Exosome-based personalised skincare

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Exosomes are – in terms of their origin – not a new technical development in skincare. They have long been a component of many herbal preparations – without manufacturers and users being aware of it. The fact that they have now become the focus of interest is due to further developments and findings resulting from the use of physiological biomembranes.

It is striking that the number of biological "micro" bodies has increased exponentially in recent decades. Their names share the suffixes "-some" (singular) and "-somes" (plural). To maintain a clear overview, it makes sense to take a closer look at some of these bodies (soma = body; Greek: σῶμα), often also referred to as microbodies.

Cytosomes

Microbodies are biomembranes (Figure 1) that are organised in cell-like, snake-like or exposed fragment forms and occur within the cells of living organisms. Metabolic reactions are catalysed enzymatically on or within these membrane bodies, which consist largely of phosphatidylcholine bilayers and proteins. For this reason, by analogy with the large organs of the body, they are also referred to as organelles (small organs, Figure 2), or cytosomes, of plant and animal cells. The spherical cytosomes (Ø 200–1500 nm[1]) include, among others:

- Aminosomes (Ø approx. 500 nm) are found in mast cells and contain biogenic amines, which are responsible for allergic reactions.
- Glyoxysomes in plant cells are capable of β-oxidation (fatty acid breakdown) and are involved in the glyoxylate cycle (similar to the citric acid cycle).
- Hydrogenosomes (Ø approximately 1000 nm) are related to mitochondria and enable micro-organisms to survive under anaerobic conditions.
- Lysosomes (Ø 100–1000 nm) contain hydrolases such as proteases and lipases, which break down proteins and lipids.
- Oleosomes serve to store lipids in organisms and possess phosphatidylcholine monolayers instead of bilayers
- Peroxisomes (Ø 100–1000 nm) enable the oxidative breakdown of intracellular substances with the aid of oxygen and hydrogen peroxide.

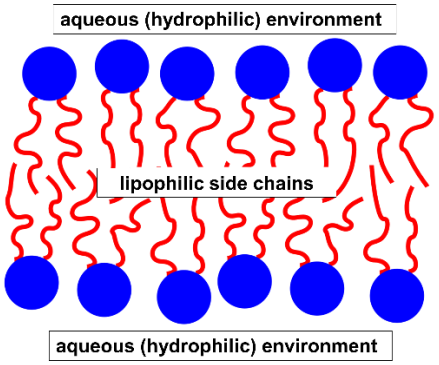

Figure 1 shows a diagram of the lipid bilayer of a biomembrane with the polar head groups (blue) and the non-polar side chains (red) [2]

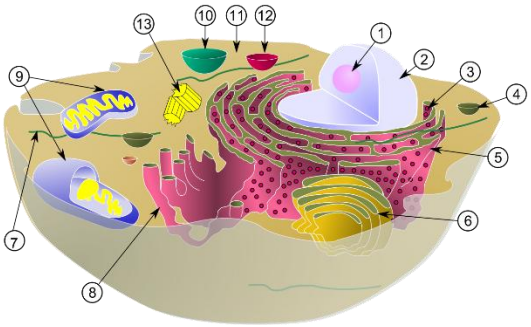

Figure 2 shows a schematic diagram of an animal cell: 1 nucleolus, 2 cell nucleus, 3 ribosomes, 4 vesicles, 5 rough endoplasmic reticulum, 6 Golgi apparatus, 7 microtubules, 8 smooth endoplasmic reticulum, 9 mitochondria, 10 lysosome, 11 cytosol, 12 peroxisome and 13 centrioles[3]

[1] 1 nm = 10^{-9} m = 0.000000001 m; 1 nanometre is equal to one billionth of a metre

[2] https://commons.wikimedia.org/wiki/File:Lipid_bilayer_fluid.svg#/media/File:Lipid_bilayer_fluid.svg (Olaf Lenz)

[3] https://commons.wikimedia.org/wiki/File:Biological_cell.svg (Messerwoland and Szczepan 1990)

