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**LASERS
AND LIGHT**
TO TREAT ACNE

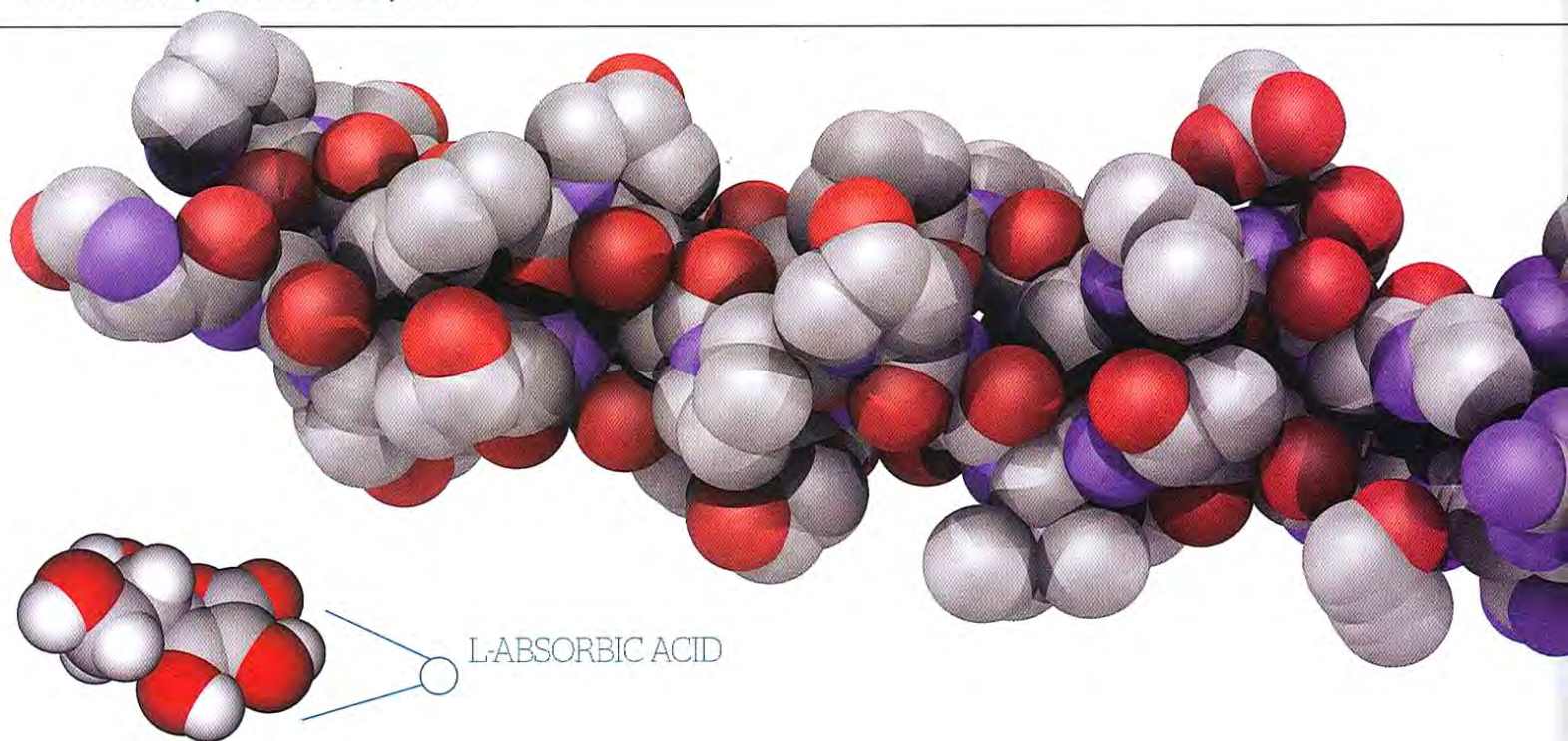
LIPOSUCTION
AFTER A POSITIVE
PREGNANCY TEST

**HAIR
TRANSPLANTATION**
ROBOTICS AND ARTIFICIAL
INTELLIGENCE

ROSACEA

Aetiology, diagnosis and treatment options

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THE SCIENCE BEHIND SKINCARE

With an ever increasing number of skincare products on the market, **Ivana Veljkovic** explains what ingredients and components are required for the most effective formulations

