Diogo Baltazar^{1,*}**¹ *London College of Fashion, University of the Arts London, London, United Kingdom*

Abstract: Cosmetic products are available in a number of forms, depending on their intended use, consumer needs and preferences, and desired sensory characteristics. Various terms used to describe cosmetic formulations are defined in this chapter, such as gel, emulsion, aerosol, and balm. By understanding the basics of colloidal science and the role of surfactants in different situations, the many functions of surfactants are explained and contextualized with each product type. A summary of the main types of haircare and skincare cosmetic products, with examples of typical ingredients with different functions, is also provided; a short introduction to oral care products is included. This chapter, therefore, introduces various cosmetic formulation types and their main ingredients, equipping the reader with the basic knowledge required to understand other aspects of cosmetic science. All ingredients in this chapter will be named following the International Nomenclature for Cosmetic Ingredients (INCI).

Keywords: Antiperspirant, Colloid, Cosmetic form, Cosmetic ingredients, Deodorant, Emulsion, Hair removal, Interfacial tension, Moisturizer, Oral care.

INTRODUCTION**Colloids**

Most cosmetic products are colloids, which are systems containing at least two phases that can be solid, liquid, or gaseous. In any colloid, one phase is finely dispersed in the other. Therefore, colloids are composed of a dispersed phase and a continuous phase, as illustrated in Fig. (1).

There are two main types of colloidal systems, which are classified according to the affinity that their phases have with one another. Lyophilic colloids (solvent loving) are those whose phases have an affinity with each other; they form spontaneously, and the obtained system is stable. Lyophobic colloids (solvent-hating) are those whose phases do not have an affinity with each other; therefore,

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their formation is not spontaneous, and the obtained systems are thermodynamically unstable. Lyophobic colloids can only be metastable, which means that such products can have reasonable shelf-lives, even though their phases will ultimately separate.

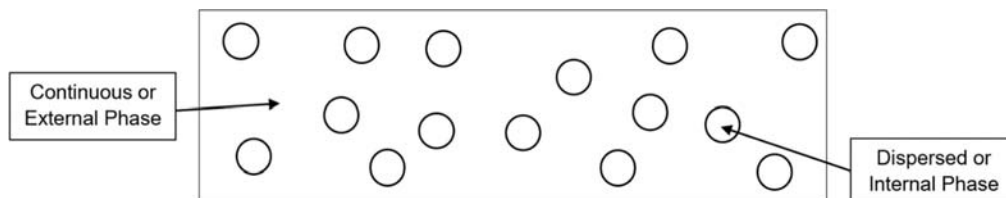


Fig. (1). Basic structure of a colloid containing two phases.

Moisturizing gels are examples of lyophilic colloids. Emulsions are examples of lyophobic colloids (made of oil and water, which do not mix naturally). There is a third type of colloidal system, termed an association colloid. These systems are made of a solvent, usually water, where surfactant molecules spontaneously self-assemble to form organized structures. Shower gels and shampoos are examples of such systems. Table 1 shows the main types of colloidal systems applicable to cosmetic products, with examples.

Table 1. The main types of colloids used in cosmetic products.

Dispersed Phase	Continuous Phase	Colloidal System	Example
Gas	Liquid	Foam	Mousse, foam during cleansing
Liquid	Gas	Aerosol	Deodorant spray
Liquid	Liquid	Emulsion	Lotion, cream
Liquid	Solid	Gel	Moisturizing gel
Solid	Gas	Aerosol	Dry shampoo
Solid	Liquid	Suspension	Scrub

Interfaces and Interfacial Tension

The region that defines the border between the dispersed and continuous phases is termed the surface or interface. In lyophilic colloids, the interface is maintained when the dispersed phase is insoluble in the continuous phase. However, in lyophobic colloids, the interface is maintained because the phases do not have an affinity with each other and stay apart. For example, water does not mix with oil since water molecules, being polar and able to bond *via* hydrogen bonds, prefer to bond with each other rather than with oil molecules, which have low polarity and bond mostly *via* weaker van der Waals forces of attraction. This causes the

molecules of each phase to experience an attraction towards their respective bulks (the phases move away from each other), which causes a state of tension along the interface: surface or interfacial tension.

