ROLE OF NANOTECHNOLOGY IN COSMECEUTICALS

KAJAL VISHWAKARMA, SWAROOP J CHATTRAJEE

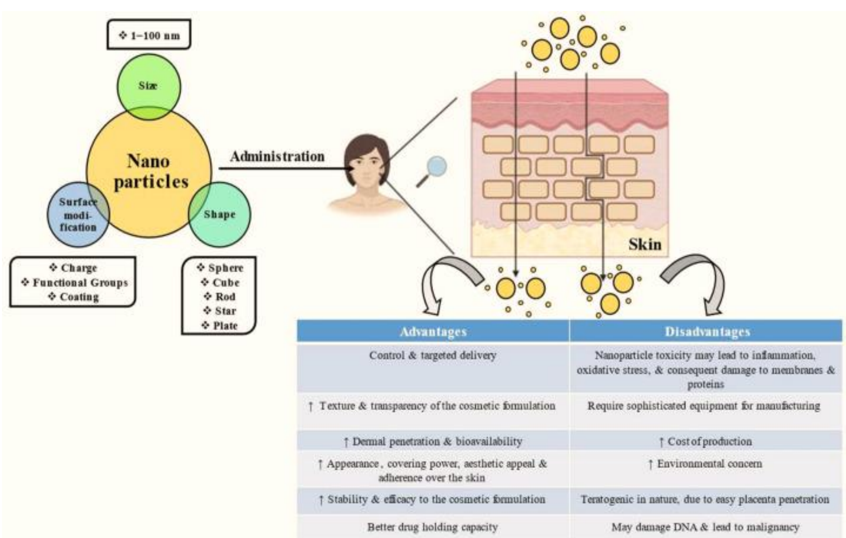
Abstract: Nano materials are materials having at least one dimension in the nano range and significantly distinct physiochemical properties these materials have been commonly used in the cosmetic industry for many years cosmetic incorporating nanomaterial so more advantage as compare to microscale cosmetics.

Keywords: Nanotechnology,Nanomaterial,Cosmetics,Cosmeceuticals,Nanocosmetics,Nanocosmeceuticals, Patent, Regulation, Health Hazards, Toxicity.

Introduction: Nanotechnology is regarded as the most imminent technology of 21st century and is contemplated as a big boon in the cosmetic industry. The term nanotechnology is the combination of two words: namely, technology and the Greek numerical “nano” which means dwarf. Thus, nanotechnology is considered as the science and technology used to develop or manipulate the particles in the size range of 1 to 100 nm. Since 1959, nanotechnology has emerged in different fields like engineering, physics, chemistry, biology, and science and it has been virtually 40 years since nanotechnology has intruded into the field of cosmetics, health products, and dermal preparations. During the era of 4000BC, the use of nanotechnology has been recorded by the Egyptians, Greek, and Romans, with concept of hair dye preparation utilizing nanotechnology.

Nanotechnology and nanodelivery systems are innovative areas of science that comprise the design, characterization, manufacturing, and application of materials, devices, and systems at the nanoscale level (1–100 nm). Nanotechnology, being recognized as one of the revolutionizing technologies, is extensively studied in the area of cosmetics and cosmeceuticals. The incorporation of nanotechnology has led to advancements in cosmetic science, resulting in increased consumer demand throughout the world. Presently, nanomaterials are attracting attention in this area, as they offer greater advantages over traditionally used cosmetic products. Further, the amalgamation of nanomaterials has greatly contributed to the global increase in the market share of pharmaceuticals and cosmetics. In the year 2019, the international market size of nanomaterials was estimated to be USD 8.5 billion and is expected to increase with up to a 13.1% compound annual growth rate from the years 2020 to 2027. Although the concept of nanomaterials (gold and silver nanoparticles) has been used in cosmetics for several years, the extensivity of applications has intensified in recent few years.

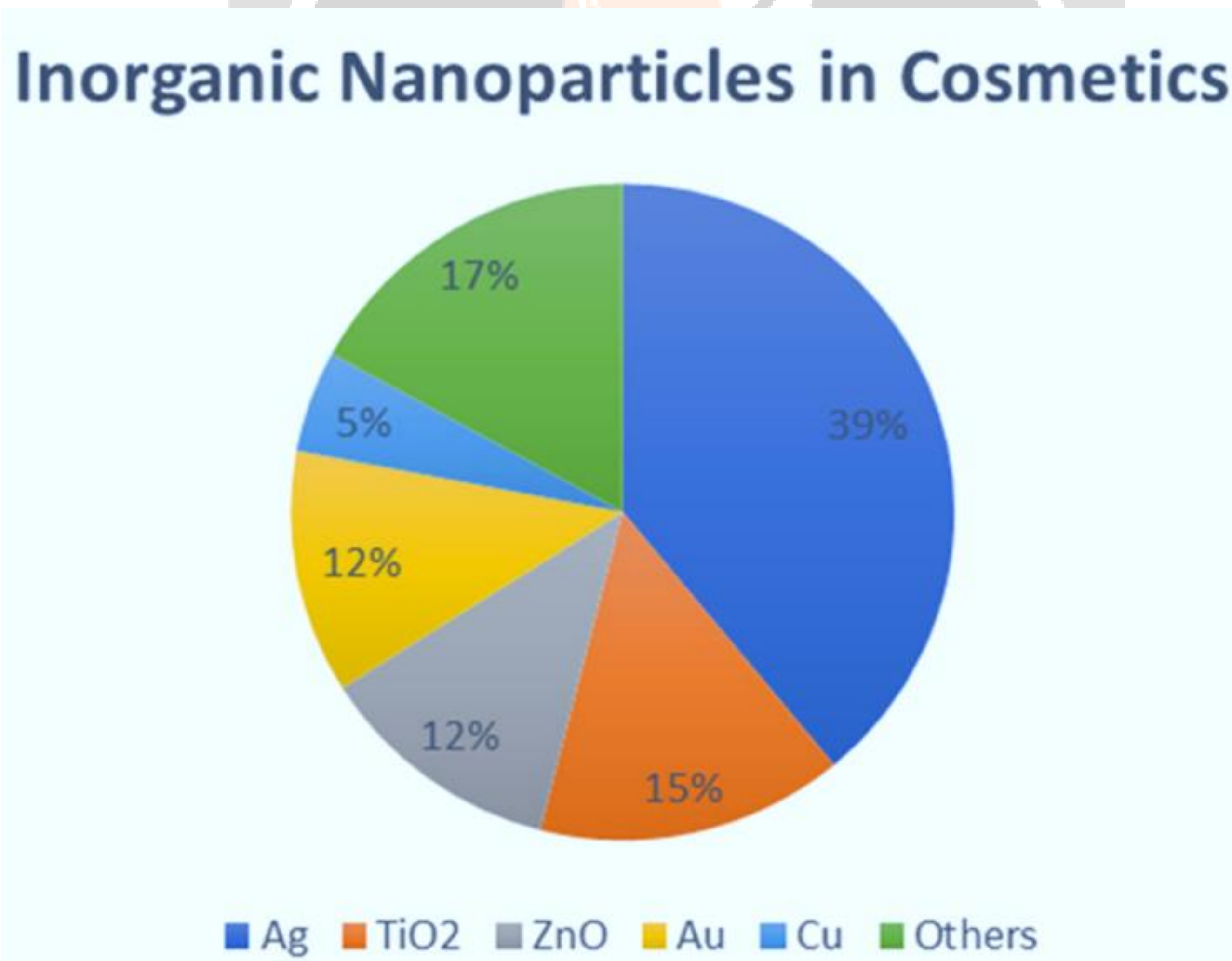
Advantages Of Nano cosmeceuticals:



