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A Review on Role of Nano Technology in Cosmeceuticals

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ABSTRACT:
Nanotechnology manifests the progression in the arena of research and development, by increasing the efficacy of the product through delivery of innovative solutions. To overcome certain drawbacks associated with the traditional products, application of nanotechnology is escalating in the area of cosmeceuticals. Cosmeceuticals are regarded as the fastest growing segment of the personal care industry and the use has risen drastically over the years. Nanocosmeceuticals used for skin, hair, nail, and lip care, for conditions like wrinkles, Photoaging, hyperpigmentation, dandruff, and hair damage, have come into widespread use. Novel nanocarriers like liposomes, niosomes, nanoemulsions, microemulsion, solid lipid nanoparticles, nanostructured lipid carrier, and nanospheres have replaced the usage of conventional delivery system. These novel nanocarriers have advantages of enhanced skin penetration, controlled and sustained drug release, higher stability, site specific targeting, and high entrapment efficiency. However, nanotoxicological researches have indicated concern regarding the impact of increased use of nanoparticles in cosmeceuticals as there are possibilities of nanoparticles to penetrate through skin and cause health hazards. This review on nanotechnology used in cosmeceuticals highlights the various novel carriers used for the delivery of cosmeceuticals, their positive and negative aspects, marketed formulations, toxicity, and regulations of nanocosmeceuticals.

KEYWORDS: Cosmeceuticals, nanocarriers, liposomes, niosomes, nanoemulsion, solid lipid nanoparticles, nanospheres, nanoparticles, nanocosmeceuticals, etc.

I. 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.

Founding member of US society of Cosmetic Chemists, Raymond Reed, coined the term "cosmetics" in the year 1961. Cosmetics can be defined as the products which amplify the appearance of the skin, intensify the cleansing, and promote the beauty of the skin. 4 As reported, the use of cosmetics was attributed to Egyptians around 4000BC and later Greeks, Romans, Chinese, Japanese, and Americans started using cosmetics. In the late 19th century, the use of cosmetics was secretly done by the women with household items in western countries and by 20th century the cosmetics were being done without concealment. By the 21th century, the cosmetics are being enormously used and with the development in technology, innovative cosmetic formulations are being developed by the incorporation of the latest technologies.

Cosmeceuticals are the cosmetic products which incorporate biologically active ingredient having therapeutic

benefits on the surface applied. These are utilized as cosmetics as they claim to enhance appearance. Cosmeceuticals are chasm between pharmaceuticals and personal care Products. Cosmeceutical products have measurable therapeutic efficacy on the skin, as drugs and formulations have diversified from skin to body to hair and they are used for the treatment of various conditions like hair damage, wrinkles, photoaging,

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skin dryness, dark spots, uneven complexion, hyperpigmentation, and so on.

Cosmeceuticals are contemplated as the fastest growing fragment of Personal care industry and the market for

personal care is increasing enormously. Despite enormous benefits of nanoparticles, little is known about the short-term and long-term health effects in the environment and organisms. Safety concerns have been raised due to the reported toxicity and possible dangers of the nanomaterials. The present article reviews the diverse classes of nanocarriers like liposomes, niosomes, solid lipid nanoparticles, nanostructured lipid carriers, nanoemulsion, and so on which are being used for delivery of nanocosmeceuticals, marketed products, and positive and negative aspects. There are a number of advantages of nanocosmeceuticals. Namely, they provide the controlled release of active substances by controlling the drug release from carriers by several factors including physical or chemical interaction among the components, composition of drug, polymer and additives, ratio, and preparation method. They are used in hair care preparations, such as in treatment of hair loss and to prevent hair from turning grey such as Identik Masque Floral Repair, Origem hair recycling shampoo, and Nirvel hair-loss control shampoo. Nanocosmeceuticals make the fragrances last longer, for example, Allure Parfum and Allure Eau Parfum spray by Chanel. These make the skin care formulations more effective and increase the efficacy of sunscreens by improving UV protection in them. By having very small size of the particles, the surface area is increased which allows the active transport of the active ingredients into the skin.

Cosmeceuticals have high entrapment efficiency and good sensorial properties and are more stable than the conventional cosmetics. Most of the nanoparticles are suitable for both lipophilic and hydrophilic drug delivery. Nanomaterials are widely used in the preparation of antiwrinkle creams, moisturizing creams, skin whitening creams, hair repairing shampoos, conditioners, and hair serums. Several positive aspects of Nanocosmeceuticals are discussed in Figure 1.

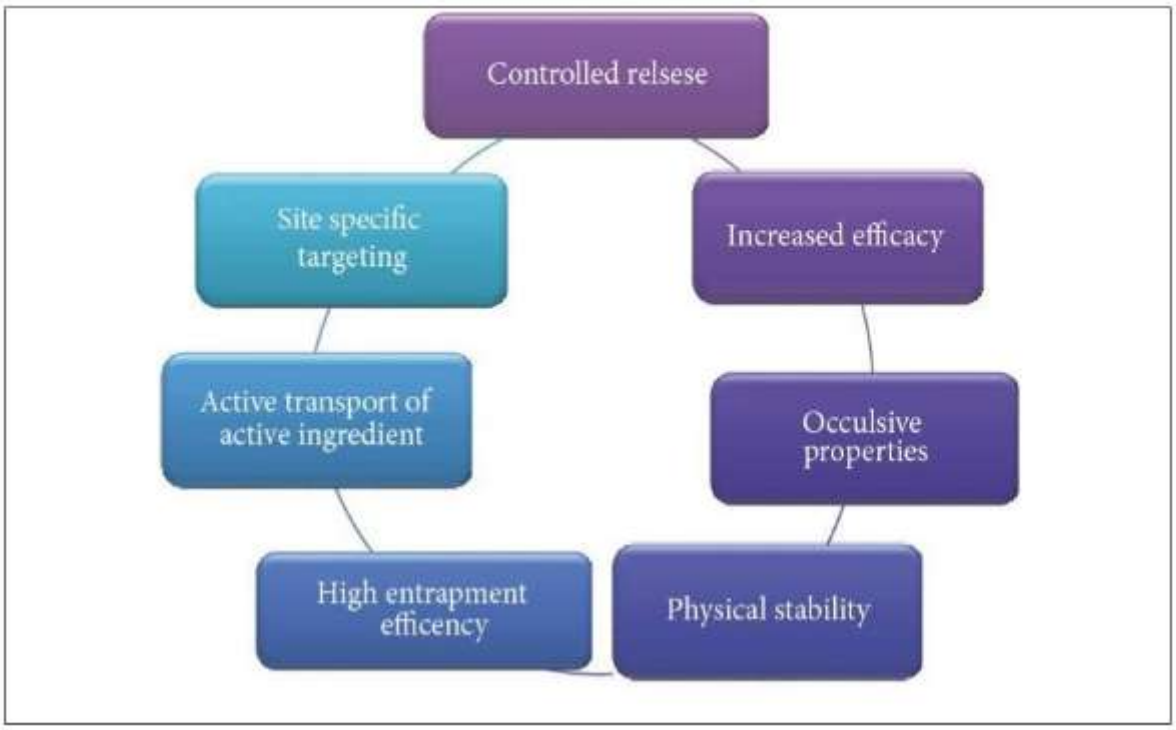

FIGURE NO: 1 PICTORIAL PRESENTATION OF POSITIVE ASPECTS OF NANOCOSMECEUTICALS.

