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Cosmeceuticals: Integrating Therapeutic Functionality into Cosmetic Science

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Abstract

Cosmeceuticals are a quickly growing group of skincare products that are in between cosmetics and drugs. These products have biologically active components that are said to provide medical or drug-like advantages for several skin problems, including aging, hyperpigmentation, acne, and damage from the sun. Cosmetics are not medications, but cosmeceuticals are made to affect skin function at the cellular level. This article talks about what cosmeceuticals are, how they work, how they are classified, and the problems that come up when trying to regulate them. It also investigates some of the most prevalent active ingredients, like peptides, antioxidants, growth factors, and plant extracts, and checks the most recent scientific evidence that supports their safety and effectiveness. Additionally, it highlights emerging trends, technological advancements, and future directions in cosmeceutical development, focusing on innovations in delivery systems and personalized skincare approaches. The review also examines the challenges of ensuring product quality, transparency in labeling, and the role of clinical studies in validating claims. As more people want skincare products that do more than one thing, cosmeceuticals continue to blur the lines between beauty and therapeutic skincare. This shows how important it is to have more strict clinical validation and clearer regulatory control.

Keywords: Cosmeceuticals, active substances, skin care, dermatology, antiaging

INTRODUCTION TO COSMECEUTICALS

Cosmetics are put on the body to clean it, make it look better, make it more appealing, or change its appearance [1]. Cosmetics can make nature's beauty fiercer and hide its flaws, but that is not enough anymore. As we get older, the idea of antiaging cosmetics becomes more significant. Antioxidant cosmetics are also in high demand because of how our present lifestyle can cause uneven skin tone through too much pigmentation and melasma. These worries led to the development of more advanced products, such as skin cosmeceuticals. Cosmeceuticals are items that are meant to clean, beautify, and make skin look better, but the maker cannot say that they have a therapeutic effect on skin. As our understanding of skin biology and the molecular pathophysiology of skin problems has grown, so have skincare products have measurable biological effects on skin. These are known as "Cosmeceuticals." Cosmeceuticals are a specific kind of product that falls somewhere between drugs and cosmetics. It has been called a medication since it has measurable biological effects on skin, yet it is controlled as a cosmetic because it purports to change looks.

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Cosmetics, smoothies, and sunscreen are the most popular cosmeceuticals on the market, and people like them [2]. People use basic cosmetics to clean and protect their skin. These topical products have soap, detergents, emulsifiers, lubricants, and colors in them, as well as different preservatives. Cream, gel, and aerosol smoothies can all be used to hide skin flaws and make the skin look brighter immediately. These formulas must be very

attractive, work right away, and endure a long time without blocking pores. Sunscreen is one of the most significant cosmetics that can keep skin safe from UV harm. There are a lot of different kinds of sunscreen on the market, but new sunscreen ingredients need to be approved by the government before they can be sold. It is very hard to come up with new antiphoto-aging and anti-pigmentation agents, yet this field is still very interesting for skin care products.

THE HISTORY OF THE GROWTH OF COSMECEUTICALS

Cosmetics have been around for a long time. Many ancient civilizations used them in extravagant ways to improve the look of their skin and get the facial traits they wanted. There are Indian and Arabic books from about 5000 years ago that talk about cosmetics, making perfumes, and aromatherapy. We do not know where cosmetics came from, although Egyptians were utilizing medications for beauty purposes as early as 3000 BC. Most of these substances were poisons. The word "cosmetic" comes from the Greek word Kosmetikos, which meaning "to arrange or adorn." The Greeks were responsible for a lot of the knowledge and expertise regarding cosmetics, but they were also notorious for being almost abnormal in their yearning for beauty. The Romans loved Greek art and turned it into science and maths. The Romans were known for using too many cosmetics, which is where the word "cosmetic" comes from. There were perfumers in Rome, and their names were typically Latinized. Most recipes for cosmetics came from Greece and were written down in the Roman Empire.

Cosmetics are things that people use to make their bodies look or smell better. Cosmetics are meant to be used on the body to clean it, make it look better, make it more appealing, or change its appearance without changing how the body works or how it looks. Some cosmetics are medications or drug-cosmetic combinations that are aimed to cure or stop diseases or ailments like acne, dandruff, or psoriasis. A cosmetic is any substance that is meant to be put on the body to change its appearance and has cleansing properties. Because cosmetics are like drugs, they need to be made with materials from trusted sources that will not hurt or make the person seem bad. Cosmetics are meant to be rubbed, poured, sprinkled, or sprayed on, put into, or otherwise used on the body to clean it, make it look better, make it more attractive, or change its appearance.

THE RULES AND REGULATIONS

The FDA makes sure that pharmaceuticals and cosmetics are safe and work as they should. Because the FDA does not have a lot of power to regulate and oversee things, the cosmetics industry has changed the definition of "cosmeceuticals" to make more money, even if it puts consumers' safety at risk. The FDA does not check claims of effectiveness, and cosmetics businesses do not have to give the FDA information about safety and toxicity before they sell their products.

The FDA's new definition of combination products made it much harder for some skincare products that are promoted as cosmeceuticals to follow the rules. But the FDA only considers a small number of items to be pharmaceuticals; therefore, this regulation area is confined to those. Most cosmeceuticals, such as skin-lightening lotions, that include different types of Vitamin A and some sunscreens, do not fit the new definition; therefore, they do not need to be looked at again. There is no current legal definition for cosmeceuticals, therefore, the businesses' use of the term to their advantage puts consumer safety at risk [3].

FDA Rules About Cosmeceuticals

People have always defined cosmetics as things that clean, beautify, make people look better, and change their appearance. There is no legal definition for cosmeceuticals, which gives the cosmetic industry a lot of freedom to interpret the term and its importance almost as they choose. An industry that is not being watched, defined, or regulated does not have to prove its claims with valid facts or a legal or scientific basis. Some cosmetics are treated as medications, while many others call themselves "cosmeceuticals," a term that the scientific community looks at with incredulity and derision [4].

The FDA and the FTC are both in charge of making sure that promises about cosmetic items are true. Because cosmetics are sold between states, advertising claims can be watched unless the FPCA says otherwise or no claim is made about the product. All statements about ingredients must be backed up, and if safety or effectiveness is claimed, "adequate," generally accepted scientific evidence must be shown before the product may be sold. Brands keep an eye on themselves via sharing monitoring resources or hiring a third party to do it.

