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Original Article

The Nanotechnology Revolution in Cosmeceuticals: A Comprehensive Overview

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ABSTRACT

A growing number of product categories are seeing a trend towards cosmetics based on nanoparticles. Numerous local and international firms are using nanotechnology as a creative way to provide high-quality and effective cosmetic goods. Cosmeceuticals, which are defined as cosmetic products with drug-like properties and whose use has increased over time, are the newest and fastest-growing sector of the health care business. Within the field of cosmeceuticals, nanotechnology has significant importance. Nanotechnology-based cosmetics provide a number of benefits, including increased medication absorption and extended cosmetic effects. This overview describes the several types of nanocarriers used in cosmetics, the products based on nanotechnology that are now available in the market, and current developments in nanotechnology.

Keywords: Cosmeceuticals, Nanocarriers, Nanoparticles, Skin delivery systems, Cosmetic nanotechnology

INTRODUCTION

The field of technology known as nanotechnology is concerned with the creation of structures that are shorter than 100 nm [1]. It is the process of working with matter at the atomic or molecular level in at least one dimension, with sizes ranging from 1 to 100 nm. Because it covers fields like organic chemistry, surface science, molecular biology, etc., applied science is extraordinarily wide [2][3]. Nanotechnology aids in the cellular level reversal of ageing. To protect the skin from the damaging effects of sunshine, cosmetics are now formulated with nanotechnology. Many forms of nanomaterials and nanocarriers, such as liposomes, niosomes, solid lipid nanoparticles (SLN), nanospheres, nanoemulsions, gold nanoparticles, dendrimers, etc., are utilised in cosmetics. Products used to enhance the appearance of the skin are called cosmetics [4]. The external preparation that is applied to the body's exterior is known as cosmetics [5][6]. "Particles intended to be applied onto human bodies or any part thereof for cleansing, beautifying, promoting attractiveness, or altering the appearance" is how the Food and Drug Administration (FDA) defines cosmetics (U. S. Food, and Drug Administration, 2018) [7]. These days, makeup is seen as a necessary component of life. They contribute to the physiological effect in addition to drawing people towards it. It has received a lot of attention from both men and women throughout the past two to four decades [8]. Cream and powder cosmetics are the most often used types. A cosmetic product with potential therapeutic or drug-like properties is called a cosmetic [9]. It can be chemically synthesised or obtained naturally. In the 1990s, the terms "cosmeceuticals" and "pharmaceuticals" were combined [10].

Two categories exist for nanoparticles:

1. **The nanosphere**
2. **Little capsules**

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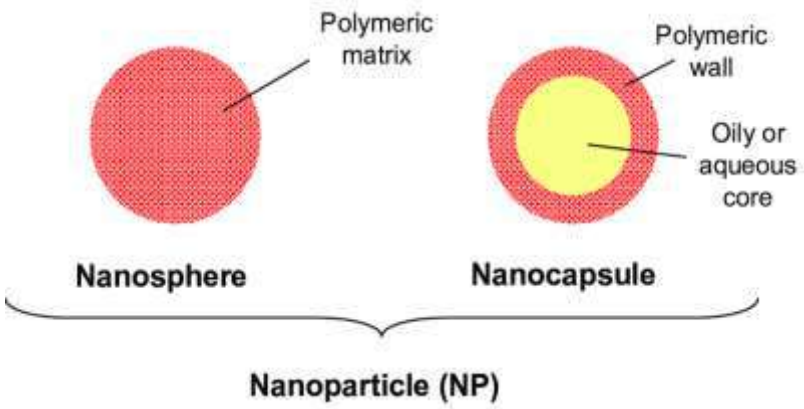
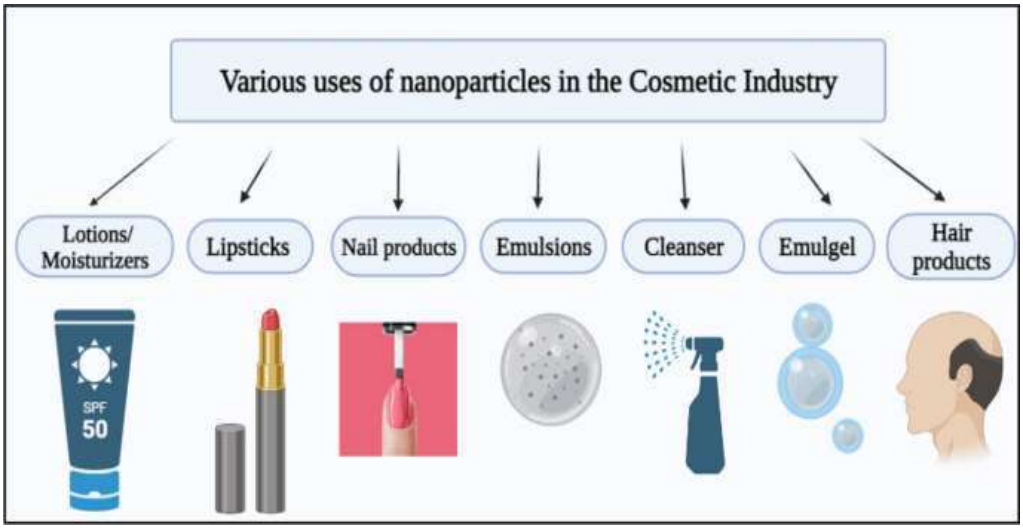


