INGREDIENT

innovation
by pHformula **FOCUS**

P.O.S.T.
recovery cream

#Daily essentials

P.O.S.T. recovery cream

The P.O.S.T. recovery cream is a gentle, soothing, and hydrating post resurfacing cream, yet enriched with key ingredients to target the skin's everyday needs.

Our daily essentials line includes our everyday favourites. From choosing your favourite cleanser, nourishing your hands and hydrating the skin, the daily essentials line provides result-driven products to suit every skin and phototype.

pHformula daily essentials offers a line of skincare products designed to restore and maintain your skin with **soothing** properties.

More than just a cleanser or moisturiser, these products working in harmony with your advanced prescriptions for enhanced results. With must-have formulations that are simple, pHformula daily essentials provides a powerful option for all skin types and phototypes.

It's the ideal balance of **soothing control** delivering optimal results without compromising the skin.

#P.O.S.T. recovery cream

As a Daily Homecare Product:
P.O.S.T. recovery cream is the ideal daily moisturiser, formulated to soothe the skin, recover its natural moisture balance, and repair its protective barrier. Its calming and nourishing properties make it optimal for everyday use, providing immediate and long-lasting hydration while promoting skin resilience. Whether used after sun exposure or to combat the effects of environmental influences such as blue light effects, it provides the skin comfort and health, leaving it feeling soft, plump, and balanced.

As a Professionally Used Product:
P.O.S.T. recovery cream is also the final step in our skin resurfacing treatments, designed to soothe, recover, and repair the skin after professional procedures. It works in the right synergy with our skin resurfacing products and protocols, providing immediate relief, reducing redness and helping to accelerate the healing process. Ideal for use after skin resurfacing or any procedure that requires soothing, this cream helps to restore the skin's integrity, providing optimal results and a calm, revitalised complexion. P.O.S.T. recovery cream has very good skin compatibility.

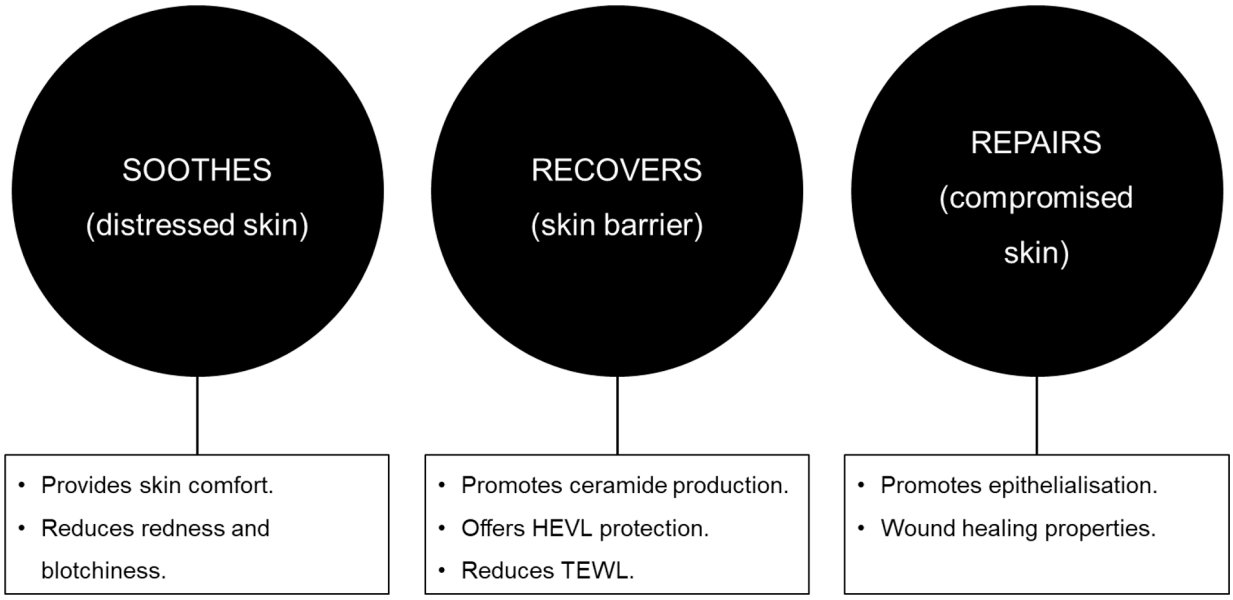
P.O.S.T.: post resurfacing moisturiser which helps to soothe the skin, reducing redness, signs of ageing, dark spots and imperfections.

RECOVERY: enhances skin repair processes and promotes skin barrier function.

CREAM: emollient cream containing a blend of humectants which attract water contributing to enhanced skin hydration, comfort, and suppleness.

#P.O.S.T. recovery cream

Main product benefits:

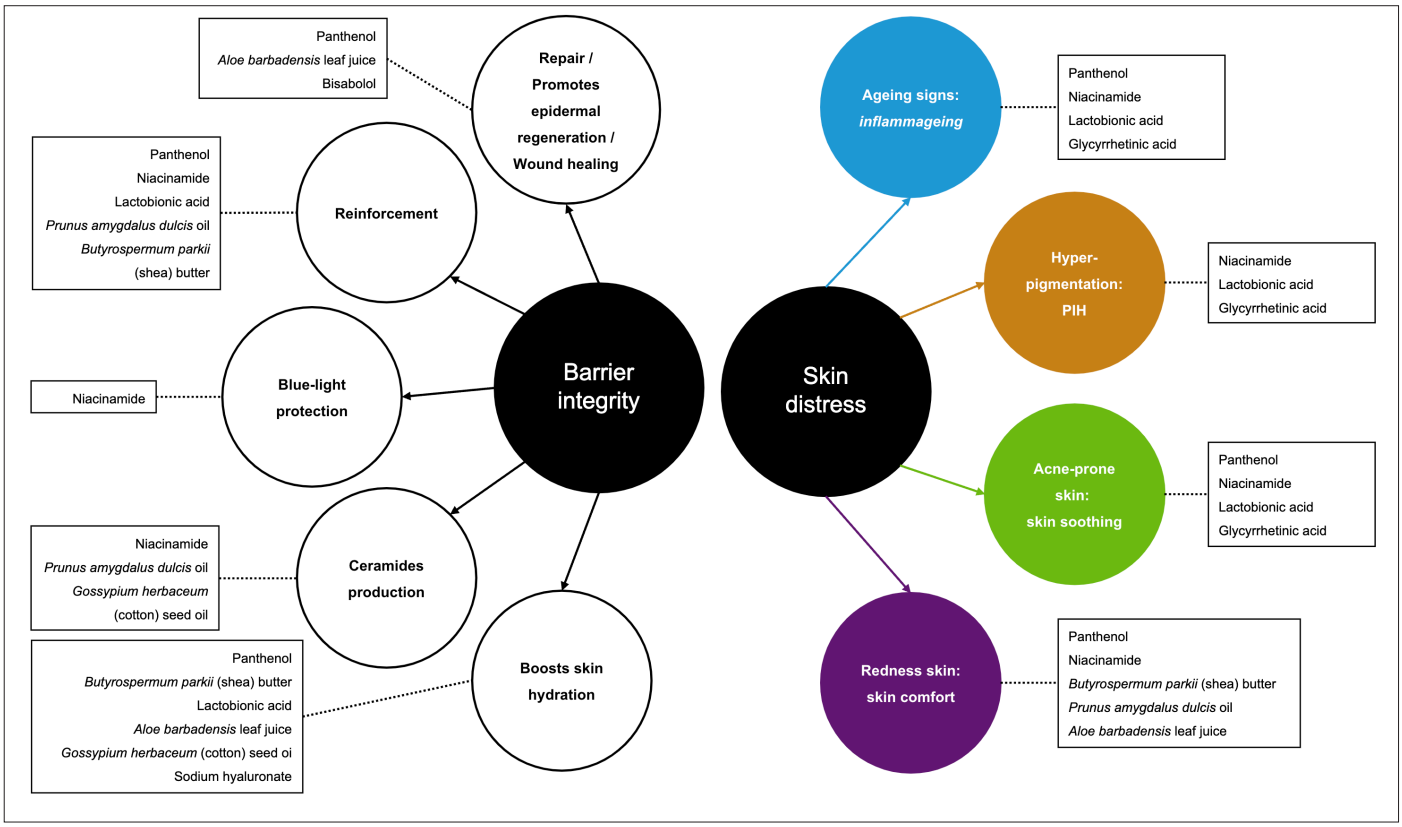


Extended skin benefits

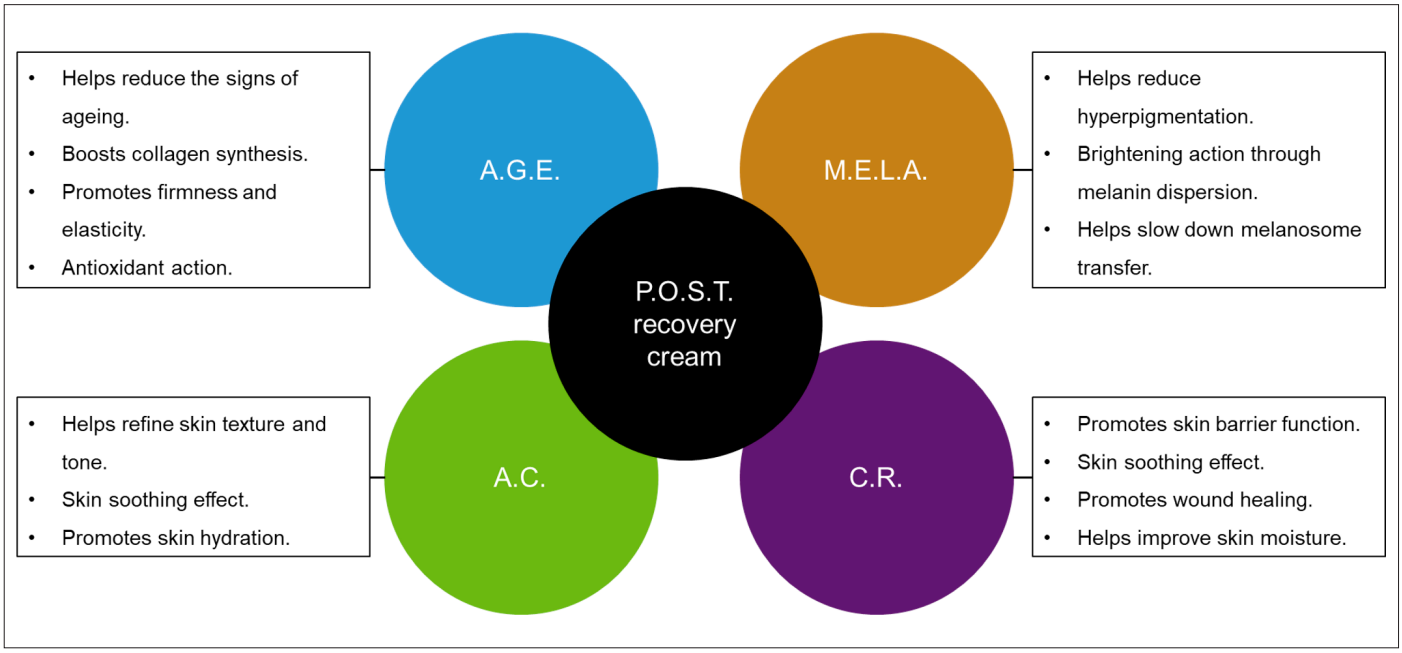
- Skin soothing action, providing skin comfort.
  - Formulated with active ingredients having described anti-inflammatory properties.
  - Reduces skin redness and blotchiness.
  - Helps to inhibit pro-inflammatory mediators.
- Protects and promotes skin barrier function and its integrity.
  - Promotes ceramide production.
  - Offers blue light protection.
  - Reduces TEWL strengthening the skin barrier.
- Enhances skin repair processes.
  - Wound healing properties.
  - Promotes epithelialisation.
- Helps to improve skin moisture retaining water and softening the skin.
- Helps reduce the signs of ageing promoting skin elasticity, plumping effect, and antioxidant action.
- Promotes skin brightening effect.

#P.O.S.T. recovery cream

P.O.S.T. recovery cream: more than a daily moisturiser



Targets all 4 skin classifications



#P.O.S.T. recovery cream

Available from April 2025

INCI:
Aqua (Water), Cetearyl Alcohol, Panthenol, Niacinamide, Butyrospermum Parkii (Shea) butter, Glycerin, Prunus Amygdalus Dulcis (Sweet Almond) Oil, Dodecane, Tetradecane, Gossypium Herbaceum (Cotton) Seed Oil, Dimethicone, Sodium Cetearyl Sulfate, Lactobionic Acid, Aloe Barbadensis Leaf Juice, Phenylpropanol, Glycyrrhetinic Acid, Propanediol, Caprylyl Glycol, Diethyl Succinate, Triethanolamine, Disodium EDTA, Bisabolol, Lecithin, PEG-8, Tocopherol, Sodium Hyaluronate, Ascorbyl Palmitate, Potassium Sorbate, Sodium Benzoate, Ascorbic Acid, Citric Acid.

Innovation: P.O.S.T. recovery cream

KEY INGREDIENTS

- Sodium hyaluronate
- Niacinamide
- Lactobionic acid
- Glycyrrhetinic acid
- Panthenol
- *Aloe barbadensis* leaf juice
- Bisabolol
- *Butyrospermum parkii* (shea) butter
- *Prunus amygdalus dulcis* (sweet almond) oil
- *Gossypium herbaceum* (cotton) seed oil

INDICATIONS

- Daily hydration for all skin types.
- Post-treatment repair
- Impaired / disrupted skin barrier
- ↑ TEWL / dehydrated skin
- Sensitive & sensitised skin
- Skin redness
- Fine lines and wrinkles
- Hyperpigmentation
- Skin imperfections
- Fitzpatrick I – VI

DIRECTIONS FOR USE

Apply to the face, neck, and décolleté on clean, dry skin every morning and evening, or use after serum or prescription products, gently massaging into the skin until fully absorbed, and follow with pHformula broad-spectrum sunscreen in the morning.

#P.O.S.T. recovery cream

P.O.S.T. recovery cream (previous formulation)	P.O.S.T. recovery cream (upgraded formulation)
	
10ml / 50ml / 100ml / 200ml	2ml / 50ml / 100ml / 200ml
Niacinamide *Linum Usitatissimum* seed oil Lactobionic acid Glycyrrhetinic acid Panthenol Bisabolol *Prunus amygdalus* dulcis oil	Sodium hyaluronate Niacinamide Lactobionic acid Glycyrrhetinic acid Panthenol *Aloe barbadensis* leaf juice Bisabolol *Butyrospermum parkii* (shea) butter *Prunus amygdalus dulcis* (sweet almond) oil *Gossypium herbaceum* (cotton) seed oil
Innovative multifunctional moisturiser. Very well skin tolerated.	Upgraded formula according to the latest regulations, boosting its versatility. Upgraded preservative system, improving shelf life. Upgraded surfactants introducing even better tolerability performance.

#P.O.S.T. recovery cream

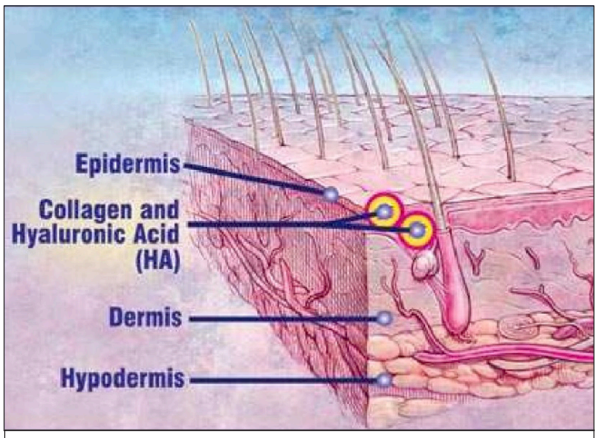
P.O.S.T. recovery PLUS (current formulation)	P.O.S.T. recovery cream (upgraded formulation)
	
50ml	2ml / 50ml / 100ml / 200ml
Niacinamide Lactobionic acid Glycyrrhetinic acid Panthenol *Aloe barbadensis* leaf juice Bisabolol *Prunus amygdalus dulcis* (sweet almond) oil *Gossypium herbaceum* (cotton) seed oil *Lactococcus* ferment lysate *Helianthus annuus* seed oil Squalene, Dodecane, Tetradecane Lactic acid	Sodium hyaluronate Niacinamide Lactobionic acid Glycyrrhetinic acid Panthenol *Aloe barbadensis* leaf juice Bisabolol *Butyrospermum parkii* (shea) butter *Prunus amygdalus dulcis* (sweet almond) oil *Gossypium herbaceum* (cotton) seed oil
The PLUS version is more emollient, nourishing and also has a probiotic activity. It is an alternative to be used in mature skin, menopause or very dry types.	Multifunctional and versatile daily choice formulation, adaptable to all skin types and phototypes.

#Sodium hyaluronate

What is Sodium hyaluronate?

Sodium hyaluronate is the sodium salt of hyaluronic acid. Hyaluronic acid is a major component of the extracellular matrix; it is produced by the cellular membranes, rather than the Golgi apparatus within the cells. The cells produce about 5 grams of hyaluronic acid per day as hyaluronic acid is needed for the body to produce new cells which is an ongoing process.

Hyaluronic acid is naturally present in the skin, but as we age, due primarily to the increased activity of the hyaluronidase enzymes, the percentage of hyaluronic acid in the skin decreases; and this loss accounts for the loss of hydration and moisture in the skin.

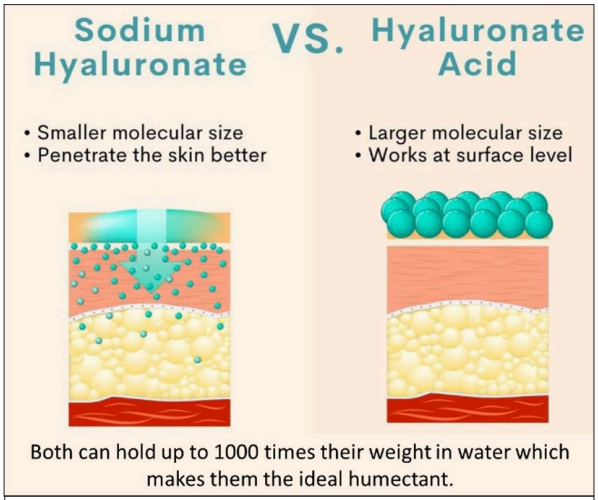


Hyaluronic acid is a major component of the extracellular matrix.

How does Sodium hyaluronate work in the skin?

Sodium hyaluronate is the main component of a family of polysaccharides similar in structure and behaviour to the amino sugars better known as glycosaminoglycans (GAGs). Sodium hyaluronate is used in various skincare applications mainly because of its excellent moisture retention property. The Sodium hyaluronate in this formulation is of medium molecular weight (1000 – 1800 kDa) and therefore works in increasing hydration in the superficial layers of the skin as well as helping to reduce TEWL.

When applied to the skin, hyaluronic acid has the ability to absorb and retain large quantities of water; maintaining optimum humidity and moisture balance even if the humidity of the surrounding air is low. Hydration is the basis for younger-looking skin. Applied to the skin, hyaluronic acid helps to restore the hydration levels and slow down the physiological process of water evaporation in the superficial layers. This action affects the mechanical properties of keratin, which becomes more flexible and elastic resulting in a smoothing effect on the skin.

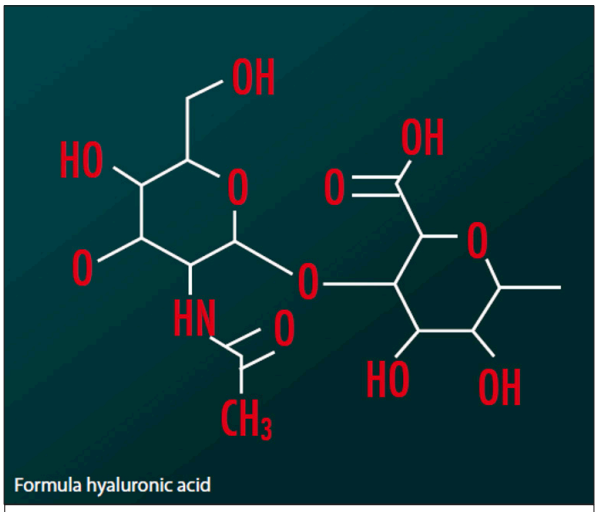


Adapted illustration showing the penetration of Sodium hyaluronate into the skin.

#Sodium hyaluronate

Sodium hyaluronate skin benefits

- Promotes skin hydration
  - Works in superficial layers to help increase skin moisture
  - Helps to reduce trans epidermal water loss (TEWL)

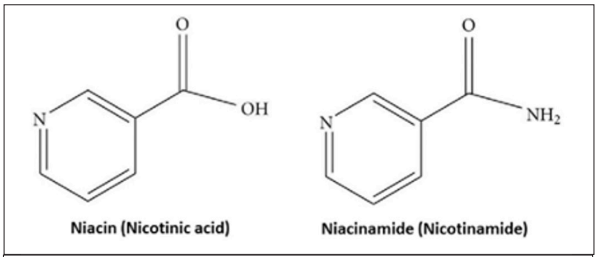


Chemical structure of hyaluronic acid.

#Niacinamide

What is Niacinamide?

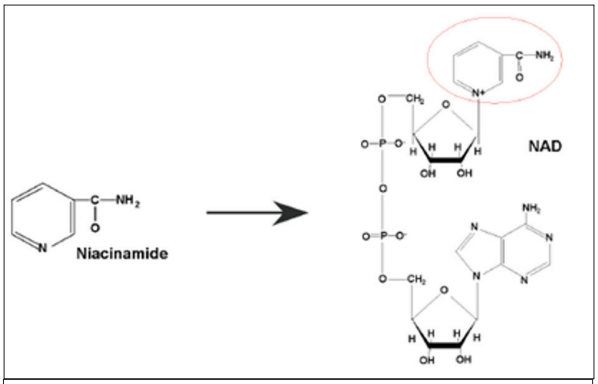
Niacinamide / nicotinamide is the amide form of vitamin B^3 (niacin), an essential water-soluble vitamin that is not stored in the body. Dietary sources include liver, meat, fish, green leafy vegetables, legumes, wheat, oat, yeast, mushrooms, nuts, milk, tea, and coffee. Niacinamide should not be confused with nicotinic acid; another form of niacin known for causing flushing due to its vasodilating properties. [1, 2, 3, 4]



Chemical structure of Niacin and Niacinamide. [2, 4]

Niacinamide is from natural origin, Vegan-friendly, China listed and Quali-B certified.

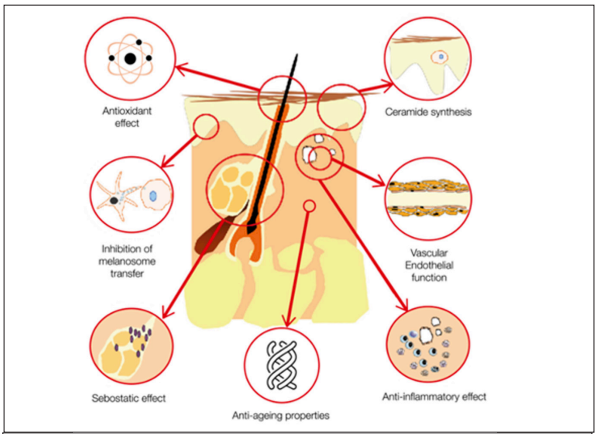
Niacinamide / nicotinamide is a precursor of nicotinamide adenine dinucleotide (NAD) and its phosphate derivative, nicotinamide adenine dinucleotide phosphate (NADP) as well as their reduced forms $NADP^+$ and NADPH. These are vital coenzymes necessary to produce cellular energy or ATP (adenosine triphosphate) and plays an important role in over 40 cellular biochemical reactions such as DNA repair. [1, 4, 5] Niacinamide is also the sole substrate and an inhibitor of the nuclear enzyme poly ADP-ribose polymerase 1 (PARP-1), which is activated by UV radiation. PARP-1 has several important cellular properties such as DNA repair and genomic stability, as well as the regulation of some transcription factors, particularly with relation to the expression of inflammatory cytokines, chemokines, adhesion molecules, and inflammatory mediators. [4]



Structure of niacinamide and inclusion within the NAD molecule. [5]

How does Niacinamide work in the skin?