Based on these facts, a narrative review of all of the relevant articles and reports was conducted by searching related keywords across different sources. Google Patents was used to collect data regarding related patents. Selected studies were compared and condensed to obtain a qualitative output based on existing theories and principles. The present review outlines various nanoparticles and nanodelivery systems used for cosmetic and cosmeceutical products, highlighting their positive and negative characteristics along with related patents. It also discusses the health and environmental risks linked with nanocosmeceuticals with suggested solutions. Further, the present review highlights the regulatory scenarios and compares the various regulations related to cosmetics. Additionally, it is intended to assist the industry and other stakeholders in identifying potential safety issues associated with nanomaterials in cosmetics. It also discusses various guidelines and recommendations prescribed by different regulatory agencies. Finally, this article aims to provide an overview of nanocosmetics and nanocosmeceuticals and their applications in cosmetic industries and suggest future directions, which may help consumers and regulators to gain awareness about the benefits as well as the toxicity related to the continuous and long-term uses of these products, thus encouraging their judicious use.

Nanomaterials Used In Cosmetics Product: Nanomaterials are materials having at least one dimension in the nano range and significantly distinct physicochemical properties. These materials have been commonly used in the cosmetic industry for many years. Cosmetics incorporating nanomaterials show more advantages as compared to microscale cosmetics. The large surface area of these particles is responsible for their efficient transportation, absorption, bioavailability, and transparency and the sustained effect of the product. However, consideration should be given to the concentration to circumvent the associated toxicity. The different nanomaterials used in the cosmetic industry.

Inorganic Particles: These are more hydrophilic, more biocompatible, safer, and exceptionally more stable particles as compared to natural nanoparticles. They can be significantly distinct, as these nanoparticles are derived from inorganic components (Ag, Au, Ti, etc.), while the natural ones are manufactured from polymers. Figure shows the percentages of different inorganic nanoparticles in cosmetic and cosmeceutical formulations.