Nanospheres are characterised as homogeneous matrix systems in which a solid sphere allows a dispersed or dissolved active component to be absorbed on the surface or confined inside the polymeric matrix structure [11]. Nanocapsules are colloidal nanobubbles having an aqueous or oily core encased in a polymeric membrane with particular characteristics [12].

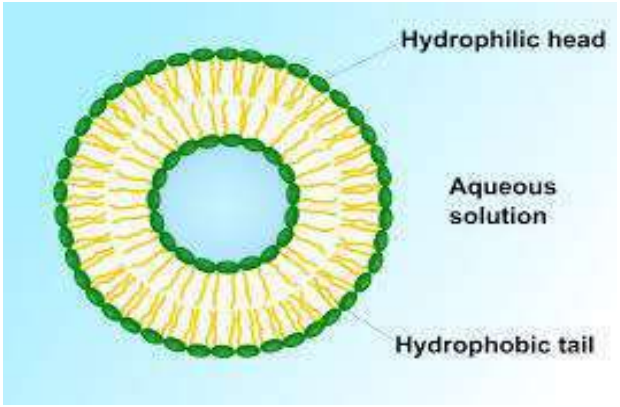
Types of Nanocarriers used for Cosmeceuticals

There are various types of novel carriers are used in cosmeceuticals as shown in figure



Liposome

Naturally non-toxic and biodegradable. A liposome, which is short for lipid body, is a vesicle made of lipid bilayer that encloses an aqueous compartment. Phospholipid is the most often utilised lipid, although liposomes may also be made with sterols, glycolipids, and sphingolipids. They are between 25 to 5000 nm in size. The biological membrane can be broken down to prepare liposomes (such as via Sonication) [13, 14].



Benefits:

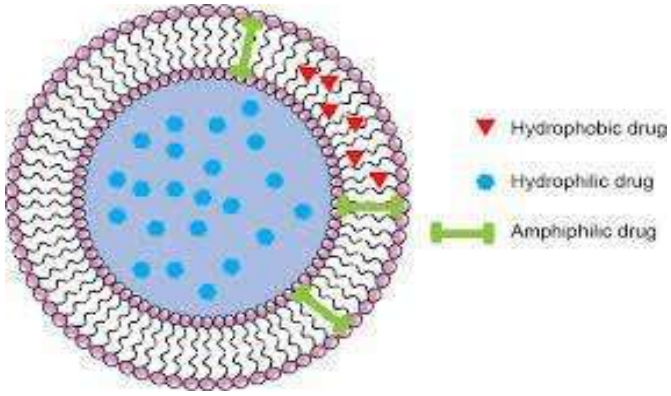
1. Liposomes have the ability to transport and encapsulate substances that are soluble in water in their polar cavity and substances that are soluble in oil in their hydrophobic cavity [15].
2. Liposomes used the encapsulating process to boost the medication's stability [16].
3. Offers selective targeting, such as liposomal doxorubicin, to the tumour tissues [17].