AS THE SCIENCE BEHIND SKINCARE formulation evolves, we are finding new and innovative ways to create products to treat a multitude of skin conditions. However, even with innovation, there are basic tenets of cosmetic chemistry that must be followed to produce effective products. Unfortunately, there are skincare companies today that make unsubstantiated claims about products that are unstable and ineffective. Trusting the science behind the efficacy of certain time-tested raw materials in addition to exploring new and exciting offerings is an important first step; having a solid understanding of what other categories of ingredients are necessary to create an excellent formulation is paramount. In this article, we will explore a number of categories of commonly used cosmetic ingredients, as well as the components necessary to create outstanding skincare formulations.



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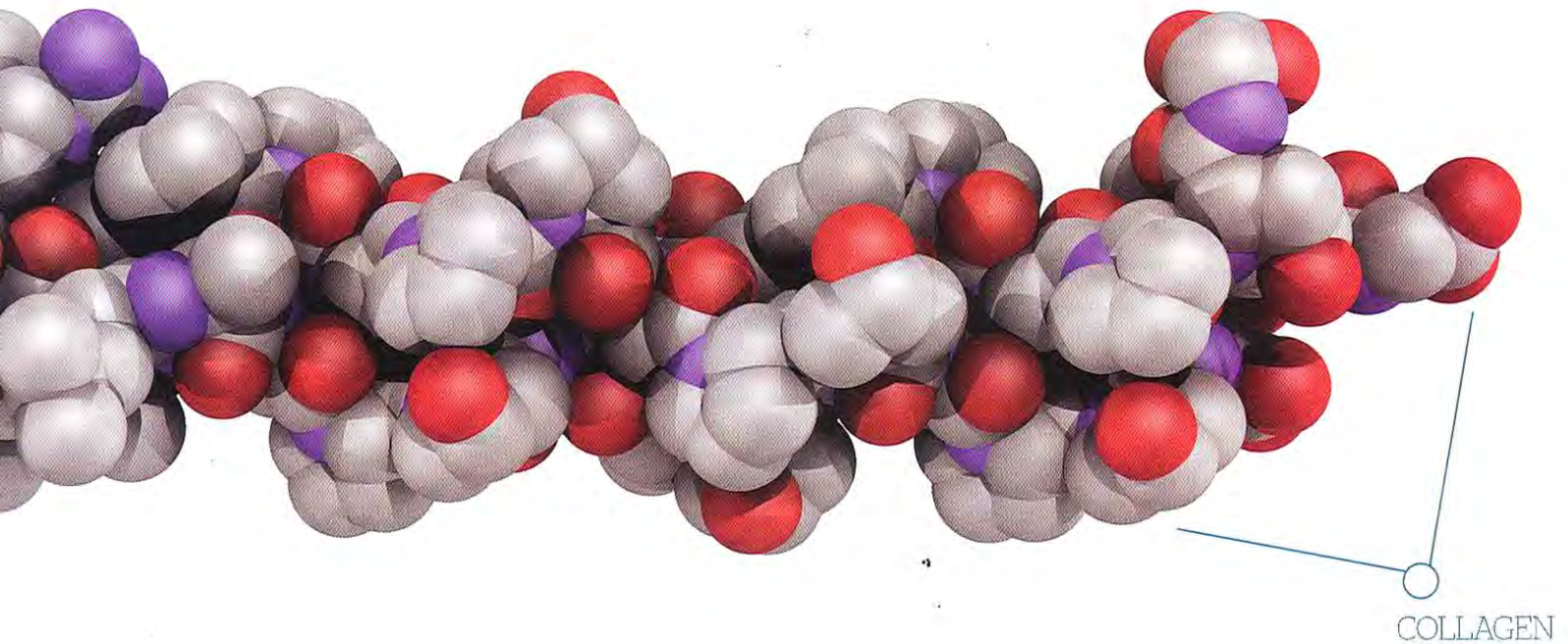
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Formulations as a whole

One common misconception regarding topical skincare products is that the results come from one key ingredient. In actuality, the formulation as a whole leads to a product's ability to deliver its purported benefits. Cosmetic products consist of a range of components:

- Key ingredients determine a product's greatest topical benefit
- Skin conditioning agents improve the skin's surface and provide a soft, smooth appearance
- Functional ingredients create the end product (cream, serum, lotion, gel) and act as a vehicle, or carrier, for the key ingredients
- Multifunctional ingredients provide some topical benefits and also assist the vehicle.