Studies have shown that niacinamide has the potential to act as an antioxidant, can improve epidermal barrier function, decrease skin hyperpigmentation, reduce fine lines and wrinkles, decrease redness / blotchiness, decrease skin yellowness (sallowness), and improve skin elasticity. [6]



Adapted. Overview of all dermatologically relevant effects of Niacinamide. [3]

#Niacinamide

Skin soothing properties

Niacinamide is an inhibitor of the nuclear poly (ADP-ribose) polymerase-1 (PARP-1) that controls the NF-$_K$B-mediated transcription and is therefore very important for the expression of adhesion molecules and pro-inflammatory mediators. Niacinamide can also inhibit the expression of MHC-II as well as the production of IL-12, TNF-α, IL-1, and nitric oxide. [3]

Niacinamide suppressed interleukin (IL)-8 production at the mRNA, and protein levels through modulation of the nuclear factor (NF)-$_K$B and mitogen-activated protein kinase (MAPK) pathways in primary keratinocytes stimulated by *Propionibacterium acnes*, now called *Cutibacterium acnes*, the etiological agent causing inflammatory acne vulgaris. [1, 4]

Niacinamide downregulated the expression of IL-6, IL-10, monocyte chemoattractant protein-1 and tumour necrosis factor (TNF)-α in UV-irradiated keratinocytes. Niacinamide reduced the synthesis of inflammatory mediators, such as prostaglandin (PG) E_2, IL-6, and IL-8 in human epidermal keratinocytes and in full-thickness three-dimensional skin organotypic models that were stimulated by UV radiation. [1]

Action on epidermal barrier function

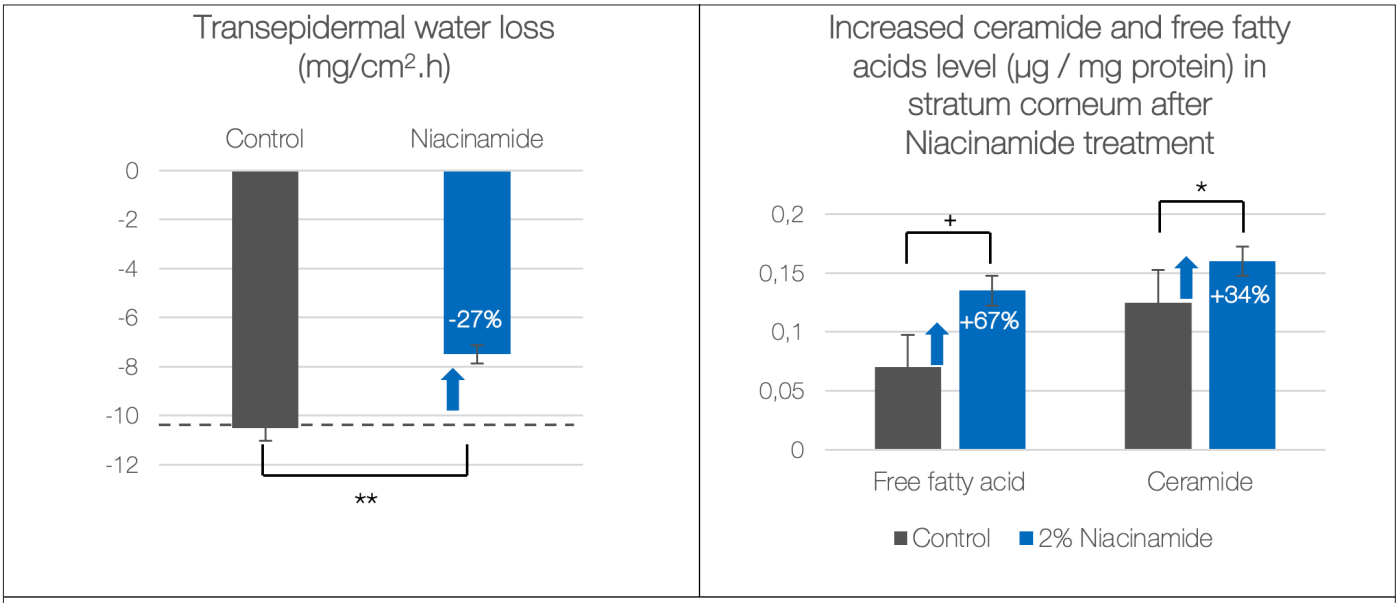
During ageing, the structural and functional integrity of the skin barrier is changed or disturbed. [1] Niacinamide may improve the skin barrier function in two ways:

1. by its ability to upregulate the synthesis of ceramides as well as other stratum corneum intercellular lipids (such as cholesterol, free fatty acids, and other sphingolipid fractions, e.g., glucosylceramide and sphingomyelin) which are major components of the skin barrier, and
2. by stimulating keratinocyte differentiation. Niacinamide stimulates the production of keratin, filaggrin, and involucrin – epidermal proteins responsible for skin barrier function by ensuring that corneocytes are firmly packed together and the cornified envelope tightly attached to the epidermal lipids. Filaggrin and involucrin also play a key role in the differentiation of keratinocytes thereby forming a fully functional stratum corneum. By stimulating keratinocyte differentiation, the stratum corneum may become thicker, which is not only associated with an improved barrier, but is also associated with greater hydration capacity in the stratum corneum. [1, 5, 6]

#Niacinamide

Niacinamide helps to strengthen the skin barrier (information from raw material supplier)

Twelve healthy male subjects with dry skin applied 2% Niacinamide for 4 weeks. Lipids were extracted and quantified from stripping of stratum corneum.



⁺p<0.01; *<0.05; **p<0.01	
TEWL was reduced by 27% when the skin was treated twice daily with 2% niacinamide for 4 weeks.	Fatty acid levels were increased by 67% and ceramides by 34%.
Technical information from supplier, data on file 2025).	

Niacinamide helps to keep the skin hydrated and normalise the skin by balancing ceramide and fatty acids in the stratum corneum.

#Niacinamide

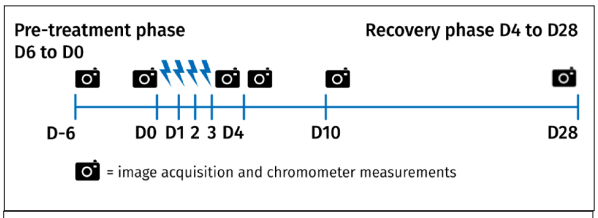
Protective effect of Niacinamide in cells exposed to environmental stressors

Niacinamide exhibited a protective effect against UVA- and / or UVB-induced DNA damage in normal human epidermal melanocytes. This effect was associated with the enhanced expression of nucleotide excision repair genes, such as sirtuin-1 (SIRT-1), and tumour suppressor protein p53.

Niacinamide is considered to be a blue light skin protection.
Blue light increases oxidative stress in the skin by inducing ROS. ROS can damage proteins and lipids. Niacinamide is able to inhibit the generation of ROS, the oxidation of lipids, proteins, and DNA, cell membrane depolarisation, and the apoptosis in human keratinocyte cells exposed to particulate matter (PM) 2.5. **Niacinamide offers protection from damage caused by urban pollutants.**

These studies may suggest that the topical application of niacinamide may alleviate oxidative stress and reduce cytotoxicity, inflammation, and pigmentation in the skin that is exposed to UV or PM. [1]

Niacinamide blue-light *in vivo* study (from raw material supplier)
33 female subjects (on average around 32 years old); 55% Caucasian, 18% Asian, and 27% mixed-ethnicity with phototype III and IV participated in a randomised double-blind study with placebo. The subjects applied a 3% Niacinamide cream formulation (without a sun filter) on the forearm, once a day, for 34 days (application started 6 days before blue light exposure to strengthen the skin). Exposition for 4 consecutive days on the forearm with an LED lamp at 450nm with 60J/cm^2 (the natural dose you get within one hour from European midsummer sun). Skin colour measurements were obtained by chromameter and image analysis.



Technical information from supplier, data on file 2025.

#Niacinamide

Image analysis results:

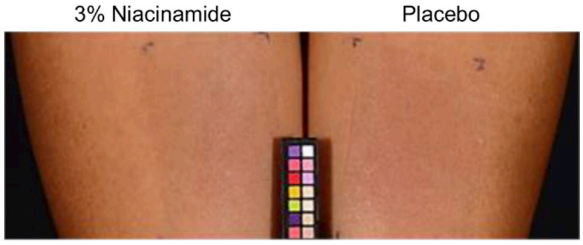
Niacinamide protects the skin from **oxidative stress** (free radicals **-48%**) *in vitro* and *ex vivo* as well as **protein damage** induced by blue light (**-48%**) *ex vivo*.

In clinical trials: Niacinamide reduced **hyperpigmentation** (**-23%**) and **redness** (**-25%**) generated by blue light exposure.

Chromameter results:

Niacinamide has proven to be effective against hyperpigmentation:

- Highly significant skin darkening after 4 days blue light irradiation.
- Immediate reduction of skin pigment darkening with Niacinamide.



Volunteer 20 - ITA° - left forearm with placebo and right with 3% Niacinamide.

Technical information from supplier, data on file 2025.

#Niacinamide

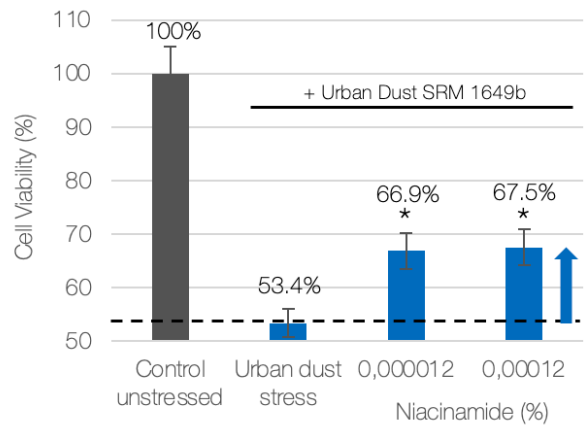
Niacinamide offers protection against pollution (from raw material supplier)

Niacinamide provides protection against urban pollutants damage for a beautiful and healthy skin.

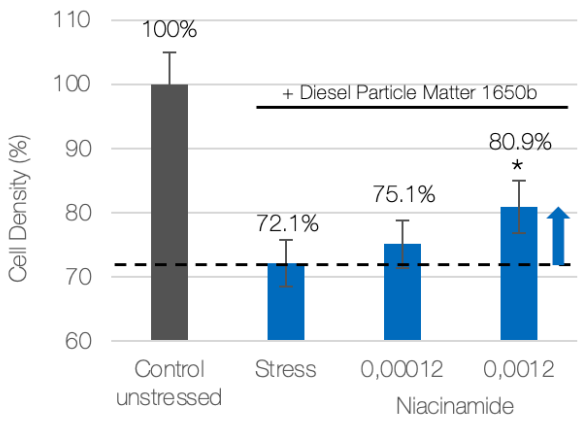
Niacinamide is the ideal candidate for urban pollution care as it:

- Strengthens the skin barrier.
- Rebalances uneven skin tone and reduces discolouration.

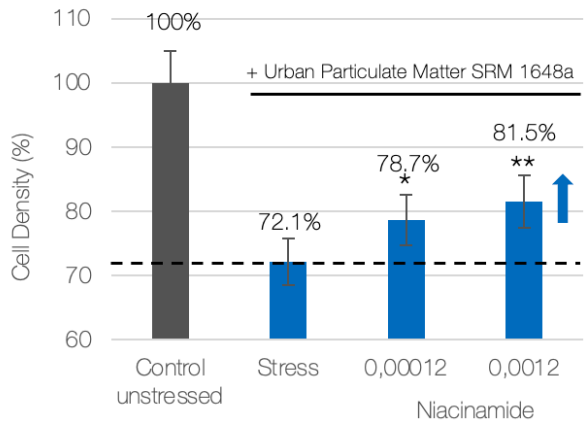
The protective effect of Niacinamide in the presence of urban particulate matter.



*p>0.05 and **p>0.01



*p>0.05 and **p>0.01



*p>0.05 and **p>0.01

Technical information from supplier, data on file 2025.

#Niacinamide

Niacinamide partially corrects cell viability even at very low concentrations.
Air pollution:

- Increases cell viability exposed to particulate matter (up to 81%) *in vitro*.

Water pollution:

- Enhances the repair of arsenic (water contamination) + UV induced DNA damage.

Antioxidant properties that helps prevent lipid peroxidation and normalises reduced antioxidants and antioxidant-enzymes
Niacinamide increases the antioxidant capacity of the skin after topical application by increasing the reduced forms (NADPH), which have potent antioxidant properties. [6] Researchers demonstrated that niacinamide scavenged single oxygen and inhibited lipid peroxidation of rat liver microsomes induced by the photosensitised reaction of methylene blue irradiated with visible light in the presence of oxygen.[1]

Antisenescence effects of Niacinamide
Niacinamide modulates cell senescence as it prolongs the replicative lifespan of fibroblasts and retards senescence in human cells. Researchers observed that niacinamide reverses the ageing phenotypes in human diploid fibroblasts as evaluated by cell morphology, senescence-associated β-galactosidase activity, and cell replication potential, and tentatively attributed this action of niacinamide to the enhancement of histone acetyltransferase activity and subsequently altered gene expression. [1]

#Niacinamide

Effects of Niacinamide on collagen and the extracellular matrix

Various studies provide evidence that niacinamide has the action of promoting the synthesis of dermal collagen and inhibiting its degradation. Niacinamide and its derivatives have been shown to increase the expression of collagen (type I, III, and V), elastin, and fibrillin (1 and 2), and reduce MMP (1, 3, and 9) and elastase activity in non-irradiated and UVA-irradiated dermal fibroblasts. Niacinamide enhanced fibroblast collagen synthesis and cellular proliferation, thereby augmenting wound healing *in vitro*. Topical niacinamide improved tissue regeneration by increasing fibroblast proliferation, collagen synthesis, and vascularisation in skin wounds of Sprague Dawley rats. [1]

Niacinamide contributes to the reduction of hyperpigmentation

In melanocyte-keratinocyte co-culture, reconstituted skin tissue model, or live skin, niacinamide consistently decreased melanin content or pigmentation. Furthermore, niacinamide slowed the melanosome transfer from melanocytes to keratinocytes. This suggests that the interaction between melanocytes and keratinocytes is important in skin pigmentation and that niacinamide may affect melanocytes indirectly by primarily affecting keratinocytes. [1, 5, 6] Niacinamide blocks reversibly the transfer of melanosomes from melanocytes to keratinocytes by inhibiting keratinocyte factors. This distinguishes niacinamide from other 'lightening' substances that inhibit tyrosinase directly. [3]

#Niacinamide

Niacinamide helps to reduce skin yellowing (sallowness)

The yellowing of skin that comes with ageing may be a result of glycation of proteins in the skin called the Maillard reaction. The Maillard reaction is a spontaneous oxidative reaction between protein and sugar that results in cross-linked proteins (Amadori products) that are yellowish-brown in colour and are fluorescent. These proteins can accumulate in the skin matrix components, similar to collagen, in response to oxidative stress as we age. Published data shows a fivefold increase in collagen oxidation products in human skin from age 20 to 80. Since NADH and NADPH are antioxidants and their levels can be increased with niacinamide, a possible effect of topical niacinamide is inhibition of oxidative processes, such as protein oxidation, glycation, and the Maillard reaction, and hence the inhibition of skin yellowing. [6]

Niacinamide helps to reduce the overproduction of sebum

Excess sebum production is implicated as a factor for the pathogenesis of comedones and inflammatory lesions in acne. A double-blinded, placebo-controlled, randomised trial with 130 patients found that a 2% niacinamide moisturiser significantly reduced sebum secretion rates when compared to a placebo moisturiser. [4]

#Niacinamide

Niacinamide skin benefits

- Skin soothing properties.
  - helps to inhibit pro-inflammatory mediators.
  - helps to reduce erythema and blotchiness.
- Helps to reinforce skin barrier function.
  - helps to reduce trans epidermal water loss.
  - promotes ceramide production.
  - stimulates the production of keratin, filaggrin, and involucrin.
- Boosts barrier repair by stimulating collagen synthesis.
- Protective effect in cells exposed to environmental stressors.
  - offers protection against blue light induced oxidative stress.
  - protective effect against UVA- and / or UVB-induced DNA damage.
  - offers protection against damage caused by urban pollution.
- Reduces the appearance of fine lines and wrinkles.
  - antioxidant properties.
  - stimulates collagen synthesis in aged fibroblasts.
  - helps to delay cellular senescence.
- Contributes to a brighter, more youthful looking skin.
  - slows down melanosome transfer to keratinocytes to help reduce hyperpigmentation.
  - reduces skin sallowness.
- Sebostatic properties. Helps to improve enlarged pores.

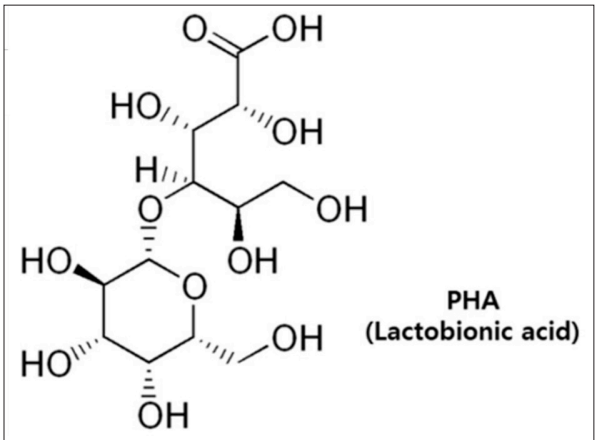
Niacinamide or the amide form of vitamin B^3.

#Lactobionic acid

What is Lactobionic acid?

Lactobionic acid (4-O-β-D-galactopyranosyl-D-gluconic acid), pKa 3.8, is a polyhydroxy bionic acid derived from lactose; it is comprised of one molecule of the sugar D-galactose and one molecule of D-gluconic acid (a polyhydroxy acid), attached via an acetal linkage. It is called a bionic acid owing to the attachment of a sugar unit (galactose) to the traditional polyhydroxy acid (gluconic acid) structure. [7]

Polyhydroxy acids (PHAs) are organic carboxylic acids with multiple hydroxyl groups. Many PHAs are also AHAs (alpha hydroxy acids); they are derived from carbohydrates and are important intermediates in carbohydrate metabolism. [8]



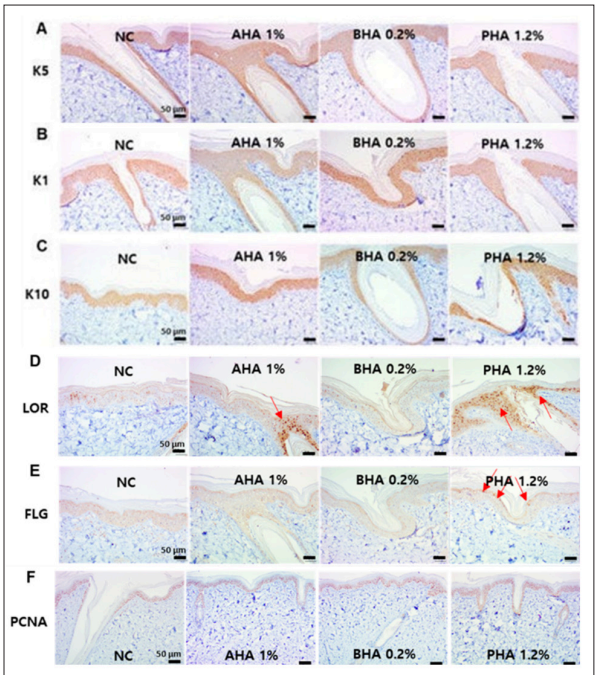
Chemical structure of Lactobionic acid. [8]

How does Lactobionic acid work in the skin?

The most important properties of lactobionic acid used in skin care include its chelating action, in consequence antioxidant activity, and its binding ability of significant amounts of water. [9]

<u>Lactobionic acid helps to improve skin barrier function</u>

Histological analysis in an *ex vivo* live full-thickness porcine skin model indicated that confirmed that the stratum corneum of the epidermis became well ordered without any damage with lower concentrations of PHA (lactobionic acid, 1.2%). TEWL measured on the 3rd and 7th days after treatment with hydroxyacids also confirmed the skin barrier-protective effects of PHAs. Of note, when PHA was applied, the expression of loricrin was greatly increased. PHA also increased the expression of filaggrin, claudin, and PCNA (proliferating cell nuclear antigen), supporting that improved skin barrier function following PHA treatment may stem from the enhancement of epidermal cell regeneration and skin barrier protein expression. Even when compared to other hydroxyacids, PHA showed the most remarkable effects on skin barrier function. [8]



Immunohistochemical staining of key protein components of the skin epidermis of *ex vivo* porcine skin with antibodies. The regions in which the expression of the specific protein is significantly higher than the negative control are indicated by red arrows. [8]

#Lactobionic acid

Hydroxyacids induce desquamation of the epidermis by enhancing the breakdown and reducing the cohesiveness of corneosomes. Hydroxyacids also increase epidermal cell renewal and epidermal enzyme activities, leading to epidermolysis and exfoliation. These effects of hydroxyacids ultimately result in the improvement of skin texture and coloration as well as clearing of the pores. In line with these reports, this study revealed that hydroxyacids improved the stratum corneum arrangement, increased basal cell proliferation and skin barrier protein expression. [8]

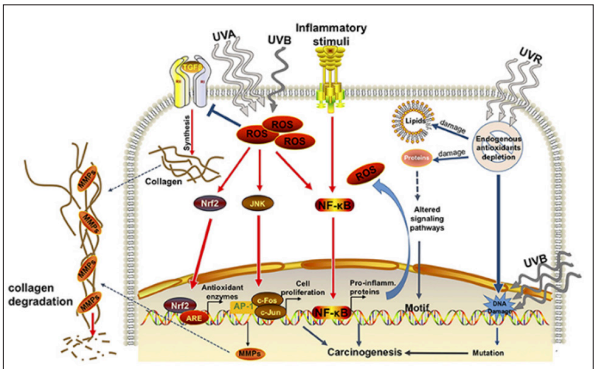
Antioxidant activity.

Lactobionic acid has a secondary antioxidant activity related to the excellent properties of chelating metal ions, mainly iron ions, and readily forms complexes with Fe^{2+} ions present in the body in the form of two important proteins: ferritin and hemosiderin. This will prevent the use of them in a competitive reaction with hydrogen peroxide known as the Fenton reaction, which forms the hydroxyl radicals responsible for ageing. In this manner, lactobionic acid inhibits the creation of most reactive free radicals in the skin. [9]

Another process that allows the formation of free radicals that adversely affect the skin condition is UV-induced lipid peroxidation. During sun exposure hydroxyl radicals are generated, leading to oxidation and consequently damaging poly-unsaturated fatty acids and other lipids. One of the significant steps in the process is the so-called pre-initiation, wherein lipid peroxides react with iron ions, producing another portion of free radicals that prevents muting of the chain reaction. Inhibition of lipid peroxidation based on the chelation of iron ions can especially protect cell membranes, rich in unsaturated fatty acids, and mitochondria from sun exposure damage. [9]

Skin hydration properties.

Lactobionic acid, a multifunctional ingredient, is a representative of PHAs (polyhydroxy acids) with strong antioxidant and skin moisturising activity. [11] It is also a strong humectant that softens the skin surface thereby reducing the appearance of fine wrinkles. [9]



Effects of solar ultraviolet radiation in skin. [10]

Simplified representation of the effects of UVR in epidermal keratinocytes. Exposure to UVR induces the formation of ROS. Increase in ROS causes the imbalance between pro-oxidants and antioxidants, generating oxidative stress, which in turn , damages lipids, proteins, and DNA.

This stresses the importance of having an antioxidant activity, helping to counteract the effects of ROS in the skin.

#Lactobionic acid

Promotes the reduction of skin ageing signs and improves skin elasticity.

Lactobionic acid is also an inhibitor of matrix metalloproteinases (MMPs) which are predominantly formed under the influence of UV radiation. MMPs are enzymes that contribute to the formation of ageing signs (i.e., wrinkles, flaccidity / laxity, and loss of skin elasticity) by causing the degradation of collagen and elastin fibres. Formation of complexes between the active forms of the metalloproteinases and lactobionic acid molecules blocks the activity of MMPs, which enables longer preservation of collagen fibres and thus improvement of skin elasticity. [9]

In vitro reduction of non-enzymatic glycation (information from raw material supplier)

Protein glycation is a process that occurs as part of the skin ageing process, caused by a non-enzymatic reaction between a reducing sugar and primary amino groups found on proteins such as collagen. These reactions, along with subsequent intermediates, can lead to gradual deterioration of collagen, which causes dermal inflexibility and accumulates over time.

Lactobionic acid at various concentrations (0.05%, 0.1%, 0.5%) was used in a study, with a known non-enzymatic glycation inhibitor, aminoguanidine, as the positive control. Results showed a significant ($p<0.05$) inhibitory effect on non-enzymatic glycation at 0.50% lactobionic acid. This result was similar to the positive control (at 0.01%).

Researchers hypothesised that this inhibitory effect may be part of the mechanism of action through which lactobionic acid helps to preserve skin elasticity and firmness.

#Lactobionic acid

The use of PHAs on photoaged skin in several skin phototypes has also been investigated; the results show that, in addition to several beneficial effects on skin physiology, PHAs elicit a significant skin lightening, although the mechanism by which that occurs has not yet been elucidated. [12]

Lactobionic acid helps to reduce hyperpigmentation (information from raw material supplier)

Lactobionic acid was tested for its melanogenesis inhibition effects in cultured B16 melanocytes. Sun exposure can stimulate melanin production that can lead to pigmentation irregularities. Inhibition of melanogenesis can therefore reduce unwanted or unplanned pigmentation. Tests were performed in the presence or absence of α-melanocyte stimulating hormone (MSH) analogue. Results showed that lactobionic acid is a moderate down-regulator of MSH-stimulated melanogenesis.