As the rule of the nature, each and everything in this universe has some positive as well as negative aspects. Some of the drawbacks associated with nanocosmeceuticals are as follows. Due to production of large number of oxygen species, oxidation stress, inflammation, damage to

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DNA, proteins, and membranes may be caused by nanoparticles. Few ultrafine nanomaterials such as carbon nanotubes, carbon-based fullerenes, TiO2, copper nanoparticles, and silver nanoparticles may be toxic to human tissues and cells. Titanium dioxide found in sunscreens has been demonstrated to cause damage to DNA, RNA, and fats within cells. No stringent scrutiny was imposed by the regulatory agencies for the approval and regulation of Nanocosmeceuticals. Nanocosmeceuticals may be harmful to environment as well. No clinical trials are required for the approval of nanocosmeceuticals, thus raising a concern of toxicity after use. Negative aspects of nanocosmeceuticals are discussed in Figure.No.2.

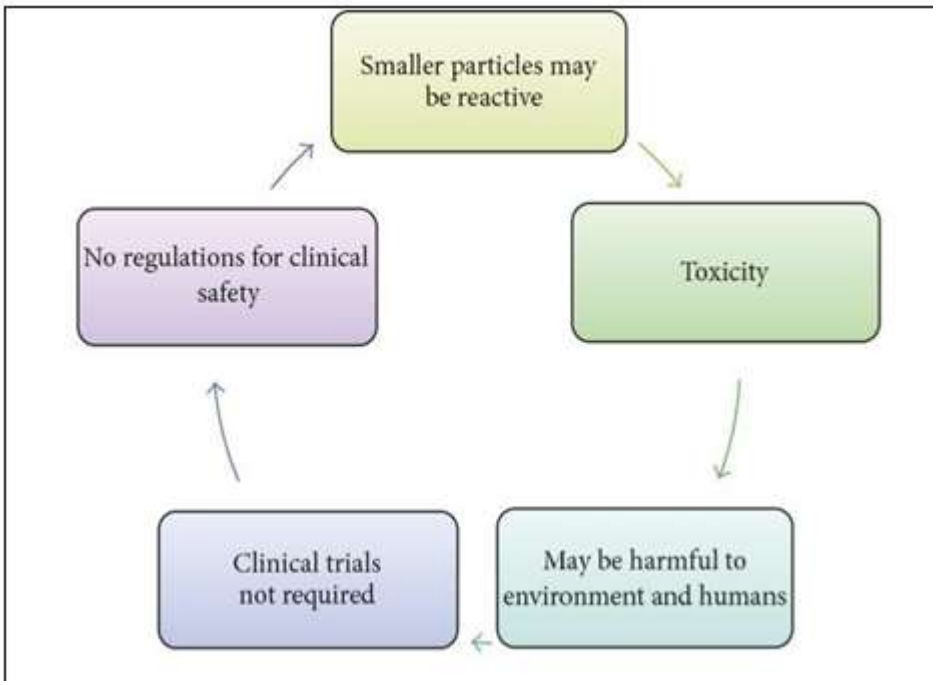

FIGURE NO: 2 PICTORIAL PRESENTATIONS OF NEGATIVE ASPECTS OF NANOCOSMECEUTICALS.

HISTORY

Back in 1986, Lancôme and Dior simultaneously launched the first nanotechnology-based cosmetic products under the name of Niosomes® and Capture®, respectively. the introduction of nanotechnology was pronounced to be a major scientific innovation and represented a major breakthrough towards the development of high-quality products; its use is now well-established in the cosmetics industry. Indeed, less demanding regulatory restrictions as compared to the development of new drugs, along with the localised action of these products, initially made the field extremely promising. Nowadays, it is widely accepted that the use of nanoparticles (NPs) significantly improves the performance of cosmetics in diverse ways, performing both as an active ingredient and/or a carrier. For this rason, these technologies may be easily recognized as industry standards. However, doubts about possible long-term 18 toxicity, together with concerns about the real advantages of nanomaterials in product performance, have often led to general mistrust . Indeed, in late 2009 the European Union recast the individual directives associated with the use of cosmetics into a single platform collecting all of the relevant products. It was then proposed that the presence of nanomaterials in these products should necessitate additional restrictions before they are authorised for use as ingredients. As a consequence, the cosmetics industry became wary of publicly promoting nanotechnology, often avoiding referring to ingredients as being composed of nanomaterials. Given this background, the present review aims to provide an update of the state of the art of the nanocosmetics field, exploring the beneficial effects of nanomaterials and offering a critical overview of toxicological issues. Among the various cosmetic product categories, our insights are mainly focused

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on skincare, which more clearly highlights the reappraisal of exploiting nanotechnology in cosmetic not surprisingly, the global beauty and personal care market value is predicted to exceed $716 billion by 2025, with much of that value related to the development of innovative and/or redesigned products and technologies. The rapid rise of the cosmetics industry has been characterized by a growing demand for innovative and personalized products designed on the basis of increasingly detailed scientific knowledge. In addition, the recent COVID-19 pandemic and associated global events have suggested that market trends for cosmetics are strongly affected by customer perceptions and are thus ever-changing; indeed, after years in which the demand has been increasingly oriented towards the use of "clean" and natural products, the pandemic has highlighted the need for safer and transparent items.

NANOTECHNOLOGYINCOSMETICS: - WHEREAREWE?

The beauty industry is one of the most enthusiastic early adopters of nanotechnology. Some reasons that Nano-scale ingredients are becoming more and more popular in the cosmetic industry is that due to their small size and extremely high ratio of surface area to volume, these nano-sized materials often have chemical or physical properties that may differ from those of their larger counterparts including increased adverse biological activity.

Some of the proposed benefits that may occur by incorporating nanoparticles in cosmetics are increased efficiency, transparency, unique texture, protection of active ingredient, and overall higher consumer compliance. For example, larger particles such as titanium dioxide and zinc oxide are white and opaque but at the nanoscale, these substances become transparent. This enables their use in moisturizers and foundations. Other nanoparticles such as aluminum oxide provide a "soft focus" effect that disguises wrinkles. These are used in high-end concealer sticks, foundations, and face powders. Carbon "fullerene" nanoparticles are used in anti-ageing creams and moisturizers partly because these tiny nanoparticles penetrate skin so effectively. Thus, cosmetics industry uses nano-scale ingredients routinely.