Each of these components is essential to a product's function and benefit. Product performance depends on the key ingredients' biocompatibility, the use of appropriate product vehicles and delivery systems, and



COLLAGEN

the stability of all of the ingredients within a formulation. Table 1 (page 14) depicts all categories, as well as examples of ingredients for each.

Trust the science

It can be tempting for consumers to choose a skincare product based solely on the new, exciting ingredients it offers and the promises the manufacturer makes; however, scientific data supporting the efficacy of the key ingredients is one of the most important considerations when choosing topical products. The chemist must vet ingredients prior to their inclusion in a formulation and the clinician should also ask the companies from which they buy their products for this science. Although, newer ingredients may seem intriguing to us all, patients ultimately need products that work. Many of the most effective cosmetic ingredients are time-tested over decades and typically have significant research backing their benefits.

Retinoids, for instance, include all derivatives of the vitamin A family, such as retinoic acid, retinaldehyde and retinol. Although retinoic acid is the form of vitamin A that interacts with the retinoic acid receptors (RAR) in the skin, it can be topically sensitising for some patients. Fortunately, retinaldehyde and retinol are successfully converted into retinoic acid within the skin. This conversion makes it possible to achieve the results of retinoic acid without inflammation¹. Studies have found that retinoids stimulate the production of collagen, hyaluronic acid, and elastin. They are also an excellent choice for treating hyperpigmentation, as they help to

inhibit the process of melanogenesis at multiple points. Retinoids also encourage cell turnover, bringing youthful, evenly pigmented cells to the skin's surface². Acne sufferers benefit from retinoids' ability to prevent follicular impaction as well.

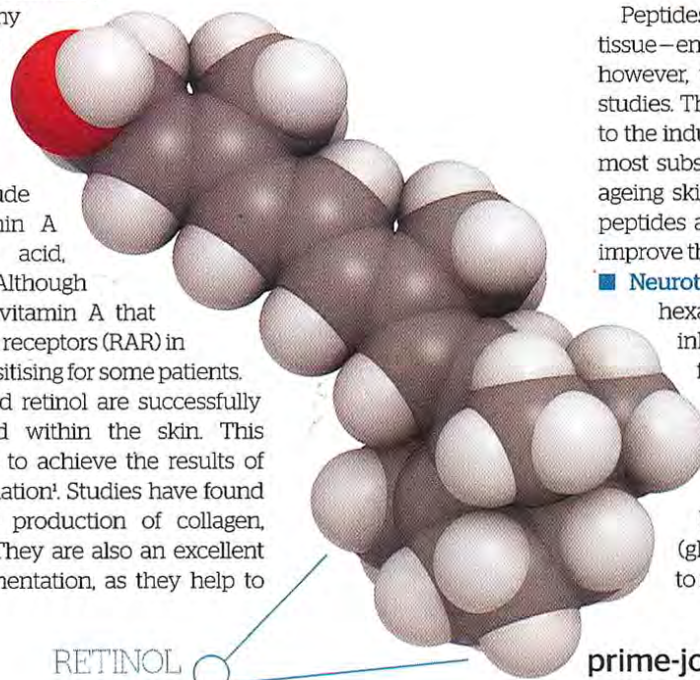
“Many of the most effective cosmetic ingredients are time-tested over decades and typically have significant research backing their benefits.”

The only bioavailable form of vitamin C for the skin is L-ascorbic acid. Esters of vitamin C, such as ascorbyl palmitate, do offer antioxidant benefits, yet they do not provide the collagen-stimulating, anti-ageing benefits of L-ascorbic acid. The additional antioxidant, anti-inflammatory, and ultraviolet (UV) protective benefits provided by L-ascorbic acid make it an excellent choice for virtually all skin types and conditions³.