Product name	Marketed by
Moisture Liposome	Cosme decorate
Liposome Day Cream	Janice carol
AzelacRU Liposomal Serum	Sesderma
Herbal Liposomal toner	Arboretum skincare
Dermosome	Microfluidics

Niosome

Non-ionic surfactants and cholesterol combine to form the tiny lamellar structures known as niosomes [18]. The structure of the amphiphilic bilayers in niosomes is such that the hydrophilic drug will be imprisoned inside and outside of the vesicles by polar regions, while the hydrophobic drug can be entrapped inside non-polar regions generated inside the bilayers, as demonstrated [19].

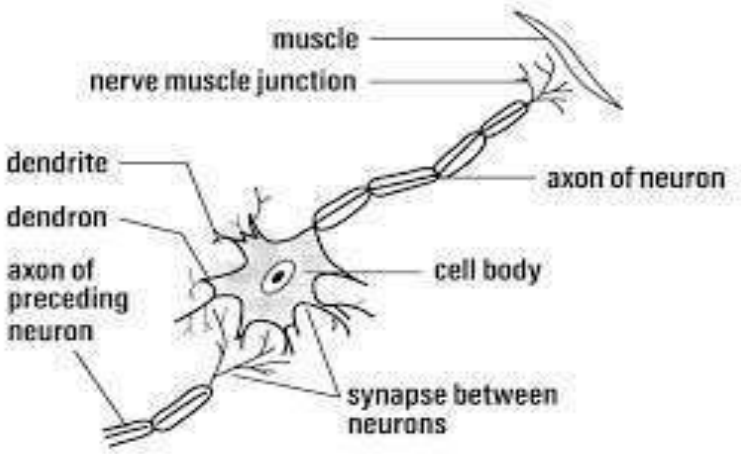
Product name	Marketed by
Identik masque floral repair	Identik
Absolute white cream	Lancome
Niosome +	Lancome



Various Marketed formulations of Niosomes

Dendrimers

Artificial polymers having branching arthicetures are called dendrimers. Their name comes from the Greek word "dendron," which means "tree" and describes the unique way the polymer units are arranged. Their unique characteristics, which include their nanoscale size, monodispersity, water solubility, manipulable surface modification, and multivalency, have primarily led to their application in drug delivery studies. Fritz made the first dendrimers. In 1978 saw Vögtle, and 1981 saw R.G. Denkewalter at Allied Corporation. Identical pieces known as dendrons are discovered when the core of a dendrimer is removed. The number of dendrons varies according on how many central cores there are (2, 3, 4, or more). Three distinct zones will be found in a dendron: the core, inner branches, and finish groups (periphery). A dendron's generation is determined by the number of branch points that extend from its centre to its margins (G-1, G-2, G-3, G-4, G-5). Compared to dendrimers of lower generations, those of upper generations are bigger, more branched, and have more finish groups at their edge [20, 21–22].



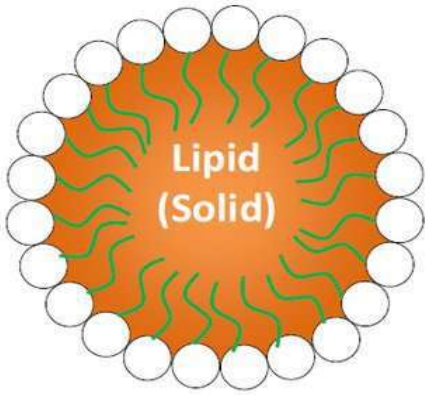
Solid Lipid Nanoparticles (SLN) are submicron colloidal carriers with a size range of 50 to 1000 nm. They are made up of physiological lipids that have been disseminated in water or an aqueous surfactant solution. [23, 24, 25].

Benefits of SLN [26, 27].

1. Greater control over the encapsulated chemicals' release kinetics.
2. No need for an extra solvent.
3. Extremely high stability throughout time.

The drawbacks of SLN [28, 29].

