# BIOINSPIRATION FOR SMOOTH AND MOISTURIZED HAIR

PinoPlex™ is a new, innovative and sustainable haircare active ingredient inspired by the concept of pine cone scales, which open and close depending on weather conditions. This upcycling product is extracted from hand-collected pine cones from French forests. As a powerful moisturizer for the hair shaft, it can combat dry and damaged hair. It not only penetrates the hair, but also retains water by levelling out the hair cuticle, making the hair smoother and shinier. PinoPlex™ prevents split ends and improves hair fibre integrity, making it more resistant to breakage. It also supports keratinocyte differentiation in the hair matrix, which makes the hair grow healthier and stronger.

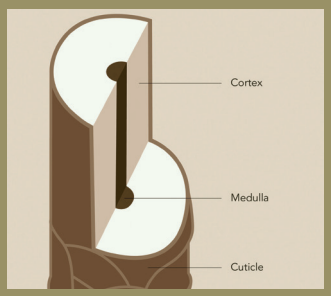
## PINE CONES AS A SOURCE OF BIOINSPIRATION

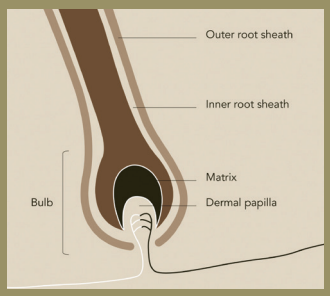
Hair that looks and feels good has been proven to improve well-being. But what do pine cones have to do with hair and well-being? Pine cones exhibit a fascinating phenomenon: The opening and closing of their scales, which is based on different weather conditions. In humid weather, the cone scales are closed, while in dry weather they are open. When immersed in water, dry cones with the scales open will close their scales after just a short time. Similar to the pine cone, well-moisturized hair has smooth scales. These scales are not completely closed, allowing for the exchange of water molecules and nutrients. However, they form a protective sheath that locks in moisture. As a result, the hair appears healthy and shiny, and it can be easily styled. On the other hand, dry and damaged hair has open, protruding scales. It is porous and dull, allowing split ends to occur. Therefore, pine cones served as a source of bioinspiration in the pursuit of a novel ingredient that will enhance both hair moisture and beauty.



## TO BE BEAUTIFUL AND SMOOTH, HAIR NEEDS MOISTURE

The hair is built of the cuticle, the cortex and the medulla. The cuticle consists of flat, keratinized, overlapping dead cells and protects the hair by regulating moisture movement. The cortex contains keratin bundles, melanin, amino acids and fatty acids, while the medulla consists of cells and air. The visible hair (hair shaft) is anchored in the scalp by the hair root, with the hair bulb, the lowest part of the root, controlling the production of hair cells. Healthy hair is optimally hydrated, with water molecules bound to macromolecules such as keratin. Harmful factors can damage the cuticle, leading to increased porosity, moisture loss and split ends. Therefore, it is important to restore and lock moisture into damaged hair fibres. PinoPlex™ not only penetrates the hair, but also stays in it by smoothing the cuticle. This results in smoother, shinier hair that is more resistant to daily stress and breakage. Thanks to its moisturizing ability, PinoPlex™ can hydrate and repair damaged hair, resulting in shiny and healthy-looking hair.




## THE BEAUTIFYING MOLECULES WITHIN PINE CONES

PinoPlex™ is a novel haircare active based on a pine cone extract. For the active ingredient PinoPlex™, cones of the Scots pine *(Pinus sylvestris)* are sustainably harvested in French Forests with the official label "Forêts d'Exception®". To produce PinoPlex™, pine cones undergo a special extraction process: A gentle, microwave-assisted extraction process was implemented to obtain the valuable ingredients from pine cones. The process starts by shredding the lignified material of the pine cones into small pieces. The material then goes into a special extraction tank where the microwave-assisted extraction takes place. The microwaves help in terms of disrupting the hardened pine cones, thus enabling the efficient solubilization of molecules. PinoPlex™ was found to be rich in polysaccharides, monosaccharides, flavonoids,

procyanidins, and osmolytes. Osmolytes like in PinoPlex™ help to regulate the water balance and are known to have a moisturizing and smoothing effect that protects the hair from drying out.

**PINOPLEX™ MOISTURIZES HAIR AND LEAVES IT LOOKING SMOOTH AND SHINY**

The effect of PinoPlex™ on the visual properties and moisture retention of hair was investigated in several studies. In a first study, hair strands were treated with a hair serum containing PinoPlex™ after being washed first. Hair shine was visually assessed after treatment and showed a significant improvement compared to the placebo treatment. In another study, PinoPlex™ was tested for its moisturizing effect on damaged, bleached hair. A strand of hair was soaked in PinoPlex™ and then dried. Results showed that the moisture content increased significantly with the application of PinoPlex™, indicating increased water absorption and moisture retention. Moreover, the effect of PinoPlex™ on hair cuticles was investigated. After treatment and subsequent air-drying, atomic force microscopy showed a smoothing of the hair cuticles. This smoothing protects the hair fibre, locks in moisture and improves the external appearance of the hair by

making it shinier. In conclusion, PinoPlex™ improves hair shine and moisture retention in hair strands and closes the cuticles.

**PINOPLEX™ PREVENTS SPLIT ENDS AND PROVIDES STRENGTH**

In a study, bleached hair strands were treated with a hair serum containing PinoPlex™ or the corresponding placebo. The serum was applied once a day for several days, with washing steps between applications. In the end, damage was caused by brushing and blow-drying the hair. Results showed that treatment with PinoPlex™ reduced split ends by 25% compared to the placebo, demonstrating a preventive effect against hair damage. Also, PinoPlex™ was tested for its ability to increase hair resistance. The more resistant a hair is, the higher its elastic modulus, and the more force is required to deform or break the hair. Therefore, a hair fibre was treated with PinoPlex™ and its elastic modulus was assessed with atomic force microscopy and compared with an untreated hair fibre. Results showed that treatment with PinoPlex™ strengthens the hair fibre by increasing its elastic modulus. Thus, the hair fibre can withstand more styling and environmental stress before hair breakage occurs. This not only strengthens the health of the hair, but also gives it a vibrant bounce.

**PINOPLEX™ ALSO SUPPORTS KERATINOCYTE DIFFERENTIATION FOR HEALTHY HAIR**

Strong hair starts in the hair root. Because of that, PinoPlex™ was tested for its positive effect on gene markers that play a crucial role in the differentiation and proliferation of keratinocytes, which are the most important cells in the hair fibre. Human keratinocytes were treated with PinoPlex™ and gene expression analysis was performed on genes that had been selected for their importance in skin and hair physiology. The treatment of these cells with PinoPlex™ exhibited a clear pro-differentiating effect by upregulating keratinocyte differentiation markers. In addition, it activated the protection genes against oxidative stress. Also, treatment with PinoPlex™ downregulated markers involved in inflammation. To summarize, PinoPlex™ could promote hair growth by stimulating keratinocyte differentiation and offers protection against oxidative stress and inflammation, as shown by the changes in the corresponding gene markers.

> "Pine cones exhibit a fascinating phenomenon: The opening and closing of their scales, which is based on different weather conditions"

The new haircare active PinoPlex™ has a dual effect on hair: The hair shaft benefits from its excellent moisturizing capacity, its hair-strengthening effect and its protection against split ends; in addition, the hair matrix benefits from the positive effect on keratinocytes, thus supporting healthy hair growth.

Mibelle Biochemistry, Stand 1J50

mibelle GROUP biochemistry