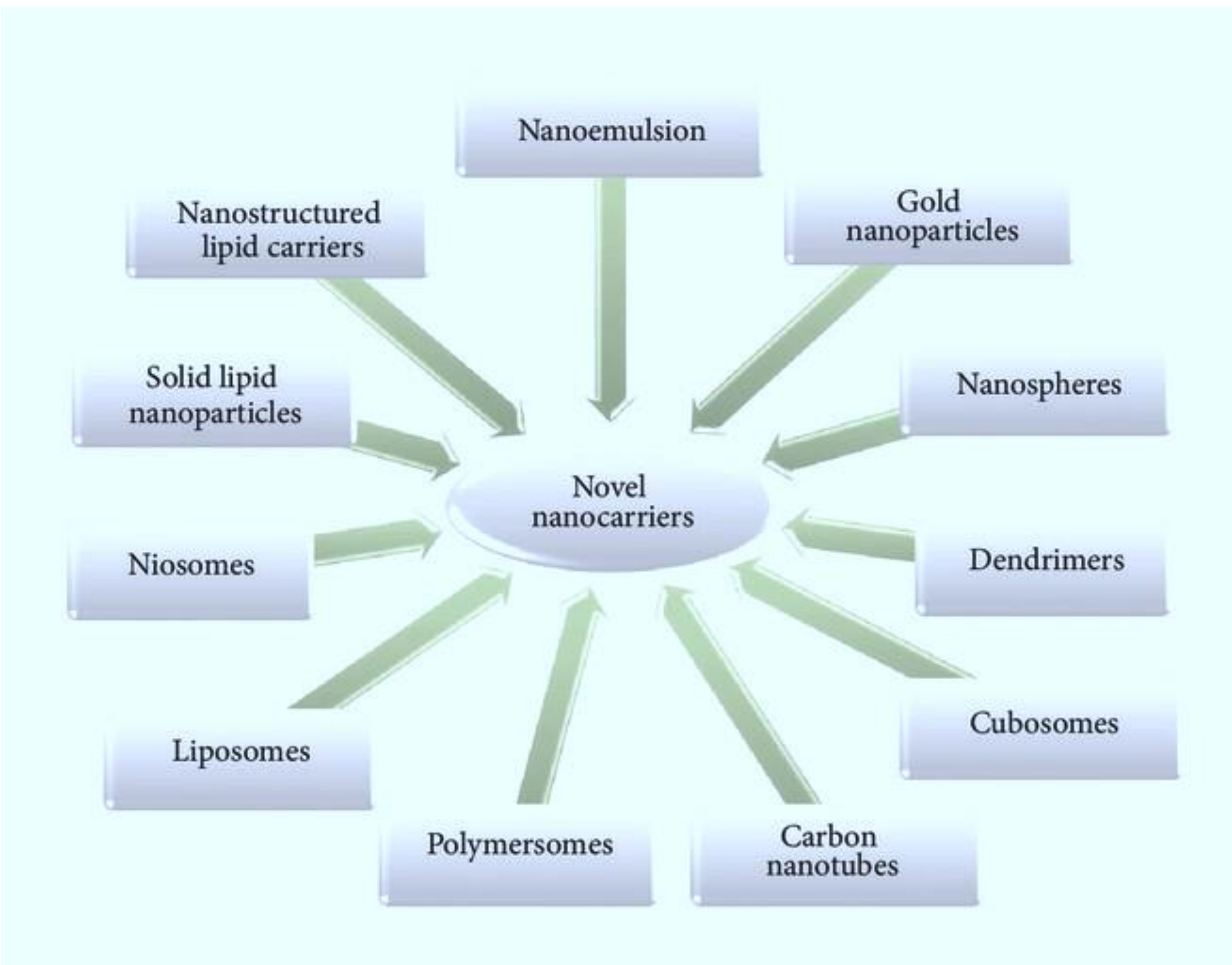


Proportions of different inorganic nanoparticles in cosmetics formulation

There are many inorganic nanoparticles used in cosmeceuticals. A few important particles are described below.

- Titanium Dioxide and Zinc Oxide.
- Gold and Silver Nanoparticles.
- Silica (SiO_2).
- Carbon Black.
- Nano-Hydroxyapatite.
- Nano-Organic (Tris-Biphenyl Triazine).
- Bucky Balls (Buckminsterfullerene/C60).
- Miscellaneous.

Novel Nanocarriers For Cosmeceuticals: For the delivery of nanocosmeceuticals, carrier technology is employed which offers an intelligent approach for the delivery of active ingredients. Various novel nanocarriers for delivery of cosmeceuticals .



Pictorial presentation of various nanocarriers for cosmeceuticals

Liposomes: Liposomes are most widely used for the cosmeceutical preparations. They are the vesicular structures having an aqueous core which are enclosed by a hydrophobic lipid bilayer. The main component of liposome lipid bilayer is phospholipids; these are GRAS (generally recognized as safe) ingredients, therefore minimizing the risk for adverse effects. To protect the drug from metabolic degradation, liposome encapsulates the drug and releases active ingredients in a controlled manner. Liposomes are suitable for delivery of both hydrophobic as well as hydrophilic compounds. Their size varies from 20 nm to several micrometers and can have either multilamellar or unilamellar structure.

Antioxidants such as carotenoids, CoQ10, and lycopene and active components like vitamins A, E, and K have been incorporated into liposomes, which are used to amplify their physical and chemical stability when dispersed in water.

Phosphatidylcholine is the key component of liposomes which has been used in various skin care formulations like moisturizer creams and so on and hair care products like shampoo and conditioner due to its softening and conditioning properties. Due to their biodegradable, nontoxic, and biocompatible nature, liposomes are used in variety of cosmeceuticals as they encapsulate active moiety. Vegetable phospholipids are widely used for topical applications in cosmetics and dermatology because of their high content of esterified essential fatty acids. For topical applications in cosmetics and dermatology vegetable phospholipids are being widely used as they have high content of esterified essential fatty acids. After the application of linoleic acid, within a short period of time the barrier function of the skin is increased and water loss is decreased. Vegetable phospholipids and soya phospholipids are used because of their ability to form liposomes and their surface activity. The transport of linoleic acid into the skin is done by these phospholipids. In a clinical study, it was proven that flexible liposomes help in wrinkle reduction and show effects like decreasing of efflorescence in the acne treatment and an increase in skin smoothness.

Liposomes are being developed for the delivery of fragrances, botanicals, and vitamins from anhydrous formulations, such as antiperspirants, body sprays, deodorants, and lipsticks. They are also being used in antiaging creams, deep moisturizing cream, sunscreen, beauty creams, and treatment of hair loss. Several positive and negative aspects of liposomes are discussed.

Niosomes: Niosomes are defined as vesicles having a bilayer structure that are made up by self-assembly of hydrated nonionic surfactants, with or without incorporation of cholesterol or their lipids.

Niosomes can be multilamellar or unilamellar vesicles in which an aqueous solution of solute and lipophilic components are entirely enclosed by a membrane which are formed when the surfactant macromolecules are organized as bilayer. Size ranges from 100 nm to 2 μm in diameter. Size of small unilamellar vesicles, multilamellar vesicles, and large unilamellar vesicles ranges from 0.025–0.05 μm, =>0.05 μm, and 0.10 μm, respectively. Major niosomes components include cholesterol and nonionic surfactants like spans, tweens, brijs, alkyl amides, sorbitan ester, crown ester, polyoxyethylene alkyl ether, and steroid-linked surfactants which are used for its preparation.

Niosomes are suitable for delivery of both hydrophobic as well as hydrophilic compounds. As a novel drug delivery system, niosomes can be used as vehicle for poorly absorbable drugs. It provides encapsulation to the drug, due to which the drug in the systemic circulation is for prolonged period and penetration is enhanced into target tissue. Niosomes overcome the problems associated with liposomes, like stability problems, high price, and susceptibility to oxidation. Niosomes are used in cosmetics and skin care applications since skin penetration of ingredients is enhanced because it possesses the property of reversibly reducing the barrier resistance of the horny layer, allowing the ingredient to reach the living tissues at greater rate. There is increased stability of entrapped ingredients and improvement in the bioavailability of poorly adsorbed ingredients. There are many factors affecting formation of niosomes, namely, nature and structure of surfactants, nature of encapsulated drug, membrane composition, and temperature of hydration which influences shape and size. Specialized niosomes are called proniosomes; these are nonionic based surfactant vesicles, which are hydrated immediately before use to yield aqueous niosome dispersions. To enhance drug delivery in addition to conventional niosomes, proniosomes are also being used.