Engineered nanoparticles are being used virtually in every type of personal care Product in the market, from sunscreens and anti-aging creams to toothpastes. However, the cosmetic industry has been reluctant to communicate the fact that it uses engineered nano-scaled materials. Acknowledging the need for more information, Friends Of the Earth issued a report in May 2006: ''Nanomaterials, sunscreens and cosmetics: small Ingredients – big risks." The report listed a number of concrete applications taken from the Wilson Center Inventory:

Products listed in this database include deodorants, soap, toothpastes, shampoos, hair Conditioners, sunscreens,anti-wrinkle creams, moisturizers, foundations, face powders, Lipstick, blush, eye shadow, nail polish, perfumes and after shave lotions. The materials involved include various metal oxides and different forms of lipid Formulations with Nano scaled droplets.

Cosmetics giant Estee Lauder entered the Nano Market in 2006 with a range of Products containing nanoparticles. The products, including anti- wrinkle creams, are said to be absorbed deeper into the skin due to nano-sized particles in the formulations Scientific Committee on Consumer Products. L'Oreal, the world's largest Cosmetics company, is devoting about $600 million dollars, of its $17 billion-dollar Revenues, to nano patents, and has patented the use of dozens of ''nanosome particles'' 800-fold smaller than a human hair as delivery systems for nutrients. With 192 patents in nanotechnology, L'Oreal now ranks No. 6 among nano patents in the United States. At L'Oreal factories, nanosize bits are being created with high-pressure machinery that Fires droplets of material at the speed of sound. Christian Dior of France, Procter & Gamble, Shiseido, Estee Lauder, and other rivals of L'Oreal are similarly incorporating Nanoparticles into cosmetics products. The other major leaders in this field Are colorescience, Revlon, Pureology, La Prairie, Neutrogena, Johnson & Johnson, Caudalie, Lancome, Chanel, Beyond Skin Science LLC, SkinCeuticals, The Body Shop, Dr Brandt, Prestige, Sircuit, Dermazone solutions, Crown laboratories, Birch trees, Nucelle, Skin Ceuticals, Rosacea Care, Image skincare, Almay, Barneys New York, Bellapelle skin studio, AmerElite solutions, AmorePacific, cell Rx, and Avon.

Novel Nano Carriers 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 are depicted in Figure No 3.

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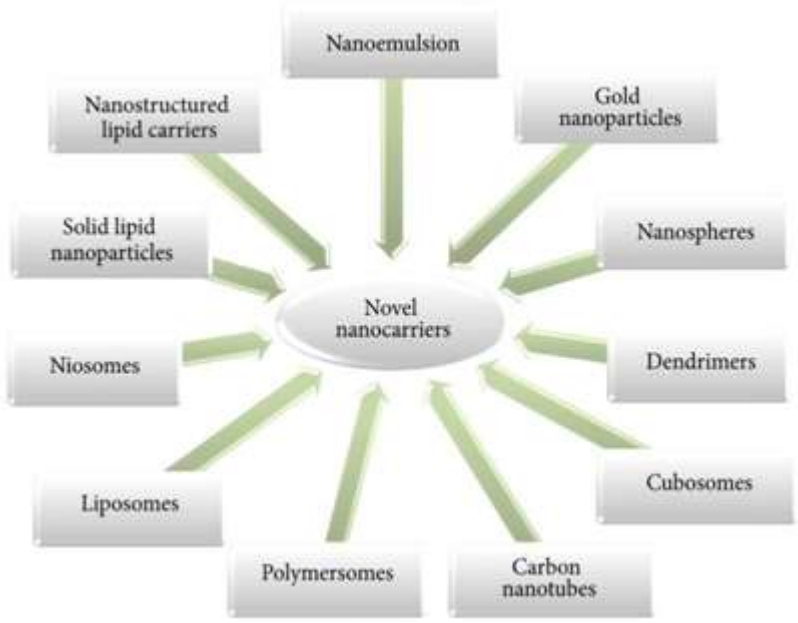

FIGURE NO: 3 PICTORIAL PRESENTATION OF NANO CARRIERS FOR COSMECEUTICALS

TYPES OF NANO MATERIALS USED IN COSMETICS:-

A] LIPOSOMES:-

Liposomes are concentric bilayered vesicles in which the aqueous volume is entirely enclosed by a lipid bilayer composed of natural or synthetic phospholipids which are GRAS (generally regarded as safe) products. The lipid bilayer of liposomes can fuse with other bilayers such as the cell membrane which promotes release of its contents, making them useful for cosmetic delivery applications. Their ease of preparation, enhanced absorption of active ingredients by skin and continuous supply of agents into the cells over a sustained period of time makes them suitable for cosmetic applications. Vesicles, other than liposomes are being used these days that claim to further enhance the penetration of substances across the skin, such as transferosomes, niosomes and ethosomes.

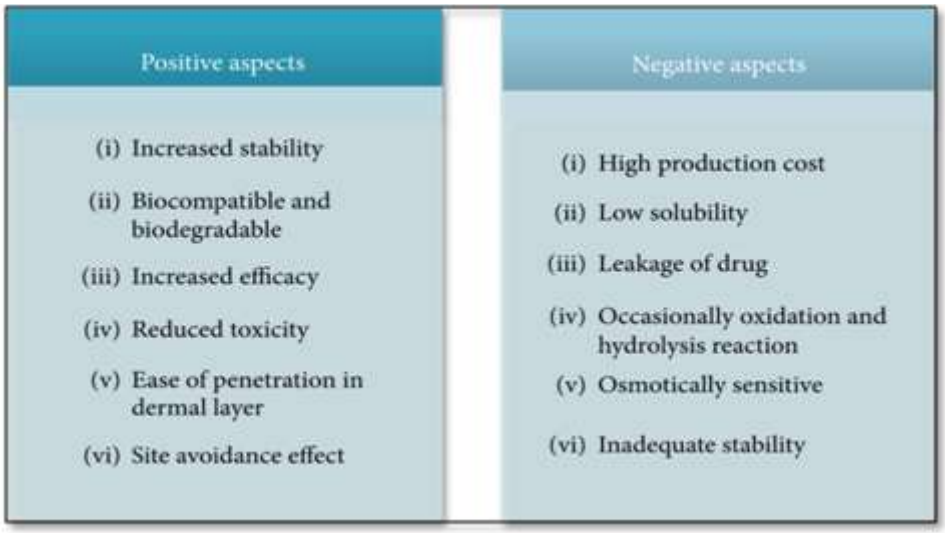

FIGURE NO: 4 PICTORIAL PRESENTATION OF POSITIVE & NEGATIVE ASPECTS OF LIPOSOME

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B] NANOEMULSIONS:-

They are dispersions of Nanoscale droplets of one liquid within another. They are metastable systems whose structure can be manipulated based on the method of preparation. The components used for their preparation are GRAS products and are safe to use. Their smaller particle size provides higher stability and better suitability to carry active ingredients; they also increase the shelf life of the product.

