

## Strong effects - phospholipids in cosmetics

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Phospholipids are indispensable for the live organism and play an essential role for both health and nutrition due to a great variety of different functions. They also prove to be perfect base substances for cosmetic products.

As one can already guess by their name, phospholipids are phosphorous containing natural substances with fatty nature. Since they play a decisive role in the structure of any cellular membrane and contribute to essential transport and control mechanisms of the metabolism, there is an abundant natural supply. Its most frequently found representative is phosphatidylcholine whereas others as e.g. the so-called platelet activating factor (PAF) already in very small amounts have a hormone-like influence on blood clotting, blood pressure and lung functions.

For a long time, the source material for the production of different phospholipids has been lecithin, a phospholipid/oil mixture which at first had been produced from egg yolk but today is exclusively extracted from soybeans.

### Lecithin as a base substance

At first, lecithin (code E 322) was rather a by-product of the oil production but now is a frequently used emulsifier in today's food production ("mayonnaise"), a bakery additive, an additive to control the flow properties in the chocolate production as well as a valuable food supplement. In cosmetics also it has already been used for a long time in the cream manufacturing process (w/o emulsions).

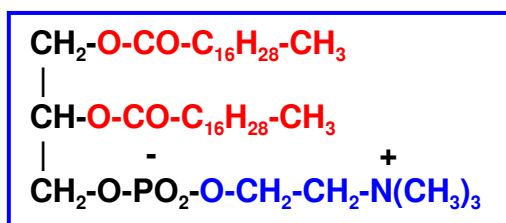
After adding egg yolk to shampoos, it turned out that the product took on conditioning properties, i.e. there was no longer electrostatic charge when combing the hairs, a feature which can be attributed to the phosphatidylcholine in lecithin. Soybean lecithin even contains about 20 percent of phosphatidylcholine.

Unfortunately even today, in the INCI it still is listed with the term lecithin due to its origin.

Phosphatidylcholine is the most prominent exponent of the phospholipids and is extracted from lecithin in a rather expensive manufacturing process. Unlike its base substance lecithin, phosphatidylcholine mixed with water spontaneously generates cell-like structures whose membranes are built up in bilayers just like in natural cell structures.

These hollow bodies are called liposomes and can only be seen with the help of an electron microscope.

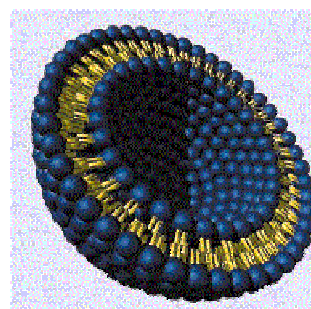
Furthermore, it is possible to encapsulate active agents in liposomes and thus penetrate them into the skin.



Formula of phosphatidylcholine  
(red: chemically bound linoleic acid, blue: choline)

### Liposomes

Depending on the concentration, emulsifiers generally have destructive effects on liposomes. As a result, lecithin which besides phosphatidylcholine and cephaline (phosphatidylethanolamine) also contains more or less important amounts of emulsifying components like phosphatidylinositol, phosphatidic acid and phosphatidylglycerine is not able to build up membrane structures.



Liposome with a sphere of phosphatidylcholine

As to their physical shape, liposome membranes have the advantage of showing a structure similar to the barrier layers of the skin and thus can easily be integrated into the skin layers. Hence, the application of liposomes

involves the cosmetically intended effect of increasing the permeability of the skin for the active agents carried along with, especially when these are encapsulated in liposomes.

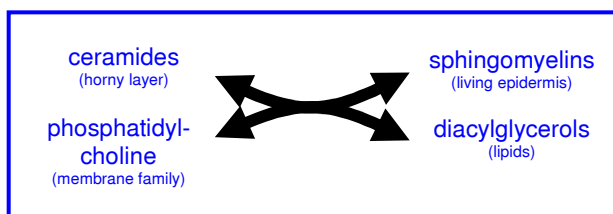
### Essential substances

The fact that the so-called empty liposomes themselves, e.g. liposomes without encapsulated active agents ("empty shells") belong to the most efficient cosmetic active agents as such, is less known. The phosphatidylcholine of the membranes contains two substances in chemically combined form which are essential for the skin, e.g. which cannot not be provided by the human metabolism: linoleic acid and choline.

While the choline part takes over skin protection functions and plays an important role especially in the prevention of skin ageing, the linoleic acid improves the natural barrier function of the skin on a long-term basis by integrating into the ceramide I. In addition to that, linoleic acid is effective on bad skin and acne.

### Regeneration of the skin

The liposomal phosphatidylcholine is effective against cornification disorders, e.g. also at the exits of the sebaceous gland which contributes to the fact that minor forms of acne (grade 1 and 2 according to the WHO) will be reduced by 70 percent within a period of 24 days; at the same time, the sebum production will decrease which is a welcome effect especially in cases of acne in connection with oily skin. In the same way, also the cornification of scars is fought. In total, a very strong effect on the skin regeneration can be diagnosed which can be compared to that of vitamin A acid or AHA acids, however for a longer period of time (3 to 4 weeks) and without any spectacular side effects.



