

Liposomal Formulations with
Natural Phospholipids

Innovative Encapsulation Systems
for Bioavailability Enhancement



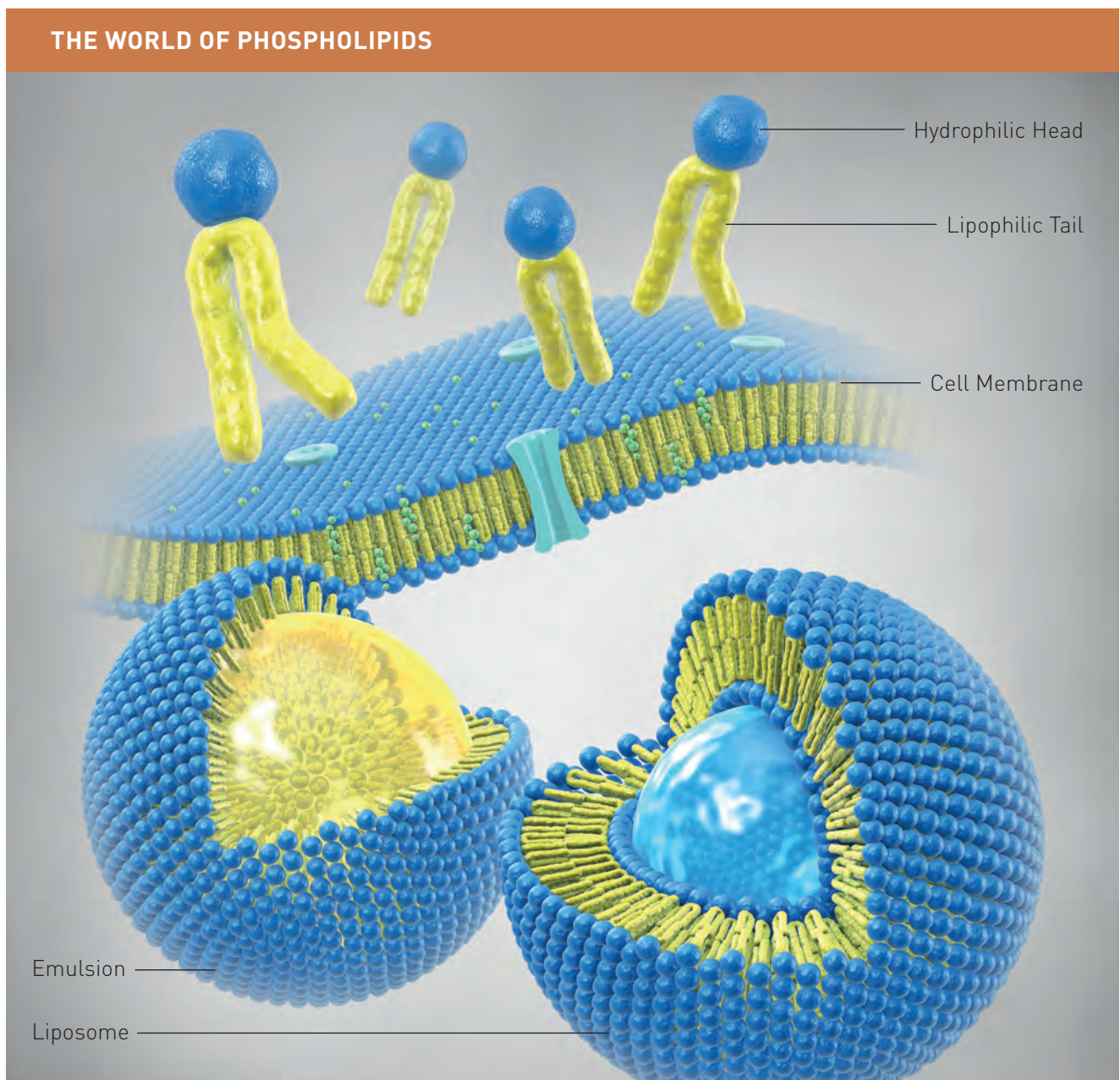
We Invest in Quality.

Phospholipids – Nature’s unique Molecules

Lipoid is the expert in the development and industrial production of high quality lecithin and phospholipids for the pharmaceutical, dietetic and cosmetic industry and the only company worldwide, offering the whole range of phospholipids in industrial scale.

Phospholipids are amphiphilic (“both loving”) molecules and consist of a hydrophilic, as well as a lipophilic moiety. They can combine with fats so that the water-friendly head groups form a shell, which encloses

a fat droplet and allows for the dispersion in aqueous media. The resulting systems are called emulsions. In absence of non-polar lipids and the presence of water, phospholipids organize as bilayer structures that are called liposomes. These arrangements are known from cellular membranes, where phospholipids establish the separation of the cell from its environment. Liposomes enclose an aqueous core that can be loaded with hydrophilic nutrients like vitamins and plant extracts.