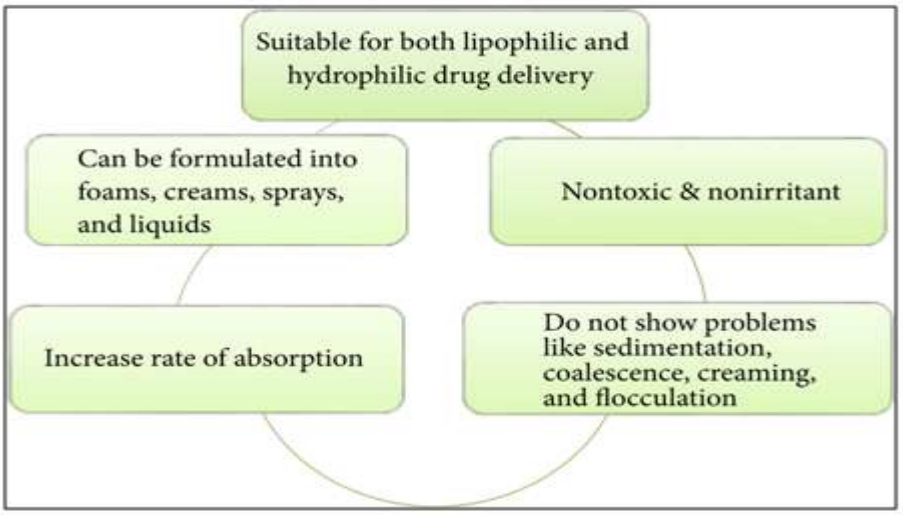

FIGURE NO: 5 MERITS OF NANO EMULSION

C] NANO CAPSULES:-

Nanocapsules are submicroscopic particles that are made of a polymeric capsule surrounding an aqueous or oily core. It has been found that the use of nanocapsules decreases the penetration of UV filter octyl methoxy cinnamate in pig skin when compared with conventional emulsions.

D] SOLID LIPID NANOPARTICLES:-

They are oily droplets of lipids which are solid at body temperature and stabilized by surfactants They can protect the encapsulated ingredients from degradation, used for the controlled delivery of cosmetic agents over a prolonged period of time and have been found to improve the penetration of active compounds into the stratum corneum. in vivo studies have shown that an SLN-containing formulation is more efficient in skin hydration than a placebo. They have also been found to show UV-resistant properties, which were enhanced when a molecular sunscreen was incorporated and tested. Enhanced UV blocking by 3, 4, 5-trimethoxybenzoylchiti (a good UV absorber) was seen when incorporated into SLNs.

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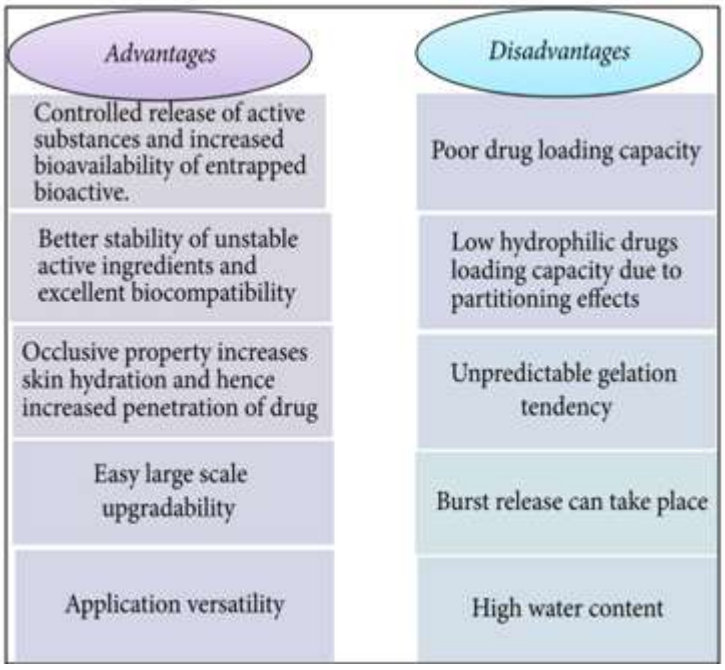

FIGURE NO: 6 BENEFITS AND DRAW BACKS OF SLNS.

E] NANOCRYSTALS:-

They are aggregates comprising several hundred to tens of thousands of atoms that combine into a "cluster". Typical sizes of these aggregates are between 10 and 400 nm and they exhibit physical and chemical properties somewhere between that of bulk solids and molecules. They allow safe and effective passage through skin.

F] NANOSILVER AND NANO GOLD PARTICLES:-

Cosmetic manufacturers are harnessing the enhanced antibacterial properties of nano silver in arange of applications. Some manufacturers are already producing underarm deodorants with claims that the silver in theproductwillprovideupto24-hour anti bacterial protection. Nano-sized gold, like nanosilver, is claimed to be highly effective in disinfecting the bacteria inthemouthandhasalsobeenaddedtotoothpaste.

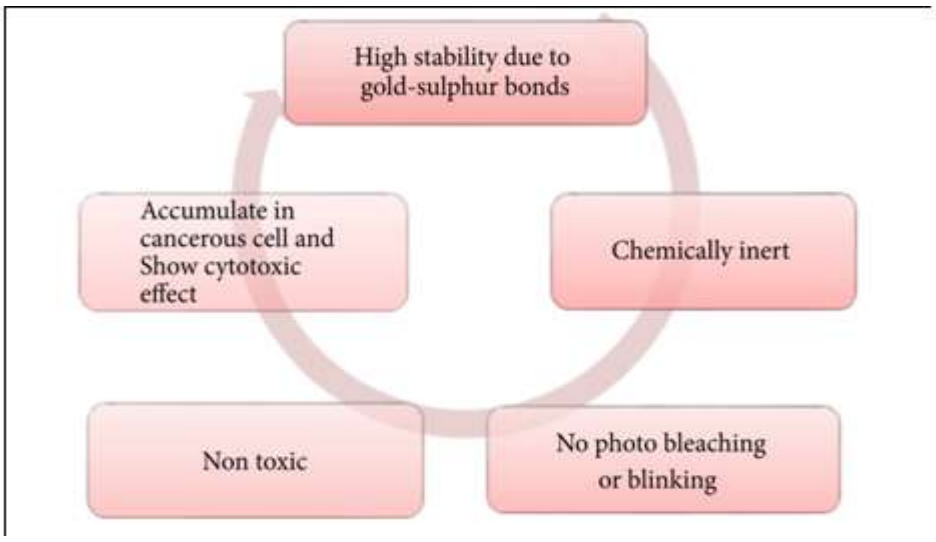

FIGURE NO: 7 VARIOUS POSITIVE ASPECTS DEPICTION OF NLC

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G] Dendrimers:-

Dendrimers are unimolecular, monodisperse, micellar nanostructures, around 20 nm in size, with a well-defined, regularly branched symmetrical structure and a high density of functional end groups at their periphery. Theycontainlargenumberofexternalgroupssuitablefo rmultifunctionalization.