Standards & Guidelines from Around the World

The New York Times first used the word "cosmeceutical" in its letters to the editor on September 24, 1984. The editorial was worried about the growing market for this new group of creams, serums, and lotions that promised to address skin problems instead of just hiding them. The cosmetics industry said that cosmeceutical skincare products were a new type of cosmetic that would have active ingredients like those found in pharmaceuticals, but they would not need a prescription or be subject to the same level of government oversight as pharmaceuticals [1]. Ten years after the New York Times editorial cautioned about the dangers of cosmeceuticals, the authors wrote about a study of these items that were sold in pharmacies in Mexico City, Mexico. There were reviews of a lot of products. The ad said these cosmetics featured active chemicals that were like those found in drugs. The results showed that a lot of products had only imprecise explanations of their contents, dose, and toxicity. This made it impossible to figure out how much inspection these items had been through before they hit the market. We talked to people from the cosmetics and pharmaceutical industries to have a better idea of what the word "cosmeceutical" means. These officials said that a lot of people were confused about the idea.

Trends in the Market and What People Want

People have called the 21st century the "century of biotechnology." The field of biotechnology is growing quickly in both business and academia, and the cosmeceutical industry is no different. There are a lot of different goods on the cosmeceuticals market that can help with practically any skin problem you can think of. These products are made by companies that make medications, cosmetics, and personal care items. The cosmeceuticals industry is a huge and promising market for academics and enterprises. Nanotechnology is the idea of making things from the ground up and using very small items in numerous areas of research. Nanotechnology is one of the most important technologies of the 21st century. Nanotechnology has had a big effect on all areas of science, including electronics, materials, biomedical devices, food, biotechnology, and cosmetics. It has created new goods in many forms, such as nanoparticles, nanoemulsions, nanospheres, nanosuspensions, and liposomes. The nanoemulsion and nanosphere product types work well to get into the skin and fight acne by acting as antimycotic and antibiotic agents. Nanocapsules keep the hair creatinine layer from breaking down in peroxide. The liposomes are made of biodegradable and biocompatible polymers that help with hair growth, moisturizing, and hypopigmentation. The rise in sales and profits for companies that sell new antiaging, tanning, sun block, hair-growing, skin-whitening, and other similar goods on demand substantially supports this expansion around the world. However, the resulting formulation is frequently made and distributed without a full understanding of how its contents can help or hurt people's health. Because of this, more people are worried about the new threats to the health and safety of customers.

The Cosmeceutical Market Is Growing

The personal care business is seeing the fastest growth in cosmeceuticals. Just like the pharmaceutical industry looks for safe and effective chemicals to utilize in medicine, big cosmetic corporations are putting money into research and watching how their products affect hair and skin. In this way, a variety of topical cosmeceutical treatments for problems like photoaging, hyperpigmentation, wrinkles, skin and hair damage, and dandruff have become very popular [1].

Skin and hair are made up of many cells, each with its unique life cycle and characteristics. The start of the cosmeceutical era coincided with a rise in research on omega-3 and -6, antioxidants, and

skin grooming polar lipid and amphiphilic nano-colloid carriers that can deliver lipophilic drugs like retinoids or flavonoids to the skin's many intracellular compartments.

Right now, dedicated research teams are looking into new treatments that work well for skin ageing, inflammatory and tumoral disorders, and scalp inflammatory conditions. Also, combining therapeutic compounds with smart and selective delivery carriers like organogel-microemulsions, liposomes, or solid lipid nanoparticles would make treatments safer and last longer.

Nanotechnology has been very important in the world of cosmetics because it can change matter at the atomic, molecular, or macromolecular level, which is about 1–100 nm long. This aptitude leads to unique developments and new ways of looking at the future of the cosmeceutical sector. Cosmeceuticals that use nanotechnology come in a wide range of goods, have more active components that are easier for the body to absorb, and last longer.

On the other side, the more we employ nanotechnology, the more we wonder if nanoparticles can go through the skin and what health risks they might pose. The current review talks about research in the field of nanotechnology-based cosmetics.

Trends and Preferences of Consumers

The worldwide cosmeceuticals industry is expected to be worth around USD 14.5 billion by 2030, with a compound annual growth rate (CAGR) of 7% from 2021 to 2030 [1]. The market is growing quickly, probably because people are changing how they live and eat. A rise in saloons and spas, along with a lot of advertising, promotional activities, and celebrity endorsements, is likely to increase the market for advanced personal care products. The market for advanced personal care products is also predicted to expand since people are making more money, their quality of life is getting better, and there are older people who are conscious of how important it is to keep their bodies clean. However, a lack of knowledge about where to find these products, especially in developing countries, could slow the expansion of the market. Plant extracts are good for your health, and their extensive use in high-end products, notably expensive herbal and personal care items, is likely to increase demand from specialty stores.

North America has overseen the market because there are a lot of dermatology clinics there, a lot of advertising, and important companies are focusing on launching new products. Germany and the U.K. are two countries in Europe that are especially important is expected to make a lot of money and likely take over the industry by 2030, as high income and awareness of advanced skin care products drive up demand. But the market in the Asia-Pacific region is expected to grow at a high CAGR because disposable income is rising in emerging markets like China and India, more salons and spas are opening, which increases the demand for better beauty care products, and there are a lot of ads and promotions that make treatments easier to find.

IMPORTANT PARTS OF COSMECEUTICALS

People like cosmeceuticals because they work well for skin care. Cosmeceuticals are topical products that contain biologically active compounds that, when applied to the skin, have pharmacological effects that reduce wrinkles, pigmentation, and hair loss. The most popular cosmeceuticals are topical antiaging agents (vitamin A derivatives, vitamins C and E, growth factor, and peptides), skin brightening agents (hydroquinone, kojic acid, ascorbic acid, glutathione, and liquorice extract), lipid regulators (AHA, BHA), and anti-androgens for treating acne (salicylic acid, benzoyl peroxide, retinic acid, and azelaic acid). People use cosmeceuticals more because they are unhappy with skin care products that do not work and because they are worried about how medicines might affect their skin [3].

Vitamin C, also known as ascorbic acid, is a strong antioxidant that dissolves in water. It gets rid of free radicals, protects against sun damage and wrinkles, and has antiaging properties. Vitamin E (α-

tocopherol), α-tocopherol succinate, nicotinamide, and L-ascorbic acid are other helpful cosmeceuticals that work as antioxidants. High molecular weight hyaluronic acid keeps skin hydrated and holds onto moisture, while low molecular weight hyaluronic acid makes skin more elastic by going deep and binding collagen [1].