Interfacial tension is responsible for the complexity of producing lyophobic systems. These solvent-hating systems cannot be made unless the phases are forced to mix, meaning lyophobic colloids rely on high energy input to be formed. This energy can be transferred to these products in the form of heat (increasing temperature) or work (mechanical mixing, stirring and dispersing).

Interfacial tension is also responsible for the fact that lyophobic systems are not stable since their phases tend to separate to reduce their surface area to a minimum. If a small portion of oil is mixed vigorously in water, droplets of oil are dispersed in water (large surface area between phases), but as soon as the energy provided by the mixing is removed, the oil droplets immediately start coagulating until they phase-separate completely (low surface area). Formulating a stable product effectively means delaying this phase separation process.

Surfactants

Surfactants (surface active agents) are key ingredients in cosmetic products because they allow for lyophobic colloids, like lotions and creams, to be produced and kept stable for reasonable periods of time. Surfactants work by reducing the interfacial tension, therefore facilitating phase dispersion and delaying the process of phase separation. Surfactants reduce interfacial tension by partially mixing with both phases, thanks to their amphiphilic structure (Fig. 2): their polar heads usually interact with water and their non-polar tails interact with oil, air, or solid surfaces; therefore, in the context of cosmetic products, surfactant heads are hydrophilic (water loving), and surfactant tails are hydrophobic (water hating).

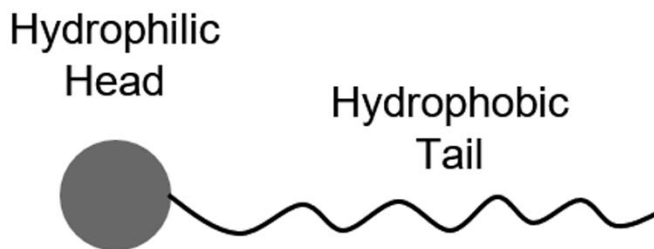


Fig. (2). Amphiphilic structure of a surfactant.

Due to their amphiphilic nature, when added to water, surfactants tend to assemble in structures called micelles, which are often spherical and cylindrical

Technological and Innovative Cosmetic Forms

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Abstract: Nanotechnology is a multidisciplinary area of science that, therefore, covers several areas of research and development, with products that aggregate nanotechnology being found in numerous sectors of society, including the cosmetics sector. In the cosmetic industry, several nanostructures are used to enhance the performance of cosmetics during consumer use or to improve their stability during shelf life. Within the nanostructured systems used in cosmetic products, we can mention liposomes, nanoemulsions, microemulsions, SLN, NLC, and liquid crystals. Each of these systems has its advantages and disadvantages, and the choice of the best system is related to the way and place of application of this cosmetic product.

Keywords: Biocompatibility, Biodegradability, Cosmetics, Encapsulated systems, Liposome, Liquid crystal, Microemulsion, Nanoemulsion, Skin penetration, Skincare.

INTRODUCTION

Nanotechnology is a multidisciplinary area of science that, therefore, encompasses several areas of research and development, with products based on aggregated nanotechnology being found in numerous sectors of society, such as Formula 1 cars and helmets, construction materials, electronic products, agriculture, medical prostheses and orthoses, dental implants, medicines, and cosmetic products [1 - 5].

But what exactly is nanotechnology?

Nano is a Greek term that stands for “*dwarf*” and is related to the diminutive size of the nanometric scale. A nanometer corresponds to a billionth of a meter, a dimension difficult to understand without a comparison with something tangible.

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A strand of hair is around 80 μm thick, while a nanoemulsion droplet is 200 nm, that is, 400 times smaller than a strand of hair [1].