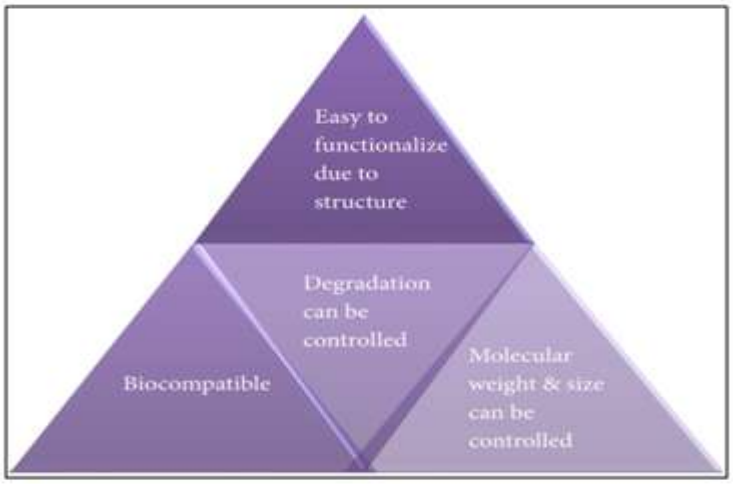

FIGURE NO: 8 ADVANTAGES OF DENDRIMERS

L] 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. 40 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.

FIGURE NO: 9 FAVORABLE ASPECTS OF NANOSPHERE

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M] CARBON NANOTUBES:-

Carbon nanotubes (CNTs) can be described as the rolled graphene with SP2 hybridization. These are seamless cylindrical hollow fibers, comprised of walls formed by graphene as hexagonal lattice of carbon, which are rolled at Specific and discrete "chiral" angles. Individual carbon nanotubes align themselves naturally into "ropes" held together by pi-stacking. The diameter ranges from 0.7 to 50 nm with lengths in the range of 10's of microns. Carbon nanotubes are extremely light in weight. These are further of 3 types: namely, single-walled CNTs, doubled- walled CNTs, and multiwalled CNTs. Single-walled CNTs are made up of single graphene sheet which is rolled upon itself with diameter of 1-2 nm, double-walled CNTs are made of two concentric carbon nanotubes, and multiwalled CNTs consist of multiple layers of graphene tubes having diameter ranging from 2 to 50 nm.

❖ **WHAT ARE NANO MATERIALS?**

WHAT ARE NANOMATERIALS? There is not a legal definition for nanomaterials. Typically, they are defined as purposely engineered materials with at least one dimension between 1 and 100 nanometers, which is about 1/8000 the width of a human hair. At this size, materials begin to exhibit unique properties that affect physical, chemical, and biological behavior. There is no single type of nanomaterial. They can differ with respect to composition, primary particle size, shape, surface coatings and strength of particle bonds. Nano-sized particles exist in nature and can be created from a variety of elements and compounds, such as carbon or silver. Most nanoscale materials are too small to be seen with the naked eye or conventional lab microscopes. Some nanomaterials are referred to as engineered nanomaterials (ENMs) which are used to design pharmaceuticals, electronics, and can be added to cloth or other materials to make them stronger yet lighter.

Some minerals become invisible but still absorb UV radiation at the nanoscale. These UV-filtering substances are increasingly used for broad-band sun protection including UVA radiation.

a) TITANIUM DIOXIDE(TIO2):-

TiO2 nanoparticles may be more toxic than larger particles of TiO2, which pose few health hazards. Many studies have found that non-nanoized TiO2 used as a mineral UV-filter in sunscreen cosmetic products does not penetrate healthy skin and poses no human health risks from skin exposure. However, rats and mice exposed to nanoized TiO2 (normally <100 nm) experience significant lung inflammation and DNA damage. This raise concerns that human inhalation of TiO2 could also lead to adverse health effects.

b) ZINCOXIDE(ZNO):-

Studies have found that even low concentrations of ZnO may lead to damage in human epidermal cells. Yet, a review of the risks of nano-st ructured TiO2 and ZnO found nanoized TiO2 and ZnO are not likely to penetrate the skin due to how they are bound. The researchers concluded both materials are safe to use as UV filters.

c) SILVER:-

Nanosized silver may lead to oxidative stress and resulting cell damage. Silver nanoparticles have shown toxic effects on the male reproductive system. Research suggests that nanoparticles cross the blood-testes barrier where they can be deposited into the testes with the potential for adverse effects on sperm cells.

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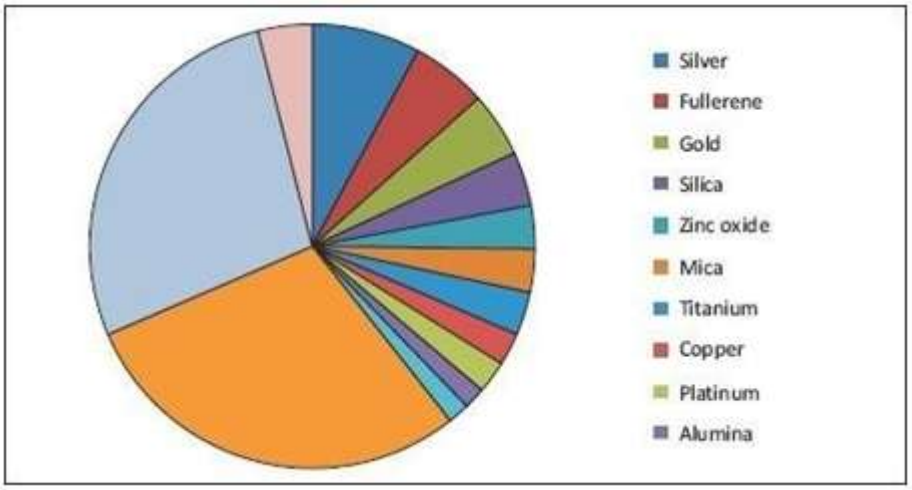

FIGURE NO: 10 PRINCIPLE NANOMATERIALS USED IN COSMETICS.

d) FULLERENES:-

Fullerenes are carbon tubes sometimes used in anti-aging and eye creams. Fullerenes may penetrate into the top two layers of the skin (the epidermis and dermis). They also make the skin unusually sensitive to light, leaving cells vulnerable to the effects of UV light exposure.