A Look at the Active Ingredients

Cosmeceuticals can be considered hybrids between cosmetics and pharmaceuticals since their use is supposed to lead to both desired esthetical effects and simultaneously treating dermatological conditions. Cosmeceuticals have a long and successful history, but their demand is rapidly increasing. Millions of kinds of cosmetic products have undergone various modifications, but most of the formulations are based on the same classes of active ingredients that were proposed years ago. Nevertheless, modern technologies have propelled and created new delivery systems, yet the same basic structure remains. For this purpose, new generations of ingredients with different chemical structures are being screened to find new ones with beneficial health effects for consumers. This has influenced the production of the latest group of cosmetic products termed "cosmeceuticals." Since there is an increased demand for natural remedies, many companies have intensive cultivation of various medicinal plants, which represent a sustainable source of active ingredients for their cosmeceutical application [1]. Traditional phytocosmetics can provide them at lower costs, however, always accompanied by dignity-associated problems. The inevitable discovery of their active ingredients. Eventually, biotechnological approaches to producing natural extracts should be considered, although presently regarded as futuristic.

Natural vs. Synthetic Ingredients

The international cosmeceutical market is quite diverse, and while the USA is leading, there is rapid growth in Europe, Asia, and other parts of the world. The need to protect the environment and human beings from industrial hazards has increased the number of consumers who are motivated to purchase ecologically safe goods or services; this phenomenon has been coined "environmentally friendly." Cosmetics containing natural ingredients are reputed to be environmentally friendly and are actively marketed globally. Although the most important task for the cosmetic industry is to improve the performance of cosmetic formulations to enhance and preserve human health and attractiveness, the urgent contemporary challenge is to enhance the environmental and safety profiles of cosmetics and cosmetic products via the introduction of green technologies [5]. Although no strict definition of "green" cosmetics is available, the cosmetic industry is working fast to establish precise and universal definitions. Thus, the supposed lack of risk for human health and safety resulted in the global explosion of food grades. Common natural or food ingredients, claims of several "non-chemical," or "green" procedures may apply.

MECHANISMS OF ACTION

Cosmetic products with pharmaceutical properties. They are referred to as topical preparations that are applied for the beautification of the facial skin as well as to treat or prevent skin ailments. Cosmeceuticals are classified into many categories, such as skin care products, hair care products, oral care products, and so forth [1]. This market is an ever-expanding cosmeceuticals sector and there is a change in lifestyle and food habits of the consumers and inclination toward personal care and grooming. Cosmeceuticals constitute the fastest-growing segment of the personal care industry. Today, various topical formulations based on cosmeceuticals are made and marketed for the treatment of different skin problems including photoaging of skin, skin pigmentation disorders, such as melasma and freckles, wrinkles, atrophic scars, facial hair damage, and hair loss.

Nanotechnology has brought unique features and interesting properties to conventional substances at the nanoscale level. Since the past two decades, nanotechnology has found a place in the field of the cosmeceuticals industry. Using innovative nanotechnology technology in the cosmeceuticals sector has brought some futuristic changes in the skin as well as in the hair care regime.

Skin Absorption and Bioavailability

Various formulations are currently available in the market as cosmeceuticals for the treatment/prevention of skin-related disorders. Skin modeling is highly demanding in testing the bioavailability of topical preparations for efficient delivery, drug efficacy and safety evaluation. Skin penetration manifests differently at distinct skin locations and relies upon skin properties. Similarly, for bioavailability assessments *in vitro* skin barrier properties, skin properties and testing locations should be matched with *in vivo* conditions. However, skin sourcing is still peer-dependent and aims to imitate *in vivo* qualities. Furthermore, adoption of artificial or lab-grown skin models are gaining ground for verification/testing of topical formulation permeation. Here is a detailed insight into skin diffusion, mechanisms of topical and transdermal delivery including foundation concepts of skin absorption, modeling, and considerations for proper preparations.

The skin is the largest organ and is central to human wellbeing. The skin barrier function is primarily provided by the stratum corneum (SC) (the outermost layer of the epidermis). It is composed of corneocytes embedded in a lipid lamella environment. Disruption of this barrier can result in water loss (dry skin) and/or penetration of haptens or irritants into the skin (dermatitis). If disruption is persistent or severe, such states may lead to deeper inflammation and/or tissue change in affected skin areas (psoriasis or leukemia). Formulations containing skin effective molecules have been applied topically. Such active substances may repair the barrier and/or fix the skin tissue by acting on receptors and cells.

Formulation of topically effective and safe materials is very complicated not only because of the market entry requirements, strict regulations and standard protocols for efficacy testing but also because of the complex nature of the skin. The SC is composed of about 15–20 layers of corneocytes profusely surrounded and embedded in a lipid environment. The outer dermis is resided with microcirculation, nerves and immune cells. The epidermis contains various key cells, and the primary beautifying metabolism occurs in the dermis. Also, skin is involved in the first defense strategies against environmental insults (UV, heat, chemical, and microbe exposure) and the risk of penetration is controlled by various systems including sexual hormones, inflammatory molecules and molecules transported by blood. Combination of all these protective measures results in a huge barrier for topical application.

Cellular Mechanisms of Action

Using the common definition of a pharmaceutical compound, which is a drug that is intended for therapeutic use and for which preclinical studies and clinical trials are usually required prior to human use; the term cosmeceutical is somewhat misapplied [1]. There are synthetic drugs that now have cosmetic uses.

Topical products that demonstrate some enhancement in the feel of the skin or changes in skin surface or pores size are still often called cosmetics [6]. The constant dawn of new claims, which in turn are evaluated as marketing strategies to distinguish ingredients in very competitive markets, provides much fodder for this review. Although the recent trend is toward naturally derived materials, there are still many synthetic materials that are widely used in skin care products and that demonstrate properties that are relevant to the topical drug field. Topics, such as hair color, sunless tanners, hair straighteners, acne treatments, and so forth, provide examples of cosmetic materials that are certainly pharmacologically active agents. These going concern formulations can be viewed as cosmetics by delineating a borderline between cosmetics and drugs. Some companies have even attempted to straddle that border with different products in the same classes having the same actives and yet differentiated by the combination of a few other botanicals and/or marketed with claims that cross that line.