Niosomes were first developed by L'Oreal in the year 1970 by the research and development of synthetic liposomes. Niosomes were patented by L'Oreal in the year 1987 and were developed under the trade name of Lancome. Various niosomes cosmeceuticals preparations are available in market, antiwrinkle creams, skin whitening and moisturizing cream, hair repairing shampoo, and conditioner. Several advantages and disadvantages of niosomes. Various marketed products and uses are discussed.

Solid Lipid Nanoparticles: An unconventional carrier system, solid lipid nanoparticle (SLN), was developed at the beginning of the 1990s, over the conventional lipoidal carriers like emulsions and liposomes. 50 to 1000 nm is the size range of solid lipid nanoparticles.

They are composed of single layer of shells and the core is oily or lipoidal in nature. Solid lipids or mixtures of lipids are present in the matrix drug which is dispersed or dissolved in the solid core matrix. Phospholipids hydrophobic chains are embedded in the fat matrix.

These are prepared from complex glycerides mixtures, purified triglycerides, and waxes; liquid lipid is replaced by solid lipid or blend of solid lipid which is solid at body and room temperature and is stabilized by surfactants or polymers. Lipophilic, hydrophilic, and poorly water-soluble active ingredients can be incorporated into SLNs which consist of physiological and biocompatible lipids. With the use of biocompatible compounds for preparing SLN, toxicity problems are avoided. Two principle methods for preparation of SLNs are high pressure homogenization method and precipitation method. Controlled release and sustained release of the active ingredients are possible; SLN which has drug enriched core leads to a sustained release and SLN having drug enriched shell shows burst release.

SLNs are popular in cosmeceuticals and pharmaceuticals as they are composed of biodegradable and physiological lipids that exhibit low toxicity. Their small size ensures that they are in close contact with the stratum corneum which increases the penetration of active ingredients through the skin.

SLNs have UV resistant properties and act as physical sunscreens on their own, so improved photoprotection with reduced side effects can be achieved when they are combined with molecular sunscreen. Solid lipid nanoparticles as carrier for 3,4,5-trimethoxybenzoylchitin and vitamin E sunscreen are developed to enhance UV protection. SLNs have occlusive property which can be used to increase the skin hydration, that is, water content of the skin. Perfume formulations also have SLNs as they delayed the release of perfume over longer period of time and are ideal for use in day creams as well.

They have better stability coalescence when compared to liposomes because they are solid in nature and mobility is reduced of the active molecules, so the leakage from the carrier is prevented . Benefits and drawbacks of SLNs are depicted. Different marketed products and their uses.

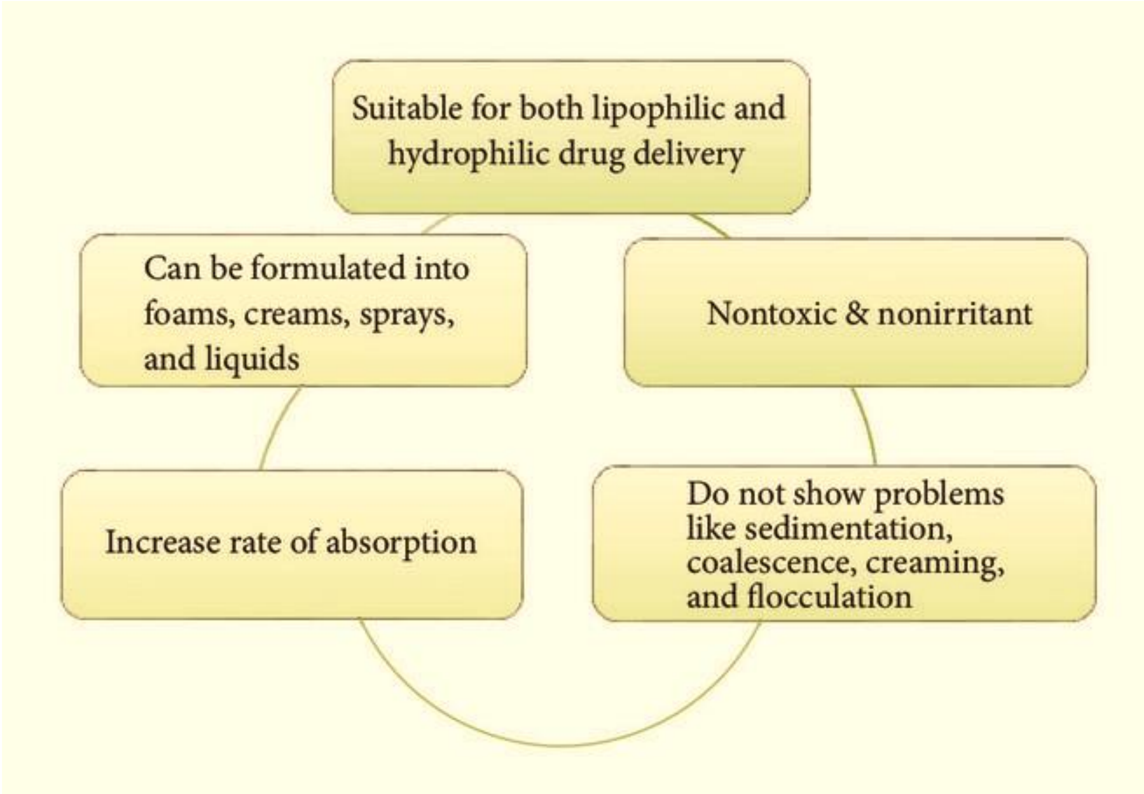
Nanostructured Lipid Carriers (Nlc): Nanostructured lipid carriers are considered as the second generation of the lipid nanoparticles. NLC have been developed so that the drawbacks associated with SLN can be overcome. NLC are prepared through blending by solid lipids along with spatially incompatible liquid lipid leading to amorphous solids in preferable ratio of 70 : 30 up to 99.9 : 0.1 being solid at body temperature. NLC are mainly of three types on the basis of which the structure is developed according to the formulation composition and production parameters, namely, imperfect type, amorphous type and multiple type. The particle size ranges from 10 to 1000 nm.