Other "somes"

Examples of non-spherical structures include:

- Glycosomes are wave-shaped biomembranes found in pathogens such as Trypanosoma. They facilitate glycolysis, i.e. the breakdown of glucose into lactic acid, for example.
- Microsomes are, like glycosomes, exposed biomembranes. They contain cytochrome P450 enzymes.
- Mitosomes are organelles with functional biomembranes in single-celled organisms that do not contain mitochondria.
- Ribosomes do not contain biomembranes, but rather macromolecules on the surface of which proteins are synthesised.
- Trypanosomes are curved, cell-like bodies found in certain single-celled organisms.

Exosomes

Exosomes (30–90 nm; Figure 3) are generally smaller than cytosomes but have a similar double-layered, spherical structure. They are also formed within cells but are released (exocytosis) as required and delivered to the cell's surroundings.

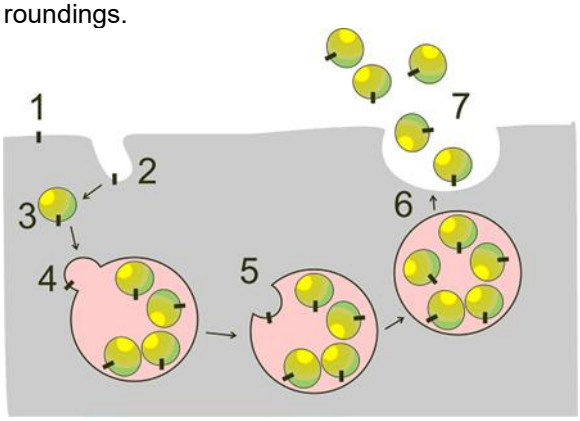

Figure 3 illustrates the formation and release of exosome vesicles[4]

Exosomes naturally perform transport and messenger functions by containing bioactive signalling molecules that communicate with other cells.

Note: The **term "exposome"**, which sounds almost identical, essentially refers to everything that affects us humans from the outside. In other words, it refers to the sum of all environmental influences – consisting of material and physical external factors.

Liposomes & Co

Artificial biomembranes have long been in use, operating on a similar physical principle to exosomes, namely the effective transport (carrier) of cosmetic or pharmaceutical active ingredients into the skin. The scales and nomenclature are correspondingly comparable:

- Liposomes are spherical biomembranes which, like the bilayers of cytosomes and exosomes, consist of phosphatidylcholine (PC). They transport and encapsulate hydrophilic active ingredients.
- Nanosomes are a synonym for PC-containing nanoparticles, also known as nanodispersions, which resemble oleosomes. They transport and encapsulate lipophilic active ingredients. In contrast to the double membranes of liposomes (bilayers), their surface consists of a PC monolayer, as in oleosomes.
- Niosomes are similar to liposomes. They consist of special niotensides (non-ionic surfactants) rather than PC and are rarely still in use.
- Transfersomes[5] belong to the liposome family, are comparatively large and, in addition to PC, contain other membrane-stabilising excipients (and, like niosomes, surfactants where applicable). They also serve as active ingredient carriers for topical preparations.

Fusion with the skin barrier

Both exosomes derived from natural sources, with their specific contents, and artificial particles loaded with active ingredients are of great interest, as both are capable, through their biomembranes, of fusing with the related bilayers of the skin barrier. It is mainly the unsaturated phosphatidylcholine contained in the biomembranes that lowers the phase transition temperature of the skin barrier bilayers.[6]
The result is increased permeability of the skin barrier. The active ingredients of natural or synthetic origin contained in the carriers can

[4] https://commons.wikimedia.org/wiki/File:Exosoma_vesicle_miguelferig.jpg#/media/File:Exosoma_vesicle_miguelferig.jpg (miguelferig)
[5] G. Cevc, D. Gebauer, J. Stieber, A. Schätzlein and G. Blume, Ultraflexible vesicles, Transfersomes, have an extremely low pore penetration resistance and transport therapeutic amounts of insulin across intact mammalian skin, Biochim Biophys Acta 1998, 1368 (2), 201-15
[6] H. Lautenschläger, Die Haut und ihre Pflege – Physiologie und Chemie im Einklang? Chemie in unserer Zeit, 55 (5), 306-319

penetrate more easily or even permeate, i.e. enter the bloodstream. This principle of enhanced penetration is widely used in cosmetics and medicine.