Lactobionic acid is less irritating to the skin compared to AHAs.

The size of the lactobionic acid molecule (molar mass 358 g/mol, volume 885.19 [Å] differs significantly from the size of glycolic acid and lactic monohydroxy acid molecules. This fact, like the higher hydrophilicity (log P -5) in the case of the mentioned compounds, makes the skin permeability of lactobionic acid lower. [9]

Lactobionic acid has a pKa close to that of other AHAs such as lactic and glycolic acid, of which the latter has a pKa of 3.80. Lactobionic acid maintains optimal bioavailability and relatively slow, though effective, penetration into the skin. It is beneficial for such a mechanism (slow / gradual-release) to limit the occurrence of severe skin irritation during treatments with lactobionic acid. [9]

#Lactobionic acid

Lactobionic acid skin benefits.

- Reinforces skin barrier function.
  - Enhances the expression of skin barrier proteins (loricrin, filaggrin, claudin, and proliferating cell nuclear antigen).
  - By promoting skin hydration due to its strong humectant properties. It also helps to reduce trans epidermal water loss.
  - Assists in increasing epidermal cell renewal.
  - Contributes to improve skin texture and tone.
  - Helps clear pores.
- Antioxidant properties.
  - Helps to inhibit MMPs thereby preserving collagen fibres and thus improving skin elasticity.
  - Promotes the chelation of metal ions.
  - Helps to protect against UV-induced oxidative stress.
- Age-reducing signs effect.
  - Helps improve photo-ageing.
  - Promotes increased skin firmness and elasticity.
  - Contributes to reduce fine lines and wrinkles.
- Skin brightening action.
  - Helps to reduce hyperpigmentation.
- Non-irritating: suitable for sensitive skin.

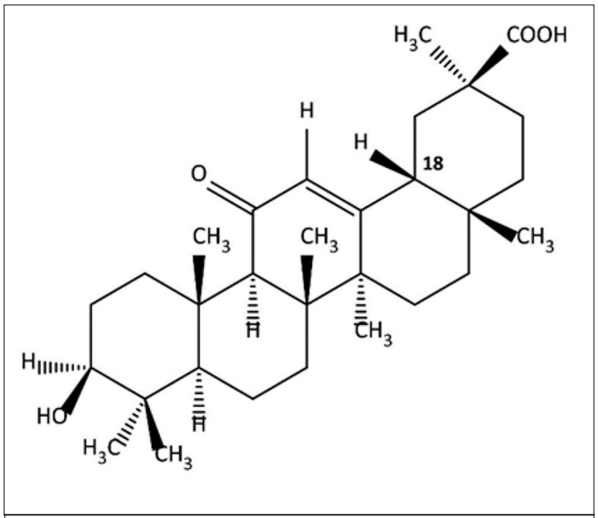
Lactobionic acid.

#Glycyrrhetinic acid

What is Glycyrrhetinic acid?

18β-Glycerrhetinic acid (INCI: Glycyrrhetinic acid) is obtained by hydrolysis of glycyrrhizic acid extracted from the roots of liquorice (*Glycyrrhiza glabra* L.). Liquorice, also known as Yashtimadhu, gancao, Grandfather Herb, and Sweetwood or yasti-madhu, is one of the most common herbs in Chinese herbal medicine, with a very long history of use. The herb is widespread, growing in southern Russia, central Asia, the Mediterranean region, northern China, and America. [13]

Glycyrrhizic acid, a triterpenoid saponin glycoside, is the major water-soluble constituent of liquorice root, while 18β-Glycyrrhetinic acid is the key metabolite of glycyrrhizic acid.[13]



Chemical structure of 18β-Glycyrrhetinic acid. [13]

How does Glycyrrhetinic acid work in the skin?

Described anti-inflammatory properties playing a role in *inflammageing* and helping to soothe the skin

Glycyrrhetinic acid exhibits anti-inflammatory activity by suppressing the expression of pro-inflammatory genes, inhibiting the production of inflammatory cytokines, and influencing the transformation of arachidonic acid into pro-inflammatory leukotrienes. Glycyrrhetinic acid may reduce the expression of the pro-inflammatory proteins, nitric oxide synthase (iNOS), and cyclooxygenase (COX) through the inhibition of NF-$_K$B and PI3K activity. [13]

#Glycyrrhetinic acid

Antioxidant properties

Glycyrrhetinic acid can activate the intracellular antioxidant system by increasing the expression of the antioxidant enzyme HO-1. Antioxidant activity is generally directed towards inactivating the free radicals generated by UV light, inhibiting lipid peroxidation, and providing protection against UV radiation.

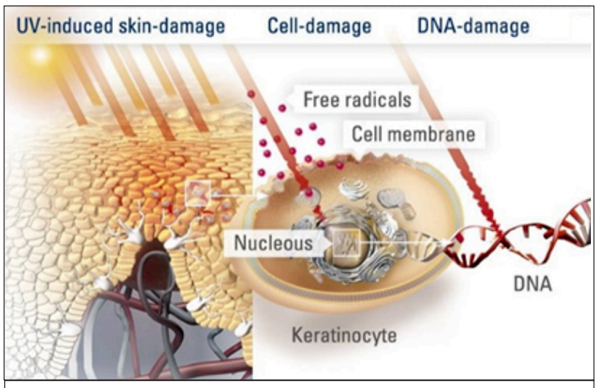
Glycyrrhetinic acid has been found to offer protection against UV-induced oxidative damage. A 10-week study on mice demonstrated that Glycyrrhetinic acid treatment increased the activities of key antioxidant enzymes, such as SOD (superoxide dismutase), and GSH-Px (glutathione peroxidase), while decreasing those of matrix metalloproteinases MMP-1 and MMP-3 and of various inflammatory cytokines, i.e., IL-6, TNF-α, and IL-10. [13]

Tyrosinase inhibiting properties that contribute to reduction in hyperpigmentation

Glycyrrhetinic acid is a known tyrosinase inhibitor and can reduce UVB-induced erythema and pigmentation when applied at topical concentrations of 0.5%. It is also known to facilitate brightening through melanin dispersion and accelerating epidermal turnover. [13]

Antimicrobial action

Glycyrrhetinic acid have been found to demonstrate substantial activity towards various bacterial strains, but not so much against fungi. [13]



UV-induced skin damage can result in DNA damage.

#Glycyrrhetinic acid

Glycyrrhetinic acid skin benefits

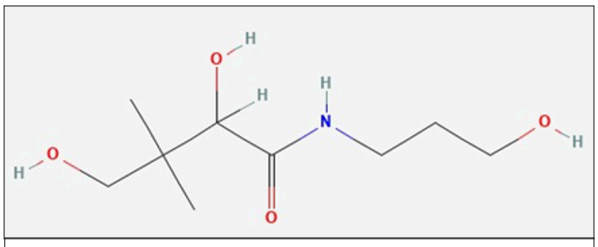
- Skin soothing action.
  - described anti-inflammatory properties.
  - helps to reduce UVB-induced erythema.
  - can suppress the expression of pro-inflammatory genes.
  - helps to inhibit the production of inflammatory cytokines.
  - influences the transformation of arachidonic acid into pro-inflammatory leukotrienes.
  - may reduce expression of pro-inflammatory proteins.
- Antioxidant properties.
  - can activate intracellular antioxidant system.
  - helps to inactivate free radicals generated by UV light.
  - contributes to inhibit lipid peroxidation.
  - assists in protecting against UV radiation.
- Helps to reduce hyperpigmentation.
  - tyrosinase inhibitor.
  - brightening action through melanin dispersion.
  - accelerates epidermal turnover.
- Antimicrobial properties.

18β-Glycerrhetinic acid.

#Panthenol

What is Panthenol?

Dexpanthenol (D-Panthenol) is the dextrorotatory isomer of panthenol, and only the dextro-form is biologically active. Panthenol (provitamin B^5) and pantothenic acid (vitamin B^5) have a similar structure, and the oxidation of panthenol produces pantothenic acid. Pantothenic acid is needed to synthesise coenzyme A (CoA), which plays a crucial role in the oxidation and synthesis of fatty acids. [14]



Chemical structure of Panthenol. [15]

D-Panthenol, pantothenic acid, and their derivatives, are regarded as safe by Cosmetic Ingredient Review, and D-Panthenol has been approved by the Food and Drug Administration and the European Commission on Cosmetics. [14]

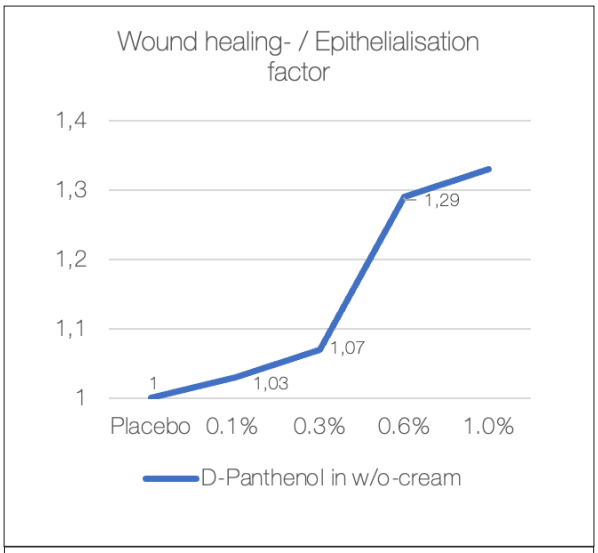
How does Panthenol work in the skin?

Since Panthenol is highly hygroscopic, it can penetrate easily into the skin and serve as a moisturiser or humectant to maintain the normal skin barrier properties, smoothness, and skin elasticity. Several *in vivo* and *in vitro* studies have shown that D-Panthenol promotes fibroblast proliferation, accelerates re-epithelialisation, moisturises the skin, restores the skin barrier, and heals wounds. [14]

<u>Panthenol helps to stimulate epithelialisation and promotes wound healing.</u>

Proliferation of fibroblasts is an important factor in wound healing; activation of fibroblast proliferation was observed both *in vitro* and *in vivo*. Several *in vitro* studies on human fibroblasts have demonstrated that the incubation of the cultures with pantothenic acid, or its derivatives, enhanced proliferation, cell migration, attachment of fibroblasts, and collagen synthesis. [16]

Weiser and Erlemann (1987) have shown, that even low concentrations of D-Panthenol have a positive influence on epithelialisation. The studies were carried out using a commercially available w/o-cream with varying concentrations of D-Panthenol.



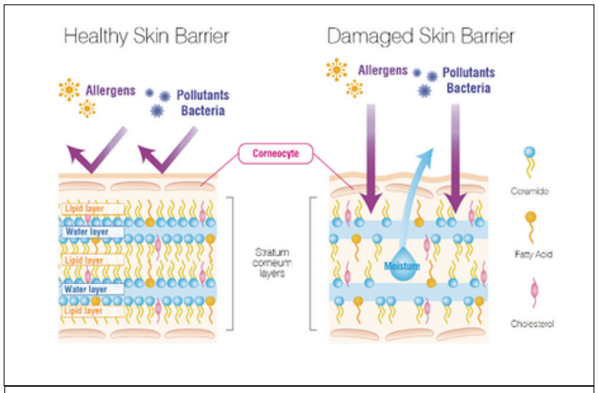
Technical information from supplier, data on file 2025.

#Panthenol

Effect of Panthenol on Skin Barrier Function

Due to its extremely hygroscopic characteristics, Panthenol provides notable humectant effects. Topical Panthenol improves skin hydration and reduces trans epidermal water loss (TEWL), thus maintaining the skin's smoothness and elasticity. The hydrating effect may be interrelated with its capacity to regenerate the epidermal barrier. [14]

- According to the evaluation of average moisture retention for 5 h, D-Panthenol mediates sustained tissue moisturising effects.
- In another clinical study, the effect of D-Panthenol cream on skin barrier repair significantly increased after sodium lauryl sulfate (SLS)-induced irritation. After application of D-Panthenol cream for seven days, the skin barrier function was restored. Significant differences were observed between D-Panthenol use and placebo treatment. [14]



Healthy versus damaged skin barrier function.

Panthenol has an anti-inflammatory effect and soothes irritated skin.

Panthenol skin benefits

- Promotes epithelialisation and wound healing.
  - Promotes fibroblast proliferation, migration, and attachment.
  - Helps to enhance collagen synthesis.
- Contributes to maintain skin barrier and helps to improve and increase the humidity properties of the skin (moisturising effect).
  - Helps to restore skin barrier function.
  - Contributes to the reduction in TEWL.
  - Humectant properties.
  - Moisturising action.
  - Assists in making dry skin softer and more elastic.
- Described anti-inflammatory effect contributes to soothe irritated skin.

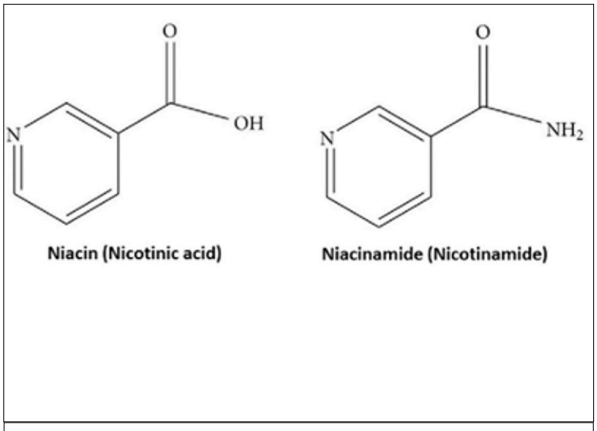
D-Panthenol or provitamin B^5.

#*Aloe barbadensis* leaf juice

What is *Aloe barbadensis* leaf juice?

Aloe vera is an herbaceous and perennial plant that belongs to the *Liliaceae* family and used for many medicinal purposes. It is traditionally used to improve skin integrity. Aloe vera is known for its anti-inflammatory, skin protection, antimicrobial, antiseptic, and wound healing properties. [17]

Aloe vera contains more than 75 different compounds, including vitamins (A, C, E, and B^{12}), enzymes (i.e. amylase, catalase, and peroxidase), minerals (i.e., zinc, copper, selenium, calcium), sugars (monosaccharides such as mannose-6-phosphate and polysaccharides such as glucomannans), anthraquinones (aloin and emodin), fatty acids (i.e., lupeol and campesterol), hormones (auxins and gibberellins), and others (i.e. salicylic acid, lignin, and saponins). [18]



Chemical structure of Aloe vera. [19]

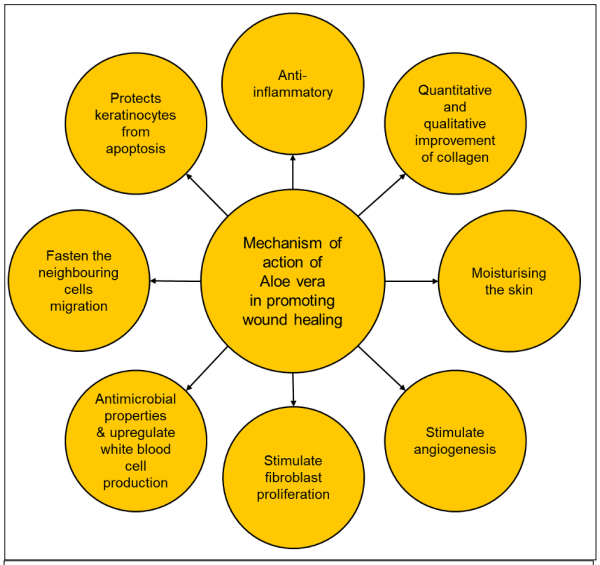
How does *Aloe barbadensis* leaf juice work in the skin?

Skin soothing effect of *Aloe barbadensis* leaf juice.

Aloe vera inhibits the cyclooxygenase pathway and reduces prostaglandin E_2 production from arachidonic acid. [20]

Healing properties of *Aloe barbadensis* leaf juice.

Glucomannan, a mannose-rich polysaccharide, and gibberellin, a growth hormone, interacts with growth factor receptors on the fibroblast, thereby stimulating its activity and proliferation, which in turn significantly increases collagen synthesis after topical aloe vera. Aloe vera not only increased collagen content of the wound but also changed collagen composition (more type III) and increased the degree of collagen cross linking. Due to this, it accelerated wound contraction and increased the breaking strength of resulting scar tissue. An increased synthesis of hyaluronic acid and dermatan sulfate in the granulation tissue of a healing wound following topical treatment has been reported. [18, 20]



Adapted mechanism of action of Aloe vera in promoting wound healing. [21]

#*Aloe barbadensis* leaf juice

Aloe barbadensis leaf juice has a moisturising effect and helps to reduce the signs of ageing.

The mucopolysaccharides help in binding moisture in the skin. Aloe vera stimulates fibroblasts which produce collagen and elastin fibres making the skin more elastic and reducing the appearance of fine lines and wrinkles. It also has cohesive effects on the superficial flaking of epidermal cells by sticking them together, which softens the skin. The amino acids also soften hardened skin cells and zinc acts as an astringent to tighten pores. [20]

Antioxidant properties of *Aloe barbadensis* leaf juice.

Antioxidants are compounds that prevent or slow down biomolecule oxidative damage caused by ROS through free radical scavenging, metal chelation, and enzyme regulation. The antioxidant activity of aloe vera is, at least in part, due to anthraquinones and related compounds which possesses peroxyl radical scavenging activity and reducing capacity. [18]

Effects on skin exposure to UV and gamma radiation.

Aloe vera has been reported to have a protective effect against radiation damage to the skin. The exact role is not known, but following the administration of aloe vera, an antioxidant protein, metallothionein, is generated in the skin, which scavenges hydroxyl radicals and prevents suppression of superoxide dismutase and glutathione peroxidase in the skin. It reduces the production and release of skin keratinocyte-derived immunosuppressive cytokines such as interleukin-10 (IL-10) and hence prevents UV-induced suppression of delayed type hypersensitivity. Likewise, it has been observed that aloe vera protected against X-radiation through antioxidant mechanisms (increased antioxidant enzyme activity and GSH content and reduced ROS production and lipid peroxidation). [18]

#*Aloe barbadensis* leaf juice

***Aloe barbadensis* leaf juice skin benefits**

- Skin soothing effect
- Promotes wound healing
- Contributing to skin barrier recovery due to its moisturising effect
  - Enhances skin hydration
  - Helps to reduce TEWL
- Helps reduce the signs of ageing
  - It stimulates fibroblast activity and proliferation
  - Promotes collagen synthesis
- Antioxidant properties
- Skin protective action

Aloe barbadensis leaf juice.

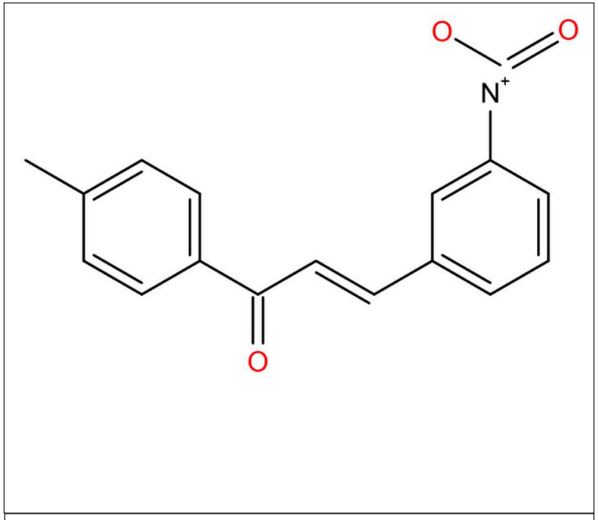
#Bisabolol

What is Bisabolol?

α-Bisabolol is one of the most important monocyclic sesquiterpenes, derived naturally from essential oils of many edible and ornamental plants. It was first obtained from *Matricaria chamomilla*, commonly known as chamomile or German chamomile. The available literature indicates that this plant along with other α-Bisabolol containing plants is popularly used in traditional medicine for potential health benefits and general wellbeing. [22]

Sesquiterpenes, a subclass of terpenes have been known for their wide range of biological functions including anti-infective, antioxidant, anti-inflammatory, and anticancer activities. α-Bisabolol has been used as a skin conditioning agent where it is integrated in many skin care formulations due to its skin soothing effects, well documented dermal absorption and the absence of dermal irritations or photosensitivity following its application. [22]

The bisabolol in the P.O.S.T. recovery cream is from synthetic origin and contains both (+) and (-)-α-bisabolol.



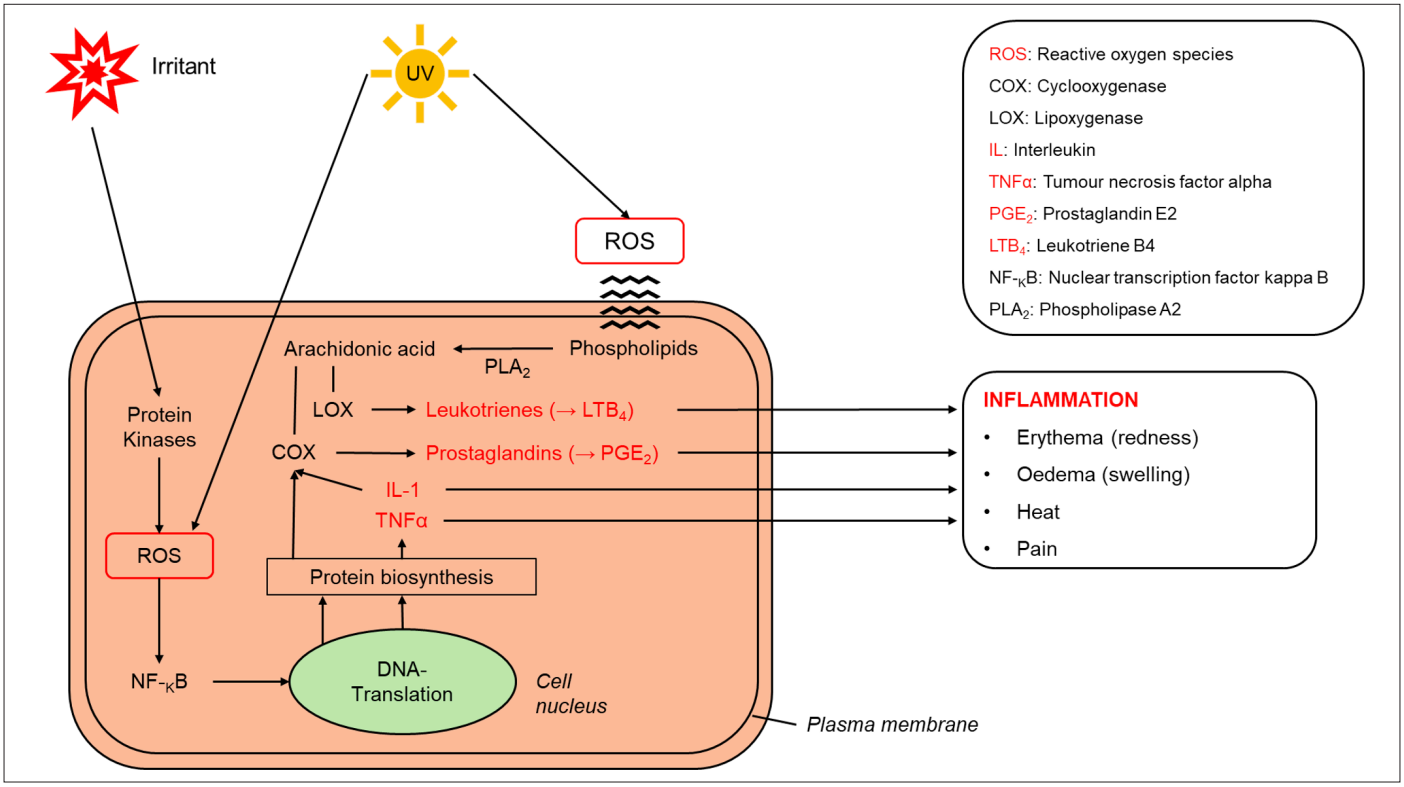
Chemical structure of α-bisabolol. [23]

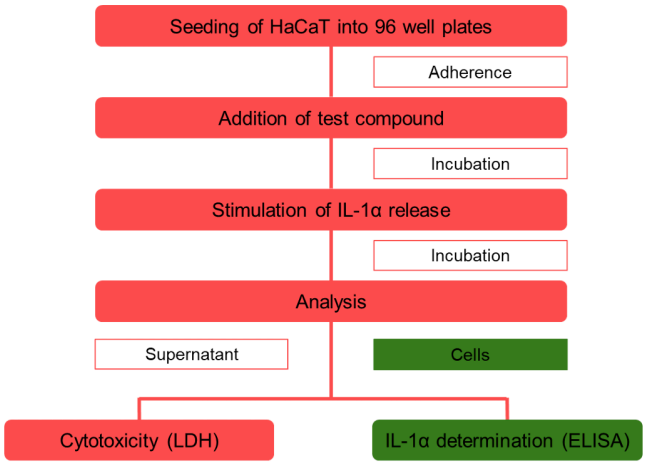
How does Bisabolol work in the skin?