EFFICACY AND SAFETY ASSESSMENT

The concept of cosmeceuticals is one of the newest and rapidly developing niches in dermal and cosmetic chemistry. The word cosmeceutical itself is a portmanteau of the words cosmetic and

pharmaceutical. In essence, it attempts to define a product in a somewhat gray area between a drug and cosmetic. This niche or market currently represents the fastest growing segment of the personal care industry, projected to reach over $40 billion dollars in global sales by 2020. It is a term that is not categorized by the FDA, but this term is widely used by skin scientists, physicians, and skin care professionals to encourage consumers to continue buying cosmetic products, especially antiaging and sunscreen products marketed with scientific claims.

Cosmetic and cosmeceutical products have traditionally been viewed as two separate entities. In general, cosmetics are products that either clean the skin or put a coating on the skin and are viewed as harmless by both consumers and the FDA.

Most of the evidence behind cosmeceutical ingredients is limited to *in vitro* research. It is estimated that for everyone clinical study addressing the effect of a component on skin, there are a hundred studies that provide propositional, lexical, biophysicochemical, or statistical evidence for the condition, chemical, or action of that ingredient.

In fact, fewer than 6500 articles were classified as clinical studies in dermatology in 2019. Of these studies, less than 1% involved any cosmeceuticals. Most clinical studies on topical agents addressed either therapeutics or shaving and waxing. Thus, in the preclinical world of dermatology and skin research, cosmeceuticals are an afterthought, easily overshadowed by the abundance of antiaging agents, topical immunomodulators, and sunscreens.

Clinical Trials and Studies

Cosmeceuticals are a hybrid between cosmetics and pharmaceuticals, intended to both provide a desired esthetic effect and treat a dermatological condition. Patients seeking cosmetic treatment desire natural possibilities of aesthetic enhancements. Demand for natural treatments surged, resulting in intensive cultivation of medicinal plants. Such plants are pricey and difficult to grow. Plant cell cultures offer another technique for the manufacture of natural cosmetic goods. The review presents instances of biosynthesis of active compounds produced by plant *in vitro* systems with potential cosmeceutical application. Applications of diverse extracts for probable cosmeceutical formulation and their activity assessed in *in vitro*/*in vivo* models are presented. Opportunities to alter the biosynthetic pathway and engineer the biosynthesis of secondary metabolites, such as anthocyanins [7].

Suggestions for appropriate clinical practices for demonstration of both efficacy and safety are presented for improved acceptance of topical skincare cosmeceutical claims. Emphasis is centered on determining the correct study design and interpretation of the data, while performing a research project that is both ethical and consistent with statutory standards specified by medical authorities. Selected dermatological formulations are offered as cases in point with illustrative results. For dermatologists interested in doing their own research on topical cosmeceuticals, various references have been published for guidance in clinical trial design and regulatory requirements for different countries and locations. In clinical practice physicians regularly need to counsel patients on the usage of cosmeceuticals. These commonly accessible topical preparations are known to contain with sometimes uncertain mechanisms of action.

Safety Testing Protocols

Cosmetics are a wide range of products that are used to make people look better. Before people may use these items, it is very important to test and establish that they are safe. After getting safety data on the ingredients and making sure that the facility follows good manufacturing procedures and the responsible cosmetic producing criteria, cosmetic producers and suppliers must make sure that the goods are safe [7].

Safety testing companies in Asian countries that were part of the study were given safety testing protocols based on the input of safety evaluation professionals. These protocols can be used by these companies. Safety testing companies are also encouraged to change and add to the protocols with their own knowledge and experience. Experiments were carried out to show how useful and applicable the safety evaluation protocols are. As a result, the study's main goal of making Asian cosmetics companies more competitive was mostly achieved. Safety testing companies are strongly encouraged to use the new testing protocols or to make them easier to use. One limitation of this study is that the testing protocols only looked at the safety of cosmetic ingredients and the quality of the products.

WELL-KNOWN COSMECEUTICAL ITEMS

Cosmeceuticals have gotten a lot of attention because they might be able to change diseases and improve skin health, which is the largest organ. Choosing the right cosmeceutical ingredients is hard because you need to know how electrophilic, reactive, and attracted they are to certain skin receptors or proteins in the SC [8]. There is not much information about how cosmeceutical formulations work with known dermatological agents either. A lot of the time, pharmacokinetic principles are not considered, and critical factors that affect the total intensity or duration of skin action, like how well the active component dissolves and spreads, are not studied.

Most people in research thought that using many topical actives together would be helpful, but they also thought that not all topical actives would work well together. The cosmeceuticals that were studied are promising and need more research. Each element wanted to leave behind a strong legacy of high-quality data in their industries. Several candidates are getting close to or have already reached the therapeutic outcomes that were claimed, and they all have promising safety profiles. There is still an urgent need to share and publish the many studies that have been done to provide convincing clinical data, even though there are already preclinical procedures in place for how safety and efficacy are attained [9].

The types of actives researched are a mix of components with different properties and functions that were grouped together and placed in certain categories. They included proteins-peptides, hydrocarbons-based, oil-extra chemicals, glycoproteins, surfactants, extraction solvents, and modified starch-polysaccharides. When it comes to bioactivities, they include independent test results for a range of activities, such as thin streaky opacity-disfigured skin, pimples-skin eruptions, ekc-disease, melasma-discoloration, acne-skin disruption, and skin "under" disorders or conditions that weaken the skin barrier against internal or external aggressors.

Products That Fight Aging

People have been looking for products that work against skin ageing more quickly in recent years. These products should not only make your skin look better, but they should also make skin problems better in a way that lasts. There are a lot of different anti-aging products on the market to meet this expanding need. But most products merely help for a short time and do not fix the problems that are there. Forty-five percent of facial skin care products are said to be antiaging products right now.

An antiaging product should (i) get rid of obvious indicators of skin ageing (if there are any), (ii) slow down skin ageing by fighting one or more known main causes of skin ageing, and (iii) change cellular processes to make skin look younger [10].

Ageing is a universal process that is controlled by genes and affected by the environment. It is one of the most difficult problems in biology. Ageing is a change in anatomy and physiology that happens all around the world. As we get older, the histological and biochemical makeup of our tissue's changes, which modifies the way our skin looks and works. Skin ageing is the process that happens beyond the age of 30 when the structure of the skin changes. The signs of ageing skin that you may

see are coarse wrinkles, loose skin, dryness, loss of shine, thinning, uneven pigmentation, different colors, wounds that take longer to heal, and uneven texture.