Although for a product to be considered nano, it needs to be on the nanometric scale, it is not just the size that classifies it as nanotechnological. According to the European Medicines Agency (EMA), for a product to be nanotechnological, its structures must be smaller than 1000 nm in diameter and have specific properties different from the same material on a larger scale [6].

Gold is an example of a substance whose properties change when in the nanometric scale. When in its natural state, it has a yellowish color; however, when in the form of nanoparticles, it absorbs different wavelengths and starts to present a red, green, and lilac color, depending on the particle size [1, 7].

In the cosmetics industry, several nanostructures are used to enhance the performance of cosmetics when they are being used by consumers or to improve the stability of the product during its shelf life.

LIPOSOME

Liposomes are encapsulated systems [8 - 12], generally spherical in shape [9, 11, 13 - 15]. A lipid bilayer forms its structure [9, 13, 14, 16, 17] composed of phospholipids [8 - 10, 13 - 15] that shelter an aqueous content in its interior [9, 13 - 16]. Liposomes can be categorized based on their size and the number of bilayers [9, 12] and it may vary according to lipid composition, size, and method of preparation [8, 9, 11, 13].

Liposomes have advantageous characteristics compared to other technologies. In addition to being able to store both hydrophobic and hydrophilic contents in its inside [9, 13, 16 - 19], their structure resembles that of the organism's cell membrane [12, 14, 16, 19], which promotes a high biocompatibility of the system [9, 11, 13 - 15], rapid absorption in tissues [8, 12, 15, 19, 20] and controlled release of the active ingredients present in its interior [9, 12, 20]. However, this technology presents some disadvantages that can become a hindrance, such as its high production cost [9, 11, 13], the high risk of oxidation and hydrolysis reactions of the phospholipids present, its low solubility [9, 11, 13], and low half-life [9, 13].

Regarding preparation methods, a wide variety of options are available in the literature. The so-called general method involves drying the lipids from an organic solvent, dispersing them in an aqueous medium, and proceeding to purify

the system [13, 14]. There are other methods mentioned, namely: extrusion [9, 12, 13], emulsification [9, 14], TLH (Thin Layer Hydration) [12, 14], and reverse phase evaporation [12 - 14].

Extrusion happens when the liposomal solution is filtered through a filter with pores of different sizes, which is a technique that allows a high homogeneity regarding liposomes [9, 12, 13].

Reverse phase evaporation is done under agitation conditions. The solvent is evaporated until it creates a dry lipid layer, resulting in the liposome [12 - 14].

The Ethanol Injection (EI) method consists of inserting a lipid solution of ethanol into an aqueous layer to form a liposome, with the ethanol being evaporated subsequently. This method has a disadvantage, as ethanol and water are an example of an azeotrope mixture, which can lead to undesirable changes in the composition of the system [11 - 14].

Liposomes have been a technology widely used in the cosmetic, food, and medicinal fields due to their versatility. Some studies prove a better absorption of actives in formulations that use the said system [9], and cases of success in the application of liposomes in products such as photoprotectors [8] and facial masks [21] are also reported, showing the great potential for further studies, in the cosmetic industry.

NANOEMULSION

Nanoemulsions are dispersed systems of small droplets of two immiscible and kinetically stable liquids [22 - 26]. It has an average droplet size within the range of 20-200 nm [22, 27 - 29]; however, some authors consider systems with up to 500 nm as nanoemulsions [30 - 32]. They can be in the form of oil-in-water (O/W), water-in-oil (W/O), or multiple nanoemulsions, such as water-in-oil-in-water (W/O/W) or oil-in-water-in-oil (O/W/O). /O) [22, 25, 33].

The methodologies for obtaining a nanoemulsion are divided into two categories: those that use high energy input and those that use low energy input [22, 25, 34, 35].