Biochemistry of phosphatidylcholine

In biochemical terms, phosphatidylcholine intervenes in the ceramide metabolism by transferring its phosphocholine group to the ceramides and thus supporting the formation

of sphingomyelins which are characteristic for living cells.

It is possible that also transport mechanisms between the different skin layers are involved in this process. In this connection, imbalances of the skin which can be diagnosed along with different skin problems like neurodermatitis and psoriasis are influenced in a positive way.

### Nanoparticles

Liposomes consisting of phosphatidylcholine also are provided with a disadvantage which is a limited assimilating capacity for oil-based substances. Experiments to compensate this by adding emulsifiers failed, as the liposomal membranes reacted very sensitive to emulsifiers which can be compared with the membranes of the skin barrier. In the final analysis, they will be destroyed.

Only after applying high pressure technology for the process of combining liposomes with oil-based substances, the manufacturing of particles of the size of liposomes but filled with oil-based substances was made possible. These particles which are free of emulsifiers are also called nanoparticles and have become one of the most effective transport vehicles for fat-soluble vitamins and just like liposomes, they have the advantage of preserving the natural membrane structure of the skin barrier. They can be compared with the chylomicrons, another one of nature's examples, which are responsible for the transport of fat out of the intestinal mucosa into the lymph vessels and bloodstream. With their 180 - 500 nm in diameter (1nm = 0,0000001 cm), chylomicrons have about the same size as nanoparticles.



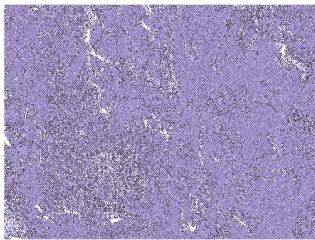
Nanoparticle with a sphere of phosphatidylcholine and a oily nucleus

Nanoparticles can be used e.g. for the manufacturing of body lotions which on the one hand have a water-like consistency, i.e. they can be easily sprayed onto the body and spread, but on the other hand also allow a maximum greasing.

A characteristic feature is that oil-based substances will not just remain on the skin surface but immediately penetrate into the skin barrier layers.

### Derma Membrane Structure

Another recent member of the membrane family is the derma membrane structure (DMS) with phosphatidylcholine which contains chemically combined palmitic and stearic acid instead of linoleic acid. Whereas liposomes and nanoparticles help to penetrate active agents into the skin apart from the fact that they themselves have very positive effects, show DMS creams a typical protective function: They restore and stabilize the skin barrier layers. Their stabilizing functions can be observed when measuring the transepidermal water loss (TEWL) after the exposure to water-containing occupational substances: the TEWL stays on its natural level. In contrast to liposomes and nanoparticles, the membranes of DMS creams are not cellular-shaped but structured just like slates in two-dimensional layers which make them very similar to the skin barrier layers.



DMS (electron microscope)

During the cosmetic treatment, DMS creams in combination with other members of the membrane family have the advantage that the skin can be made receptive for the penetration of active agents with liposomes and/or nanoparticles and subsequently be re-closed with DMS. In addition, DMS creams act like the skin itself: used as base creams, they can assimilate fats and oils as well as aqueous solutions as for example solutions enriched with moisturizing substances. Furthermore, a combination of DMS with liposomes and nanoparticles offers a broad variety of different applications which proved successful especially in cases of problem skins.

### Further applications

Avoiding emulsifiers in membrane-containing products positively reduces the wash-out effect of both skin care and skin-own protective

substances. This effect is supported by an additional specific feature of phospholipids, especially of the phosphatidylcholines: they combine with the proteins (keratin) of the skin and simultaneously fixate the fat-soluble skin care substances carried along with. This specific effect is also the reason for the hair conditioning described above and has an interesting parallel in the transport proteins of the bloodstream where lipoproteins, which mean compounds of proteins and phosphatidylcholines transport the food lipids through the blood vessels.

### Finely dispersed particles

In dermatology and cosmetics, this effect can be used for specifically designed oil bathes by mixing a phosphatidylcholine-oil-concentrate with the bathwater which spontaneously generates particles similar to nanoparticles ("semisomes"). These are virtually filtered out by the skin keratin and then fixated in the skin. Those products are specifically recommended for sensitive skin and persons with atopic symptoms. The bath concentrates can also be used in the wellness-sector by adding essential oils which subsequently are finely dispersed on the skin just like oils or fat substances.

Oleogels enriched with phosphatidylcholine also provide an emulsifier-free fat transport. Oleogels consist of more than 90% of lipids and are free of water as a rule. Despite of their high fat content they penetrate very fast into the skin and are recommended for extremely dry skin, lip care, cold protection in winter and the skin care for patients confined to bed.

### Use in cosmetics

Phospholipids virtually are multitaskers. Due to a broad variety of different functions they play a decisive role in health and nutrition. For their use in cosmetics they meet the following requirements:

- they support the **physiology** of the skin
- their **chemical features** correspond to those of endogenous substances
- in terms of **physical features**, they build up the same structure (bilayers) as the skin
- they are powerful **active agents**

In form of food supplements, phospholipids provide the body with essential substances ("beauty coming from the inside") and have a protective function for the stomach and the

liver. In addition to that, they are indispensable for the functioning of cells, brain and nerves.

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