Topical inflammation

- Causes
  - Physical damage
    - Temperature (heat or cold)
    - Irradiation (UVA and / or UVB)
    - Trauma (mechanical, including scratching)
  - Chemical or biochemical damage (e.g. detergents, soap)
  - Microorganisms, parasites or toxins
- Reaction
  - A dynamic cellular and vascular response to insult or injury
    - If regulated, it is beneficial and protective
    - If unregulated, it can cause tissue damage

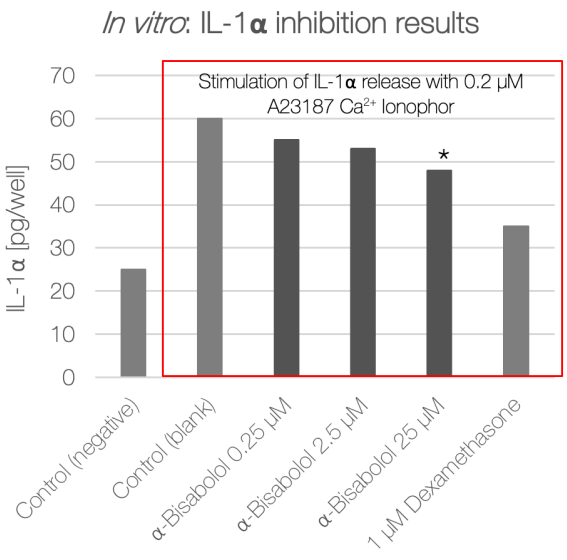
#Bisabolol





*HaCaT: Human immortalised keratinocytes

In vitro: IL-1α inhibition experimental setup.



* = > 25% reduction vs. control

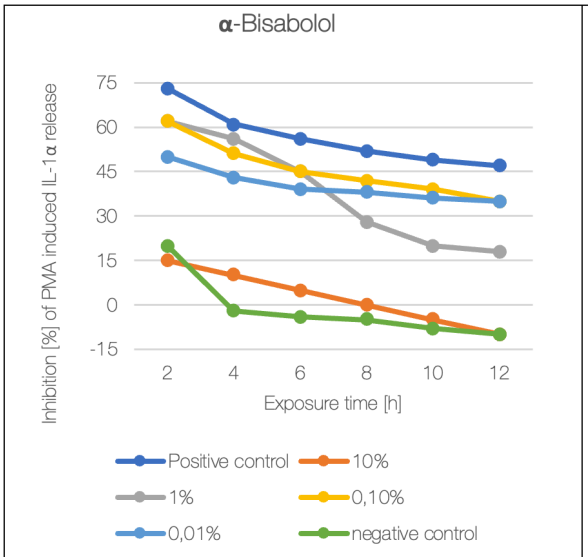
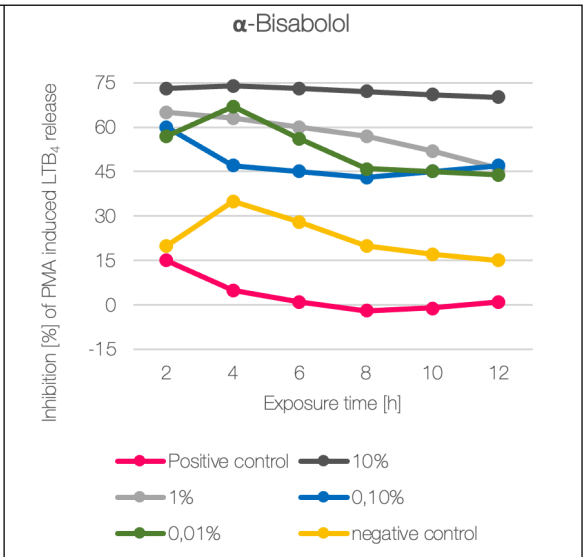
All anti-inflammatory data are mean values of at least 2 experiments.

Technical information from supplier, data on file 2025.

2. *In vitro*: IL-1α, LTB_4 inhibition

Experimental setup:

- SkinEthic (epidermis-like model based on cultures of keratinocytes from human foreskin on a polycarbonate filter).
- Irritant: PMA (Phorbol-12-myristate-13-acetate)
- Application area: 4 cm^2
- Incubated with test substances (topical application 2 mg/cm^2)
- IL-1α and Leukotriene B4 (LTB_4) release measured (ELISA)
- Cell viability verified with MTT assay
- Test substances:
  - α-Bisabolol → 0.01%, 0.1%, 1.0%, 10%
  -Indomethacin (positive control)
  -Sesame oil (negative control)

<table>
<tr>
<td> 
</td>
<td> 
</td>
</tr>
<tr>
<td>IL-1α inhibition SkinEthic® results:
• This test spans over a vast concentration range: 0.01 – 10%
• The efficacy of both products almost equals that of Indomethacin.
• Sesame oil, the carrier for products, appears to be an irritant itself.
• The overall efficacy is best around 0.1% for both Bisabolol qualities.</td>
<td>LTB_4 inhibition SkinEthic® results:
• This test spans over a vast concentration range: 0.01 – 10%
• Indomethacin is not truly a positive control for LTB_4 inhibition.
• Sesame oil, the carrier of the products, appears to be inhibitory itself.
• Both forms of α-Bisabolol are LTB_4 inhibitors.
• This result is in line with that reported by Ammon et al.:
- IC_{50} for LTB_4 inhibition: 30 µM/L = 0.02% (-)-α-Bisabolol.</td>
</tr>
<tr>
<td>α-Bisabolol is an effective inhibitor of IL-1α.</td>
<td>α-Bisabolol is an effective inhibitor of LTB_4.</td>
</tr>
<tr>
<td colspan="2">Technical information from supplier, data on file 2025.</td>
</tr>
</table>

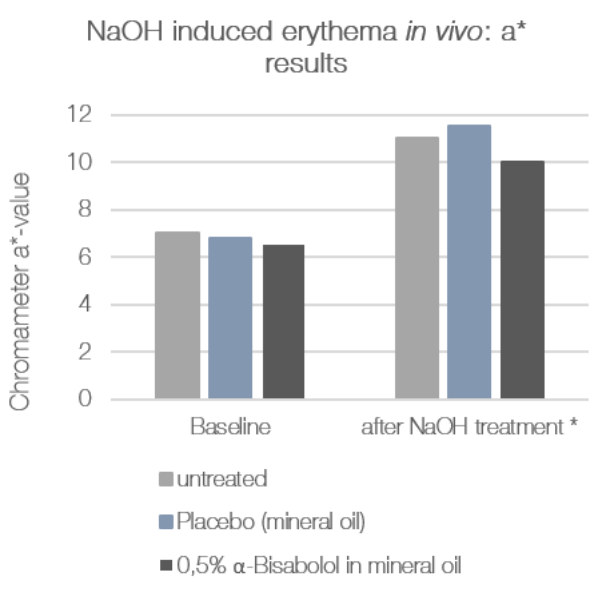
3. *In vivo*: NaOH induced erythema

Test protocol:

Test products:

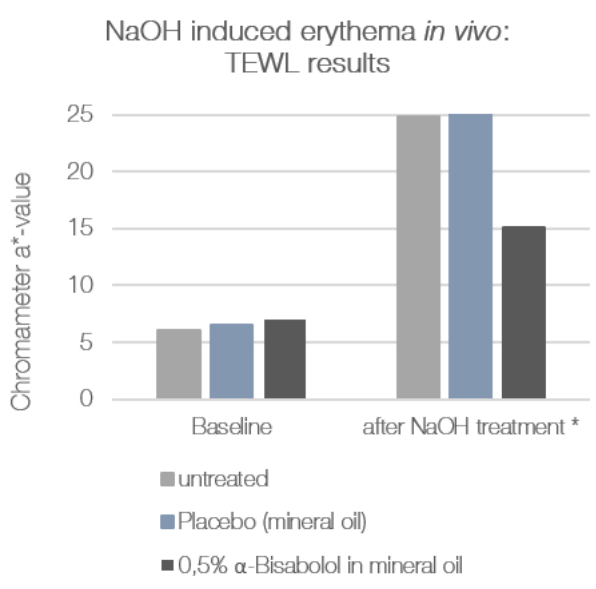
- mineral oil (placebo)
- mineral oil + 0.5% α-Bisabolol
- untreated

Subjects:	Number of individuals: 15 (pilot study)
Test area:	Inner sides of forearms
Application:	Products are applied once as pretreatment; 2h later: 50µl 0.1M NaOH for 12h under occlusion (untreated only 4h)
Evaluation:	Baseline and following 12 h NaOH exposure
Test parameter:	Skin redness (Chromameter a*-value), TEWL



*12h NaOH exposure for treated areas.

*4h NaOH exposure for untreated areas.



*12h NaOH exposure for treated areas.

*4h NaOH exposure for untreated areas.

Protective effect of α-Bisabolol against NaOH exposure.

Technical information from supplier, data on file 2025.

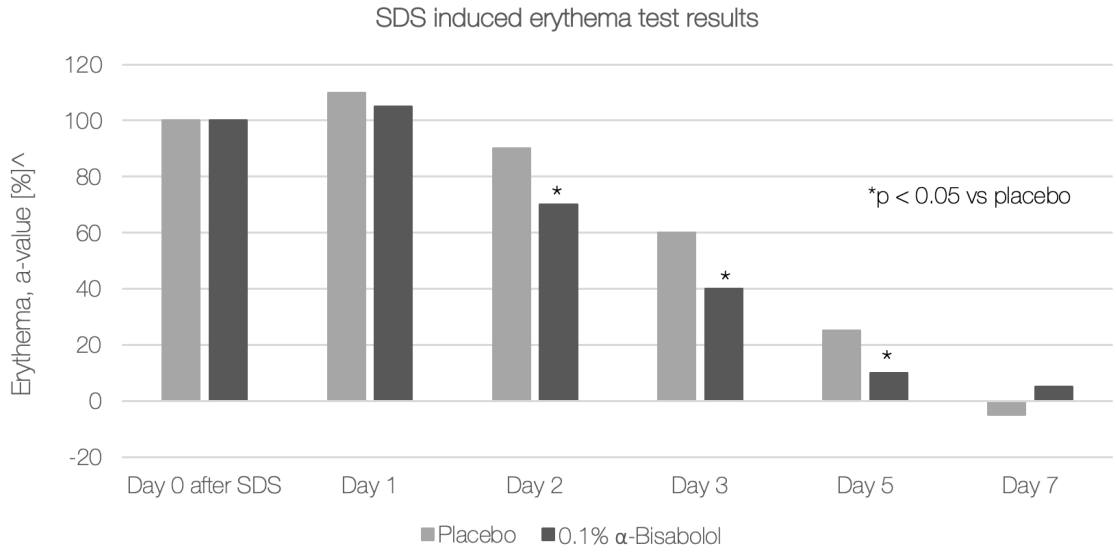
4. *In vivo*: SDS induced erythema

Test protocol:

Test products:

- Vehicle (placebo)
- vehicle + 0.1% α-Bisabolol

Subjects:	Number of individuals: 20
Test area:	Inner sides of forearms
Application:	4-6 h after SDS treatment, then for 7 days, twice daily (2 mg/cm^2)
Evaluation:	before treatment with SDS
	4-6 h after SDS treatment
	4-6 h after the last daily application on day 1, 2, 3, 5, and 7
Test parameter:	Skin redness



^ (SDS – baseline) = 100% erythema

Baseline = 0% erythema

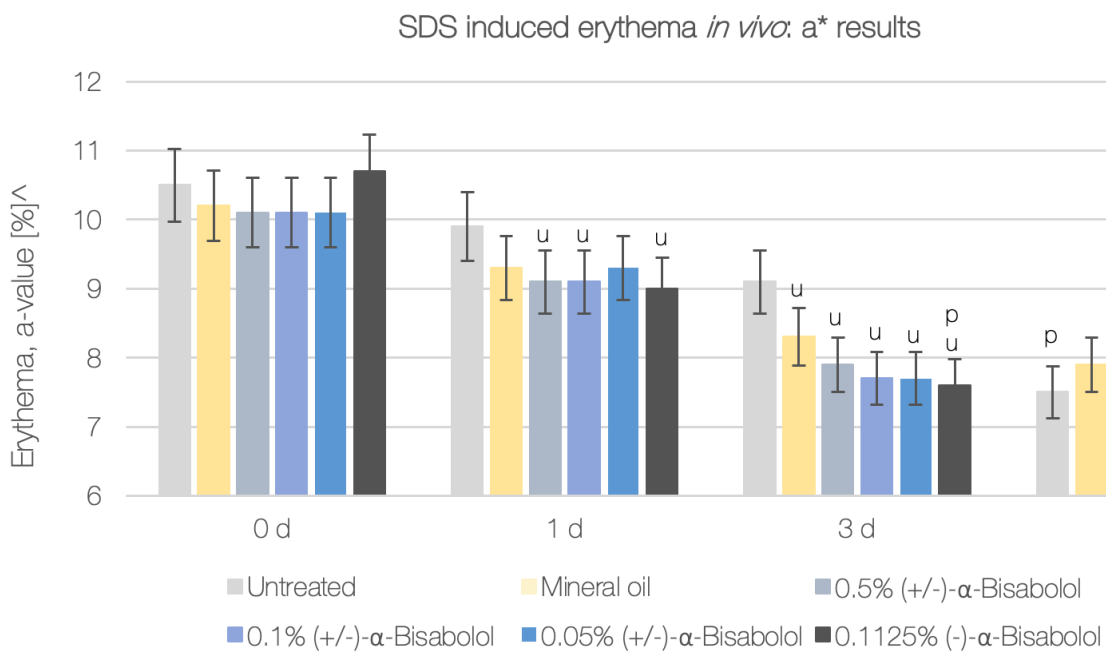
Erythema reduction after SDS treatment

Technical information from supplier, data on file 2025.

#Bisabolol

Test protocol:
Test products:
- Untreated
- Mineral oil (placebo)
- 0.5% (+/-)-α-Bisabolol in mineral oil
- 0.1% (+/-)-α-Bisabolol in mineral oil
- 0.05% (+/-)-α-Bisabolol in mineral oil
- 0.1125% (-)-α-Bisabolol in mineral oil

Subjects:	Number of individuals: 30
Test area:	Inner sides of forearms
Application:	2.5 h after SDS treatment, then for 5 days, twice daily (2 mg/cm^2)
Evaluation:	2 h after SDS treatment
	2 h after the last daily application on day 1, 3, and 5
Test parameter:	Skin redness



"u" = $p < 0.05$ vs untreated

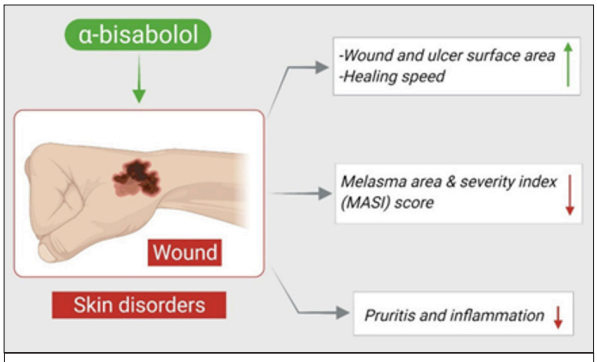
"p" = $p < 0.05$ vs placebo

Effectiveness of different α-Bisabolol concentrations on SDS-induced skin irritation.

Technical information from supplier, data on file 2025.

#Bisabolol skin benefits

Bisabolol has a wound healing effect.
α-Bisabolol has been demonstrated to promote the healing of wounds. [22]



Effects of α-Bisabolol on skin disorders. ↑: increase; ↓: decrease. [22]

Bisabolol skin benefits

- Excellent skin soothing activity.
  - Described anti-inflammatory properties.
  - Helps reduce irritation and sensitivity.
  - Contributes to the reduction in skin redness.
- Promotes wound healing.

Bisabolol. [24]

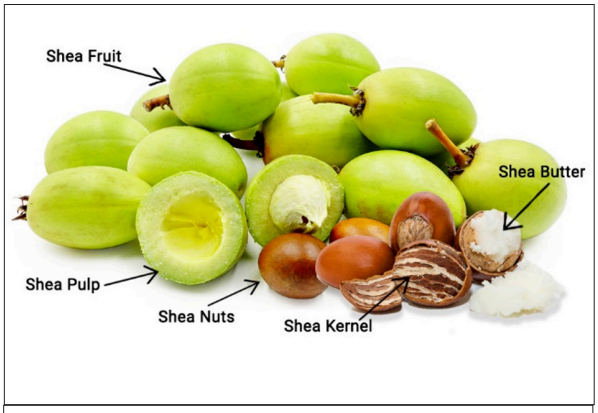
#*Butyrospermum parkii* (shea) butter

What is Shea butter?

Shea butter (*Butyrospermum Parkii*) is an off-white or ivory-coloured fat extracted from the nut of the African Shea tree (*Vitellaria paradoxa*). The Shea tree grows naturally in the wild of the dry savanna belt of West Africa, from Senegal in the West to Sudan in the East and onto the foothills of the Ethiopian mountains.

Shea butter is legendary for its use as a component in cosmetic formulations. Shea butter contains a saponifiable fraction rich in stearic and oleic acids and to a lesser amount palmitic, linoleic, and arachidic acids. The unsaponifiable fraction contains bioactive substances that are responsible for Shea butter's medicinal properties.

Although, the Shea nut is distantly related to the Brazil nut which cross-reacts with almond, hazelnut, walnut, and peanut, there are no reports of an allergic reaction relating to the topical or oral use of Shea butter and is therefore considered safe for individuals with a nut allergy. [25, 26]



The various parts of the shea fruit.

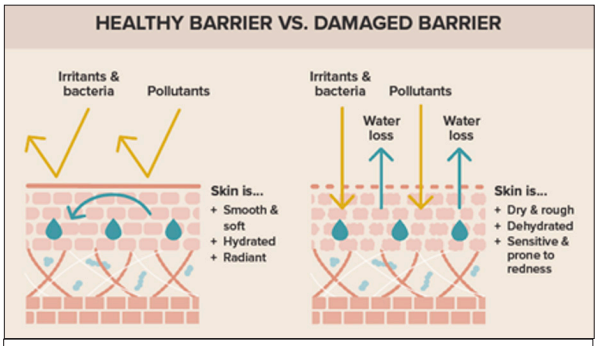
How does Shea butter work in the skin?

Shea butter promotes skin barrier recovery due to emollient and moisturising properties

Shea butter melts at body temperature, has good water-binding properties and absorb rapidly into the skin. [25] Shea butter has shown to be more effective compared to mineral oil at preventing trans epidermal water loss (TEWL). In a test where participants' arms were washed in ethanol, it was found that Shea butter was able to help the skin recover from TEWL within two hours. [26]

Shea butter's skin soothing properties

The skin soothing properties of Shea butter have been noted through inhibition of iNOS, COX-2, and Cytokines via the NF-$_K$B pathway in Lps-Activated J774 Macrophage cells. Further studies have also indicated that Shea butter may reduce reaction to skin irritants. [26]



The importance of a healthy skin barrier [27]

#*Butyrospermum parkii* (shea) butter

Shea butter skin benefits

- Skin barrier recovery:
  - Emollient and skin conditioning properties
  - Helps to reduce trans epidermal water loss
  - Contributes to skin hydration levels
  - Provides short- and long-term hydration
  - Water-binding properties which contributes to the reduction of trans epidermal water loss
- Soothing activity
  - May help to soothe and soften the skin
- Antioxidant properties

Shea butter. [28]

#*Prunus amygdalus dulcis* (sweet almond) oil

What is *Prunus amygdalus dulcis* (sweet almond) oil?
The almond tree is a deciduous tree from the *Rosaceae* family. The seed, commonly known as sweet almond, is edible. Sweet almonds are native to temperate and desert areas in the west of Asia, wherefrom it gradually spread to the warm and dry areas in the Mediterranean basin. Sweet almond oil is obtained by cold pressing of the fruits of *Prunus amygdalus* Stokes var. *dulcis* DC. More than 90% of the fatty acids are unsaturated (oleic and linoleic). The unsaponifiable fraction, which usually amounts to 0.7% of the almond oil, is mainly composed of squalane, tocopherol, and phytosterols.

Sweet almond oil. [29]

Sweet almonds have been traditionally used for different preparations, including pharmaceutical and cosmetic applications. Almonds are used to treat skin affections and almond oil is used to heal superficial skin burns, dermatosis, and dry skin.

How does *Prunus amygdalus dulcis* (sweet almond) oil work in the skin?
Sweet almond oil has skin barrier repairing activity.
Sweet almond oil is a clear, pale straw-coloured, odourless, and sweet tasted oil, with a high fatty acid content and emollient power, which favour restoration of the skin lipid balance. It is very well tolerated and therefore widely employed as an excipient, lubricant, sebum-restoring, and reepithelialisation agent.

The function of polyunsaturated fatty acids (PUFAs) in the regeneration of skin barrier function and skin hydration is well documented. Dry skin has been demonstrated to contain reduced linoleic acid amount, which suggests that this fatty acid is required for optimal barrier function. Polyunsaturated fatty acids, like linoleic acid, are considered essential for some functions, for example prostaglandin synthesis. It has also been proven that the ceramides present in the epidermis contains several fatty acid derivatives, 41% of them being linoleic acid (omega 6).

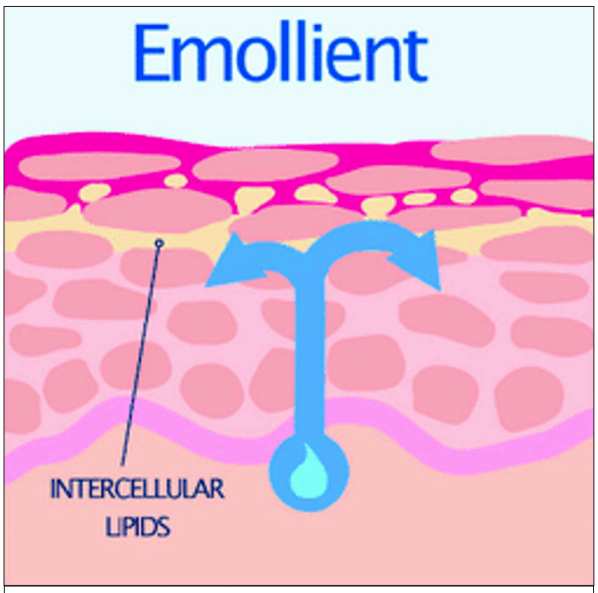
#*Prunus amygdalus dulcis* (sweet almond) oil

Additionally, oleic acid has been found to improve transportation of PUFAs into skin as it promotes skin penetration through a mechanism including softening of the stratum corneum. Polyunsaturated fatty acids or physiological lipids, locally applied, may reach lower skin layers thus enhancing the skin's barrier properties.

Further research shows that increasing the levels of these essential fatty acids in the skin enhances the production of beneficial eicosanoids. The balance between the different eicosanoids is critical for maintaining healthy skin barrier structure and function as well as skin homeostasis. In addition, these fatty acids are useful as a vehicle for active ingredients because they increase the penetration of the active ingredients.

The unsaponifiable fraction – mainly composed of squalane, tocopherol, and phytosterols (mainly sitosterol, campesterol, and stigmasterol) – supplies the skin with highly nutritious substances. Topic applications of vegetal unsaponifiable fractions on dermal connective tissue, improves skin tonicity and flexibility.

Therefore, sweet almond oil is highly recommendable to formulate in skin care products with moisturising and emollient activities.



The mechanism of action of moisturisers. [30]

Emollients stimulate the intracellular bilayers of the stratum corneum. They improve the 'feel' of the skin by filling the spaces in between corneocytes and imparts a sense of softness and plasticity to the skin. It also helps to improve the overall appearance and texture of the skin.

#*Prunus amygdalus dulcis* (sweet almond) oil

***Prunus amygdalus dulcis* (sweet almond) oil skin benefits.**

- Promotes skin barrier function.
  - Emollient power, favouring restoration of the skin lipid balance.
  - Moisturising action.
  - Reduces trans epidermal water loss.
- Re-epithelialisation agent with emollient activity.
  - Imparts a sense of softness and plasticity to the skin.
  - Helps improve the overall appearance and texture of the skin.
- Antioxidant properties.

Sweet almond oil.

#*Gossypium herbaceum* (cotton) seed oil

What is *Gossypium herbaceum* (cotton) seed oil?
Cotton species belong to the *Gossypium* genus, with around 40 species of shrubs of the *Malvaceae* family. Cotton (*Gossypium herbaceum*) seed oil is a high-quality refined vegetable oil taken from the seeds of the cotton plant. It is light in colour and nearly odourless.

Cottonseed oil is used for its excellent skin conditioning and emollient effects. Thanks to the high content of the essential fatty acid, linoleic acid, *Gossypium herbaceum* seed oil is the ideal ingredient for skin care applications. [31]

Cotton seed oil.

How does *Gossypium herbaceum* (cotton) seed oil work in the skin?
Information from the raw material supplier indicates that the activity on the skin is caused by the content of carbohydrates and proteins found in cotton seeds.