E) SILICA:-

Nanoized Silica may lead to pregnancy complications when injected intravenously into pregnant mice. It also appears nanoized silica can cross the placenta, leading to deposits in the fetal liver and fetal brain. Ultrafine crystalline silica (SiO2) nanoparticles induce cell damage leading cell mutations and cancer cells with two nuclei in human in vitro cells.

F) CARBONBLACK:-

Ultrafine carbon black particles may alter genes in lung cells, lead to inflammation and inhibit the growth of cells that line the circulatory system. Research suggests nanosized carbon black may lead to mutations in the lung cell of rats exposed 15 months earlier.

❖ HEALTH, RISK AND SAFETY CONSIDERATIONS:-

The cosmetic industry willingness to use novel nanoparticles in its products while adverse health effects remain so poorly understood has raised concern among the scientific community. The properties of nanoscale materials (measuring 5100 nm) differ significantly from larger sizes. There is a general relationship between particle size and toxicity; the smaller a particle, the greater its surface area to volume ratio, and more likely it is to produce toxicity. Toxicity is partly a result of increased chemical reactivity that accompanies a greater surface to volume ratio. Thus, the diverse array of surface properties achieved due to reduction in particle size that catalyzes the surface chemistry of nanoparticles is supposed to be responsible for their toxic potential. The increased capacity of nanoparticles to penetrate skin and gain access to our mammalian cells is a double-edged sword where it may be useful for medical purposes, but result in far greater uptake of substances that exert an adverse health effect.

The fears arising from the use of nanotechnology in cosmetics are due to questions regarding possible genetic mutations due to chronic exposure. Traditionally, anti-aging skin care products were designed to hold moisture in the skin by creating a barrier between the skin and external environment. Nanoparticles in the new generation of cosmetics do not function in this manner as they are designed to penetrate the upper layers of the skin and stimulate new skin cell production which gives skin a new, plump, and youthful appearance. Nanoparticles make it possible to enable a multitude of chemicals into the deeper layers of skin because the chemicals are encompassed by the particles. Many of these chemicals may produce irritation. While the beneficial aspects of the nanomaterials are well known, several reports suggested adverse impact of nanomaterials on mammalian cells. Further, there is evidence that many types of nanoparticles may be toxic. The exposure assessment for NMs follows a similar procedure to non-NM ingredients, but with a special focus on the nano-aspects. In Figure No.12,

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the schematic outline of the safety assessment of a cosmetic product containing NMs is presented. In Europe, there are NMs for which the SCCS has expressed inconclusive opinions, e.g., Colloidal Silver (nano) , Styrene/Acrylates copolymer (nano) and Sodium styrene/Acrylates copolymer (nano) , and Silica, Hydrated Silica, and Silica Surface Modified with Alkyl Silylates (nanoform), which is why the EC requested that the SCCS to should assess if a potential risk can be identified.

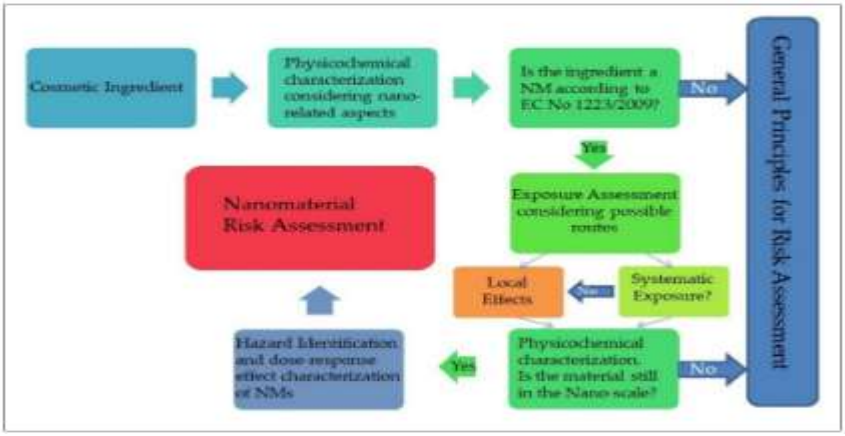

FIGURE NO: 11 SCHEMATIC OUTLINES FOR THE NANOMATERIAL SAFETY ASSESSMENT IN COSMETICS.

One of the most important aspects to take into consideration is the NMs' routes of exposure. The primary route is skin exposure with the stratum corneum as the first layer of epidermis. There are still some uncertainties regarding the possibility of NMs penetrating through the stratum corneum into viable layers, where toxicological concerns may arise. In Figure No.13, a schematic of the structure of the human skin is presented. Although very small NMs still have much larger molecular weights compared to known molecules which penetrate the skin, further tests for every NM to be used in a cosmetic formula should be performed. Extra attention to safety assessment should be given to sprays or aerosols that may contain NMs, because exposure via inhalation Possible. For NMs, in addition to the weight-based concentration of the NM, the concentration should also be given in terms of particle number concentration and surface area. Also, changes in the aggregation and/or degradation/dissolution status of the NM during exposure should be accounted for. Apart from skin exposure, oral exposure-to NMs existing in toothpastes, mouthashes, and lipsticks-is also possible.

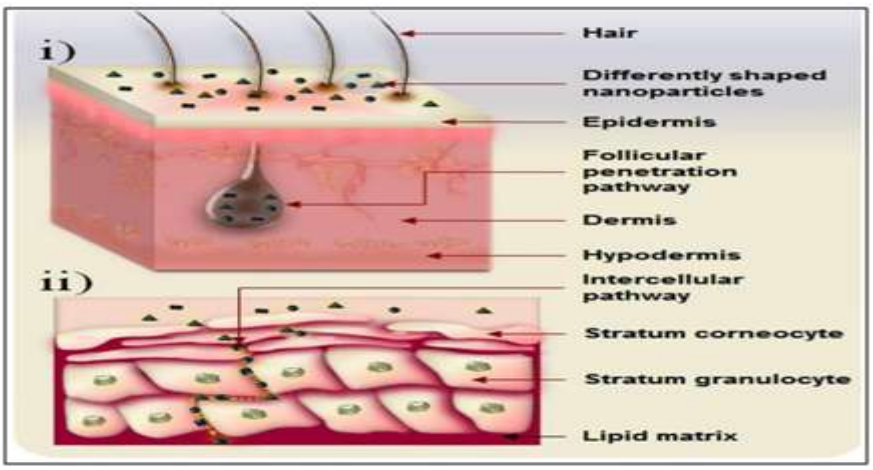

FIGURE NO: 12 TWO MAIN POSSIBLE SKIN PENETRATION PATHWAYS ARE ILLUSTRATED.