High energy input methodologies involve high shear forces, such as those induced by high pressure homogenizers, microfluidizers, and sonication [22, 36, 37]. After preparing a conventional emulsion, the dispersed phase is reduced to tiny droplets on a nanometric scale, by providing high energy [25, 37]. Due to the need for high-cost investments, high-energy input methodologies are more commonly used on an industrial scale to produce nanoemulsion systems [25].

CHAPTER 11

Photoprotective Formulations

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Abstract: The toxic effects of UV light are a big concern for human health. Sunlight's UV radiation is composed of UV-C, UV-B, and UV-A, and each of these different types has distinct biological effects. The UV filters impede the passage of UV light by absorbing and/or scattering a large fraction of the incident radiation. The formulations of photoprotectors must offer security, be non-toxic, non-comedogenic, and non-allergenic, and stable against external agents, while also offering versatility, as this characteristic will influence the user's adherence. The final product must have pleasant cosmetic properties. Vehicles and excipients used in photoprotectors play a crucial role in both adherence to the use of these products and in photoprotection itself. Ingredients considered to be antioxidants, DNA protectors, and other compounds that protect against UV-A and visible light radiation have often been included in current sunscreen formulations, being an emerging area of research and development. Additionally, nanotechnology is being applied to achieve sunlight protection. This combination increases the efficiency and stability of sunscreens and prevents the active principles from penetrating deeply into the skin. Effective natural photoprotective substances, such as plant extracts or mycosporin-like amino acids, have been proposed as ingredients in sunscreens as an alternative to synthetic filters. On the part of the consumer, there is still a need for continuing education, as well as dispelling myths about sun protection. It is necessary to invest in the development of new formulations that adapt to the consumer's lifestyle and have sensory aspects of high acceptability.

Keywords: Antioxidant, Cosmetics, Efficacy, Epidermis, Filters, Formulation, Ingredients, Market, Organic, Product, Protection, Photodamage, Photoprotector, Radiation, Skin, Stability, Sun, Sunscreen, Synthetic, UV.

INTRODUCTION

Sun exposure has a profound impact on the skin, which can manifest in both beneficial and harmful ways. While moderate sun exposure is essential for the

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synthesis of vitamin D, prolonged exposure to ultraviolet (UV) radiation can lead to acute and chronic skin damage. Sunscreens are topical formulations designed to protect the skin from the harmful effects of UV radiation by absorbing, reflecting, or scattering UV rays. To achieve a wide spectrum photoprotection, sunscreens are designed with UV filters, which are responsible for the major photoprotective activity. Advances in nanotechnology and materials fields have revolutionized sunscreen formulations by enhancing the performance and cosmetic properties of UV filters. Additionally, the increasing demand for natural and eco-friendly skincare products has led to the exploration of natural compounds as potential UV filters and antioxidant agents in sunscreens. These natural compounds can neutralize free radicals generated by UV radiation, reducing oxidative stress and inflammation in the skin. Incorporating natural ingredients in sunscreens not only enhances their protective benefits but also appeals to consumers seeking more sustainable and skin-friendly options. The purpose of this chapter is to provide a detailed guideline for researchers and experts on the current applications and photoprotective formulations available in the market, and to provide a brief overview of the recent advances in the field.

Effects of Sun Exposure on the Skin

The organ most exposed to environmental sunlight is the skin. Due to this fact, the harmful effects caused by skin exposure to UV irradiated by sunlight or emitted from artificial light have garnered special interest from the scientific healthcare community. The action mechanism by which UV Radiation (UVR) causes skin damage is mainly caused by UVR-associated molecular changes that lead to cellular malfunction.

The UVR from sunlight is composed of UV-C, UV-B, and UV-A; therefore, it is characterized by shorter wavelengths than the visible spectrum. Due to the wavelength, each of the different types of UVR has distinct biological effects [1].