- Cotton seeds contain carbohydrates. These compounds have the capacity to absorb and retain water under certain conditions. Some carbohydrates can remain on the stratum corneum surface, acting as moistening and filmogenic substances that considerably improve biomechanical properties of the skin.
- Cotton seeds are rich in amino acids. Researchers have found that the hydrolysed protein component caused a significant increase in the immediate extensibility (Ue) of the skin. Two high molecular weight proteins were also incorporated in an aqueous solution and showed a significant decrease in Ue (immediate extensibility, which reflects the elastic properties of the skin) during the treatment period. This was attributed to the fact that these proteins formed a film on the skin surface that provided a tensing effect.

Cotton seed oil is obtained from *Gossypium* sp. seeds.

Therefore, cotton is recommended for the formulation of skin care products with a moisturising and conditioning effect on the skin.

#*Gossypium herbaceum* (cotton) seed oil

Gossypium herbaceum (cotton) seed oil promotes skin barrier function.

Topical application of *Gossypium herbaceum* seed oil rich in linoleic acid has been shown to restore the lipid barrier in humans suffering from essential fatty acid deficiency (EFAD) and impaired stratum corneum functions. Decreased susceptibility to skin xerosis in winter has also been demonstrated for these oils. In addition, linoleic acid is also regarded as a biological precursor of vital ceramides, which are shown to be essential for the barrier function of the skin. Consequently, topical application of triglycerides rich in linoleic fatty acids, such as cotton-seed oil, can improve the skin barrier function. [31]

Gossypium herbaceum (cotton) seed oil has antioxidant activity.

The level of natural tocopherols in refined cottonseed oil is 700-800 ppm, mainly α- and γ-tocopherols (alpha and gamma tocopherols). Tocopherols are the most essential lipid-soluble antioxidants in the cell membranes, acting by a free radical scavenging mechanism. [31, 32]

***Gossypium herbaceum* (cotton) seed oil skin benefits.**

- Promotes skin barrier function
  - Restorative action on skin barrier function
  - Moisturising effect
  - Promotes the synthesis of vital ceramides
- Antioxidant properties
- Emollient properties

Cotton (*Gossypium herbaceum*) seeds on the cotton plant. [31]

#Product summary

Neutral daily moisturiser

Soothes distressed skin

Ideal after treatments

Helps the skin to heal

Restores hydration balance

Boosts skin comfort

Promotes skin barrier recuperation

Protects against BL damage

#P.O.S.T. recovery cream

The importance of the skin barrier

Skin barrier integrity

- The importance of the skin barrier
- Components of the skin barrier
- Impaired skin barrier function

Re-epithelialisation / repair / wound healing

- Wound healing phases
- How skincare products contribute to skin repair / wound healing / re-epithelialisation

The effect of BL-exposure on healthy skin

Direct effects of BL

- ROS overproduction
- RNS overproduction
- Hyperpigmentation

Indirect effects of BL

Skin distress

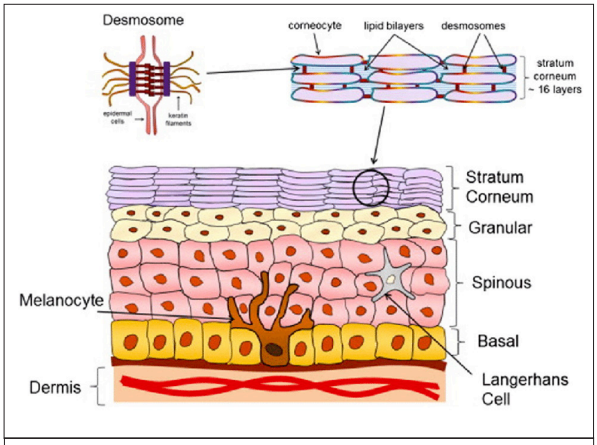
- Ageing signs: *inflammageing*
- Hyperpigmentation signs: PIH
- Acne-prone skin
- Redness skin: impaired skin barrier

#Skin barrier integrity

The importance of the skin barrier

The skin is a key organ, serving as a chemical, physical, and immune barrier between the internal milieu and the external environment. It serves as a permeability barrier to sustain terrestrial life, preventing excessive water loss, while protecting the body from various insults, from mechanical to microbial to oxidative. An intact barrier function of the skin is important in maintaining skin health. [33]

The outer layer of skin, the stratum corneum, is composed of anucleate corneocytes that are surrounded by lamellar bilayers composed of ceramides, fatty acids, and cholesterols, which all play roles in skin barrier function. For instance, the corneocytes contribute to mechanical integrity, mitigate ultraviolet radiation, and help regulate hydration, while the adjacent lamellar components form the permeability barrier, have antimicrobial properties, and counter free radical oxidation. In conjunction with these protective properties, the components of the skin barrier also contribute to downstream signalling (for instance, initiating an inflammatory response), and elements of the skin barrier can influence one another. As such, proper regulation of skin barrier components is essential, as dysregulation is implicated in multiple dermatologic conditions. [33]



The components of the epidermal skin barrier. [34]

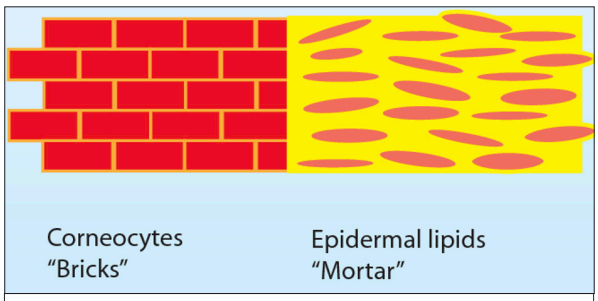
The outermost layer, the stratum corneum, is designed to be difficult to penetrate to protect from environmental insults. The granular, spinous, and basal layers of the viable epidermis are responsible for generating and renewing the stratum corneum and are involved in wound healing. The epidermis also contains Langerhans cells and melanocytes. The skin barrier provides innate immune functions.

Components of the skin barrier

The skin barrier can be divided into 4 types as physical, chemical, biochemical, and immunological barrier, and the stratum corneum has been reported as having an influence on simple barrier functions as well as the structure and functional roles of the living cell layers such as the epidermis and dermis. [35]

Brick-and-mortar model

The stratum corneum consists of corneocytes that crosslinked with lipids and proteins. An epidermal keratinocyte changes to a corneocyte through proliferation and final differentiation, and it desquamates as a result of protease existing in the stratum corneum, a process that generates various proteins and lipids. The most typical model used to explain the structure and function of the stratum corneum is the two-compartment model, which was explained as the 'brick-and-mortar' model. [35]



The brick-and-mortar pattern of the stratum corneum. [36]

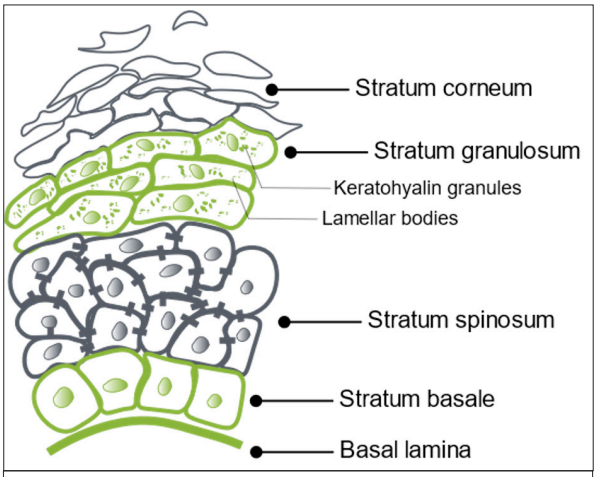
#Skin barrier integrity

The stratum corneum is characterised having a “brick-and-mortar” structure due to the long, flat, tile-like form of the corneocytes (bricks) and the inter-corneocyte lipids as the mortar. Also to consider in this model, is the corneodesmosomes, which are the protein structures connecting corneocytes, cornified envelope and cornified lipid envelope surrounding the corneocytes. Corneodesmosomes are representative components of the stratum corneum, which prevents fluids in the body from being lost and inhibits the penetration of harmful substances from the outside. [35]

Lamellar bodies, profilaggrin / filaggrin

Lamellar bodies formed on the Golgi apparatus include lipid components that will form inter-corneocyte lipids and various lysosomal enzymes that provide the catalytic action for hydrolysis of corneodesmosomes. The lipids include phospholipids, sphingomyelin, glucosylceramide and cholesterol and the enzymes include lipid hydrolase, lycosidase, protease, and acid phosphatase, helping to form the barrier function. [35]

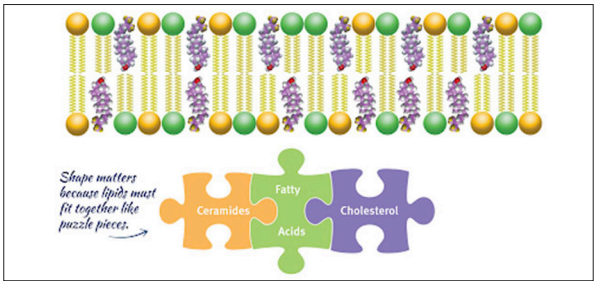
Lamellar bodies starts to appear from the top of the stratum spinosum and it exists most abundantly in the stratum granulosum, adhering to the cell envelope on the boundary between the stratum granulosum and stratum corneum and discharging lipids to the intercellular space through extracellular secretion. ω-Hydroxy-ceramides are included inside the lamellar bodies of the corneocyte lipid envelope. [35]



The layers of the epidermis showing the lamellar bodies. [37]

Lamellar membrane lipids and inter-corneocyte lipids

In sensitive, dry, and atopic skin, it is known that the function of the lipid envelope which is the skin barrier is often damaged. Generally, skin lipids which act as barriers refer to inter-corneocyte lipids and originate from lamellar bodies. Inter-corneocyte lipids are considered the mortar of the brick-and-mortar model and it accounts for approximately 10% of the mass of the stratum corneum. The skin barrier lipids consist of ceramide, cholesterol, and free fatty acids at a molecular ratio of 1:1:1, and the permeability barrier and antimicrobial barrier of the stratum corneum coexist. Sphingolipids which are typical skin barrier lipids and sphingolipid metabolite, sphingosine 1-phosphate, also provide the antimicrobial action. [35]

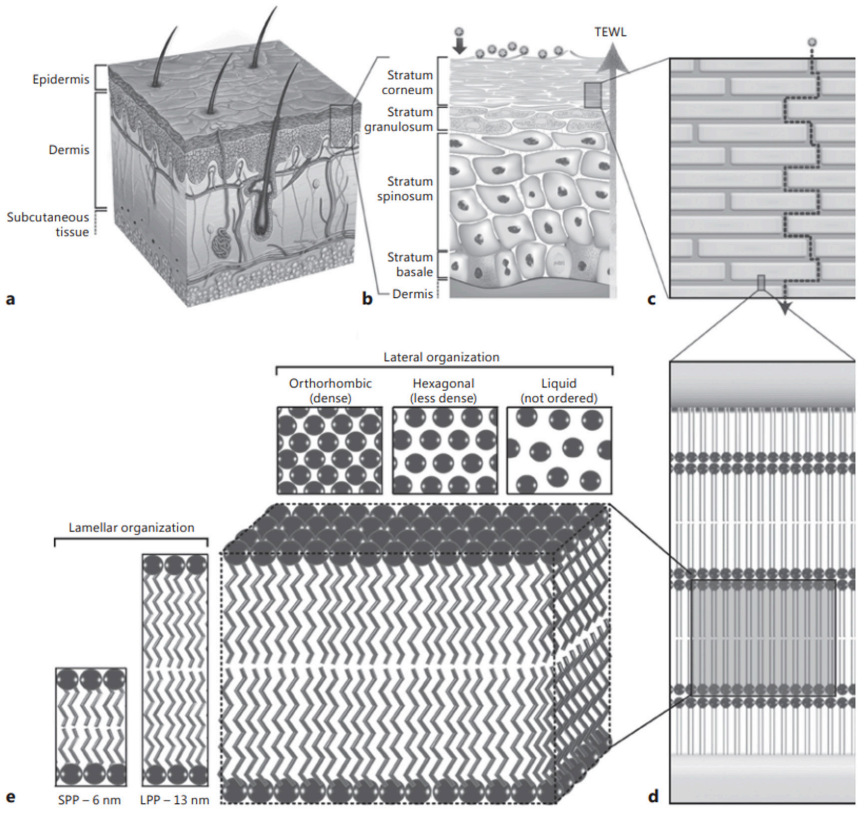


The skin barrier in 2 dimensions. [38]

The three main components of a well-functioning skin barrier are cholesterol, fatty acids, and ceramides. These are all types of fat (lipid) molecules that must be present in a specific ratio to keep the skin moist and healthy.

#Skin barrier integrity

It is considered that a functional change in the skin barrier of aged / mature skin results from abnormality in important lipid components that are necessary for the formation of the lamellar structure of the stratum corneum and the function of the skin barrier deteriorates accordingly. Important elements (moisture content of the stratum corneum, epidermal pH) that are vital for the maintenance and the basic functions of the skin barrier, are damaged and lipid synthesis are reduced so that total lipid content of the inter-corneocyte lipid envelope decreases. Inter-corneocyte lipids forms the lipid envelope in various layers called a lamellar structure, and in particular, the ceramide element is known to play an important role in the function of inter-corneocyte lipids. [35]



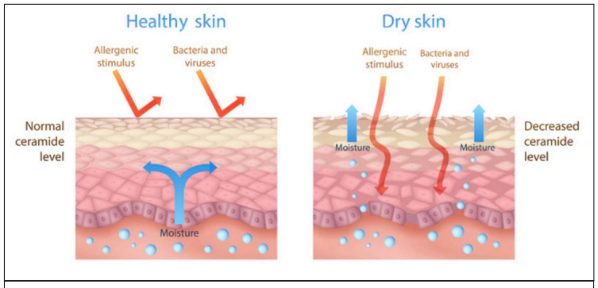
Explanation of the lipid organisation in the stratum corneum. [39]

A: Cross-section of the skin, B: zooming in on the epidermal tissue, in which the outermost skin layer, C: the stratum corneum, functions as a 'brick-and-mortar' barrier. It is suggested that pathogens penetrate into the deeper epidermal layers via the lipid matrix (intercellular; illustrated by the arrow). D: When focusing on this lipid matrix, one is able to distinguish the lipid lamellae: stacked lipid layers in a highly ordered, 3-dimensional structure. E: The lamellar organisation is characterised by an SPP and an LPP (long and short periodicity phases). Besides, stratum corneum lipids adopt a lateral organisation that can either be liquid, hexagonal, or orthorhombic.

#Skin barrier integrity

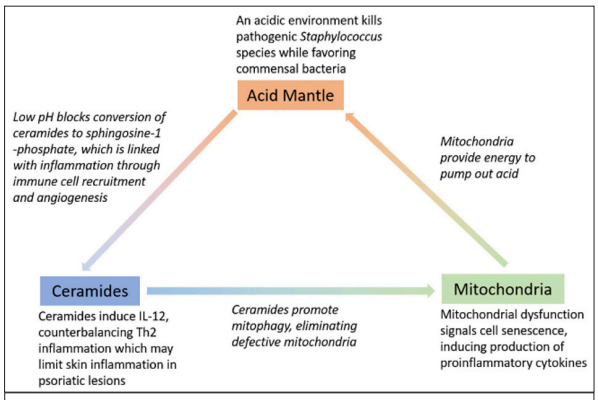
Ceramides

Stratum corneum lipids such as ceramides contribute to the barrier function of the epidermis, while also facilitating maintenance of the acid mantle. Stratum corneum lipids form a hydrophobic layer which, along with the tight junctions and desmosomes underlying the stratum corneum, prevent dehydration and retain water inside the skin. Ceramides, a derivative of sphingolipids, are a marker of stratum corneum lipids. Ceramides are composed of an acyl chain and a sphingoid base. The barrier function of the stratum corneum is determined by the different subclasses of ceramides, which can differ in the acyl chain, sphingoid base structure, length of sidechains, and other structural variations. [33]



Ceramides contributes to a healthy skin barrier. [40]

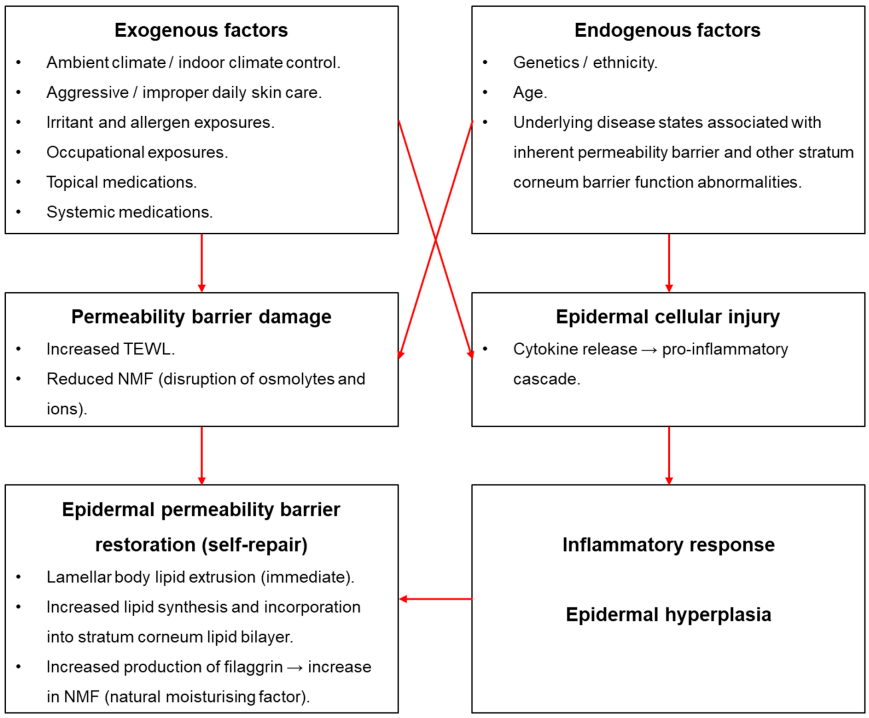
As lipids, ceramides constitute part of the physical skin barrier, contributing to the intercellular lamellar sheets in the stratum corneum. In this structure, ceramides help skin barrier health by repelling water, thus maintaining skin moisture by preventing water loss while also preventing skin irritation from outside substances. Additionally, ceramides promote mitophagy, eliminating abnormal mitochondria. Maintaining a healthy skin barrier requires intact mitochondria in all layers of the skin that produce the energy needed to pump out acid and maintain the acid mantle of the skin. [33]



Interplay between the acid mantle, ceramides, and mitochondria and their key roles in maintaining the skin barrier. [33]

Compromised skin barrier and impaired skin barrier function

Exogenous factors that can alter the integrity of the stratum corneum cause an increase in transepidermal water loss (TEWL) and alterations of stratum corneum proteins and lipids, progressively leading to compromised skin. Unless these factors are adequately countered by stratum corneum self-repair mechanisms and / or moisturisation, the stratum corneum becomes overstressed, with continued increased TEWL leading to incomplete desquamation, loss of skin elasticity, increased skin rigidity, and epidermal proliferation which can lead to hyperkeratosis. Exogenous factors that lead to increased TEWL and stratum corneum / epidermal barrier dysfunctions include improper skin care, exposure to cutaneous irritants, occupational exposures, application of certain topical agents, and low ambient humidity. [41]



Physiological adaptions of the stratum corneum in response to factors promoting desiccation (e.g., increase in transepidermal water loss, decrease in natural moisturising factor, damage or reduction in stratum corneum lipids, damage to stratum corneum proteins). [41]

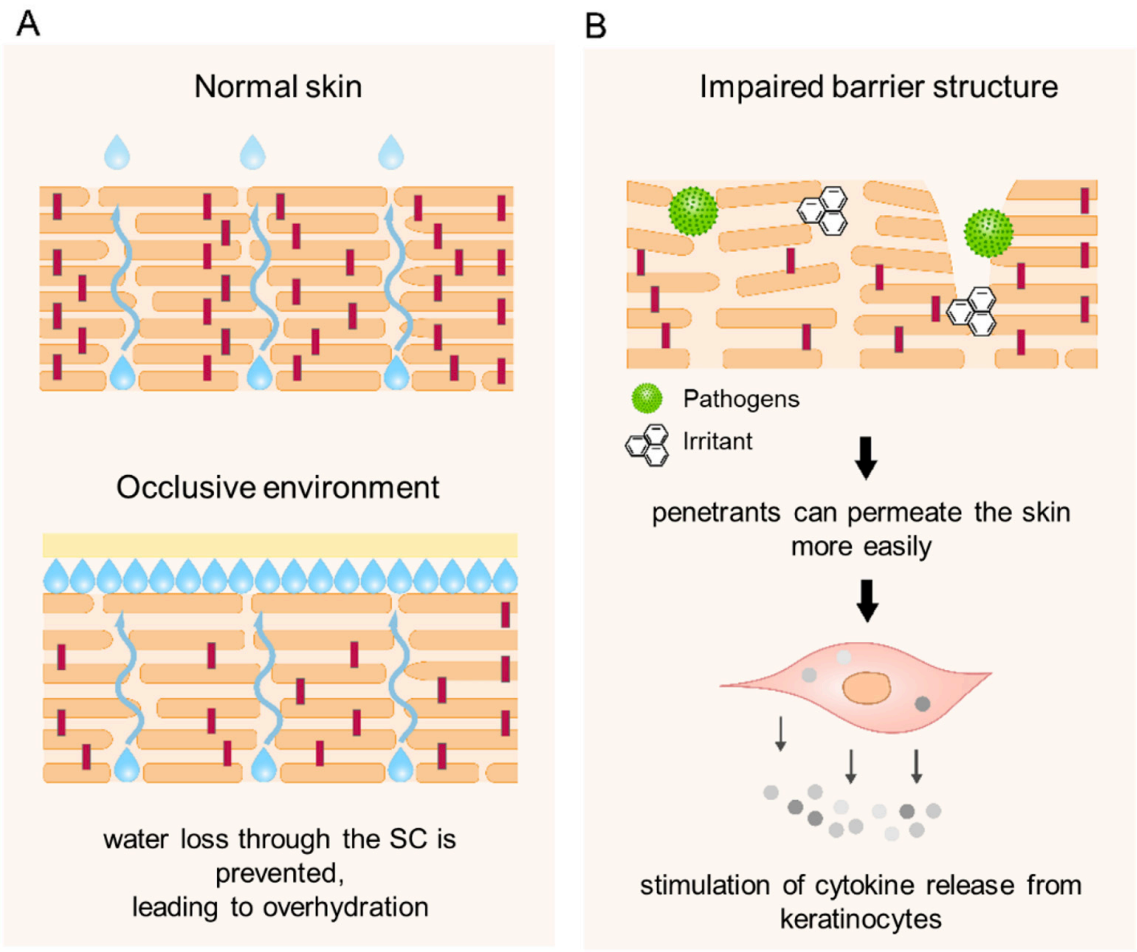
#Skin barrier integrity

When the skin barrier is under compromising conditions, cytokines such as tumour necrosis factor (TNF) and interleukin (IL), especially IL-1 and IL-6 are secreted at first. However, if the barrier damage persists and these cytokines rise chronically, it may cause an adverse result such as inflammation or proliferation. [35]

According to the skin dryness process, a 'cytokine cascade' is formed due to changes in the moisture inflow, overall ion distribution and secretion of various cytokines such as IL-1 on the stratum corneum during the epidermal damage / procedure aggression process. Also, as DNA synthesis increases, abnormal corneocyte proliferation occurs, causing inflammation and the barrier restoration such as secretion of lamellar body lipids or proliferation and / or biosynthesis of lipids also occurs due to epidermal barrier damage. Abnormal epidermal keratinocyte differentiation occurs due to the cytokine cascade and scale (flakiness) occurs due to incomplete desquamation of the damaged stratum corneum. This leads to a vicious circle of transepidermal water loss (TEWL) increase, decrease in moisture content of the stratum corneum, loss of epidermal NMF (natural moisturising factor) and enzyme denaturation of stratum corneum, making skin dryness worse. [35]

An interesting point is the fact that IL-4, IL-13, and IL-25 reduces keratinocyte's filaggrin synthesis, and this becomes important evidence for presenting the model that skin barrier damage induces an inflammatory response and the induced inflammatory response damages the skin barrier again. [35]

#Skin barrier integrity



Adapted illustration showing skin permeability disruption. [42]
(A) Normal skin versus skin within an occlusive environment.
(B) Impaired barrier structure leading to a 'cytokine cascade.'