There is an increased scientific and commercial attention for NLC during the past few years because of the lower risk of systemic side effects. NLC when compared to SLN show higher drug-loading capacity for entrapped bioactive compound because of the distorted structure which helps in creating more space. Other limitations of SLN like reducing particle concentration and expulsion of drug during storage are solved by the formulation of NLC. They are formulated by biodegradable and physiological lipids that show very low toxicity. NLC have modulated drug delivery profile, that is, a biphasic drug release pattern; in this the drug is released initially with a burst followed by a sustained release at a constant rate. They possess numerous advantageous features like increased skin hydration due to occlusive properties, and the small size ensures close contact to the stratum corneum leading to the increased amount of drug penetration into the skin. There are stable drug incorporation during storage and enhanced UV protection system with reduced side effects.

In October 2005, the first products containing lipid nanoparticles were introduced in the cosmetic market, namely, NanoRepair Q10® cream and NanoRepair Q10® serum, Dr. Rimpler GmbH, Germany, offering increased skin penetration. Currently there are more than 30 cosmetic products available in the market containing NLC . Depiction of various positive aspects of NLC. List of marketed products, manufacturers.

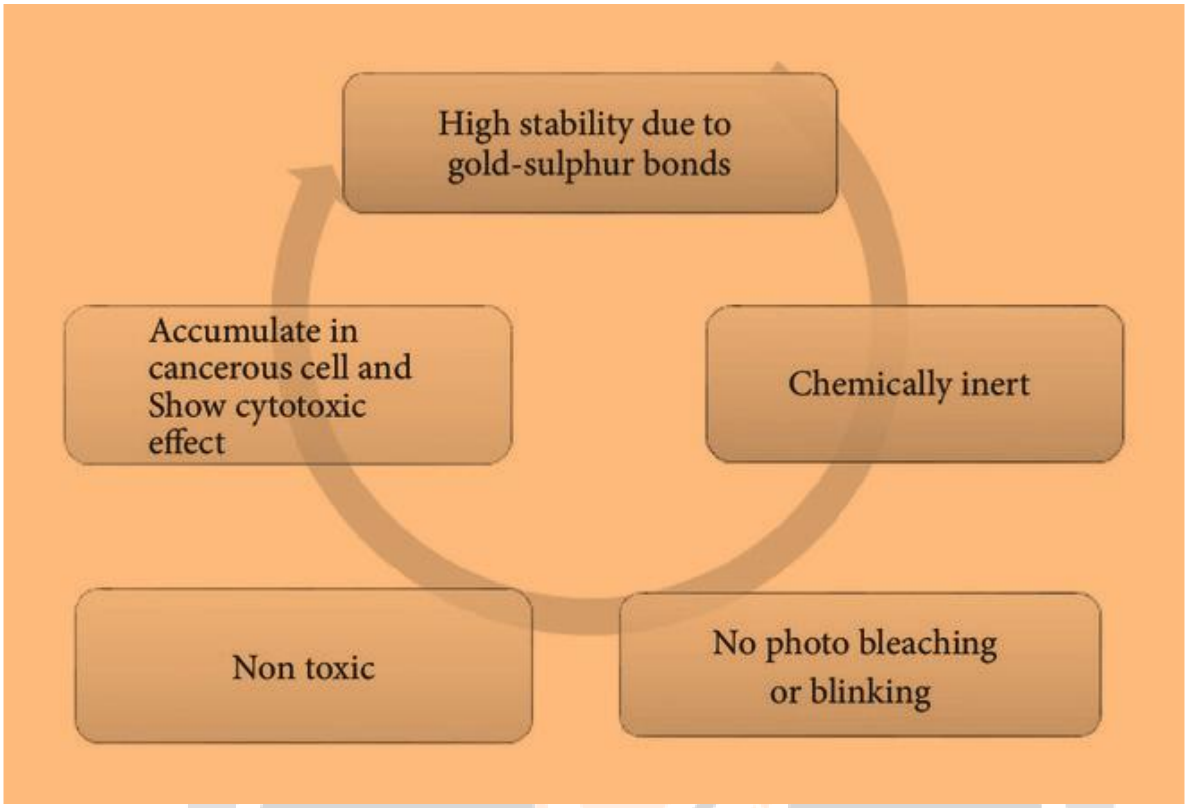
Nanoemulsions:

Nanoemulsions are considered as the kinetically or thermodynamically stable dispersion of liquid in which an oil phase and water phase are in combination with a surfactant. Their structure can be manipulated on the basis of method of preparation, so as to give different types of products. Depending on the composition different types of nanoemulsions are oil in water, water in oil, and bicontinuous nanoemulsion. They exhibit various sizes ranging from 50 nm to 200 nm. These are dispersed phase which comprises small particles or droplets, having very low oil/water interfacial tension. They have lipophilic core, which is surrounded by a monomolecular layer of phospholipids, making it more suitable for delivery of lipophilic compounds.