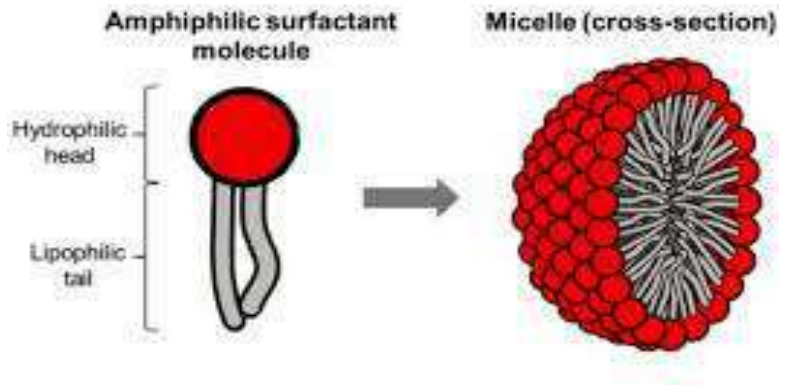
1. Unexpected tendency towards gelatin.
2. Particle Development



Gold Nanoparticles

Colloidal gold, another name for gold nanoparticles, are tiny gold particles with a diameter of 1 to 100 nm that are dissolved in water [30]. By altering their size, shape, and surface chemistry, gold nanoparticles can have compatible optical and electrical characteristics. Owing to their potent antifungal and antibacterial characteristics, gold nanoparticles have gained significant use in the cosmetic industry. Lotions, anti-aging creams, deodorants, and other goods include these nanoparticles [31]. Large companies such as L'Oreal Paris use gold nanoparticles to create the best lotions and creams possible [32]. Polymersomes are a type of artificial vesicles that are made of small, hollow spheres that contain solutions. Polymersomes are formed of utilising amphiphilic synthetic block copolymers to create the vesicle membrane, and should have radious spanning from 50 nm to 5 µm or more [33,34]. Their thick and stiff bilayer gives them more stability than liposomes. The majority of polymersomes that have been documented have an aqueous solution at their centre, and they are excellent for encasing and protecting delicate substances including medications, enzymes, other proteins and peptides, and snippets of DNA and RNA [35, 36]. The polymer some separates the substance that is enclosed from exterior materials—like those that are present in biological systems—by providing a physical barrier. The cosmetics industry regularly uses

polymerosomes, and several It has a filed patent [37, 38]. The nanoemulsion An oily phase that is disseminated in an aqueous phase or an aqueous phase that is distributed in an oily phase, creating droplets or oily phases of nanometric sizes, is what constitutes an isotropic dispersed system of two non-miscible liquids. In general, nanoemulsions load oleophilic active substances more readily than microemulsions, which may be advantageous in some situations [39]. Unlike microemulsions, which need a large amount of energy to produce, nanoemulsions are thermodynamically unstable entities [40]. Phase-inversion temperature approach, micro fluidization, and high-pressure homogenisation are the three techniques most often employed to create nanoemulsions [41].



Product name	Marketed by
Vitacos Vita Herb Nano vital whitening cream	Vitacos Cosmetics
Vitacos Vita Herb Nano vital whitening Essence	Vitacos Cosmetics
Vital nanoemulsion A-VC	Marie Housie
Nanocream	Sinerga

Various Marketed Formulation of Nanoemulsion

Lipid carriers with nanostructure (NLC)

The delivery method known as nanostructured lipid carriers (NLC) is made up of partially crystallised lipid particles that range in size from 100 nm to 200 nm and are distributed in an emulsifier-containing aqueous phase [42]. NLC is mostly composed of lipids, water, and emulsifier. Particle sizes range from 10 to 1000 nm. It can be used topically, intravenously, orally, or through the eyes [43]. Based on its structure, NLC was split into three categories: Imperfect Type, Multiple Type, and Amorphous Type.