Formulations for Treating Acne

This chapter is all about acne, what causes it, and how to treat it. Estrogens offer a larger range of anabolic effects than testosterone, yet the two steroids work differently in different biological systems. This chapter is about finding selective estrogen receptor modulators (SERMs) that work like estrogen receptor agonists in some tissues but not in others. Giving mice 17beta-estradiol (E2) before and at the start of the short photoperiod changes the way serotonin-expressing neurons are spread out in the brain and stops the seasonal drop in body weight and fat gain. It is important to establish the analytic validity of pharmacogenetic tests that are now available to clinical labs for them to be used successfully in practice.

Evidence-based guidelines still do not do a good job of defining how to treat acne vulgaris. New clinical guidelines stress the use of a mix of topical and oral drugs, including both traditional and new ones. Some of the things that can cause acne are more sebum production, keratinization of the follicular epithelium that is not typical, and C. colonization, acne, and swelling. Topical treatments, oral drugs, or a mix of both may be used to treat the condition. The goal of therapy is to make the condition less severe and stop scarring, deformity, and mental discomfort. The goal of therapy is to lower the person's risk of getting acne to a level that is manageable.

Agents That Make Skin Brighter

A good skin brightening agent works quickly and does not irritate any skin type too much. Age spots and changes in skin color might happen because of things outside the body or because of the natural process of ageing. UV radiation is an exogenous factor that causes discoloration by making too much of the red pigment and lipid peroxides that are caused by free radicals. Chemical exfoliation is the most frequent way to deal with skin discoloration, but you must keep using it. We need additional ways to prevent negative effects and avoid basolemic alterations than too much peeling.

Hexylresorcinol only stops Tpy, which lowers the amount of melanin made and changes Dopa to Dopaquinone. The dark pigment comes out when Dopaquinone is changed into Hydroxylnoreugenin. Hexylresorcinol stops Tpy, which lowers the amounts of Hydroxynoreugenin. This makes MEL less likely to resolve. Adding ethanol changes the shape of the membranes of cell organelles, which makes it easier for hexylresorcinol to get in and be exposed. Hexylresorcinol kept its ability to stop tide, whether it was free or conjugated in the homogenate of mouse melanoma. Silymarin protects against both UV rays and oxidation. Because of these physiological barriers, no resistance development is envisaged. The results of the *in vivo* investigation showed that the new formulation worked better. The skin's function was fully restored, and there were no negative effects. The new recipe had C10-30 Alkyl Acrylate Crosspolymer and isolated AV, which made the actives better at getting through the skin. They were looking at the crystalline forms of both actives to see if they could make the effects last longer.

The method included looking at both the procedure and the outcomes to get ready for a bigger study and development that would be aimed at the industry. This included finding a model reactant with the different synthetic interrogators and coming up with a complicated and sensitive screening method that used these interrogators. The main goal was to use new techniques to increase the number of substrates or systems that could be examined. This would make it easier to make fluorophore arrays that are important to orthodontics.

PROBLEMS IN THE COSMECEUTICAL BUSINESS

There are a lot of problems with the new cosmeceutical sector. There is not enough restriction on how the word "cosmeceutical" can be used in marketing and labeling claims, which has led to the spread of false goods that cannot prove they work. Without government rules, goods that do not really

help skin conditions have been able to thrive. There are a lot of goods on store shelves and infomercials that say they are cosmeceuticals, so people should be careful about scams, especially because celebrities have endorsed them. Dermatologists are starting to work with more cosmetic brands, and customers do not always know why these endorsements are happening. When looking for skin care products, it is crucial to make sure they follow the advice of a dermatologist. A product with "over-the-counter" or "drugstore" label does not mean it is safe, works, or is right for you [11].

Believing in the rewards is another part of how consumers value things. A cosmeceutical that has a celebrity endorsement could not be trustworthy because the consumer cannot be sure that the celebrity, who has access to dermatological resources, has checked the product out before endorsing it. In this case, it would be helpful for the FDA to set up a national branding scheme for cosmeceuticals that have been tested for safety and effectiveness. The FDA is working to set rules for the market and start awareness programs on the differences between cosmetics and pharmaceuticals. A national branding scheme could make it easier for people to find products that fulfil these standards. In the end, stricter rules for the sector, no matter how they are put in place, will help make cosmeceuticals a real category and make sure that customers buy safe and effective goods.

Problems with Quality Control

The growing field of cosmeceuticals has opened a lot of chances for quick innovation and the release of new, better goods. At the same time, it is more important than ever to keep an eye on product safety and claims. Dozens of legal jurisdictions around the world, including California, the European Union, Japan, Canada, and the Association of Southeast Asian Nations (ASEAN), have called for more product safety regulation because of growing concerns about the safety of cosmetics. Lawmakers in the United States are thinking about amending the Food, Drug, and Cosmetic Act, which has not been changed in more than 80 years, in part because of these kinds of worries. The rise of these laws has a big effect on how products are made and what kinds of formulations are employed. Along with following the rules, science-based testing and validation processes are becoming more important because there are so many competing cosmeceutical goods and so many lawsuits that are getting a lot of media attention.

High-end firms' products that cost a lot of money are frequently the ones that get the most attention. More quality control testing can lead to modifications in the formulation that modify the brand's character and have a big effect on the performance, claims, and pricing steps of mainstream products.

Competition and New Ideas in the Market

Many different companies make cosmetics, which makes the personal care products market particularly dynamic, competitive, and fragmented. Due to the rising demand for cosmeceuticals, major pharmaceutical corporations are now entering the increasing market for these goods. Because of this, traditional cosmetic companies made a skin-friendly recipe by adding a new line of gentle, allergen-free products that were more natural. Many domestic competitors have also entered the market and expanded their product lines to match the growing demand for goods that protect against the sun, whiten skin, and slow down the ageing process. Pharmaceutical businesses have also made skincare products that contain chemicals that go deep into the epidermal layers to fix skin problems. These companies have also entered the cosmeceuticals sector. The US and Europe have been the biggest markets in the last few years, bringing in more than half of all sales. The Asian Pacific region, on the other hand, has been the fastest expanding market, mostly because people's lifestyles are changing and their incomes are going up, especially in emerging areas [12].