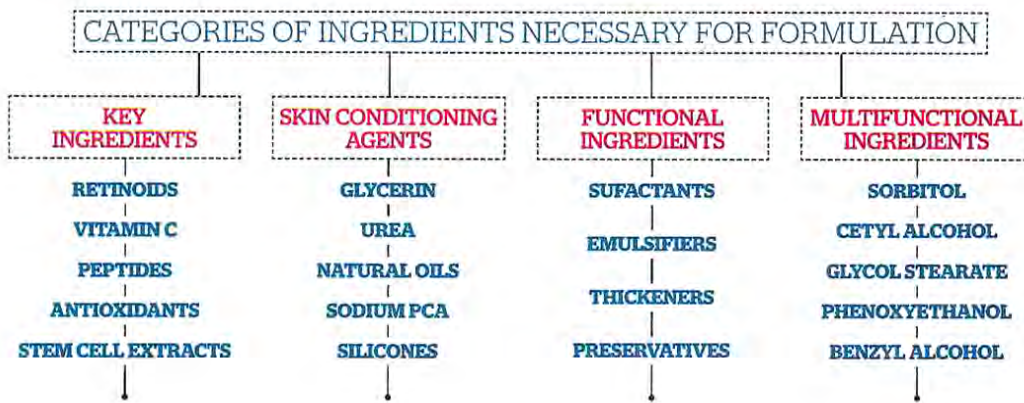
Peptides—the key building blocks of nearly all living tissue—encompass a large category of topical ingredients; however, very few have been legitimised in scientific studies. The topical use of peptides is still relatively new to the industry and, while many are being marketed, the most substantiated agents are used in the treatment of ageing skin. Neurotransmitter-affecting peptides, carrier peptides and signal peptides, work in different ways to improve the integrity of the skin:

■ **Neurotransmitter-affecting peptides** include acetyl hexapeptide-8, a chain of six amino acids that inhibits neurotransmitter release. *In vivo* studies found that twice-daily application of acetyl hexapeptide-8 for 30 days resulted in a 30% decrease in the depth of dynamic wrinkles⁴

■ **Carrier peptides** include copper peptides that increase the uptake of copper by cells when paired with a tripeptide (glycyl-L-histidyl-L-lysine). Copper is used owing to its involvement in collagen deposition



RETINOL



▷ through the activation of lysyl oxidase. Research suggests that the copper peptide increases collagen, glycosaminoglycan and adhesive protein production⁵

■ **Signal peptides** are used to initiate specific responses within the skin. A number of age control signal peptides are currently available, yet only a few are backed by legitimate studies:

■ **Palmitoyl pentapeptide-4** refers to lysine-threonine-threonine-lysine-serine paired with palmitic acid. *In vitro* studies show a stimulation of types I and III collagen, as well as enhanced production of fibronectin⁶

■ **Palmitoyl oligopeptide** is a combination of valine-glycine-valine-alanine-proline-glycine and palmitic acid. Studies suggest that this long-chain peptide stimulates the production of multiple dermal fibroblasts⁷. Palmitoyl oligopeptide can be used alone or in conjunction with other peptides.

Although the body has its own endogenous free radical-quenching mechanisms, daily application of topical antioxidants provides significantly heightened protection against matrix breakdown and the visible signs of facial ageing⁸. Antioxidants function in three ways: primary antioxidants or electron donors; secondary antioxidants, which chelate metal ions; and co-antioxidants, which facilitate other antioxidants. Many offer multiple protective benefits, such as preventing and reversing free radical damage⁹. Many antioxidants offer more than one free radical quenching benefit. All skin types benefit from antioxidants, as they are an important line of defence against UV induced cellular damage, photoageing and the development of certain cancers¹⁰.