Type 1: Imperfect Type

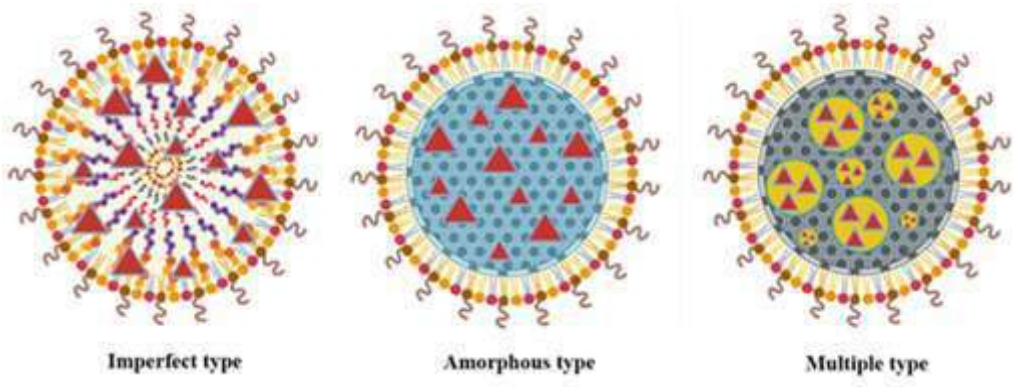
Solid and liquid lipids are blended.The difference in the structure of lipids and special requirements in the crystallization process lead to a highly imperfect lipid matrix[44]

Type 2: Multiple Type

The multiple oil/fat/water,drug can be accommodated in the solid, but at increased solubility in the oily parts of the lipid matrix.[45]

Type 3: Amorphous Type

Lipids are mixed in a way that prevents them from crystallizing. The lipid matrix is solid but in a amorphous state. Eg. Hydroxy Octscosanylhydroxy Stearate. [46]



Limitation of NLC

1. Poor Drug Loading Capacity.
2. Relatively High-water content of dispersions

3. Drug Expulsion after Polymeric Transition during Storage.

Product name	Marketed by
Regeneration cream	Scholl
Intensive serum Nano repair Q10	Dr. Rimpler
Iope supervital extra Moist eye cream	Amore pacific

List of Marketed products of NLCsssss

Major Classes of Nano cosmeceuticals

1. Sunscreen

Sunscreen, sometimes referred to as sunblock, is a type of topical preparation that comes in lotion, spray, gel, foam (such as whipped or expanded foam lotion), stick, or other form that either reflects or absorbs UV rays from the sun, helping to prevent sunburn. Additionally, wrinkles, dark patches, and sagging skin can be prevented or slowed down by diligent usage of sunscreen [47]. Sunblocks can be classified into two categories based on how they work: chemical sunscreens (such as UV organic filters, which absorb UV rays) and physical sunscreens (such as zinc oxide and titanium dioxide, which remain on the skin's surface and primarily deflect sunlight) [48].

2. Moisturizer

There are several types of moisturisers, including lotions, creams, ointments, bath oils, and soap alternatives. The most efficient emollient is petroleum jelly. Moreover, antioxidants, ceramides, emulsifiers, perfumes, humectants, penetration enhancers, preservatives, and solvents may be present in emollient cosmetics. Certain items are advertised as having anti-aging and skin-improving properties. There is less scientific evidence to support the numerous claims made about the advantages of plant and animal extracts for the skin [49]. The substances with the ability to draw water are called humectants [50]. Alpha hydroxyl acids are a significant class of humectants. Additional materials utilised include propylene glycol, urea, and glycerine [51].

3.Hair care

Hair care is the general word for cosmetology and hygiene that includes human scalp hair as well as, to a lesser extent, facial, pubic, and other body hair. Hair care practices might vary depending on a person's culture and, therefore, their physical hair type. Hair can be treated using waxing, sugaring, threading, shaving, colouring, plucking, and other methods [52]. Salons, barbershops, and day spas are the primary locations where hair care services are provided. Commercial items are also sold for use at home. There are two types of hair cosmetics: those that target the cortex (hair colour, bleaching chemicals) and those that target the exocuticle (shampoo, conditioner, serums, hair spray, waxes, gels) [53].

4.Lip Balm:

Balm's main function is to create an occlusive layer on the lip surface, which seals in moisture and protects the lips from the elements. Wind, freezing

temperatures, and dry air all drain moisture from the body, which dries out the skin[54]. Because the skin of the lips is so thin, they are particularly susceptible and frequently show indications of dryness first. While occlusive substances like petroleum jelly and waxes keep lips comfortable and stop moisture loss, flavourings, colourants, sunscreens, and other medications provide additional, targeted benefits. Lip balm can be applied straight from a tube resembling lipstick or anywhere a finger is used to apply it on the lips [55]. When lip balm first hit the market, even if earwax may be its source, it was developed in the 1880s by Charles Browne Fleet [56].