Cosmeceuticals are changing as science and personal care demands change quickly. Cosmeceuticals' bioactive ingredients are very important for improving skin texture, protecting skin from injury, and treating skin and scalp problems.

Researchers are looking into a lot of different *in vitro* and *in vivo* procedures, models, and techniques to see what herbal formulations could be able to do for cosmetics. There are three types of tests: those that have been used before in medicated pharmaceutical formulations, those that have been made up specifically for cosmeceuticals, and those that are still being tested on animals and even people. Recent research on cosmeceuticals is still focused on making sure that products meet safety and effectiveness standards. But there is still no scientific word, adjective, or categorization that is widely accepted by scientists, businesses, or government agencies.

WHAT WILL HAPPEN NEXT IN COSMECEUTICAL RESEARCH

Cosmeceuticals or over-the-counter topical products can start biological processes in the skin that can have effects on the body that are like those of prescription medications. Cosmeceuticals usually affect the architecture of the skin through their active ingredients. So, knowing how skin is made up and how it works will help you find the best place for cosmeceuticals to work and make it easier to figure out how they work. The skin is the largest sense organ and covers around 2 m^2. The cutis is the name for the outer layer of skin on adults. It is usually 1.5–4.0 mm thick, but it can be thicker or thinner depending on where it is on the body. There are also several layers in the skin, such as the epidermis, dermis, subcutis (hypodermis), and appendages. The dermal-epidermal junction (DEJ) is the place where the epidermis and dermis meet. It is a twisted and folded area. Cells in connective tissue and muscle tissue are far apart from one other because of substances between them that are gel-like. This makes the tissue look solid and rubber. The epidermis, which comes from the ectoderm, protects the body from the outside world by acting as a physical, chemical, and microbial shield. It also controls trans-epidermal water loss (TEWL) to keep the body in balance and makes different parts for biological and structural purposes [1].

New Ingredients and Technologies

Cosmetics That Use Nanotechnology

As many fields have improved, our knowledge of skin has grown a lot. Biotechnological skin care products, also known as cosmeceuticals, are the fastest-growing part of the personal care industry. The cosmeceutical industry has grown a lot in the last few years and now makes over a billion dollars around the world. Many topical cosmeceutical treatments for problems, like photoaging, hyperpigmentation, wrinkles, acne, rosacea, and hair damage, are now very common. Emerging nano- and biotechnologies have been pushing the development of antiaging and dermatological cosmeceuticals from both a research and marketing point of view. This has made it possible to move from classic formulations based on small molecules to new products based on biopolymers, biotechnological peptides, cosmetics and cosmetic nanotechnology, active system technologies, and nanocarriers. It is time for an educated public to learn about the science behind the things they buy and to make smart choices about things that are safe and have been proven to work.

Nanoparticles in the World of Cosmetics

In the world of cosmeceuticals, traditional molecules are being replaced more by new active nanoparticles and new drug delivery systems that use different types of nanoparticles. Several cosmetic companies have started making and selling nano-sized cosmetics like sunscreens, skin whiteners, anti-wrinkle creams, and hair growth stimulants. Cosmetics that use nanotechnology have a lot of different products, more active ingredients that are easier for the body to absorb, and longer-lasting effects that look better. Most of the growth is expected to come from nano-cosmetic products, so food companies and raw material suppliers are making nano-emulsions, micellar systems, and lipid vesicles.

Customized Cosmeceuticals

Cosmeceuticals, which are made up of both cosmetic and pharmaceutical molecules, are the fastest-growing part of the personal care industry. Cosmeceuticals are topical products that combine cosmetics with pharmaceuticals or dermaceuticals. They are generally considered ingredients that can alter the structure or function of the skin with medicinal benefits but fall short of a regulated drug.

Cosmeceuticals maintain biological functions, such as moisturization, exfoliation, reduction of wrinkles, skin weight modification, and protection. Generally considered topical applications which are designed to promote and nourish where the first major category of cosmeceuticals produces an effective response. Photoprotectants, such as sunscreens, are generally considered important cosmeceuticals in this category. The second category of topical treatments involves materials that alter the condition of the epidermal layer, including balms, keratinolytics, desquamation, astringents, and anti-seborrheics.

Drugs are usually referred to as substances or mixtures that are intended to treat, cure, prevent, or diagnose human disease drug efficacy is defined as the ability to obtain the desired biological and therapeutic response in the intended patient population as compared to other treatments. Above all, contraindications need to be stated. Drugs must be labeled to indicate their ingredients, indicating the patient population pointed out. The composition should be sufficiently specific to meet potential patents, proprietary, and intellectual property objectives. Drug products are most often administered whereby the influence of the exterior matrix is not as important.

Cosmeceutical efficacy spans a broader category that includes chemicals defined as cosmetics, medicine, or both which are free of pathogenic contamination and comply with good manufacturing practice. Some consider soap a drug, although it would not be a cosmeceutical. Several claims can identify a cosmeceutical, including cosmetic restrictions, premarket testing, and an emphasis on safety/image rather than tentativeness which falls to efficacy.

ETHICAL CONSIDERATIONS

No-Truth-in-Advertising

- The New Legality of False Advertising Cosmetic companies had to ultimately admit for a period that their face creams and other cosmetics could not make medical claims nor promise to heal crow's feet or enlarge lips. In the 1930's the FDA decided against misleading advertising saying, noise to the senses would induce a purchase. If a product does not work, whether legally because it is a cosmetic or possibly because believability was stretched past its specified purpose, what is the recourse to consumers? Something was discovered in the 1930's: old technology, antiquated thinking or no science would not necessarily win out in advertising lawsuits. An example of this now would be Pro'dia chasing multiple frozen dinner firms for making false/pseudoscience medical claims. "Skinogen 4" made the promise that supper filled with fish oil would enhance skin. The FDA cited false advertising on grounds of broken malaria, dermatologists' credibility, and misbranding.
- The long-time vendor of the Agents of Change the Derby anti-wrinkle cream advertisements with the twin spokespeople model the essence of lesbain and puritanical conservativism is now, sadly, moot. People's faces were compared to those of 1930's movie stars before and after a series of visions. The 30s would also reject the idea that advertising might make some things better after firearms scratched Bonny and Clyde's more gorgeous guns and makeup, which made people panic. However, actress/model ambassadors are just now getting equal treatment from cosmetic companies and magazine editors. Meanwhile, doctors were told to read pompous and false statements that made things look better, including breast enlargements and purple anti-gravies.
- *The New Doctor-Commercials:* The doctor is still not as well-known as his clients (save for where they live), and no cosmetic corporations were on the FDA base when S. 2391 (1914). Some firms skipped the FDA and went straight to Premiere D'alga, a glycollic acid cream for acne that is popular with celebrities. These well-made creams might make your brain work a little better in Gucci bags. No study has investigated "guessed patents" or Phillips facialrosy whiplas and forehead wrinkles that happen when you use too much serum and toners.