#Skin barrier integrity

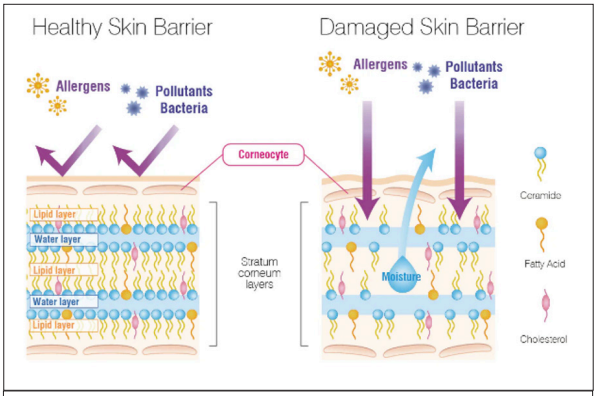
Re-epithelialisation / repair / wound healing

The integrity of the stratum corneum (SC) is the primary determinant of the skin's barrier function. As the skin is exposed to multiple exogenous factors that may lead to epidermal barrier impairment, the SC is continuously active in maintaining a functional physiologic state by resorting to a variety of self-repair mechanisms. [43]

Once transepidermal water loss (TEWL) is increased beyond the normal homeostatic level, multiple self-repair mechanisms are induced within the SC and at the granular zone transition layer of the epidermis. Initially, an inflammatory cascade triggers the release of tumour necrosis factor (TNF), interleukin (IL)-1, and IL-6, promoting keratinocyte hyperproliferation. This increased epidermal thickness aims to counter the excessive TEWL. [43]

Simultaneously, an increased synthesis of SC lipids is evoked, such as cholesterol and ceramides, and constituents of the natural moisturising factor (NMF), namely urea, pyrrolidone carboxylic acid, lactic acid, urocanic acid, and various amino acids, replenishing the SC structure. If these self-repair mechanisms fail, or do not meet the needs of the skin barrier, clinical signs are triggered, such as scaling and flaking, loss of elasticity, micro and macro fissures, and hyperkeratosis. [43]

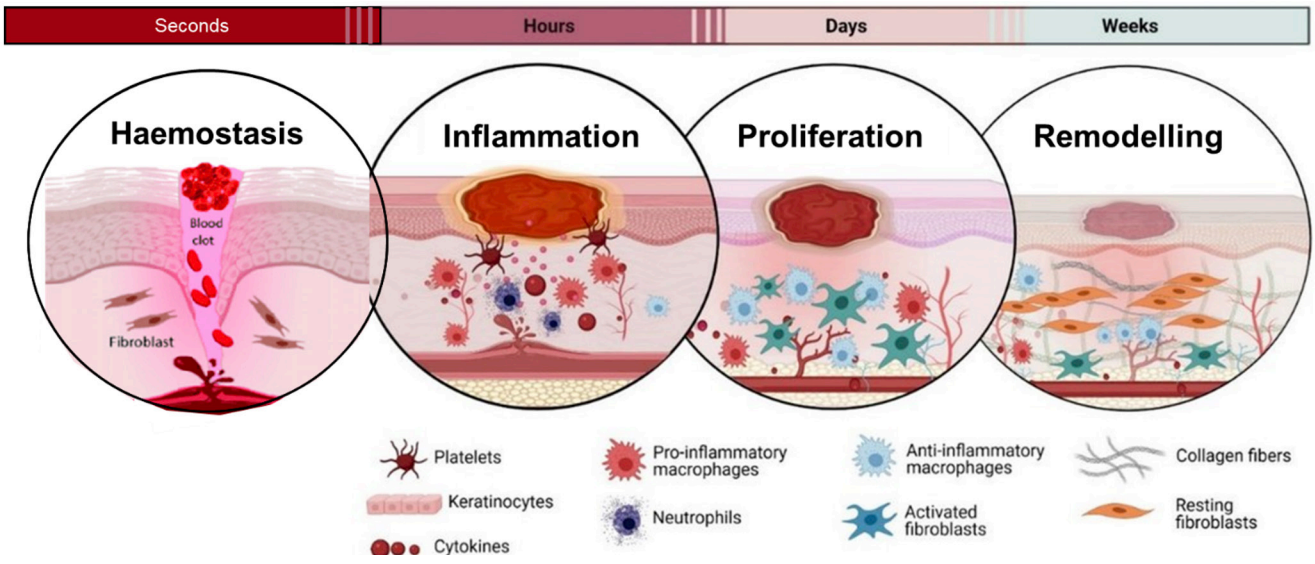
In addition to the epidermal barrier, skin injury can also affect the dermis. Wounds result from the disruption of the epidermis, dermis, and deep subcutaneous fat and blood vessels (full thickness wound), the epidermis and superficial dermis (partial thickness wound), or only the epidermis (superficial wound) due to thermal or physical damage, thus compromising the cohesiveness of the epithelium. [43]



The importance of barrier integrity.

Wound healing phases

Wound healing consists of a dynamic, interactive, and orchestrated process, involving four phases – haemostasis, inflammation, proliferation, and remodelling – that partially overlap with each other. Depending on the extent of the lesion this process may not always involve all phases. [43]



Adapted illustration of the wound healing phases. [44]

The timeline and overview of the healing phases also shows the involvement of the key cellular populations involved in the different phases.

1. Immediately after a trauma, if blood vessels are affected, platelet activation triggers fibrin production and subsequent clot formation, inducing a haemostatic effect (**haemostasis**).

2. An **inflammatory response** is readily initiated and, as a result of platelet degranulation and release of both chemotactic signals and bacterial degradation products, the innate immune system is activated, and neutrophils and monocytes are recruited to the wounded tissue. Monocytes differentiate into macrophages, inducing an active defence response against foreign bodies, as well as secretion of chemokines and growth factors.

3. The **proliferation phase** takes place within two to three days after the wound generation, when keratinocytes induce re-epithelialisation. Endothelial cells promote angiogenesis and fibroblasts begin to form new extracellular matrix.

4. Lastly, in the **remodelling phase**, the previous inflammatory processes are downregulated and substituted by events aiming to reorganise the connective tissue, initiating the contractile response. [43]

How does skincare products contribute to skin repair / wound healing / re-epithelialisation?

Substances with an active role in the **inflammatory** phase or in the remodelling phase are often incorporated into skincare formulations. They can act by neutralising free radical species or reducing pro-inflammatory mediators,

Soothing action: - Panthenol - Niacinamide - *Butyrospermum parkii* (shea) butter - *Aloe barbadensis* leaf juice - Glycyrrhetinic acid - Bisabolol	Antioxidant properties: - Niacinamide - Lactobionic acid - *Butyrospermum parkii* (shea) butter - Glycyrrhetinic acid - *Gossypium herbaceum* (cotton) seed oil

or in the **wound healing** (repair) or regeneration phase, either by improving collagen synthesis or inhibiting its degradation.

- Panthenol
- Niacinamide
- *Aloe barbadensis* leaf juice
- Bisabolol
- *Prunus amygdalus dulcis* (sweet almond) oil

#Skin barrier integrity

Skincare formulations can help **recover the impaired skin barrier** through 3 different mechanisms of action:

A. Increasing the moisture of the epidermal layer by their hygroscopic properties
B. Boosting the synthesis of structural proteins reducing the TEWL
C. Promoting the synthesis or replacement of key mortar lipids
Skincare formulations can further impact the damaged skin barrier namely through the improvement of skin hydration.

A) Hygroscopic substances (panthenol) that bind and retain water in the SC, therefore reducing TEWL.

- Panthenol
- *Butyrospermum parkii* (shea) butter
- *Gossypium herbaceum* (cotton) seed oil
- Lactobionic acid
- *Aloe barbadensis* leaf juice

B) Active ingredients that boost protein synthesis in the epidermis contributing to skin barrier recovery.

- Niacinamide
- Lactobionic acid

C) This moisturiser effect is provided by ingredients that boost the synthesis of skin structural lipids, restoring directly the skin barrier.

- Niacinamide
- *Prunus amygdalus dulcis* (sweet almond) oil
- *Gossypium herbaceum* (cotton) seed oil

Proper skin hydration provides flexibility, protecting it from damage and promoting the desquamation process, enabling activation of hydrolytic enzymes. [43]

#Skin barrier integrity

Therefore, P.O.S.T. recovery cream is the ideal product to repair, soothe, and moisturise the skin not only after controlled chemical skin resurfacing but also after advanced aesthetic procedures.

Versatile and multifunctional formulation

6 soothing molecules
7 molecules to recover skin barrier
5 molecules to heal / repair

Panthenol
Niacinamide
Shea butter
Aloe Vera
Glycyrrhetinic acid
Bisabolol

Panthenol
Niacinamide
Shea butter
Aloe Vera

Sweet almond oil
Cotton seed oil
Lactobionic acid

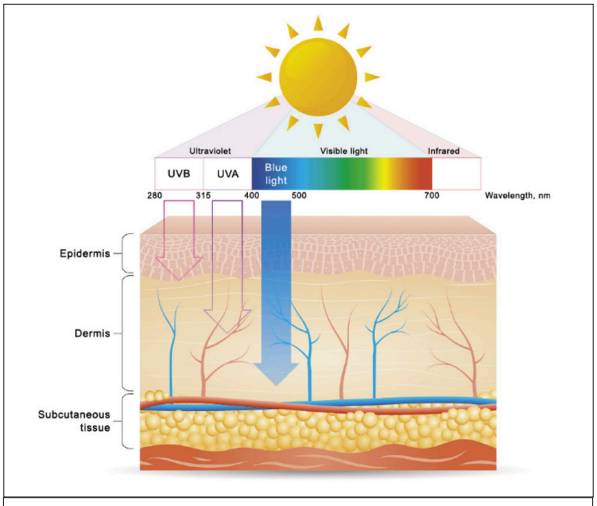
Panthenol
Niacinamide

Aloe Vera

Bisabolol
Sweet almond oil

The effect of blue-light exposure on healthy skin

Blue light is defined as light within the wavelength range of 400 nm (violet) to 500 nm (cyan). Blue light has lower energy than ultraviolet (UV) radiation (280-400 nm) and can reach further into the dermis, up to the depth of 1 mm. The sun is the main source of blue light, which is also emitted by electronic devices, such as computer monitors, flat-screen televisions, smartphones, tablets, and fluorescent light bulbs. Changing lifestyles, with less time spent outdoors and increased use of light-emitting diode (LED) and fluorescent lighting and electronic screens via smartphones, televisions, computer monitors, and laptops, have changed the pattern of blue light exposure in humans. [45]



Solar radiation spectrum and depth of skin penetration. [45]
UV: ultraviolet.

Direct effects of blue light exposure

Blue light exerts its direct effects on the skin by interacting with chromophores, in which it triggers a change from a ground state to an activated state. Chromophores responsible for the direct effects of blue light include flavins, porphyrins, nitrosated proteins, and opsins. Activation of these molecules results in overproduction of reactive oxygen species (ROS) and release of reactive nitrogen species, i.e., nitrogen monoxide (NO), and hyperpigmentation. [45]

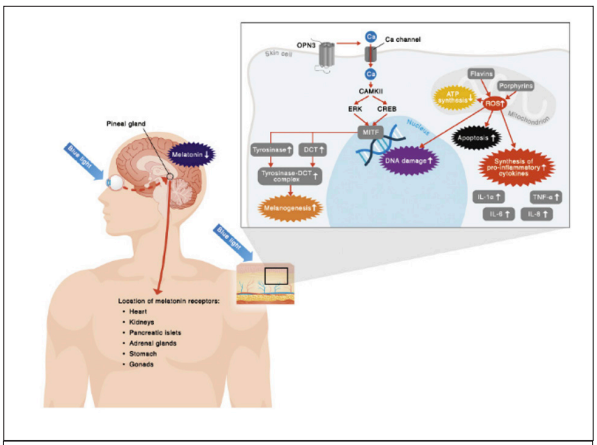
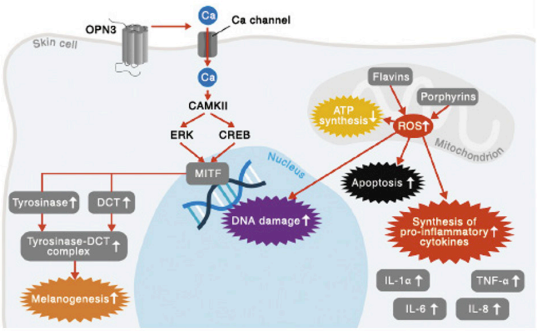


Diagram of cellular photoreceptors interacting with blue light and associated activated pathways. [45]

ATP: adenosine triphosphate
CAMKII: calcium/calmodulin-dependent protein kinase II
CREB: cyclic adenosine monophosphate (cAMP) response element-binding protein
DCT: dopachrome tautomerase
ERK: extracellular signal-regulated kinase
IL: interleukin
MITF: microphthalmia-associated transcription factor
OPN: opsin
ROS: reactive oxygen species
TNF: tumour necrosis factor.

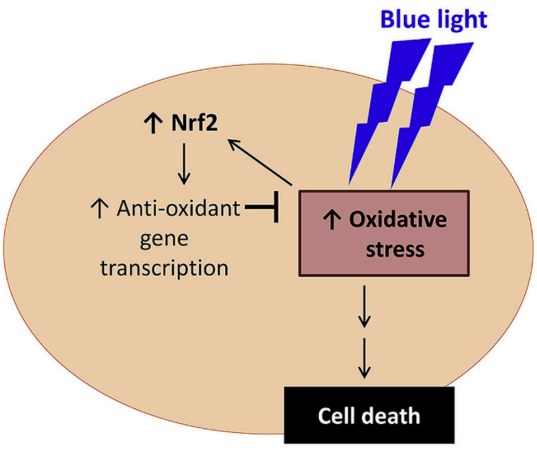
ROS overproduction

Multiple studies have shown that blue light exposure causes excessive ROS generation in cultured human keratinocytes and dermal fibroblasts in healthy human volunteers. They found that ROS generation was induced by radiation in the range between 360 and 470 nm, suggesting that blue light has a greater contribution to ROS generation from carbonylated proteins located in the stratum corneum than UV. In experiments on hairless mice, blue light delayed permeability barrier recovery and reduced the thickness of the lipid layer located between the stratum corneum and stratum granulosum. [45]



Adapted diagram showing blue light associated activated pathways (melanogenesis, DNA damage, cell death, and skin distress). [45]

Blue light-induced ROS overproduction is associated with decreased cell viability and / or cell proliferation, increased pro-inflammatory signalling, and disrupted collagen metabolism. Dermal fibroblasts exposed to blue light exhibited general metabolic inhibition, reduced adenosine triphosphate (ATP) synthesis, and reduced collagen lattice contractility. Studies showed that blue light suppressed proliferation in human keratinocytes by increasing the expression of the transient receptor potential vanilloid 1 (TRPV1) and downregulating the epidermal growth factor receptor (EGFR) / phosphoinositide 3-kinase (PI3K)) / AKT / forkhead box O3α (FOXO3α) pathway. They have also shown that blue light causes an increase in ROS and tumour necrosis factor-α (TNF-α). Blue light also suppressed the expression of *TP73*, a gene involved in proliferation, in primary human keratinocytes and melanocytes. In addition to ROS overproduction, blue light irradiation increased the levels of pro-inflammatory cytokines, interleukin (IL)-1α, IL-6, IL-8, and TNF-α in cultured human keratinocytes. Another study demonstrated that visible light irradiation of reconstituted human epidermis resulted in increased IL-1α and matrix metalloproteinase-1 (MMP-1) release. Other researchers reported that blue light exposure increased cyclo-oxygenase-2 (COX-2) expression in human explants. [45]



Adapted illustration of the impact of sunlight-intensity blue light on the skin. [47]

#Skin barrier integrity

Roughly speaking, blue light can produce reactive oxygen species. A reactive oxygen species is an unstable molecule that contains oxygen and interacts with other molecules. The primary free radical brought on by exposure to blue light is superoxide (O_2), a highly reactive anion radical that is created by flavins. According to research, the creation of superoxide by blue light may play a substantial role in the ageing and carcinogenesis of the skin. [46]

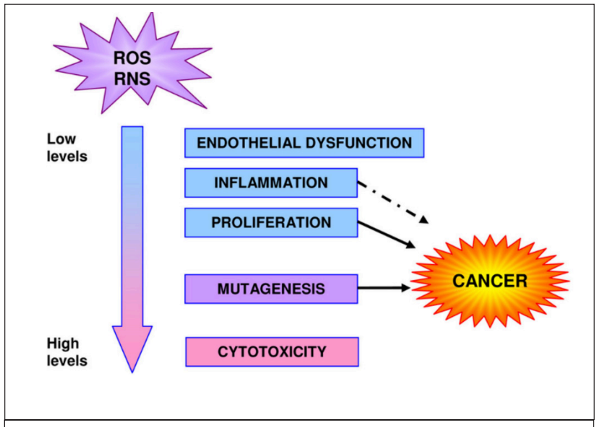
Overexposure to ROS can harm skin cells, accelerate ageing, cause hyperpigmentation, and cause melasma. By generating DNA damage, these unstable chemicals also cause inflammation and the destruction of the skin's healthy collagen and elastin, which furthers skin laxity, premature ageing of the skin, and wrinkles. In skin cells, blue light activates the enzyme matrix metalloproteinases (MMPs), which have been shown to break down collagen and speed up the ageing process. These MMPs not only break down the existing collagen but also impede the synthesis of new collagen, preventing healing. [46]

Antioxidant levels in cells with ROS are also affected. These species are eliminated by antioxidants in the skin, thus after exposure to blue light, they become depleted in the body. It could take up to 24 h for the endogenous repair. The majority of superoxide is quickly changed into hydrogen peroxide. Blue light may not primarily harm cells by overpowering their antioxidant defences, but rather by continuously producing small amounts of radicals that may slip past the body's regular defences and harm DNA permanently. [46]

Reactive nitrogen species overproduction

Studies have demonstrated that at wavelengths of 412-426 nm and high fluences, blue light is cytotoxic to human keratinocytes and skin-derived endothelial cells. However, at 453 nm and at fluences of up to 500 J/cm^2, blue light inhibits proliferation by inducing differentiation, as shown by increased levels of involucrin and keratin-1 messenger RNA (mRNA). In a study, blue light inhibited innate immune responses in human keratinocytes by inducing the S-nitrosylation of various proteins, including TIR-domain-containing adapter-inducing interferon-β (TRIF), Myd88, and nuclear factor-$_K$ light chain enhancer of activated B cells (NF-$_K$B). Blue light irradiation also blocked Toll-like receptor (TLR) 3- and TLR5-induced NF-$_K$B phosphorylation, resulting in reduced levels of TLR-induced pro-inflammatory cytokines. [45]

In the dermis, blue light causes the release of free nitric oxide (NO). Blue light irradiation considerably raised the intradermal levels of free NO, as discovered by electron paramagnetic resonance spectrometry *in vitro* with human skin specimens. Blue light irradiation of human skin resulted in significant NO emanation from the irradiated skin area as well as significant NO translocation from the skin surface into the underlying tissue, as detected by CLD *in vivo* in healthy volunteers. NO reacts with superoxide to form peroxynitrite, which may cause DNA damage that results in cell damage but no apoptosis has been seen. Researchers discovered that human keratinocyte and cutaneous fibroblast proliferation was inhibited by blue light. [46]



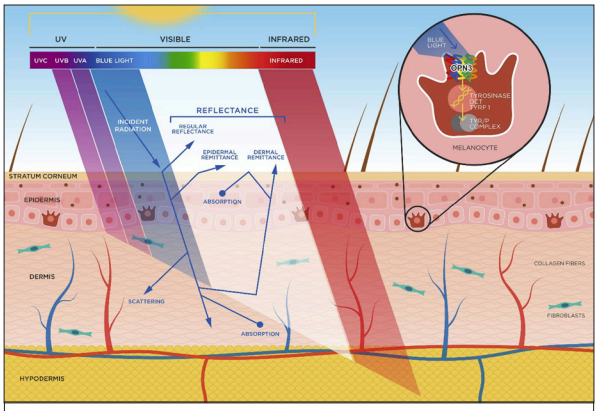
Biologic effects of reactive oxygen species (ROS) and reactive nitrogen species (RNS). [48]

Low levels of ROS and RNS may stimulate the inflammatory response, endothelial dysfunction, and cell proliferation, whereas higher levels may induce mutagenesis or have cytotoxic effects. The arrows indicate effects directly (continuous line) or indirectly (dashed line) related to oncogenesis.

Hyperpigmentation

Blue light is capable of causing pigmentation and hyperpigmentation of the skin, the latter of which can lead to mottled hyperpigmentation or age spots. A study conducted on 20 volunteers with skin types IV-VI found that, compared with UV, blue light produced darker hyperpigmentation that lasted longer. While both UV and blue light cause hyperpigmentation via ROS generation, only blue light causes hyperpigmentation via opsin stimulation. In skin biopsies from healthy volunteers, blue light irradiation over 5 consecutive days resulted in increased perinuclear vacuolisation in keratinocytes and an increased number of melan-A-positive cells. Blue light irradiation increased melanin production, oxygen saturation, and haemoglobin content in female volunteers. Skin darkening and erythema have also been observed after exposure to blue light. [45]

Opsins are a class of photosensitive G protein-receptors, which regulate various signalling cascades. In addition to the retina, opsins are expressed in the skin. When exposed to blue light, OPN3 (opsin-3) initiated a signalling cascade that finally increases the enzymes tyrosinase and dopachrome tautomerase (DCT) that are responsible for melanogenesis. Blue light-induced hyperpigmentation is more pronounced and persistent in people with darker skin (Fitzpatrick types III-VI), likely because they have higher levels of tyrosinase-DCT complexes than people with lighter skin (Fitzpatrick types I and II). [45]



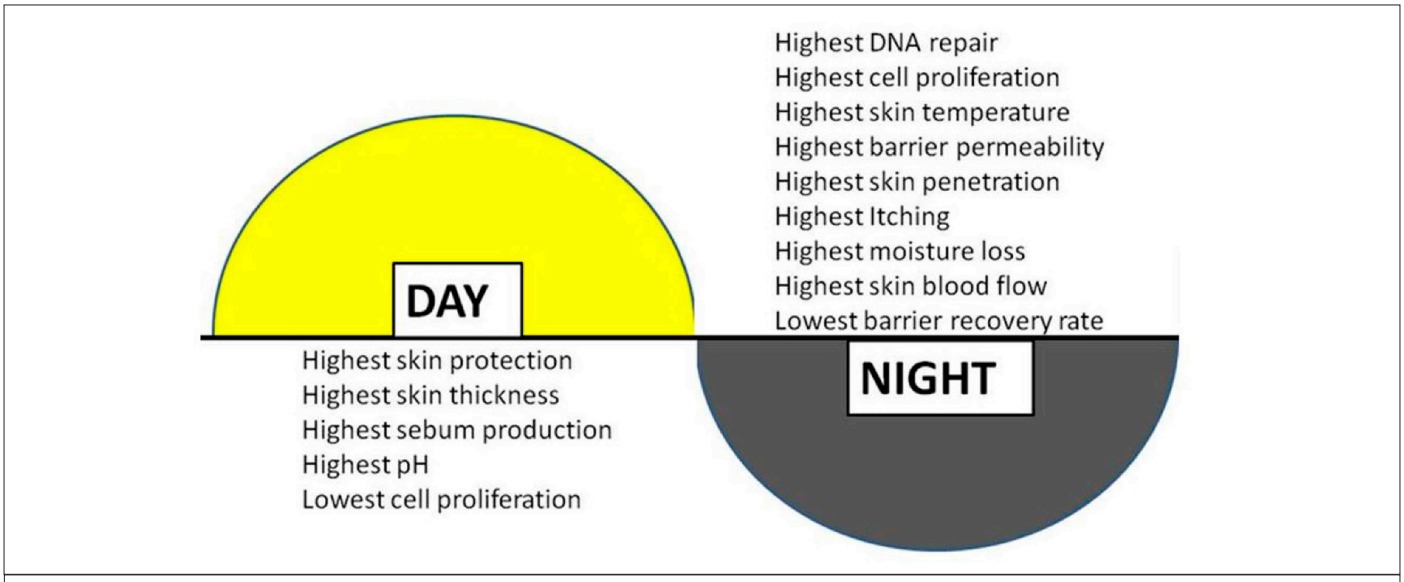
Schematic representing the optical pathways and relative penetration depth of UV and visible light. [49]

Blue light directly activates the OPN3 receptor at the surface of melanocytes that further induces the transcription of melanocytic enzymes but also stabilises tyrosinase activity by promoting its complex with DCT, leading to prolonged melanogenesis.

DCT: dopachrome tautomerase.

Indirect effects of blue light

In addition to directly affecting the skin, blue light can exert indirect effects on the body by disrupting the normal circadian rhythm. This occurs via both the central mechanism, which involves stimulation of light-sensing receptors located in the retina, and via the peripheral mechanism, which involves direct interaction with skin cells. By disrupting the normal circadian rhythm, blue light can negatively affect the skin repair processes that take place during the night. [45]



The oscillation of human skin properties as they cycle through the day and night. [50]

For example, sebum production has been shown to be higher during the daytime than at night. Higher values for itch and moisture loss occur during the evening.