5. Nail care:

Another class that falls under cosmeceuticals is nair care. The advantage of using nanotechnology in nail polish formulation is that it improves durability and dries quickly [57]. maintenance for the toenails and fingernails. Bad nail care can lead to a number of nail problems. The following guidelines are followed to maintain the health of nails: use a fine-textured file to keep nails shaped and free of snags; cut nails straight across with only a slight rounding at the tip; and keep nails dry and clean to prevent bacteria and other infectious organisms from gathering beneath the nails [58].

6.Skin cleanser

The hydrolipid layer that covers the skin varies based on the body part and contains oleaginous gland secretions. A product that cleans or eliminates debris or other various items from the skin is referred to as a cleanser. For oily skin types, cleaners with active ingredients are better since they help stop breakouts. But they will overdry and aggravate dry skin, which might exacerbate how the skin looks and feels [59]. You may require a creamy lotion-type cleanser if your skin is dehydrated. For oily or even average skin, they are typically too mild; nonetheless, dry skin requires far less washing force. For dry, sensitive, or dehydrated skin, it might be wise to use an alcohol-free cleanser [60].

Various nanotechnology based cosmeceutical product in the market

Product Name	Marketed By	Marketing Claim	Uses
Primordial Optimum Lip	Lancome	It delivers vitamin E via nanocapsule technology to reduce the lip bleeding and feathering due to fine lines and wrinkles	Lip Treatment
Eye contour Nano lift	Euoko	Based on the Nanocapsules technology, it also provides instant smoothness, and gives radiance to the eye area and also dimishes the appearance of dark circle and puffiness	Antiwrinkle antiaging
Hydra Zen Cream	Lancome	Nanocapsules of pure vitaminE provide powerful antioxidant protection. A light touch of self-tanner ensure a natural, healthy glowing skin.	Moisturizer
Nano Gold Firming Treatment	Chantecaille	Small nanoparticles of pure gold are bound to silk microfibers to firm and Tone skin, while it delivers anti-inflammatory healing	Antiaging
Cosil whitening Mask	Natural Korea	It is made with the nanocolloidal silver used for the effect of getting ridof germs from your face, soothing the skin condition and keeping the skin radiant and soft	Facemask
LifePak Nano	Pharmanex	It is a nutritional antiaging program formulated to nourish and protect cells, tissues and organs in the body with the purpose of guarding against the ravages of aging	facegel
Dior Snow PureUV Base SPF 50	Dior	It contains nano Uv filters for Ultra protection against the damaging effects of UV rays	Sunscreen

Recent Advances in cosmeceuticals

A significant area of the development of nanotechnology has emerged for traditional sectors due to growing consumer demand for better products. [61] A report about Import Alert 66-38 for skin care items was recently released by the USFDA [62]. This is due to the fact that a variety of skin care products claim to be able to slow down the ageing process. As to the USFDA, a statement such as "molecules absorb and expand, exerting upward pressure to elevate wrinkles upward" might potentially indicate an interior structural alteration, which is necessary for a product to be classified as a medicine. According to the FDA, these assertions about cosmetic labelling are illegal. The legislation also mandates that any sunscreen and cosmetic product that is launched that contains nanoparticles be individually assessed for safety. Notification of cosmetic products using nanomaterials must be sent to the commission electronically, together with information on the product's identity, specifications, amount, pharmacological profile, safety information, and predicted exposure situations. A cosmetic product containing nanoparticles must be notified within six months after its release onto the market [63]. Many cosmeceuticals change the physiological processes in the skin, but their manufacturers don't conduct clinical research and make specific claims instead of putting their goods through the FDA's costly and drawn-out approval procedure. The cosmetics industry is facing novel and peculiar issues [64].

CONCLUSION

Nowadays, cosmeceuticals are a crucial component of aesthetic medicine, and their market share is growing daily. Because of the product's special category, patients can use cosmetics with active substances that are good to improve the look of their skin. Cosmetics based on nanotechnology have to be created and marketed with the utmost regard for both the environment and consumer health.

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