Gold Nanoparticles:

Nanogold or gold nanoparticles exhibit various sizes ranging from 5 nm to 400 nm. Interparticle interactions and assembly of gold nanoparticles play an important role in determination of their properties. They exhibit different shapes such as nanosphere, nanoshell, nanocluster, nanorod, nanostar, nanocube, branched, and nanotriangles. Shape, size, dielectric properties, and environmental conditions of gold nanoparticles strongly affect the resonance frequency. The color of nanogold ranges from red to purple, to blue and almost black due to aggregation. Gold nanoparticles are inert in nature, highly stable, biocompatible, and noncytotoxic in nature. Nanogold is very stable in liquid or dried form and is nonbleaching after staining on membranes; they are also available in conjugated and unconjugated form. They have high drug-loading capacity and can easily travel into the target cell due to their small size and large surface area, shape, and crystallinity



Nanospheres:

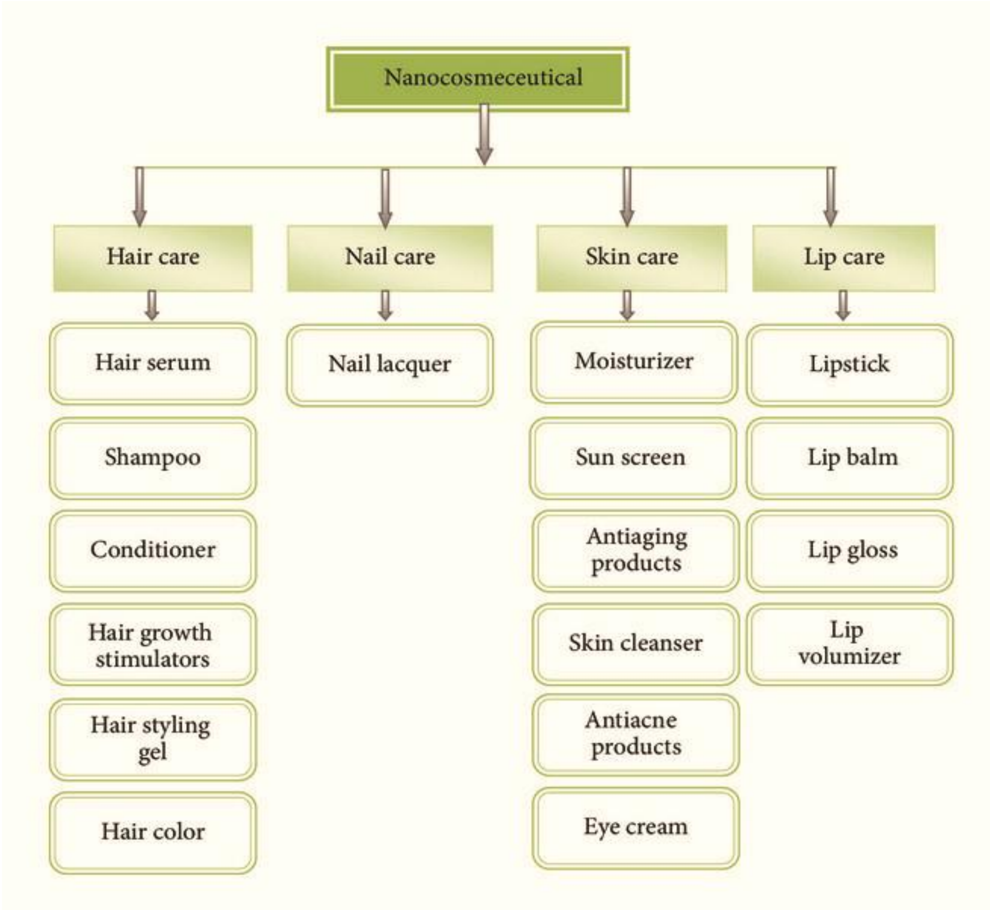
Nanospheres are the spherical particles which exhibit a core-shell structure. The size ranges from 10 to 200 nm in diameter. In nanospheres, the drug is entrapped, dissolved, attached, or encapsulated to the matrix of polymer and drug is protected from the chemical and enzymatic degradation. The drug is physically and uniformly dispersed in the matrix system of polymer. The nature of the nanospheres can be crystalline or amorphous. This system has great potential and is being able to convert poorly absorbed, labile biologically active substance and poorly soluble active substance into the propitious deliverable drug. The core of nanospheres can be enclosed with diverse enzymes, genes, and drugs.

Nanospheres can be divided into two categories: biodegradable nanospheres and nonbiodegradable nanospheres. Biodegradable nanospheres include gelatin nanospheres, modified starch nanospheres, and albumin nanospheres and nonbiodegradable nanospheres include polylactic acid, which is the only approved polymer.

In cosmetics, nanospheres are used in skin care products to deliver active ingredients into deep layer of the skin and deliver their beneficial effects to the affected area of the skin more precisely and efficiently. These microscopic fragments play a favorable role in protection against actinic aging. Use of nanospheres is increasing in the field of cosmetics especially in skin care products like antiwrinkle creams, moisturizing creams, and antiacne creams. Pictorial presentation of favorable aspects of nanospheres

Major Classes In Nanocosmeceuticals:

Cosmeceuticals are contemplated as the fastest growing segment of personal care industry. A plethora of nanocosmeceuticals are assimilated in nail, hair, lip, and skin care. Major classes in nanocosmeceuticals are depicted in Figure



Skin Care:

Cosmeceuticals for skin care products ameliorate the skin texture and functioning by stimulating the growth of collagen by combating harmful effect of free radicals. They make the skin healthier by maintaining the structure of keratin in good condition. In sunscreen products zinc oxide and titanium dioxide nanoparticles are most effective minerals which protect the skin by penetrating into the deep layers of skin and make the product less greasy, less smelly, and transparent.SLNs, nanoemulsions, liposomes, and niosomes are extensively used in moisturizing formulations as they form thin film of humectants and retain moisture for prolonged span. Marketed antiaging nanocosmeceutical products assimilating nanocapsules, liposomes, nanosomes, and nanospheres manifest benefits such as collagen renewal, skin rejuvenation, and firming and lifting the skin.