Schematic diagram of phospholipids, an emulsion (phospholipid monolayer encapsulation of lipophilic ingredients) and a liposome (phospholipid bilayer encapsulation of hydrophilic ingredients).

Liposomal Formulations – Diverse Possibilities, Numerous Advantages



Enhancement of Bioavailability

Liposomal formulations improve the bioavailability of nutrients

Gastrointestinal Protection

Liposomal formulations protect nutrients from degradation and support the mucosal barrier function

Natural Choline Source

Liposomal formulations with phosphatidylcholine are natural sources of the vitamin-like nutrient choline

Liposomal formulations are ideally suited for the development of innovative products with three main advantages.

Firstly, they can improve the delivery and bioavailability of nutrients. This enhancement of bioavailability is a process naturally occurring in the body, where phospholipids are found in bile, contributing to the digestion and improving the uptake of nutrients. An example for the enhancement of bioavailability by liposomal formulations is vitamin C. The superior delivery of vitamin C could be shown in a study^[1], where the oral delivery of the vitamin, encapsulated in liposomes, resulted in higher circulating levels - compared to unencapsulated vitamin C.

Secondly, liposomes protect labile compounds from premature degradation in the gastrointestinal tract and therefore help to maintain the health benefits

of sensitive ingredients. Additionally, liposomes provide the benefits of their molecular building blocks, the phospholipids. These are part of the gastrointestinal mucosa, where they build up a protective barrier against the aggressive gastric acid and digestive enzymes. In pharmaceutical applications, the combination of nonsteroidal anti-inflammatory drugs with phospholipids helps to attenuate side effects related to gastrointestinal irritation^[2,3]. Likewise, formulations with natural phospholipids contribute to the maintenance of the gastrointestinal mucosa.

Thirdly, the major phospholipid phosphatidylcholine (present in cell membranes of animals and plants) is also the natural source of the vitamin-like nutrient choline. Thus, liposomal formulations with natural phospholipids supply the body with choline and essential fatty acids, providing additional benefits^[4,5].

Lipoid Products for the Preparation of Liposomes

For the preparation of liposomes, phospholipids are mixed with water and the desired active ingredients. Ethanol or glycerol may be added to improve the stability of the product or to enhance the solubility of the ingredients. High-shear mixing is usually applied for the preparation of liposomes.

In a second step, ultrasound or high-pressure homogenization may be used to obtain smaller and homogeneously distributed liposomes. In general, a higher energy input usually results in a more homogenous product, but also lead to a rise in temperature, so that cooling

during manufacturing becomes necessary.

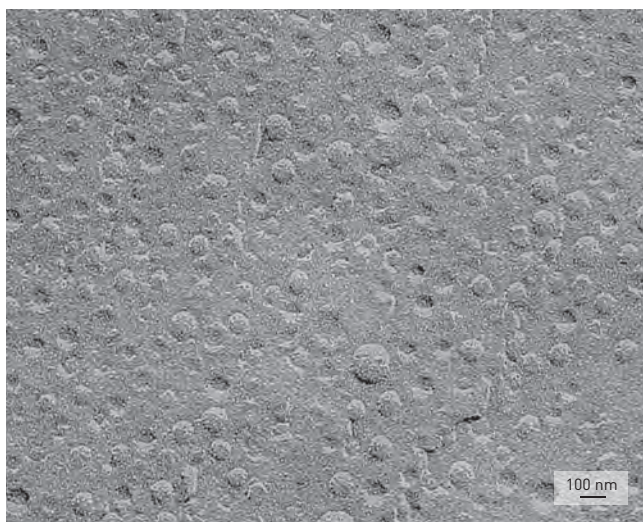
Lipoid offers purified phospholipids from non-GMO soy (e.g. LIPOID P 45) and sunflower (e.g. LIPOID H 90) that are particularly suited for the preparation of liposomes.

Furthermore, a pre-formulation of empty liposomes is available (LIPOID Liposome Basic), that can be mixed with a wide range of active ingredients. It allows an easy and quick development of individual liposomal products. The electron micrographs at the bottom confirm that LIPOID Liposome Basic remain unchanged after dilution.