Stem cell extracts

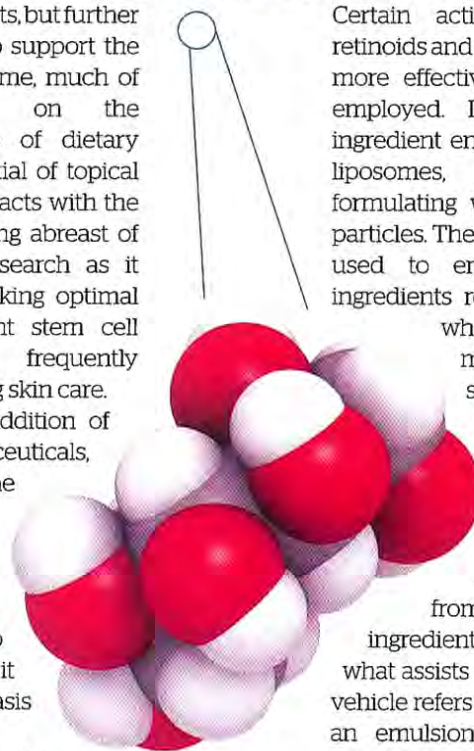
Scientific research supports the use of certain plant stem cell extracts, but further research may be needed to support the efficacy of others. At this time, much of the research focuses on the photoprotective properties of dietary botanicals, citing the potential of topical products that use plant extracts with the same characteristics. Keeping abreast of plant-derived stem cell research as it evolves is essential for making optimal treatment choices as plant stem cell technology is more frequently incorporated into anti-ageing skin care.

Before considering the addition of plant stem cells into cosmeceuticals, it is critical to understand the role of stem cells in the skin. The majority of skin stem cells reside in the basal layer of the epidermis. Their primary function is to replenish the skin as it undergoes normal homeostasis and wound repair¹¹.

Like all stem cells, those in the epidermis are undifferentiated, capable of dividing themselves for extended periods of time and differentiating into multiple lineages based on their tissue origin¹². When a stem cell divides, the daughter cells have the potential to either remain a stem cell, like the parent cell, or they can differentiate into cells with a more specialised function, known as progenitor cells.

In recent years, researchers have identified naturally occurring botanicals with substantial antioxidant activity proven to protect skin stem cells from UV-

SORBITOL



“A product’s vehicle is created by using ingredients from the multifunctional ingredient category, and is most often what assists with product penetration.”

induced oxidative stress, inhibit inflammation, neutralise free radicals, and reverse the effects of photoageing. Consequently, cosmeceutical products containing extracts derived from plant stem cells have the ability to promote healthy cell proliferation and protect against UV-induced cellular damage in humans⁴.

Product penetration

Asking about a product’s delivery system is becoming a more common question from clinicians and patients. It is a valid question, although it is more useful to understand when a delivery system is actually necessary to a product’s efficacy. Certain active ingredients, such as retinoids and L-ascorbic acid, are typically more effective if a delivery system is employed. Delivery systems include ingredient encapsulation in polymers or liposomes, and micronisation or formulating with very small ingredient particles. These delivery mechanisms are used to ensure a product’s active ingredients reach the level of the skin where they will provide the most benefit. While delivery systems of this kind certainly have their place within the industry, most skincare products do not need them to be effective.

A product’s vehicle is created by using ingredients from the multifunctional ingredient category, and is most often what assists with product penetration. A vehicle refers to a product’s base, which is an emulsion, a suspension or a gel. Emulsions have a creamy consistency

and are formulated to ensure the active ingredient is evenly distributed throughout the product; they combine water-soluble and oil-soluble ingredients, leading to penetration into both the aqueous and lipid environments of the skin. In some cases, thick creams can impede active ingredient penetration, as travelling

through the product’s base itself requires a significant amount of a molecule’s energy. For this reason, emulsions are typically better suited for moisturisers, versus corrective topicals.