Hair Care:

Hair nanocosmeceutical products include shampoos, conditioning agents, hair growth stimulants, coloring, and styling products. Hair follicle, shaft targeting, and increased quantity of active ingredient are achieved by intrinsic properties and unique size of nanoparticles. Nanoparticles subsuming in shampoos seals moisture within the cuticles by optimizing resident contact time with scalp and hair follicles by forming protective film. Conditioning nanocosmeceuticals agents have purposive function of imparting softness, shine, silkiness, and gloss and enhance disentangling of hair. Novel carriers like niosomes, microemulsion, nanoemulsion, nanospheres, and liposomes have major function of repairing damaged cuticles, restoring texture and gloss, and making hair nongreasy, shiny, and less brittle.

Lip Care:

Lip care products in nanocosmeceuticals comprise lipstick, lip balm, lip gloss, and lip volumizer. Variety of nanoparticles can be coalesced into lip gloss and lipstick to soften the lips by impeding transepidermal water loss and also prevent the pigments to migrate from the lips and maintain color for longer period of time. Lip volumizer containing liposomes increases lip volume, hydrates and outlines the lips, and fills wrinkles in the lip contour.

Nail Care:

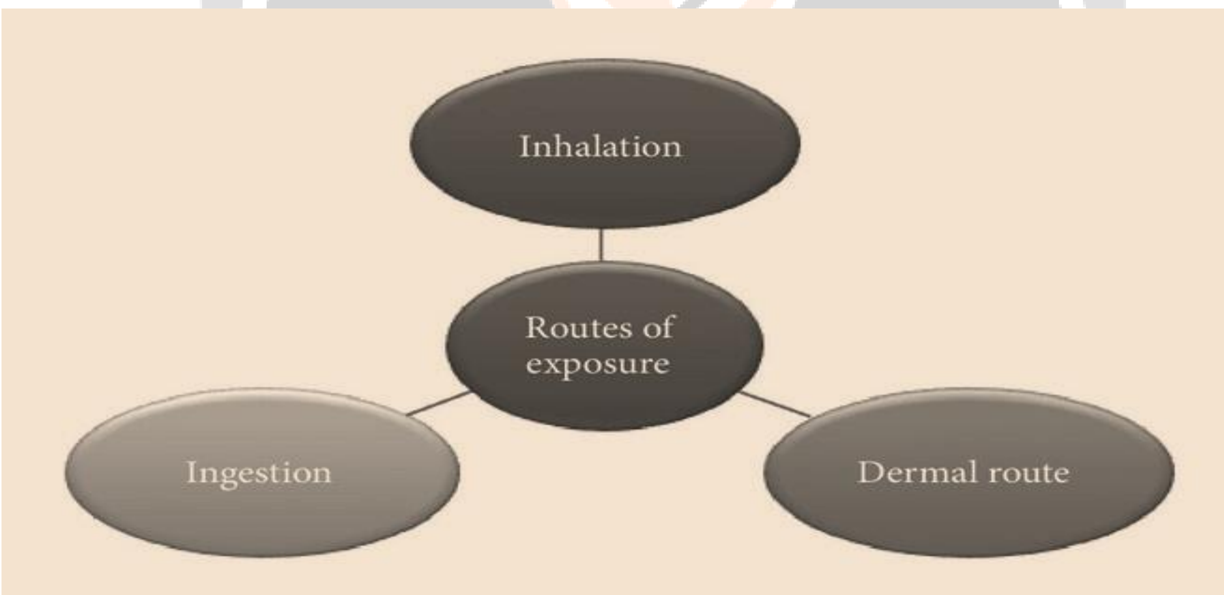
Nanocosmeceuticals based nail care products have greater superiority over the conventional products. The nail paints based on nanotechnology have merits such as improved toughness, fast dryness, durability, chip resistance, and ease of application due to elasticity. New strategies such as amalgamating silver and metal oxide nanoparticles have antifungal properties in nail paints for the treatment of toe nails due to fungal infections.

Toxicity Of Nanoparticles Used In Cosmeceuticals:

Number of workforce and customers exposed to nanoparticles are escalating because of increasing production and application of the wide diversity of cosmeceuticals products that contain nanomaterials. Despite their huge potential benefit, little is known about the short-term and long-term health effects in the environment and organisms. Due to health hazards, product functionality, and environmental concerns, there may be possible constrains. Concerns have been raised on the possible dangers which may arise on the skin penetration of nanomaterials after their application to the skin.

Toxicity of nanoparticles immensely depends on variety of factors like surface properties, coating, structure, size, and ability to aggregate and these factors can be altered and manipulated in the manufacturing process. Nanoparticles having poor solubility have been shown to cause cancer and can exhibit more pronounced toxicity.Health hazard may arise due to the surface area of nanoparticles when compared with the same mass concentration of large particles. Toxicity also depends on the chemical composition of nanoparticles which is absorbed on the skin. There is a relationship between particle size and toxicity: the smaller the size of the nanoparticles, the greater the surface area to volume ratio, due to which there is higher chemical and biological reactivity.

Health hazard caused by nanoparticles to the humans depends on the degree of exposure and the route through which they access the body. Inhalation, ingestion, and dermal routes are the possible routes by which humans can get exposure to the nanoparticles. Routes of exposure of nanoparticles .



Inhalation:

According to the National Institute of Occupational Health and Safety, the most common route for exposure of airborne nanoparticles is inhalation. Consumers may inhale the nanoparticles and may get exposure through respiratory route, while consuming the products, such as perfumes, powders, and aerosol and workers can get exposed to the nanoparticles during the production. Evidences from the studies conducted on animals suggest that vast majority of nanoparticles inhaled enter the pulmonary tract and some may travel via nasal nerves to the brain and gain access to other organs via blood. Silicon dioxide inhalation toxicity study suggests that particle size of 1–5 nm produces more toxicological response than 10 nm equivalent dose. Experiments on carbon nanotubes have revealed that on chronic exposure interstitial inflammation and epithelioid granulomatous lesions are caused in lungs. Some carbon based fullerenes might oxidize cells or may be hazardous when inhaled. Results of pulmonary administration of TiO_2 ultrafine particles than TiO_2 fine particles show that ultrafine particles resulted in more lung injury. Gold nanoparticles of sizes 2, 40, and 100 nm, when exposed to intratracheal route, were found in the liver and macrophages. It has been demonstrated that the exposure to TiO_2 of particle size 20 nm even at low doses causes complete destruction of DNA, whereas 500 nm TiO_2 have small ability for DNA strand breakage.