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The nanomaterial (i) enters via hair follicles (the follicular penetration pathway) and (ii) diffuses through the
gaps between corneocytes (the intercellular penetration pathway).

❖ **MAJORCLASSESINNANOCOSMECEUTICALS:-**

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 .No.14.

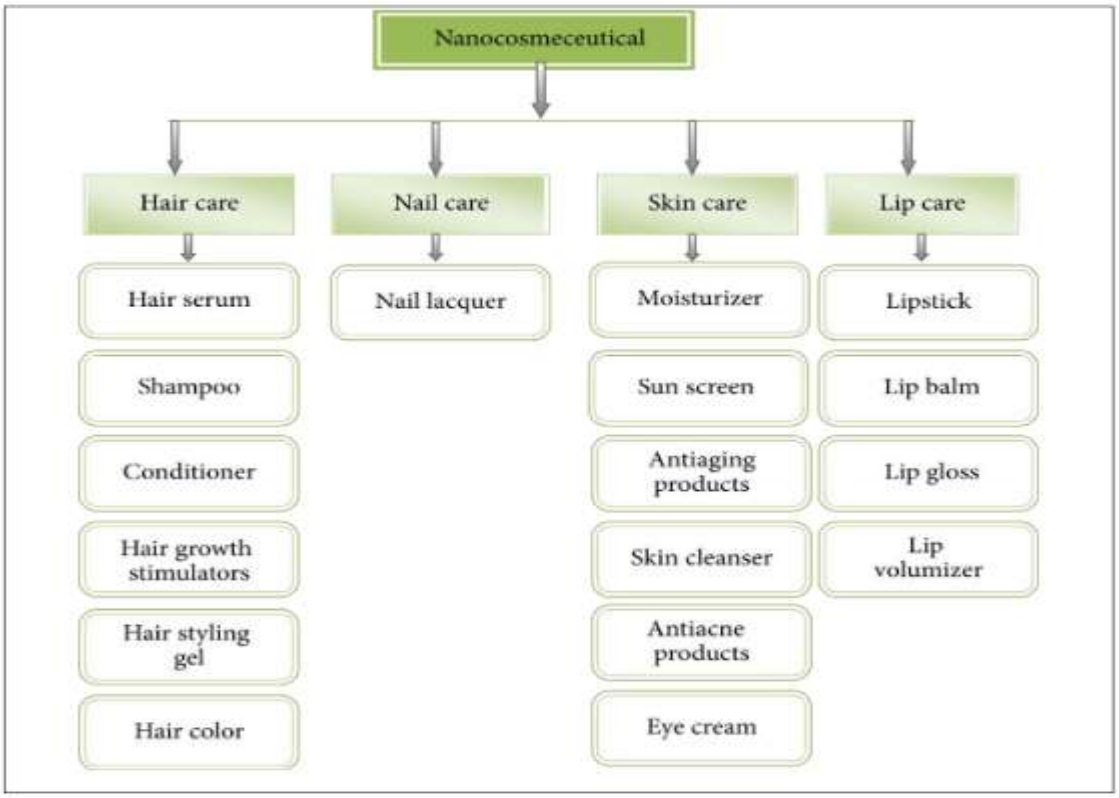

FIGURE NO: 13 MAJOR CLASSES IN NANO COSMECEUTICALS.

A] 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.

B] 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,

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nanospheres, and liposomes have major function of repairing damaged cuticles, restoring texture and gloss, and making hair nongreasy, shiny, and less brittle.

C] 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. 76 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.

D] 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. 79

❖ **Characterization Methods For Safety Assessment Of Nanoparticlesin Cosmetics:-**

The opinions of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) deals with the risk assessment methodologies available for evaluating the possible adverse health and environmental effects of nanotechnology products 80 and also on the investigation of nanomaterials. The specific characteristic of nanomaterials will require new test strategies to determine the mechanisms of potential injury that they may cause. The main parameters that are evaluated for the safety of nanomaterials are the following:

1) PHYSICAL-CHEMICAL PROPERTIES:-

Physical properties like size, shape, specific surface area, aspect ratio, agglomeration/aggregation state, size distribution, surface morphology/topography, structure, solubility and chemical properties like structural formula/molecular structure, composition of nanomaterial (Including degree of a purity, known impurities or
additives), phase identity, surface chemistry (composition, charge, tension, reactive sides, physical structure, photocatalytic properties, zeta potentials), hydrophilicity/lipophilicity have to be analysed. There are several general principles and procedures for approaching basic particle. Characterisation that also apply to nanoparticles and which are endorsed by national and international standardisation bodies such as ISO and ASTM.

2) MATHEMATICAL MODELLING:-

These predictive models range from simple, empirical algorithms to complex mathematical equations which sometimes require knowledge and estimation of experimentally inaccessible parameters. But, since, in none of these models, data relating to macromolecular compounds or particle structures have been included, they cannot be used with any confidence to predict what might happen when such entities contact the skin.

3) MICROSCOPIC TECHNIQUES:-

More useful information from the in vitro studies can be obtained by microscopic examination of the skin post treatment. While absolute quantification may not be possible, visualization of the tissue to which an active has been applied can provide valuable insight. The methods used for microscopic evaluation are shown in following Table:

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Techniques used	Advantages
Laser scanning confocal microscopy (LSCM)	• 3-dimensional views of the skin can be obtained from relatively thick tissue samples with little or no tissue artefacts • Clearly demonstrate the impact of a nanoparticle formulation on the delivery of a model active • Visualize the affinity of particulate vectors for follicular openings
High-resolution transmission electron microscopy	• Visualize individual particles in ultra-thin sections of tissue • Can use X-ray analysis to identify the chemical composition of the visualized vector
Particle induced X-ray	• Large fields of view

TABLE NO: 1 TECHNICAL METHODS USED FOR MICRO SCOPIC EVALUATION

4.IN VITRO METHODS:-

Though there are a number of alternative methods and technologies for studying the molecular mechanisms involved in the biological activity of compounds, only validated methods are permitted for cosmetic products. These validated methods must be used when testing is required, for the safety assessment of cosmetic ingredients. Methods of assessment in vitro have mirrored work in the area of mammalian toxicology. For example, several approaches used to study oxidative assessment have been used, and more slowly work is taking place in the area of genomics and proteomics. The different validated in vitro tests employed are depicted in Figure.