UVR can penetrate the skin layers to varying depths depending on its wavelength. UV-A, which has a longer wavelength (320-400 nm) and less energy, can penetrate the deeper layer of the dermis and can damage DNA by indirect photosensitization reaction by the production of Reactive Oxygen Species (ROS) (Fig. 1). UV-C has high energy and a shorter wavelength (200-280 nm). It is effectively prevented from reaching the Earth's surface by the ozone layer, although accidental exposure can occur from artificial radiation sources such as germicidal lamps. UV-B, which has an intermediate wavelength range (280-320 nm), can reach the epidermis layer and is absorbed by DNA, resulting in molecular rearrangements that form photoproducts, such as cyclobutane-type pyrimidine dimers [1, 2]. The stratum corneum of the epidermis absorbs 70% of

UV-B radiation. It contributes approximately 80% of the harmful effects associated with sun exposure, whereas UV-A radiation is absorbed by approximately 70-80% of the cells in the dermis and melanocytes of the basal epidermis, producing only 20% of the harmful effects [3] (Fig. 1).

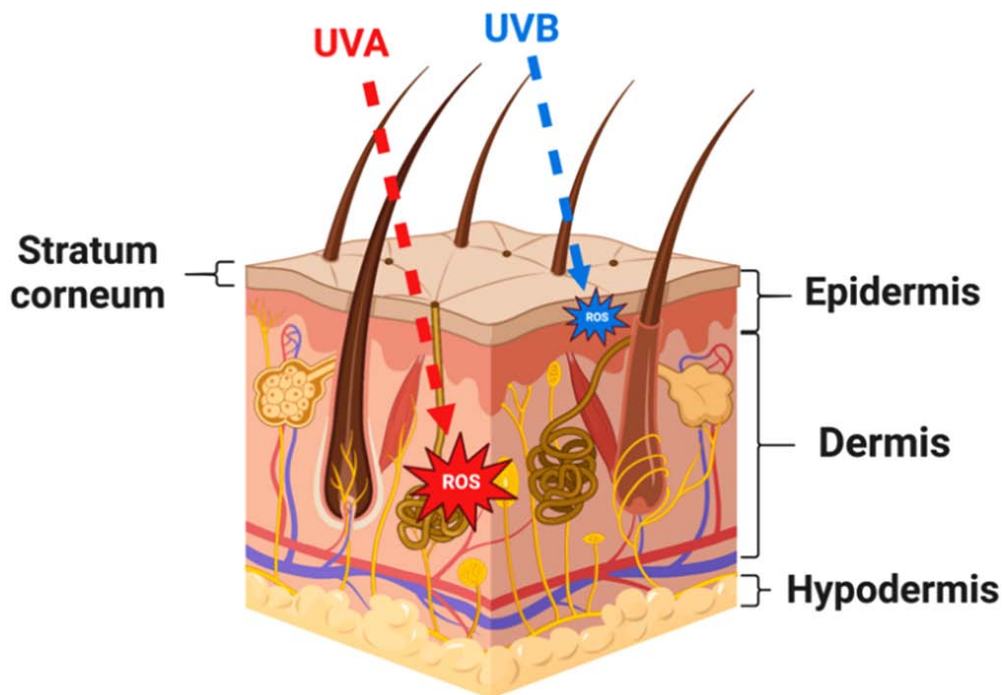


Fig. (1). UV-A and UV-B penetration into skin layers. Illustration created under Biorender license.

Chromophores are molecules responsible for absorbing radiation. These can be endogenous (for example, DNA, melanin, urocanic acid, small peptides, and cholesterol) or exogenous (photosensitizing drugs), and they can induce a photobiological response, either acute, such as sunburn, induced photosensitivity, edema, pain, erythema, followed by exfoliation, tanning, and epidermal thickening, or chronic. Carcinogenesis and premature skin aging (“photoaging”) are generally believed to be consequences of chronic UVR exposure [3].

The UVR at the molecular level can alter cellular functions as it damages many molecules and structures. Ultraviolet Radiation (UVR) has the potential to impact structures like DNA, causing mutations in the DNA chains. If these mutations are not repaired, they may contribute to the formation of melanoma [4].

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