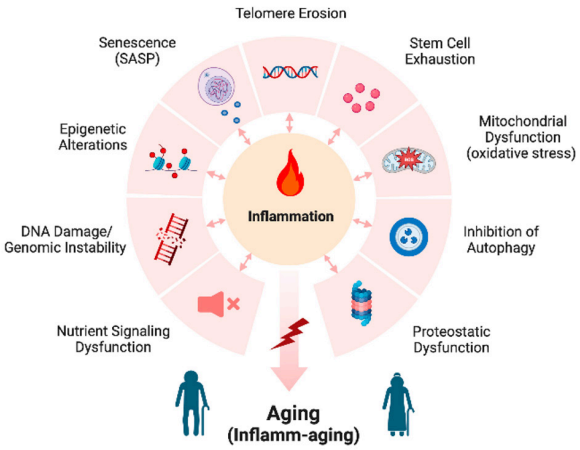
The circadian rhythm has been shown to affect multiple cellular and physiological processes occurring in the skin. For example, the rate of blood flow, permeability to both hydrophilic and lipophilic compounds, transepidermal water loss are all higher in the evening and at night than during the day. On the other hand, sebaceous gland activity is highest during the day and decreases in the evening and at night. Repair of sunlight-induced DNA damage also mostly occurs at night with one exception: the enzyme 8-oxofuanine DNA glycosylase (OGG1), which is involved in the base excision repair pathway and is most active in the morning. OGG1 levels are decreased in shift workers, suggesting that healthy sleep is required for its optimal functioning. Therefore, the circadian rhythm influences processes occurring in the skin, with most of the repair and regeneration taking place at night. [45]

Ageing signs: *inflammageing*

Ageing affects all cells of the body, leading to impaired system function. One characteristic of ageing individuals is chronic low-level inflammation throughout the body. Since inflammation induces oxidative stress and other effects that can impact proper system functioning over time, this chronic inflammation is thought to promote ageing, called *inflammageing*. Excessive inflammation of the skin, the largest organ of the body, can result in widespread effects on other systems. An important function of skin is to serve as a barrier to prevent the entry of environmental insults, such as microorganisms, and to retain water and other substances inside the body. Disruption of this barrier results in skin inflammation that can impact the whole individual. It is known that with age, the skin becomes less able to maintain the barrier, therefore a poorly functioning (impaired) skin barrier contributes to *inflammageing*. [51]

Research demonstrated that the skin could serve as the initiation site of inflammatory responses. Langerhans cells, epidermal-resident antigen-presenting (dendritic) cells, are an important factor underlying immune system responses and inflammation of the skin, but epidermal keratinocytes are also able to express and secrete pro-inflammatory cytokines. [51]

As mentioned above, the acute disruption of the cutaneous barrier can influence skin inflammation, in fact, it is a common initiating cause of cutaneous inflammation. When this epidermal permeability barrier is acutely disrupted in young mice, a rapid increase in the mRNA and protein expression of various cytokines in the skin results, as well as epidermal hyperplasia and thickening. Concomitantly, these mice exhibit elevated levels of cytokines in the blood stream. Furthermore, another study examining the effects of occlusion on the levels of epidermal pro-inflammatory cytokines, such as IL-1α, IL-1β, tumour necrosis factor (TNF)-α and granulocyte-macrophage colony-stimulating factor, found that these inflammatory mediators are also increased by epidermal barrier disruption. [51]

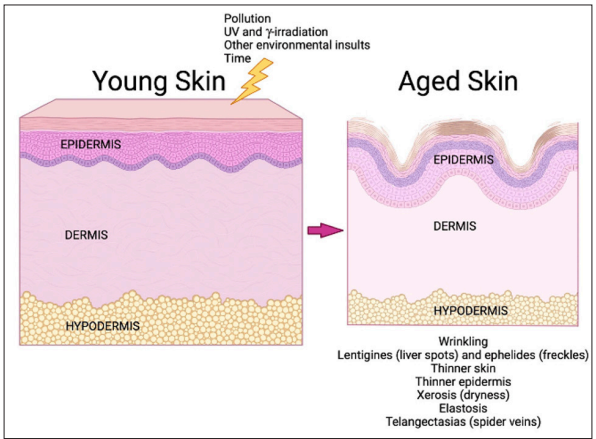


Mechanisms of ageing. [51]

The mechanisms thought to underlie the ageing process include proteostatic dysfunction, inhibition of autophagy, mitochondrial dysfunction (which results in increased oxidative stress), stem cell exhaustion, telomere erosion, senescence (and the associated senescence-associated secretory program, or SASP) epigenetic alterations, DNA damage and genomic instability, and nutrient signalling dysfunction. These various mechanisms often increase inflammation, which leads to *inflammageing*.

UV radiation also triggers skin inflammation, which can often be visibly seen in terms of acute erythema and oedema—commonly known as sunburn. UV irradiation of the epidermis results in the production of ROS in keratinocytes, leading to oxidative stress, which can cause mitochondrial and cell damage. In an unfortunate cycle, this oxidative stress induced by UV radiation leads to heightened production of ROS, which contributes to the initiation of inflammation and the activation of pro-inflammatory cytokines such as IL-2, IL-6 and TNF-α. This process involves multiple pathways, including the induction of gene expression through transcription factors such as NF-κB, hypoxia-inducible factor 1-alpha (HIF-1α), nuclear factor erythroid 2-related factor 2 (Nrf-2) and activator protein 1 (AP-1). UV radiation also activates pathways involving lipoxygenase and cyclooxygenase, the activity of which produces both ROS and lipid mediators that induce inflammation and further enhance oxidative stress. Inflammation induced by UV radiation is also associated with a deficiency of klotho, a transmembrane protein and anti-ageing hormone that plays a protective role against various stressors. [51]

On the other hand, intrinsic ageing primarily results from the passage of time and the accumulation of ROS over time, potentially influenced by genetic factors. The mechanism of the increased ROS is not completely understood but is thought to involve cumulative mitochondrial DNA damage, leading to mitochondrial inefficiency and electron leak. ROS, along with decreased protective antioxidant, growth factor and hormonal activity, contribute to skin deterioration. In addition to the damaging effects of ROS, decreased activity of these factors due to ageing may lead to skin damage through a subsequent increase in cytokines. Intrinsic damage of the skin may manifest as thinning of the skin, changes at the epidermal–dermal junction and a reduction in melanocytes and Langerhans cells. [51]



Skin ageing. [51]

Over time, ageing skin undergoes a number of alterations that contribute to dysfunction. In addition to chronological ageing, certain external stimuli can accelerate ageing; these include ultraviolet (UV) and γ-irradiation and exposure to pollution and other environmental insults, such as cigarette smoke. Skin function declines with age.

Reduced ECM proteins in the dermis result in wrinkling, elastosis, and thinner skin (since the dermis represents 90% of the skin thickness), and abnormalities in pigmentation lead to lentigines (liver spots) and ephelides (freckles).

Epidermal dysfunction results in a thinner epidermis (due to decreased proliferation of aged epidermal keratinocytes) and xerosis (from reduced production of proteins involved in skin hydration and deficiencies in the epidermal permeability barrier).

Telangiectasias and thinning of the subcutaneous fat (in some but not all regions of the body) also characterise aged skin.

Some processes that take place during skin ageing should be mentioned. They include degeneration and loss of collagen elastin fibres, both in the dermis as in the dermo-epidermal junction, presenting morphologically as layers of decreased thickness and fibroblast cells; reduced levels of GAGs (increased water skin loss); and an increased number of metalloproteinases. It was shown that in the dermis of aged skin, there are more neutrophils and mast cells than in young individuals, which is correlated with upregulation of IL-8. Some studies showed that in the aged epidermis, there is a lower number of Langerhans cells and they are less willing to relocate to trauma/infection localisation. [52]

Moreover, there is also an ageing of the immune system that results in various processes such as the accumulation of senescent cells which, with time, leads to cell cycle blockade (moderated by p16 protein). An evaluation of ageing skin showed that it has more senescent fibroblasts than young skin, and that its accumulation leads to an imbalance of skin homeostasis and causes poorer wound healing and the start of oncogenesis. It has been shown that with ageing, dermal fibroblasts release a lower level of IGF-1 which leads to poorer collagen synthesis and skin atrophy due to the increased accumulation of the DNA damage-induced phosphorylated histone protein, γH2AX, and p16INK4a-positive epidermal cells. In the case of photo-ageing, a higher amount of pro-melanogenic growth factors, including hepatocyte growth factor and SCF are encountered. Senescent keratinocytes accumulate in the elderly, producing more IL-1α in comparison to young people. Aged melanocytes also showed elevated markers of *inflammageing* characteristic of skin atrophy due to the influence on basal keratinocytes (activation of CXC chemokine receptor 3-dependent mitochondrial ROS). [52]

#Skin distress

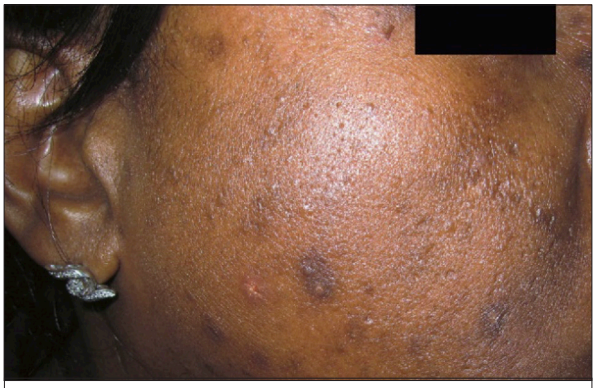
Skin ageing results in reduced skin flexibility and density (wrinkling), a reduced ability to heal or resist external pathogens or toxins, and an increased tendency to pigmentation disorders, dry skin, and telangiectasia. There are studies on transepidermal water loss (TEWL). Some authors found a relationship between ageing and higher TEWL rates (in some just on the décolleté region). Furthermore, the TEWL rate was also higher among aged women than men. That process can cause epidermal disruption causing *inflammageing*. Some authors analysed photo-exposed skin samples from women (aged from 20 to 70 years) and described histological and morphological changes of aged skin such as epidermal thinning, rete ridge pathlength loss, and stratum corneum thickening. They hypothesise that a better outcome can be expected in slowing down *inflammageing* when treatments that reduce the signs of ageing are started at a younger age. [52]

A study presented several conclusions— (1) *inflammageing* depends on changes in epidermal function, (2) epidermal dysfunction elevates pro-inflammatory cytokines in both the skin and serum, and (3) restoring epidermal functions (i.e., by topical emollients) reduces pro-inflammatory cytokine levels (TNF-α, IL-1β, IL-6). Emollients are believed to maintain normal epidermal function and decrease pro-inflammatory cytokine levels.[52]

The reason(s) why P.O.S.T. recovery cream has a positive influence in skin with *inflammageing*: Because it is working in soothing distressed skin and also contributes to improve the epithelisation.

Hyperpigmentation signs: PIH

Post-inflammatory hyperpigmentation (PIH) appears as dark and flattened spots on the body, which can range in colour from brown to black depending on the extent of damage and skin tone. The loss of even skin tone is caused by the enhanced synthesis and deposition of melanin in skin cells; these changes are frequently aggravated by exposure to excess sun and ultraviolet radiation (UVR). PIH can also be triggered by inflammatory skin conditions such as acne and atopic dermatitis, allergies, injuries, and aesthetic procedures such as chemical peels, laser treatment and dermabrasion. [53]



Post-inflammatory hyperpigmentation due to acne (inflammatory skin condition) in a dark phototype. [54]

Hyperpigmentation can affect any person, regardless of age and gender. However, it is well documented that it is more frequent and can be more severe in individuals with darkly pigmented skin (Fitzpatrick III-VI), who are less likely to use photoprotection. In addition, excess melanogenesis and irregular melanin deposition are also more severely enhanced by inflammatory processes such as acne in darker skin. The cause of discolouration may be linked to exogenous factors, such as the use of certain skin care products and medications or exposure of the skin to mechanical injuries. Endogenous factors, including hormonal changes or systemic diseases, can also contribute to the more prevalent occurrence of PIH. [53]

One of the major mechanistic explanations for the origin of PIH points to inflammation, which contributes to the damage of the basal layer of the epidermis and acts as a trigger for melanocytes to release melanosomes containing pigment to the surrounding skin cells; the pigment granules can persist for a prolonged time leading to further discolouration of the epidermis. When PIH affects the epidermis, cytokines, chemokines, and reactive oxygen species (ROS) released during inflammation stimulate melanocyte growth as well as the synthesis of melanin and its transport into the surrounding keratinocytes. Among the physiological factors promoting these events are epidermal growth factor (EGF), interleukin-1 (IL-1), interleukin-6 (IL-6), tumour necrosis factor (TNF) as well as leukotrienes such as LTc4 and LTd4, prostaglandins E_2 and D_2, and thromboxane-2. The pigment is usually increased in the basal compartment of the epidermis, which is also accompanied by up-regulated expression of melanoma marker antibody (NKI/beteb) and metalloproteinase 2 enzyme (MMP-2). [53]

Recent studies have suggested different histologic patterns of PIH based on skin layer involvement. For PIH involving the epidermis, it is thought that hyperpigmentation results from an increase in the number (hyperplasia), size (hypertrophy), and activity of melanocytes. Histologically, these cellular changes are characterised by an increase in epidermal melanin and with minimal dermal changes. In cutaneous pathologies where the basement membrane zone is the major target, such as systemic lupus erythematosus and lichen planus, PIH forms following disruption of basal keratinocytes and subsequent deposition of melanin granules within the dermis. Clinically, this presents as slate-grey and / or blue-black pigmentation. [55]

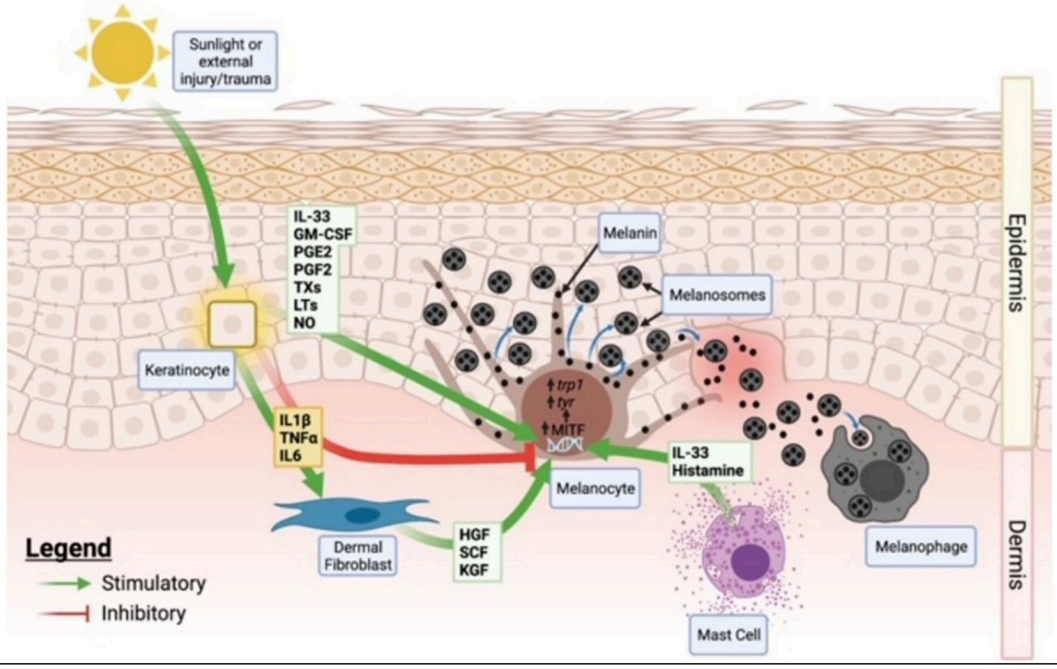


Diagram illustrating the proposed mechanism by which post-inflammatory hyperpigmentation (PIH) occurs. [55]

In this illustration, the major (proposed) pathways involved in PIH include the release of inflammatory cytokines from keratinocytes and growth factors from dermal fibroblasts. Following the production of melanin, its deposition in the dermis can occur in two ways, which are illustrated in this diagram: (1) Melanin can directly be deposited into the dermis through the gaps in the basal lamina; (2) macrophages engulf melanin in the epidermis; these melanophages migrate from the epidermis to the dermis, which contribute to dermal pigmentation.

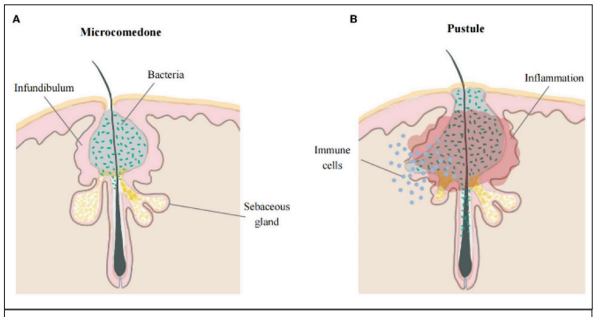
Two major theories have been proposed explaining the presence of melanin within the dermis. The first theory considers melanocytes as the donor of melanosomes, which are directly deposited into the dermis through gaps in the basal lamina. In addition, it has been proposed that free melanosomes may be taken up by macrophages, which migrate to the dermis. The second theory postulates that abnormal keratinocytes along with their melanosomes undergo phagocytosis and are subsequently transferred to the dermis. Dyskeratotic keratinocytes contain mainly condensed tonofilaments, nuclear chromatin, and melanosomes. Dyskeratotic cells and melanosomes become engulfed by macrophages. Melanosome-laden macrophages are known as melanophages. These melanophages migrate and deposit in the dermis, contributing to dermal pigmentation. [55]

The reasons why P.O.S.T. recovery cream has a positive influence in skin with hyperpigmentation: because it helps to soothe distressed skin (PIH) and reduce hyperpigmentation by downregulating tyrosinase, slowing melanosome transfer, brightening the skin by dispersing melanin and accelerating epidermal turnover.

Acne-prone skin

Acne vulgaris, one of the most common skin diseases, is a chronic cutaneous inflammation of the upper pilosebaceous unit (PSU) with complex pathogenesis. Inflammation plays a central role in the pathogenesis of acne vulgaris. During the inflammatory process, the innate and adaptive immune systems are co-ordinately activated to induce immune responses. [56]

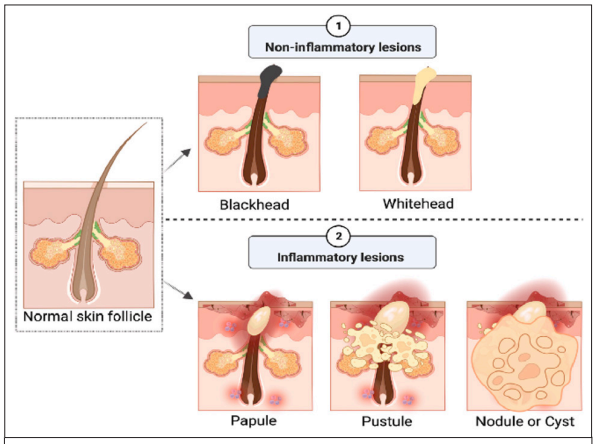
Cutibacterium acnes (*C. acnes*; formerly known as *Propionibacterium acnes*) is a commensal microorganism that resides mainly in the anaerobic portions of the pilosebaceous follicles. [56] *C. acnes*, which plays a substantial role in the pathophysiology of inflammatory acne, is an additional acne-causing agent. *C. acnes* is an anaerobic, lipophilic, gram-positive pathogen that prefers to colonise in sebaceous follicles because they produce large amounts of sebum and provide an excellent anaerobic habitat for bacterial growth. *C. acnes* secretes a lipase enzyme that metabolises the triglycerides of sebum into glycerol and fatty acids, which can lead to the formation of comedones and inflammation on the skin. [57]



Early acne lesions and late acne lesions. [56]

(A) The early stage of acne occurs in the hair follicle infundibulum. Microcomedones are mostly composed of lipids with clusters of bacteria, and the outer shell is made up of corneocyte layers.
(B) The walls of the follicles rupture, leading to extrusion of the content and causing a rapid inflammatory response.

On continuation to the above, *C. acnes* process, when the immune system detects *C. acnes*, the inflammatory process begins. *C. acnes* has a strong inflammatory effect, which may produce chemostatic agents like lymphocytes, neutrophils, and macrophages. In addition, these conditions cause follicular damage, rupture, and the release of microbes, fatty acids, and lipids into the dermis layer. These mechanistic processes will produce inflammatory lesions such as ulcers (pustules, nodules, cysts, and papules). Non-inflammatory lesions are smaller and less pus-filled than inflammatory lesions. In addition, it was discovered that neutrophils produce reactive oxygen species (ROS), which damage the follicular epithelium and contribute to acne inflammation. This causes the follicular substances to be expelled into the dermis, resulting in a variety of inflammatory acne lesions. [57]

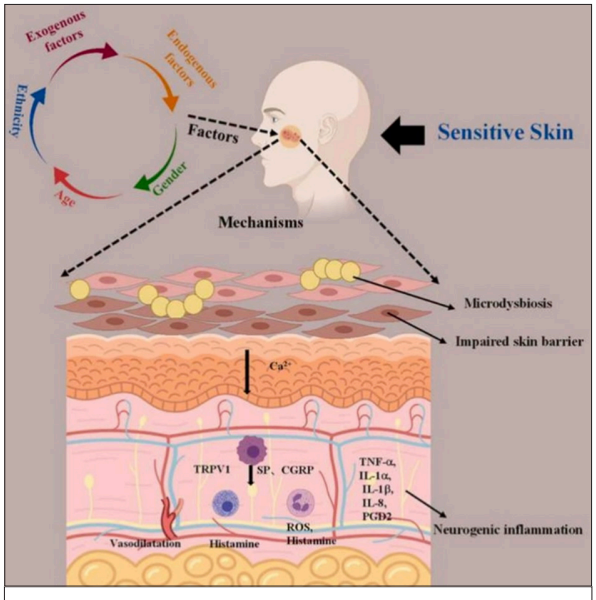


Schematic illustration of major distinguishing of the two types of lesions (non-inflammatory, inflammatory) and their pathogenies. [57]

The reasons why P.O.S.T. recovery cream has a positive influence in acne-prone skin is because it helps to soothe distressed skin, boosts skin barrier function and have additional sebostatic and antimicrobial activity of certain ingredients such as Niacinamide and Glycyrrhetinic acid.