Suspensions are usually in liquid form

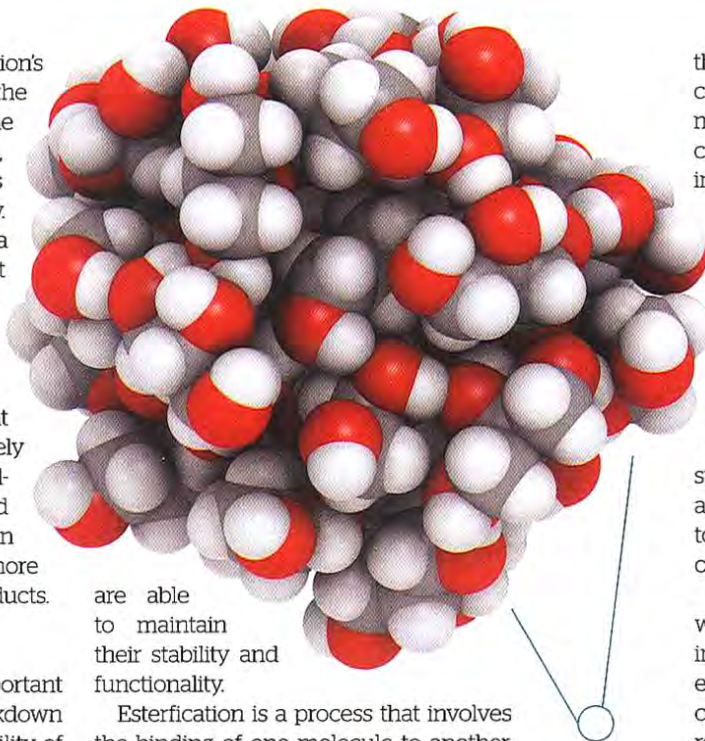
and separation of a suspension's ingredients is typical. Agitating the bottle is necessary to redistribute the ingredients throughout the product, ensuring the key ingredients penetrate into the skin properly. Suspensions are used when a product's ingredients will not dissolve when mixed with oil or water. Often, cleansers will be suspensions.

A gel base is commonly used in serum products. Gels are transparent semi-liquids that are either completely water-soluble or completely oil-soluble. Gels are thinner and typically penetrate easier than emulsions, making them the more common vehicle for corrective products.

Ensuring stability

Stability pertains to three important aspects of a product: chemical breakdown of its key ingredients, physical stability of the product, and the prevention of abnormal microbial growth. Some think of preservatives as a negative; in fact, preservatives protect the product and the consumer by preventing the growth of harmful bacteria, yeast, and mold. In actuality, all products that contain water must have some type of preservative system in place. Certain multifunctional ingredients offer preservative properties as well as other benefits, allowing for misleading 'preservative-free' claims.

If a product breaks down, or oxidises, it loses efficacy. Oxidation involves the altering of an ingredient's molecule. In some cases, this alteration is beneficial. For example, the conversion of retinol into retinoic acid in the skin involves oxidation of the retinol molecule. This type of oxidation must be assisted by certain enzymes and occur within the skin, not in the bottle, in order to make it effective. Oxidation is negative when a product oxidises before it is able to interact with the skin. The most obvious indication of product oxidation is darkening in colour over time. Many of the most effective topical ingredients, including retinoids, L-ascorbic acid and a number of sunscreen agents, are inherently unstable and prone to oxidation. Oxidation typically occurs when a fragile ingredient comes in contact with an oxygenating agent in the presence of air, water or light. Special steps must be taken to ensure products that contain unstable ingredients



GLYCERIN

are able to maintain their stability and functionality.

Esterification is a process that involves the binding of one molecule to another. Ester molecules can be effective, but the skin must be able to break apart the ester and free the actual active ingredient. One example is the esterification of peptides with fatty acids in order to make them lipophilic, thus enabling them to penetrate through the stratum corneum to reach the epidermis and dermis. Another example is ascorbyl palmitate, which combines L-ascorbic acid (vitamin C) with palmitic acid. While this seems like a logical way to stabilise the active L-ascorbic acid, the skin lacks the mechanism to free it; therefore, these esters do not provide all of the ingredient's topical benefits.

Encapsulation is a protective casing

that shields the active ingredient from contact with air, water or light. This method of stabilisation is widely considered the most effective, as the ingredient is still in its most active form.

The casings are easily broken upon manipulation or contact with skin, thereby releasing the active ingredient.

Synergistic activity, or formulating with complementary ingredients that are able to protect one another from breakdown, enhances a formulation's stability. The most common form of synergistic activity is the use of L-ascorbic acid with vitamin E. When formulated together, these ingredients replenish each other's activity⁴⁵.

Choosing the appropriate components when creating skin care formulations is an important job for the chemist. Creating efficacious topical products for the clinician to provide to their patients is a rewarding part of the cosmetic chemist's job. Though it can be difficult for the clinician and patient alike to determine which is best among all of the product options available, understanding select fundamentals of cosmetic chemistry can help significantly. Trusting the science behind skin care is much more useful than listening to marketing messages, which are often over-blown. When well-formulated, the skincare topicals of today are capable of producing excellent, visible results.

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