Ingestion:

Nanomaterials may be ingested in the body from unintentional to intentional transfer from hand to mouth. Nanoparticles can be ingested from cosmeceuticals that are applied on lips or mouth like lipsticks, lip balms, lip gloss.

According to the studies, after ingestion, nanomaterials rapidly pass out of the body but sometimes some amount may be taken up that can migrate to the organs. Studies conducted on the layers of pig skin show that certain nanomaterials can penetrate in the layers of the skin within 24 hours of exposure. When mice were orally ingested with zinc oxide nanoparticles with 20 nm and 120 nm at different doses, as a result spleen, heart, liver, bones, and pancreas became the target organs. Copper nanoparticles are found in variety of commercially available cosmeceuticals. Mice exhibited toxicological effects and heavy injuries to internal organs when exposed to copper nanoparticles. Silver nanoparticles are widely used in wound dressing and antimicrobial formulations and now are being used in cosmeceuticals like soaps, face creams, and toothpaste. Silver nanoparticles are used for their antimicrobial activity in the cosmeceuticals. The silver concentration that is lethal for bacteria is the same concentration which is lethal for both fibroblasts and keratinocytes. Various studies conducted on rats suggest that silver nanoparticles when exposed to rat neuronal cells led to size decrease and irregularities in shape and also demonstrated that mouse germline stem cell even at low concentrations of silver nanoparticles reduced drastically the function of mitochondria and cell viability. When mice were exposed to gold nanoparticles of 13.5 nm by ingestion, significant decrease in the RBCs, body weight, and spleen index was observed.

Dermal Routes:

Intracellular, transcellular, and transfollicular are the three pathways by which infiltration across the skin occurs. The dermal exposure of lesser size particles <10 nm can penetrate more easily and are disastrous than greater ones >30 nm. There are possibilities that nanoparticle penetration could be affected by skin barrier alterations such as scrapes, wounds, and dermatitis conditions. Prolonged erythema, eschar formation, and oedema were reported with nanoparticles less than 10 nm. Fullerenes are currently being used in cosmeceuticals like moisturizers and face creams but the toxicity related to them remains poorly understood. Report by Professor Robert F. has identified that face creams which have fullerenes incorporated are found to cause damage in the brain of the fish and have toxic effects in the liver cells in humans. Some studies demonstrated that fullerene-based peptides had the capability of penetrating intact skin and their traversal into dermis could be easy due to mechanical stressor. Quantum dots taken intradermally could penetrate regional lymph nodes and lymphatics. There are proven studies that engineered nanoparticles like single or multiwall carbon nanotubes, quantum dots with surface coating, and nanoscale titania are able to alter gene or protein expression and have lethal effects on epidermal keratinocytes and fibroblast. Currently there are few issues regarding the impact of nanoparticles of titanium dioxide and zinc oxide in sunscreens on health, safety, and environment. Increased production of reactive oxygen species (ROS), including free radicals, is due to greater surface area, greater chemical reactivity, and smaller size. Free radical and reactive oxygen species production is the primary mechanism for toxicity of nanoparticles. Titanium dioxide and zinc oxide generate ROS and free radical when exposed to ultraviolet (UV) radiations, which have potential in inflammation and oxidative stress and can significantly damage membranes, proteins, RNA, DNA, and fats within cells. A research on TiO_2 nanoparticles toxicity demonstrated that when these nanoparticles subcutaneously given to the pregnant mice, they were transferred to the offspring and there was a reduced sperm production in male offspring and brain damage as well. Nanoparticles of cobalt-chromium have potential that they can cross the skin barrier and damage fibroblast in humans.

Global Scenario Of Nanocosmeceuticals:

Drugs are subjected to the stringent scrutiny requirements imposed by FDA for their approval but there are no such requirements for cosmetics. Cosmeceuticals are the products which are on the borderline between cosmetics and pharmaceuticals. The Federal Food, Drug and Cosmetics Act and FDA do not recognize the term “cosmeceuticals” and the aesthetic and functional benefits are enjoyed by the products without crossing over into becoming over the counter drugs. Many cosmeceuticals alter the physiological processes in the skin, but manufactures avoid holding clinical trials and making the specific claims to avoid subjecting their products to expensive and lengthy approval process by FDA. New and unfamiliar challenges are being faced by the cosmetic industry.

Conclusion:

Nanotechnology is considered to be the most promising and revolutionizing field. Over the last dozen of years, nanotechnology is widely being used and is beneficial in the field of dermatology, cosmetics, and biomedical applications as well. New technologies and novel delivery systems have been invented by scientists, which are currently being used in the manufacture of cosmeceuticals. By the increase in use of cosmeceuticals, the conventional delivery systems are being replaced by the novel delivery systems. Novel nanocarriers which are currently being used are liposomes, niosomes, NLC, SLNs, gold nanoparticles, nanoemulsion, and nanosomes in various cosmeceuticals. These novel delivery systems have remarkable potential in achieving various aspects like controlled and targeted drug delivery, site specificity, better stability, biocompatibility, prolonged action, and higher drug-loading capacity. There is lack of convincing evidences for the claims of effectiveness, so industries are required to provide them. There are huge controversies regarding the toxicity and safety of the nanomaterials; various researches are being carried out to determine the possible health hazard and toxicity. Meticulous studies on the safety profile of the nanomaterials are required. Nanoproducts should be fabricated in such a way that their value and health of the customers are improved. Clinical trials are not required for the approval of cosmeceuticals so the manufacturers enjoy the benefit and avoid holding clinical trials and lengthy procedures. Lastly, stringent laws should be imposed on the regulation and safety of cosmeceuticals and nanoparticles used in them.

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