Redness skin

Skin sensitivity (synonyms: reactive, hyper-reactive, intolerant, or irritable skin) is defined as the onset of erythema and / or tightness, prickling, burning, or tingling sensations (possibly pain or itching), due to various factors, which may be physical (ultraviolet radiation, heat, cold, and wind), chemical (skin care, soap, water, and pollution), psychological (stress), or hormonal (menstrual cycle). [58]



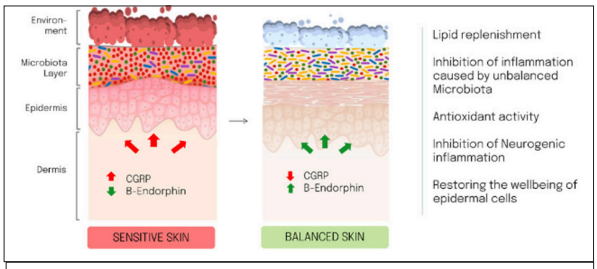
The discomfort associated with sensitive skin can be triggered by various endogenous and exogenous factors. [59]

Impaired skin barrier

A well-organised multilayered lipid structure between the corneocytes is essential for barrier function. Compromised / impaired barrier function causes patients with pre-existing clinical and subclinical dermatological disease to present with sensitive skin. Dry skin, rosacea, and acne have also been linked to enhanced skin reactivity and were associated with sensitive skin, which may indicate a tendency to barrier impairment and increased vascular reactivity. Barrier permeability is key to identify sensitive skin. [58]

#Skin distress

Skin sensitivity is associated with impaired function of the outermost layer of the skin (epidermal barrier), increased permeability of the skin, and high loss of water through the skin (transepidermal water loss). Individuals with sensitive skin may have a thinner outermost layer (stratum corneum), which leads to increased penetration of water-soluble chemicals into the skin. Studies have shown that imbalances in the lipid composition within the stratum corneum, such as significant decreases in neutral lipids, are related to impaired function of the skin barrier. Researchers compared the average level of ceramide in different areas of the body and found that the ceramide content in the facial stratum corneum correlated with skin sensitivity, with lower average values observed in the sensitive group compared to the non-sensitive group. [59]



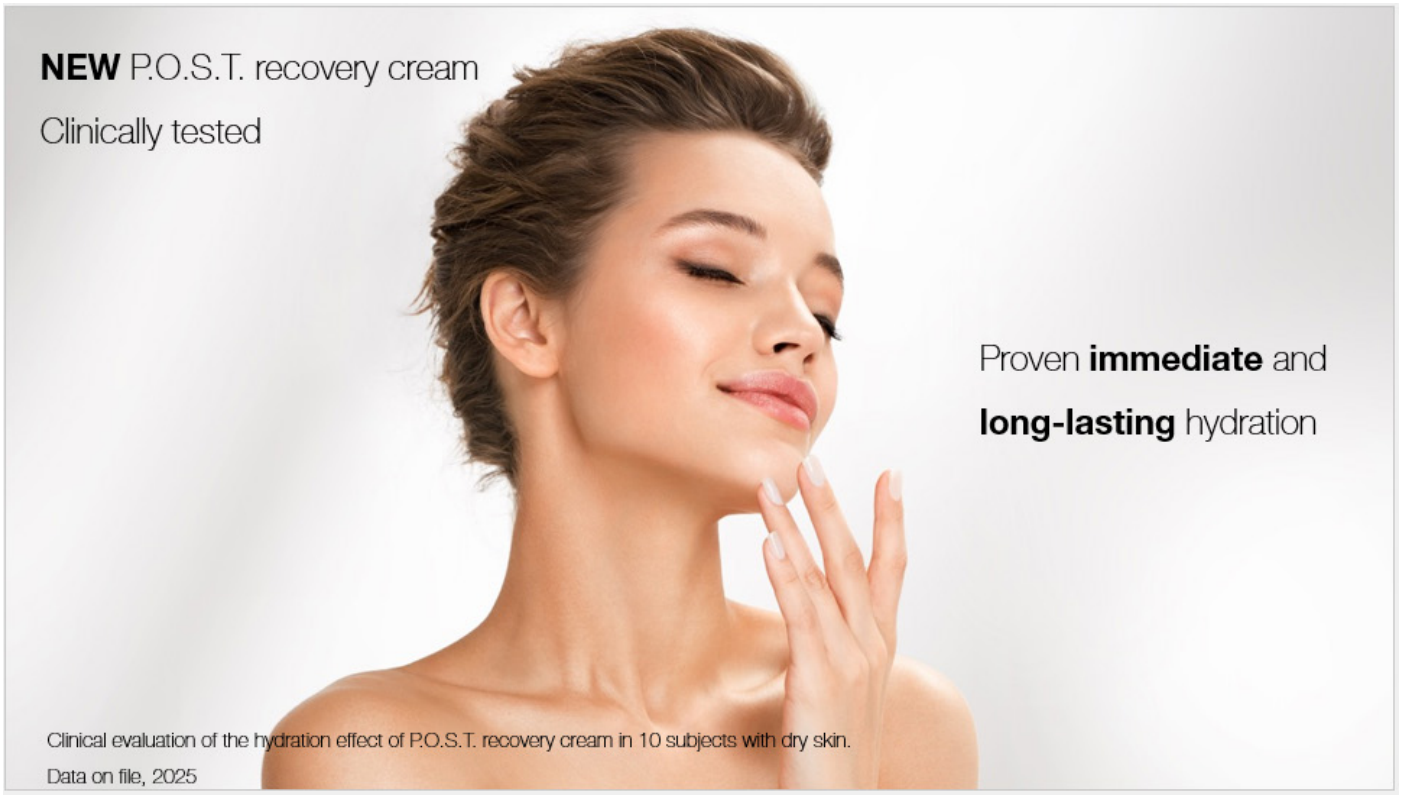
The skin barrier fulfils a multitude of functions and it is key to keep a balanced skin. [60]

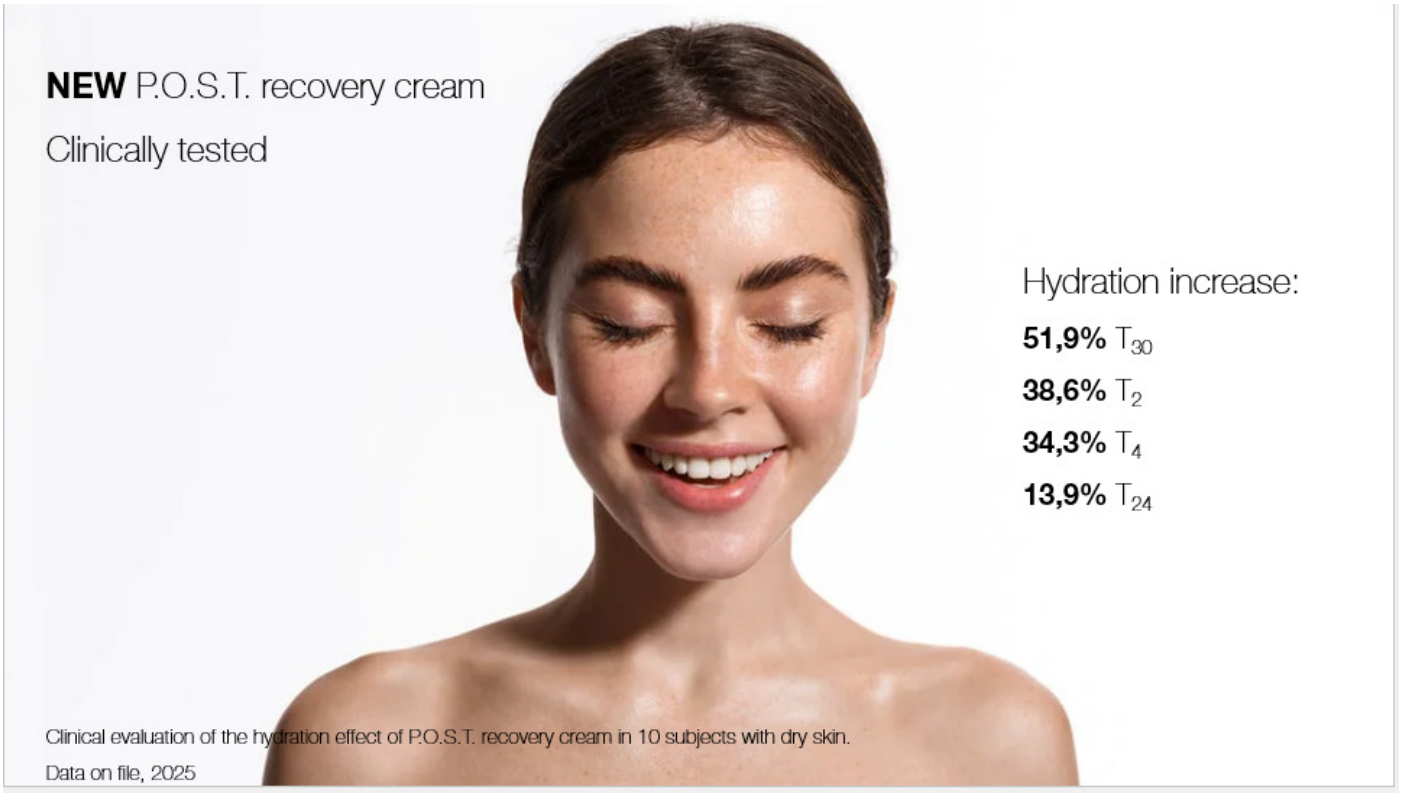
Structural contributors to skin sensitivity [58]

Structural component	Contributing factors
Stratum corneum	Thin stratum corneum. Decreased hydration of the stratum corneum. Disruption of the stratum corneum.
Sweat glands	Increased sweat glands influence permeability.
Epidermal innervations	Increased epidermal innervation increases skin sensitivity.
Lipids	Increased neutral lipids. Decreased sphingolipids. Decreased lipids.
TEWL	High baseline TEWL associated with increased susceptibility to irritants.

The reasons why P.O.S.T. recovery cream has a positive influence in C.R. skin is because it helps to soothe distressed skin, boosts ceramide capacity, recovering the skin barrier, and repairs compromised skin.

Hydration kinetics summary





#Bibliography

1. Boo, Y.C. (2021). 'Mechanistic Basis and Clinical Evidence for the Applications of Nicotinamide (Niacinamide) to Control Skin Aging and Pigmentation', Antioxidants, 10 (1315): 1-24. Available at: https://www.mdpi.com/2076-3921/10/8/1315

2. Bains, P., Kaur, M., Kaur, J., and Sharma, S. (2018). 'Nicotinamide: Mechanism of action and indications in dermatology', Indian Journal of Dermatology, Venereology and Leprology, 84 (2): 234-237. Available at: https://ijdvl.com/nicotinamide-mechanism-of-action-and-indications-in-dermatology/

3. Wohlrab, J., and Kreft, D. (2014). 'Niacinamide – Mechanisms of Action and Its Topical Use in Dermatology', Skin Pharmacology and Physiology, 27: 311-315. Available at: https://sci-hub.hkvisa.net/10.1159/000359974

4. Chen, A.C., and Damian, D.L. (2014). 'Nicotinamide and the skin', Australasian Journal of Dermatology, 55: 169-175. Available at: https://optoderm.com/wp-content/uploads/2017/11/Nicotinamide-and-the-skin.pdf

5. Matts, P.J., Oblong, J.E., and Bissett, D.L. (2002). 'A Review of the Range of Effect of Niacinamide in Human Skin', IFSCC Magazine, 5 (4): 285-289. Available at: https://www.researchgate.net/publication/286270242_A_Review_of_the_range_of_effects_of_niacinamide_in_human_skin

6. Levin, J., and Momin, S.B. (2010). 'How Much Do We Really Know About Our Favourite Cosmeceutical Ingredients?', The Journal of Clinical and Aesthetic Dermatology, 3 (2): 22-42. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2921764/

7. Green, B.A., Edison, B.L., and Sigler, M.L. (2008). 'Antiaging Effects of Topical Lactobionic Acid: Results of a Controlled Usage Study', Cosmetic Dermatology, 21 (2): pp. 76-82. Available at: https://cdn.mdedge.com/files/s3fs-public/Document/September-2017/021020076.pdf

8. 8. Hwang, J., Jeong, H., Lee, N., Hur, S., Lee, N., Han, J.J., Jang, H.W., Choi, W.K., Nam, K.T., and Lim, K. (2021). 'Ex Vivo Live Full-Thickness Porcine Skin Model as a Versatile In Vitro Testing Method for Skin Barrier Research,' International Journal of Molecular Science, 22 (2): 657. Available at: https://www.mdpi.com/1422-0067/22/2/657

9. Algiert-Sielińska, B., Mucha, P., and Rotsztejn, H. (2018). 'Lactic and lactobionic acids as typically moisturising compounds,' International Journal of Dermatology, 1-6. Available at: https://www.et-fine.com/10.1111/ijd.14202

10. Dunaway, S., Odin, R., Zhou, L., Ji, L., Zhang, Y., and Kadekaro, A.L. (2018). 'Natural Antioxidants: Multiple Mechanisms to Protect Skin From Solar Radiation', Frontiers in Pharmacology, 9. Available at: https://www.frontiersin.org/journals/pharmacology/articles/10.3389/fphar.2018.00392/full

11. Tasić-Kostov, M., Lukić, M., and Savić, S. (2019). 'A 10% Lactobionic acid-containing moisturiser reduces skin surface pH without irritation – An in vivo/in vitro study', Journal of Cosmetic Dermatology, 1-6. Available at: https://www.et-fine.com/10.1111/jocd.12908

12. Kornhauser, A., Coelho, S.G., and Hearing, V.J. (2012). 'Effects of Cosmetic Formulations Containing Hydroxyacids on Sun-Exposed Skin: Current Applications and Future Developments,' Dermatology Research and Practice, 2012: 1687-6105. Available at: https://www.hindawi.com/journals/drp/2012/710893/

13. Kowalska, A., and Kalinowska-Lis, U. (2019). '18β-Glycyrrhetinic acid: its core biological properties and dermatological applications', International Journal of Cosmetic Science, 41: pp. 325-331. Available at: https://onlinelibrary.wiley.com/doi/full/10.1111/ics.12548

14. Cho, Y.S., Kim. H.O., Woo, S.M., and Lee, D.H. (2022). 'Use of Dexpanthenol for Atopic Dermatitis – Benefits and Recommendations Based on Current Evidence,' Journal of Clinical Medicine, 11: 3943. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9322723/

15. National Centre for Biotechnology Information (2023). PubChem Compound Summary for CID 4678, Panthenol. Available at: https://pubchem.ncbi.nlm.nih.gov/compound/Panthenol

16. Ebner, F., Heller, A., Rippke, F., and Tausch, I. (2002). 'Topical Use of Dexpanthenol in Skin Disorders,' American Journal of Clinical Dermatology, 3 (6): 427-433. Available at: https://www.researchgate.net/publication/11264343_Topical_Use_of_Dexpanthenol_in_Skin_Disorders

17. Hekmatpou, D., Mehrabi, F., Rahzani, K. and Aminiyan, A. (2019). 'The Effect of Aloe Vera Clinical Trials on Prevention and Healing of Skin Wound: A Systematic Review', Iranian Journal of Medical Sciences, 44 (1): 1-9. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6330525

18. Sánchez, M., Gonzáles-Burgos, E., Iglesias, I., and Gómez-Serranillos, M.P. (2020). 'Pharmacological Update Properties of Aloe Vera and its Major Active Constituents,' Molecules, 25 (6): 1324. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7144722/

19. Mitra, A., Singh, M., Banga, A., Pandey, J., Tripathi, S.S., and Singh, D. (2023). 'Bioactive Compounds and Therapeutic Properties of Aloe vera – A Review,' Plant Science Today. Available at: https://www.researchgate.net/publication/369374894_Bioactive_Compounds_and_Therapeutic_Properties_of_Aloe_vera-_A_Review

20. Surjushe, A., Vasani, R., and Saple, D.G. (2008). 'Aloe Vera: A Short Review,' Indian Journal of Dermatology, 53 (4): 163-166. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2763764/

21. Massoud, D., Alrashdi, B.M., Fouda, M.M.A., El-Kott, A., Soliman, S.A., and Abd-Elhafeez, H.H. (2023). 'Aloe vera and wound healing: a brief review,' Brazilian Journal of Pharmaceutical Sciences, 58 (2). Available at: https://www.researchgate.net/publication/366995321_Aloe_vera_and_wound_healing_a_brief_review

22. Eddin, L.B., Jha, N.K., Goyal, S.N., Agrawal, Y.O., Subramanya, S.B., Bastaki, S.M.A., and Ojha, S. (2022). 'Health Benefits, Pharmacological Effects, Molecular Mechanisms, and Therapeutic Potential of β-Bisabolol,' Nutrients, 14 (7): 1370. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9002489/

#Bibliography

23. Santa Cruz Animal Health (2024) α-Bisabolol. [Image]. Available at: https://www.scbt.com/pt/p/alpha-bisabolol-515-69-5

24. INCI Guide (2024) Bisabolol. [Image]. Available at: https://inci.guide/plant-extracts-derivatives/bisabolol

25. Ferreira, M.S., Magalhães, M.C., Oliveira, R., Sousa-Lobo, J.M., and Almeida, I.F. (2021). 'Trends in the Use of Botanicals in Anti-Aging Cosmetics', Molecules, 26 (3584): pp. 1-18. Available at: https://www.mdpi.com/1420-3049/26/12/3584

26. Israel, M.O. (2014). 'Effects of topical and dietary use of shea butter on animals', American Journal of Life Sciences, 2 (5): pp. 303-307. Available at: https://www.researchgate.net/publication/277021242_Effects_of_Topical_and_Dietary_Use_of_Shea_Butter_on_Animals

27. Begoun, P., (2023) Your Skin's Barrier: Why It's Such a Big Deal. [Image]. Available at: https://www.paulaschoice.co.uk/your-skins-barrier-why-its-such-a-big-deal

28. Kumar, K. (2021) What Does Shea Butter Do for Your Skin? [Image]. Available at: https://www.medicinenet.com/what_does_shea_butter_do_for_your_skin/article.htm

29. Zahariev, B. (2024) Bitter vs. Sweet Almond Oil: How Are They Different? [Image]. Available at: https://greengold-int.com/blog/difference-between-almond-oil-and-sweet-almond-oil/

30. Barnes, T., M., Mijaljica, D., Townley, J.P., Spada, F., and Harrison, I.P. (2021). 'Vehicles for Drug Delivery and Cosmetic Moisturisers: Review and Comparison,' Pharmaceutics, 13: 2012. Available at: https://www.researchgate.net/publication/356677407_Vehicles_for_Drug_Delivery_and_Cosmetic_Moisturizers_Review_and_Comparison

31. INCI Guide (2024) Gossypium Herbaceum Seed oil. Available at: https://inci.guide/essential-oils-fixed-plant-oils/gossypium-herbaceum-seed-oil

32. Shahrajabian, M.H., Sun, W., and Cheng, Q. (2020). 'Considering White Gold, Cotton, for its Fibre, Seed Oil, Traditional and Modern Health Benefits', Journal of Biological and Environmental Sciences, 14 (40): 25-39. Available at: https://www.researchgate.net/publication/342509562_Considering_White_Gold_Cotton_for_its_Fiber_Seed_Oil_Traditional_and_Modern_Health_Benefits

33. Baker, P., Huang, C., Radi, R., Moll, S.B., Jules, E., and Arbiser, J.L. (2023). 'Skin Barrier Function: The Interplay of Physical, Chemical, and Immunologic Properties,' Cells, 12 (23): 2745. Available at: https://www.mdpi.com/2073-4409/12/23/2745

34. Zhang, R., Hummelgård, M., Örtegren, J., Olsen, M., Andersson, H., Yang, Y., Zheng, H., and Olin, H. (2021). 'The triboelectricity of the human body,' Nano Energy, 86: 106041. Available at: https://www.researchgate.net/publication/350658876_The_triboelectricity_of_the_human_body

35. Jang, H.H., and Lee, S.N. (2016). 'Epidermal Skin Barrier,' Asian Journal of Beauty and Cosmetology, 14 (3): 339-347. Available at: https://www.researchgate.net/publication/308852577_Epidermal_Skin_Barrier/fulltext/57f4153108ae8da3ce538148/Epidermal-Skin-Barrier.pdf

36. Addor, F.A., and Aoki, V. (2010). 'Skin barrier in atopic dermatitis,' Anais Brasileiros de Dermatologia, 85 (32): 184-194. Available at: https://www.semanticscholar.org/paper/Skin-barrier-in-atopic-dermatitis.-Addor-Aoki/db0965241aa495d430e018d12b92d3a141cbc7f3

37. Nano Live (n.d.) Lamellar Bodies and Keratohyalin Granules in Normal Human Epidermal Keratinocytes. [Image]. Available at: https://www.nanolive.ch/keratinocytes-promocell/

38. Von Neuschatz, D. (2021) Skin Barrier – the unsung hero of skin health: How to repair it and optimize its strength. [Image]. Available at: https://www.newyorksocialdiary.com/skin-barrier-the-unsung-hero-of-skin-health-how-to-repair-it-and-optimize-its-strength/

39. Agner, T., Itin, P, and Jemec, G.B.E. (2016). 'Skin Barrier Function,' Current Problems in Dermatology, 49: 1-172. Available at: https://perpus.univpancasila.ac.id/repository/EBUPT180533.pdf

40. Keya Seth Aromatherapy (2023) Ceramide. [Image]. Available at: https://www.keyaseth.com/blogs/ingredient-info/ceramide?shpxid=e962b319-9150-4fbe-8c65-016e858604f2

41. Del Rosso, J., Zeichner, J., Alexis, A., Cohen, D., and Berson, D. (2016). 'Understanding the Epidermal Barrier in Healthy and Compromised Skin: Clinically Relevant Information for the Dermatology Practitioner,' Journal of Clinical and Aesthetic Dermatology, 9 (4 Supplement 1): S2-S8. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5608132/

42. Rahma, A. and Lane, J.E. (2022). 'Skin Barrier Function in Infants: Update and Outlook,' Pharmaceutics, 14 (2): 433. Available at: https://www.mdpi.com/1999-4923/14/2/433

43. Torres, A., Rego, L., Martins, M.S., Ferreira, M.S., Cruz, M.T., Sousa, E., and Almeida, I.F. (2023). 'How to Promote Skin Repair? In-Depth Look at Pharmaceutical and Cosmetic Strategies,' Pharmaceuticals, 16 (4): 573. Available at: https://pmc.ncbi.nlm.nih.gov/articles/PMC10144563/

44. Petkovic, M., Mouritzen, M.V., Mojsoska, B., and Jenssen, H. (2021). 'Immunomodulatory Properties of Host Defence Peptides in Skin Wound Healing', Biomolecules, 11: 952. Available at: https://www.researchgate.net/publication/352809533_Immunomodulatory_Properties_of_Host_Defence_Peptides_in_Skin_Wound_Healing

45. Suitthimeathegorn, O., Yang, C., Ma, Y., and Liu, W. (2022). 'Direct and Indirect Effects of Blue Light Exposure on Skin: A Review of Published Literature,' Skin Pharmacology and Physiology, 35 (6): 305-318. Available at: https://karger.com/spp/article/35/6/305/826941/Direct-and-Indirect-Effects-of-Blue-Light-Exposure

46. Kumari, J., Das, K., Babaei, M., Rokni, G.R., and Goldust, M. (2023). 'The impact of blue light and digital screens on the skin,' Journal of Cosmetic Dermatology, 22 (4): 1185-1190. Available at: https://onlinelibrary.wiley.com/doi/full/10.1111/jocd.15576

47. Chen, W., Wu, C., Xu, Z., Kuse, Y., Hara, H., and Duh, E.J. (2017). 'Nrf2 protects photoreceptor cells from photo-oxidative stress induced by blue light', Experimental Eye Research, 154: 151-158. Available at: https://www.sciencedirect.com/science/article/pii/S0014483516305103

#Bibliography

48. Battelli, M.G., Polito, L., Bortolotti, M., and Bolognesi, A. (2015). 'Xanthine oxidoreductase in cancer: more than a differentiation marker,' Cancer Medicine, 5 (3): 1-12. Available at: https://www.researchgate.net/publication/287808567_Xanthine_oxidoreductase_in_cancer_More_than_a_differentiation_marker

49. Lim, H.W., Kohli, I., Granger, C., Trullàs, C., Piquero-Casals, J., Narda, M., Masson, P., Krutmann, J., and Passeron, T. (2021). 'Photoprotection of the Skin from Visible Light-Induced Pigmentation: Current Testing Methods and Proposed Harmonization,' Journal of Investigative Dermatology, 141 (11): 2569-2576. Available at: https://www.sciencedirect.com/science/article/pii/S0022202X21011234

50. Matsui, M.S., Pelle, E., Dong, K., and Pernodet, N. (2016). 'Biological Rhythms in the Skin,' International Journal of Molecular Sciences, 17 (6): 801. Available at: https://www.mdpi.com/1422-0067/17/6/801

51. Agrawal, R., Hu, A., and Bollag, W.B. (2023). 'The Skin and Inflamm-Aging', Biology, 12 (11): 1396. Available at: https://www.mdpi.com/2079-7737/12/11/1396

52. Pająk, J., Nowicka, D., and Szepietowski, J.C. (2023). 'Inflammaging and Immunosenescence as Part of Skin Aging – A Narrative Review', International Journal of Molecular Sciences, 24 (9): 7784. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10178737/

53. Markiewicz, E., Karaman-Jurukovska, N., Mammone, T., and Idowu, O.C. (2022). 'Post-Inflammatory Hyperpigmentation in Dark Skin: Molecular Mechanism and Skincare Implications', Clinical, Cosmetic and Investigational Dermatology, 15:2555-2565. Available at: https://www.dovepress.com/post-inflammatory-hyperpigmentation-in-dark-skin-molecular-mechanism-a-peer-reviewed-fulltext-article-CCID

54. Chandra, M., Levitt, J., and Pensabene, C.A. (2012). 'Hydroquinone Therapy for Post-inflammatory Hyperpigmentation Secondary to Acne: Not Just Prescribable by Dermatologists', Acta Dermato-Venereologica, 92: 232-235. Available at: https://medicaljournalsweden.se/actadv/article/view/8872/12353

55. Maghfour, J., Olayinka, J., Hamzavi, I.H., and Mohammad, T.F. (2022). 'A focused review on the pathophysiology of post-inflammatory hyperpigmentation', Pigment Cell & Melanoma Research, 35 (3): 320-327. Available at: https://onlinelibrary.wiley.com/doi/full/10.1111/pcmr.13038

56. Huang, L., Yang, S., Yu, X., Fang, F., Zhu, L., Wang, L., Zhang, X., Yang, C., Qian, Q., and Zhu, T. (2024). 'Association of different cell types and inflammation in early acne vulgaris', Frontiers in Immunology, 15: 2024. Available at: https://www.frontiersin.org/journals/immunology/articles/10.3389/fimmu.2024.1275269/full

57. Vasam, M., Korutla, S., and Bohara, R.A. (2023). 'Acne vulgaris: A review of the pathophysiology, treatment, and recent nanotechnology-based advances', Biochemistry and Biophysics Reports, 36: 101578. Available at: https://www.sciencedirect.com/science/article/pii/S2405580823001590

58. Inamadar, A.C., and Palit, A. (2012). 'Sensitive skin: An overview', Indian Journal of Dermatology, Venereology, and Leprology, 79: 9-16. Available at: https://www.researchgate.net/publication/233958014_Sensitive_skin_An_overview

59. Jiang, C., Guo, C., Yan, J., Chen, J., Peng, S., Huang, H., Wu, W., Nie, Y., Pei., Y., and Sun, H. (2024). 'Sensitive skin syndrome: Research progress on mechanisms and applications,' Journal of Dermatologic Science and Cosmetic Technology, 1 (2): 100015. Available at: https://www.sciencedirect.com/science/article/pii/S2950306X2400013X

60. Carst & Walker (2023) Understanding the significance of the skin barrier. [Image]. Available at: https://carst.com/understanding-the-significance-of-the-skin-barrier/