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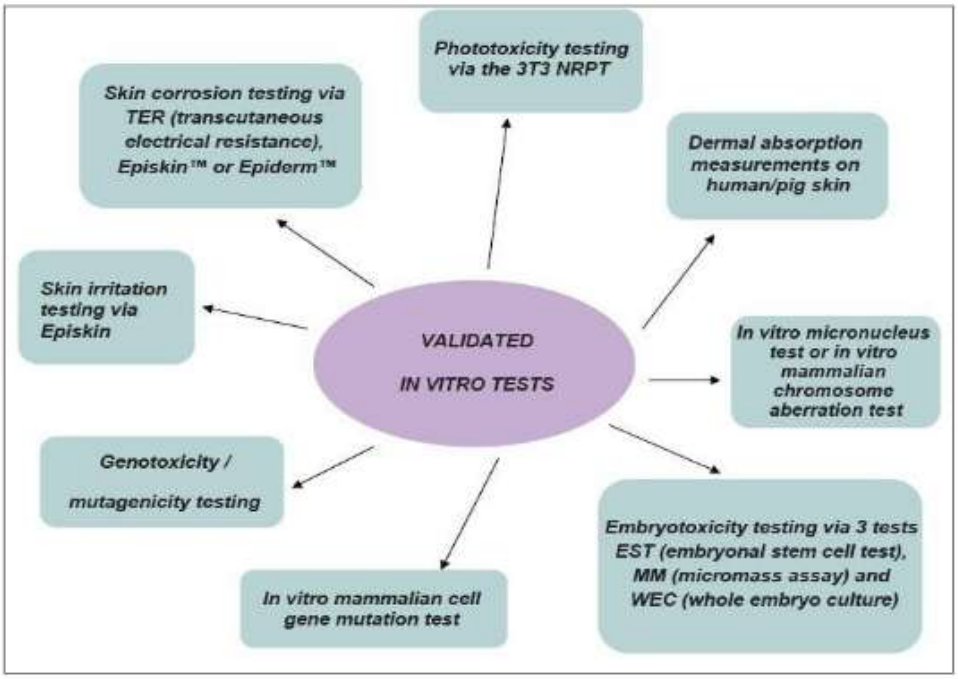

FIGURE NO: 14 VALIDATED IN VITRO METHODS EMPLOYED

❖ **REGULATIONS:-**

A] REGULATION OF THE USE OF NANOMATERIALS IN COSMETICS:-

- For every cosmetic product that contains nanomaterials, a high level of protection of human health shall be ensured.
- EU Cosmetics Regulation 1223/2009/EC, Art 16 Cosmetic manufacturers have to demonstrate the safety of
- any ingredient used in cosmetics. – SCCS guidelines for safety assessment of nanomaterials. – Cosmetics industry guidelines for nanomaterials.
- In addition to the normal notification, cosmetic products containing nanomaterials shall be notified to the
- Commission by the responsible person by electronic means six months prior to being placed on the market.
- Environmental safety is under the scope of the REACH Regulation.
- As off summer 2013 nano-ingredients will be labelled with the word 'nano' in the ingredients list for consumer information.

B] NANOMATERIAL NOTIFICATION DATA SHALL CONTAIN AT LEAST THE FOLLOWING:-

- The identification of the nanomaterial including its chemical name (IUPAC) and other descriptors as specified
- in point 2 of the Preamble to Annexes II to VI;
- The specification of the nanomaterial including size of particles, physical and chemical properties; An estimate of the quantity of nanomaterial contained in cosmetic products intended to be placed on the market per year;
- The toxicological profile of the nanomaterial;
- The safety data of the nanomaterial relating to the category of cosmetic product, as used in such products;
- The reasonably foreseeable exposure conditions.

C] NOTIFICATION OF NANOMATERIALS UNDER THE EU COSMETICS REGULATION:-

- In case of safety concerns: The SCCS (Scientific Committee on Consumer Safety) should give opinions, where appropriate, on the safety of use of nanomaterials in cosmetic products.
- These opinions should be based on full information being made available by the responsible person.
- The SCCS provides opinions on health and safety risks (chemical, biological, mechanical and other physical risks) of non-food consumer products (e.g. cosmetic products and their ingredients, toys, textiles. clothing, personal

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care and household products) and services (e.g. tattooing, artificial sun tanning).

- http://ec.europa.eu/health/scientific_committees/consumer_safety/i ndex_en.htm Pre-authorisation of positive list materials supersedes nano- notification (colorants, UV-filters or preservatives).

D] TIMETABLE OF NANOMATERIAL PROVISIONS UNDER THE EU COSMETICS REGULATION:-

- 11 January 2013 -11 July 2013 Notification of existing nanomaterials to the Commission. New nanomaterials will always be notified six (6) months prior to marketing.
- By 11 January 2014, the Commission will make available a list of all nanomaterials used in cosmetic products, including those used as colorants, UV-filters and preservatives. The list will be regularly updated.
- By 11 July 2014, the Commission will publish a report on the use of nanomaterials in the European Union
- in different cosmetic product groups, including those used as colorants, UV-filters and preservatives. The report shall be updated annually.
- The Commission shall regularly review the provisions of this Regulation concerning nanomaterials in the light of scientific progress and shall, where necessary, propose suitable amendments to those provisions. The first review shall be undertaken by 11 July 2018. 84

❖ **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. 85 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. 86

❖ **Major Products And Services Offered By Cosmeceuticalcompanies:-**

Among the many businesses in the same sector, 10 firms are regarded as significant rivals who provide their customers with comparable products and services. These companies are listed as the top 10 Cosmetic companies during 2018. The top 10 companies in same industry is despited in following table:

Sr.No	NameoftheCompany	Industry	ProductsandServices
1.	Lakme	PersonalCare	Face,Body,Hair,Nailandservices throughLakmeBeautySalons,onlineservices.
2.	Lotus	HerbalandAyurvedic	Facecare,suncare,whiteglow,anti-aging,bathandbodycare,haircare,lipcare,facialkit,eyecare,baby Care.
3.	Biotique	PersonalCare	MenandwomenAyurvedicskinproducts
4.	L'Oréal	PersonalCare	Colouringproducts,haircaremakeupandskincareproducts.
5.	ShahnazHusain	HerbalandAyurvedic	HerbalproductsandAyurvedictreatment.
6.	RevlonIndia	Personalcare	Makeup Cosmetics, Hair colour, Nailsand Beauty tools and service thoughonlineRevlonProfessionalservices.

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7.	Maybelline	Cosmetics	Makeup,Eyebrows,lip,nailcareproducts,onlinesales.
8.	Himalaya	Healthcareproducts	Pharmaceuticals,personalcare,babycare, well-being, nutritionandanimalhealthproducts.
9.	ColorBar	Cosmetics	Beautyandskincareproducts, onlineservices.
10	Elle18	HealthandBeauty	Cosmetics and onlineservices.

TABLE NO: 2 WORLD'S TO P10 COSMECEUTICAL COMPANIES & THEIR PRODUCTS AND SERVICES.

II. CONCLUSION:-

Nanotechnology is considered to be the most promising and revolutionizing field. Over the last dozens 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. Nano products 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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