Cosmetic use

As mentioned at the outset, the plant-derived exosomes found in cosmetics are not new and are present, for example, in cold-pressed plant juices in the form of vacuoles (Figure 4). They are enriched, for example, by ultrafiltration or extracted from high-pressure homogenates and contain phosphatidylcholine (PC) with its essential fatty acids (linoleic acid, alpha-linolenic acid) as well as the full spectrum of plant constituents – alongside enzymes, antioxidants and minerals. The enhancement of topical penetration depends on the PC content, which is why the artificial liposomes and nanodispersions produced from (soya) PC are far more effective in terms of their carrier function.

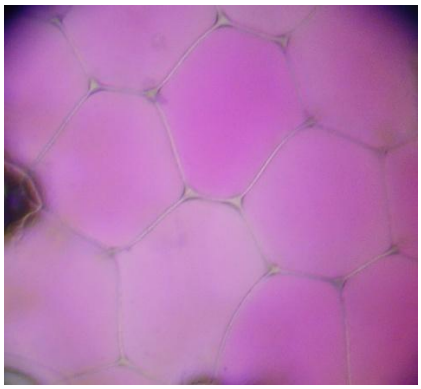

Figure 4 shows a vacuole, a cell organelle enclosed by a cell membrane[7]

Exosomes and their contents are said to have specific cosmetic effects, but these have not been causally proven in any way. Even the question of the concentration of the particles, as well as the concentrations of the plant-based ingredients highlighted by marketing, usually remains unanswered.
Ultimately, one can expect effects similar to those of ordinary plant extracts, which are processed in various ways.

In contrast, the situation with liposomes and nanosomes is entirely different. They are loaded with defined concentrations of active ingredients according to the desired effect at the target site and demonstrate high bioavailability.
Due to their structure, exosomes, liposomes and nanosomes are compatible with lamellar, PC-containing cream bases, meaning they can be mixed together. Lamellar creams behave in a similar way to the bilayers of the skin barrier by fusing with the added biomembranes. In this way, modular systems can be created for use in personalised skincare.[8] A key advantage is the ability to precisely and continuously adjust the level of skin protection, the skincare properties and the active ingredient dosages of the formulations.
Marketing departments are keen to adopt physiological terminology, for example for nano- and conventional oil-in-water emulsions, by referring to them as oleosomes. It is certainly advisable to take a closer look in such cases.

Medical use

Animal or even human exosomes are not used in cosmetics. The situation is quite different in aesthetic medicine, which in turn prepares specific, personalised exosome concentrates and uses them for various purposes.[9] They can be isolated and processed from bodily fluids (e.g. blood), tissue, and a wide variety of cells (e.g. platelets). Consequently, their applications, whether applied topically or via injection, are highly versatile for skin regeneration and to combat:

- Skin ageing
- Inflammation
- Hair loss
- Hyperpigmentation

Here too, extrapolating from studies to individual treatments leaves many questions unanswered. Particularly in the aesthetic sector, as with cosmetic treatments, high prices are accompanied by high expectations.

Dr Hans Lautenschläger

[7] https://commons.wikimedia.org/wiki/File:Rhoeo_Discolor_epidermis.jpg#/media/File:Rhoeo_Discolor_epidermis.jpg (Markus Nolf)
[8] H. Lautenschläger, Personalisierte Hautpflege – technologische und rechtliche Voraussetzungen, Medical 2025 (2), 15–19 and 2025 (3), 20–21
[9] M. L. Storre, Trend-Therapie Exosomen, Ästhetische Dermatologie & Kosmetologie 2025 (4), 17