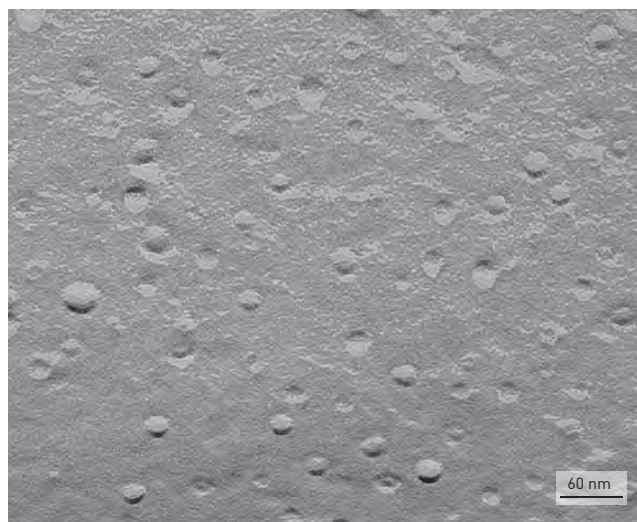
A selection of products, suited for the preparation of liposomes:

NON-GMO SOYBEAN	
LIPOID P 45	Fatfree soybean lecithin with 45 % phosphatidylcholine (non-GMO)
NON-GMO SUNFLOWER	
LIPOID H 90	Phosphatidylcholine from sunflower lecithin with ≥ 90 % phosphatidylcholine (non-GMO)
NON-GMO LIPOSOMAL PRE-FORMULATION	
LIPOID Liposome Basic	Pre-formulated empty liposomes with soybean phospholipids (non-GMO) in glycerine

Many more products are available on request.



Electron micrograph of LIPOID Liposome Basic



Electron micrograph of diluted LIPOID Liposome Basic

Frame Formulations for Functional Applications

1. Liposome Formulation with Vitamin C – based on LIPOID P 45

Phase	Ingredient	% w/w
A	Sodium Ascorbate	10.0
A	Potassium Sorbate	0.2
A	Deionized Water	75.0
B	Citric Acid	0.2
C	LIPOID P 45	10.0
D	Deionized Water	4.6

Procedure

- Dissolve components A in water at room temperature
- Add B and dissolve
- Add C to phase AB and disperse completely while stirring
- Adjust pH value 5.5 with B
- Add D to phase ABC with stirring
- Homogenize with a rotor-stator mixer while cooling

Technical Data

- Appearance: brown, milky liquid
- pH value: approx. 5.5
- Liposome size: around 250 - 300 nm

2. Liposome Formulation with Glutathione – based on LIPOID H 90

Phase	Ingredient	% w/w
A	LIPOID H 90	10.0
A	Ethanol	10.0
B	Glutathione	4.50
B	Deionized Water	65.50
C	Sodium Hydroxide	q.s.
D	Deionized Water	add to 100 %

Procedure

- Dissolve LIPOID H 90 in ethanol
- Dissolve glutathione in water
- Adjust pH value 6.0 with C
- Add phase BC to A while stirring
- Adjust pH value 6.0 of phase ABC and add the missing amount of water
- Homogenize with a rotor-stator mixer while cooling

Technical Data

- Appearance: white, milky liquid
- pH value: approx. 6.0
- Liposome size: around 250 - 300 nm

3. Liposome Formulation with Vitamin B Complex – based on LIPOID Liposome Basic

Phase	Ingredient	% w/w
A	Niacinamide (Vitamin B3)	0.32
A	Thiamine (Vitamin B1)	0.022
A	Pyridoxine HCl (Vitamin B6)	0.028
A	Cyanocobalamin (Vitamin B12)	0.00005
B	LIPOID Liposome Basic	add to 100 %

Procedure

- Dissolve components A in B at room temperature
- Vitamin B12 can be pre-dissolved in a minimal amount of water, if necessary

Technical Data

- Appearance: brown, clear, viscous liquid
- pH value: approx. 5.3
- Liposome size: around 30 - 50 nm

Regulatory

All products

Safety	We affirm that these products are non-toxic, safe and suitable for the intended use.
Non-GMO	All products meet the non-GMO standards set by Regulation (EC) No. 1829/2003.
Vegan	All products can be used in vegan formulations.
LIPOID P 45	Ingredients: Soybean lecithin (non-GMO), natural mixed tocopherols.
LIPOID H 90	Ingredients: Phosphatidylcholine from sunflower lecithin (non-GMO), natural mixed tocopherols. LIPOID H 90 does not contain any allergens.
LIPOID Liposome Basic	Ingredients: Glycerine, soybean phospholipids (non-GMO), natural mixed tocopherols, water, sodium chloride.



NATURAL &
SUSTAINABLE



NO HARMFUL
CHEMICALS



REUSAGE
OF WASTE



VEGAN



CERTIFIED



NON-GMO

References

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- [3] Cryer, B., Bhatt, D. L., *et al.* (2011). Low-dose aspirin-induced ulceration is attenuated by aspirin-phosphatidylcholine: A randomized clinical trial. *The American Journal of Gastroenterology*, 106(2), 272.
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- [5] EFSA panel on dietetic products, nutrition and allergies (NAD) 2011. Scientific opinion on the substantiation of health claims related to choline. *EFSA Journal* (2011); 9(4), 2056.

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Manufacturing in three plants in Germany.

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