Making Cosmeceuticals That Are Good for the Environment

Increasingly, personal care, cosmetics, and home care products need active components from natural plants. One of the most important things that has come out of this huge need is the huge

amount of natural biodiversity. Plants are forced to gather extracts from a wide range of plants and animals around the world. But this is just the most cost-effective way to run a core production plant. It seems to be sense that the bioactivities of at-risk species are hard to find since they develop slowly, are not very productive, and are in short supply. Also, the expanding global demand for these kinds of things has a bad effect on ecology and biodiversity. To regulate this, personal care product formulation must start using plant species that are harder to get right now. This makes the issue almost impossible. Also, plants grown on fields can pick up harmful substances that can have a big impact on human health when they are used.

As these activities become more worldwide and the responsibility for their effects on the environment grows, biobases must be in place to make sure that bio-based goods are pure, viable, and have a negative effect. Plants are extremely crucial in the quest for green sustainability since they are bio-based and follow many of the same rules, such as tracking and tracing, toughness testing, testing for secondary compounds, and labor exploitation. When making bio-based products, like plant secondary metabolites, the first step is to track and trace the plants that the materials came from, test their purity and violation, and reduce their negative effects on existing chemicals like pesticides. Finally, the products must be able to break down and be environmentally and socially sustainable.

Testing on Animals and Other Options

Animal testing is a very controversial bioethics problem, especially when it comes to cosmetics. Cosmetics are a poorly regulated global industry worth billions of dollars. Animals have been used for a long time to test cosmetics to show that they are safe for people to use. Cosmetics companies often send safety data to countries that are almost entirely based on *in vivo* reports. This data includes advice on how to safely utilize any chemical that could meet skin or mucous membranes. There are thousands of compounds that are not allowed, and changes, crossovers, and routing of ingredients, whether they are alone or in mixes, have led to a recent restriction on animal testing for cosmetic ingredients. Most experiments are done on SAEs, which is a bad idea because it is like testing pharmaceutical medications on young, healthy volunteers.

The EU's 35-year ban on selling cosmetics that have been tested on animals in labs gives people confidence that safety standards are being met. But there are still real worries that regulatory norms do not only lead to dirty coats that aren't in the database. There is still a real worry that safety information for cosmetic components may be too low and that false negative results may be more likely because no *in vivo* or *in vitro* sensitivity tests have been suggested. Hobson's dilemma for the cosmetic business came from the two-sided symmetry of the law: if wrong safety profiles cause SAEs paranoia, how can anything get past *in vivo* tort? There was already a suspended computer program that would lower the impious PI. Then, both basic and manufactured MW allergens fell via (bio)-logical grids of padded local asterisks. But this kind of treacle problem is a common one that goes beyond any physical flaws.

TEACHING AND INFORMING CONSUMERS

Cosmetic goods are generally used to stop and treat skin issues. The cosmeceutical study is cutting-edge since it looks ahead to the future of finding skin problems and making dermatological products. Skin is the body's largest organ and acts as a barrier, but it is also the most exposed area and is, therefore, more likely to be damaged by pollutants, grime, dust, smoke, and UV radiation. Dermatological formulations including creams, lotions, gels, and ointments can help fix these kinds of skin disorders. These products have pharmaceutical compounds in them that go deep into the skin to treat bacterial infections, inflammation, and skin discoloration. Nanopharmaceuticals have made their way into the cosmeceutical sectors thanks to advances in the pharmaceutical industry. This has led to better topical treatments [1].

Cosmetic dermaceutics are products that can change the look of skin via active hyperbioadherable delivery systems. Most of the time, these products come from plants and contain active ingredients,

such as free radical scavengers like D-Panthenol, Vitamin C, tocopherol, and Vitamin E. Active compounds, like herbal extract, metals, or lipid-encapsulated moieties, are more advanced formulations that work well and stay stable against reactive species defense. In aesthetics, these products are applied to the skin in a way that is not scientifically proven.

This definition of cosmeceuticals includes compounds with active ingredients that are meant to be used in addition to standard treatments for certain skin conditions, especially dermatologic disorders. Active ingredients, like retinoic acid and hydroquinone, when used as cosmeceuticals, are not a replacement for standard treatments but rather an addition to them. They do not improve the overall medical condition, and the side effects of cosmeceuticals can make it worse. This is why grade A to C consumers need to be educated before and after they buy them. Before and after they buy something, customers want to get information regarding safety. They do not want to get messages on what is in the products. Price seems to change how people want to learn.

Understanding Labels and Claims Made in Marketing

Modern products can do both pharmacological and aesthetic things, as well as improve appearance. A "cosmeceutical" is a product that claims to provide these mixed benefits. Cosmetics help stop and treat systemic and localized skin diseases, while therapies only help address localized skin problems. Cosmeceuticals work on the skin, however most of the time they are just for looks. Over the years, they have become more trustworthy as beauty products thanks to smart marketing. High-end stores and spas push personalized and genetically based care cosmetics. Packaging focuses on natural health, wellbeing, and biotechnology. Modern products can do both pharmacological and aesthetic things, as well as improve appearance. A "cosmeceutical" is a product that is touted as having these mixed benefits. Cosmetics talked about how skin function changes in both quantity and quality to stop and reduce diseases, while therapeutics helps with the local dermatologic control of skin conditions. We did an informal survey of eleven college-educated people with different educational and career backgrounds to find out what they thought about the face-to-face interview approach. Most people thought of "cosmeceuticals" in the "best" way, using words like "natural" and "botanicals."

What Dermatologists Do

More doctors, especially dermatologists, are becoming part of celebrity culture. Most dermatologists are not well-known by name, but a lot of them are well-known in certain regions, like New York, Los Angeles, and the physician-owned skin-care businesses they advocate, which have become huge hits with consumers. Dermatologists are involved in this mix of real medicine with "celebrity" and business, which is something that most doctors try to avoid. In a lot of ways, traditional medical professions depend on being able to see the patients and their area from a distance. There are a lot of instances about doctors who have been publicly shamed for "gossiping" about their patients.

For the company, this tactic is less about convincing dermatologists that the products work and more about giving company representatives a chance to tell their side of the story. Safety and efficacy discussions become tightly controlled information sessions, and results can be "spun" and retaliated against as excessive or inaccurate based on the board members' positions. This means that physicians can become major players in data definition battles, and physicians who do not have access to this information can suffer indefensible consequences. On the other hand, physicians have some control over their contracts, such as how much and what type of participation they have in a consumer group or media appearance, and they have access to warehouses of industry knowledge that they can use for personal gain and to inform future interactions with companies on the "inside."

EXAMPLES OF SUCCESSFUL COSMECEUTICALS

In the last few years, new ingredients have been added to the cosmeceutical market thanks to advances in science. Liposomes have been used a lot in dermal drug delivery because they can make active compounds more chemically stable, help them penetrate the skin better, and lower the risk of

skin irritation. Researchers have also successfully developed and studied new Phytosome complexes that combine phytochemicals with phosphatidylcholine.

Researchers have also investigated new biomimetic vesicles made of ceramide, sphingomyelin, and cholesterol. The main difference is that these vesicles are bigger (about 200 nm), which is about the same size as the SC lamellae (about 20–250 nm). This means that they can use the film-forming dendric type behavior of ceramide 2 to hydrate the upper epidermis without destabilizing it, which leads to long-lasting hydration and topical drug retention. In the same way, scientists have made new hair care products that feature water-in-oil emulsions in them to help active ingredients get deeper into human hair. Researchers have also employed hydroxyapatite nanocrystals to replace minerals on the surface of teeth.

Researchers chemically changed glycyrrhizic acid, an old natural humectant, to make squaric acid dibutyl ester (SADBE), which is a good topical treatment for alopecia areata. All these examples show that new or scientifically changed substances could lead to the formation of newer generation of cosmetics as we learn more about human biology and chemistry. More importantly, these newer generation active formulations can work in different ways or even better than the chemistry that were used in the past.

On the other hand, many projections are good at paving the road for new targets that could assist in the finding of new substances. It is thought that medicine must be engineered to be bio-compatible to be delivered through the skin. For this reason, the building of the human skin barrier needs to be shown. So, lipophilic medicines are typically not used for prospective topical cosmeceutical tracing for the reasons given above. In the future, hybrid liposome formulation could be utilized to put lipophilic medications on the skin by changing the representative skin barrier. For example, scientists made big liposomes by putting together layers of cationic and anionic phospholipids.

Famous Brands and What They Do

Olay is not only the oldest science-based brand still in business, but it is also one of the biggest, with sales of more than $2.3 billion around the world. The brand’s image as a science-driven one was solidified by the billions of dollars it has spent on research and development since the 1980’s, when people were cutting back on spending. After buying the brand in 1985, the chemistry department at a university built the “research” fort. It was then enlarged to include a flagship center and a second one in a different location. It was disclosed that there is a distinct patent portfolio for DNA-oligo derivatives. These changes led to the creation of a new product line that was sold over the world at a set price. The skin care group is now the only segment that has consistently seen double-digit growth, thanks to several of these winning brands and their expanding product lines. More importantly, it makes the most money, even though it is smaller than some of its competitors. Another corporation had a similar fight. After the acquisition, the skin care division had to combine and get rid of the weakest portfolio of brands that were not making money. The first thing to go was a brand, and a short-lived and pointless attempt to rewrite the famous tagline that revolutionized the rules of advertising. The R&D team moved to a huge estate and quickly became the only skin care lab in the corporation that people believed in. Behind the locked doors, subsidies brought in a group of top-notch biochemists from new companies, with the promise that they would have complete laboratory support at any target place on Earth.

Reviews And Testimonials from Customers

More people are using cosmeceuticals to make themselves look better. Cosmeceuticals are quite popular all over the world. Many surveys show that people all over the world utilize cosmeceutical items like hair care products, fairness creams, sunscreens, and antiaging skin care products. Based on these polls, these products also have a huge market in India. A survey done in India in July 2004 found that 65% of women and 30% of men use fairness creams. Other surveys show that people are more knowledgeable of how to use sunscreen goods since they are more aware of skin care products

in general. A report from 2010 shows that 40% of people are utilizing products to fight ageing. Herbs are becoming increasingly popular with people these days. Some polls show that some herbal products that are important all over the world are either prohibited or taken off the market because they were mixed with cosmetics. Nanoformulation is making India more important for herbals as cosmeceuticals.

There have been several polls in India about how much people know about cosmeceuticals, how well they work, what adverse effects they could have, and how satisfied people are with the goods after using them. These polls show how people in India think about cosmeceuticals. It also shows that people were unsure at first about how safe and effective cosmeceuticals were [13].

CONCLUSIONS

Researchers and cosmetic firms have been interested in the science of cosmeceuticals since the word was first used in 1984. People want to keep their skin looking better after using new technologies, like chemical peels and laser treatments, that focus on changing and rearranging the epidermis and dermis. No one can argue that cosmetics are less invasive than drugs or biopharmaceuticals. Because of this, the rise of cosmeceuticals has led to the creation of successful skin care companies, and this part of the cosmetics industry has grown into a huge business around the world. But like in the pharmaceutical field, the border between cosmetics and drugs has been called into question. Cosmeceuticals are becoming more controversial these days. The fact that the FDA does not have an official definition of the word “cosmeceuticals” is one of the biggest points of contention. The concept of cosmeceuticals also has a big effect on how chemical cosmetogenetic claims are made and how much nondrug cosmetics cost.

Both chronological and thematic organizations have done a good job of making references explicit, covering the most important ones. References are showing up again. There is a well-written, thorough, useful, and current article about the rapidly growing field of commercial cosmeceuticals. It is exciting and surprising how quickly formulation technology and ingredients are changing and how they are being used in skincare cosmetics to make cosmeceuticals. The introduction of bitter recognition that the frontier also attracts fast development of fake science, non-equality of safety and effectiveness regulation to OTC cosmetics, unresolved mechanism of drug delivery system, questionable combination treatment approaches, etc., may give a wakeup call and a way toward stronger public consumption protection regulation, fairer competition among manufacturers and healthier growth of the industry.

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