AN ANALYSIS OF THE FUNCTION OF NANOTECHNOLOGY IN COSMETICS AND PHARMACEUTICALS

Tanuja Annarao
Research Scholar
Department of Pharmacy
Sunrise University, Alwar, Rajasthan.
tanujawarad25@gmail.com

Dr. Allenki Venkatesham
Research Guide
Department of Pharmacy
Sunrise University, Alwar, Rajasthan.

ABSTRACT:

Innovative nanotechnology boosts product effectiveness, showing research and development advancement. Nanotechnology improves cosmeceuticals. Cosmetics are the fastest-growing personal care category. Nanocosmeceuticals treat skin, hair, nail, and lip wrinkles, photoaging, hyperpigmentation, dandruff, and damage. Nanoemulsions, microemulsions, solid lipid nanoparticles, nanostructured lipid carriers, and nanospheres have replaced traditional delivery methods. These nanocarriers improve skin penetration, regulated and prolonged drug release, stability, site-specific targeting, and trapping. Nanotoxicological research has raised concerns about employing nanoparticles in cosmeceuticals since they may infiltrate skin and create health issues. This nanotechnology review examines the benefits and downsides of several carriers for cosmeceuticals, their commercial formulations, toxicity, and restrictions.

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

INTRODUCTION

Nanotechnology, the most promising 21st-century technology, may enhance cosmetics. "Nanotechnology" originates from "technology" and "nano," meaning dwarf. Nanotechnology generates or manipulates 1–100 nm particles. Over 40 years ago, nanotechnology penetrated cosmetics, health, and skin goods. Physics, chemistry, biology, and engineering have utilised nanotechnology since 1959. Egyptians, Greeks, and Romans colored hair using nanotechnology about 4000 BC. Raymond Reed, founder of the US Society of Cosmetic Chemists, invented "cosmetics" in 1961. Cosmetics cleanse quicker and improve skin. 4 Egyptians utilized cosmetics about 4000 BC, followed by Greeks, Romans, Chinese, Japanese, and Americans, according to reports. Western ladies stopped hiding their makeup around the early 20th century. Cosmetics were widely used in the 21st century, and new formulas were developed employing cutting-edge technology.

Cosmeticseuticals include therapeutic ingredients. They improve cosmetics. Cosmetics are between drugs and personal care. Cosmeceuticals are proven to treat hair loss, wrinkles, photoaging, skin dryness, dark spots, uneven skin tone, hyperpigmentation, and other skin diseases.

Cosmetics are the fastest-growing personal care sector. Nanoparticles have many advantages, but their environmental and health impacts are unknown. Nanomaterials are unsafe. This article examines nanocosmeceutical nanocarriers, benefits and drawbacks, and marketed products. Liposomes, niosomes, solid lipid nanoparticles, nanostructured lipid carriers, nanoemulsion, and others. Nanocosmeceuticals help. Physical or

chemical interactions between components, drug composition, polymer, additives, ratio, and manufacturing process control drug release from carriers. They prevent hair loss and graying in Identik Masque Floral Repair, Origem hair recycling shampoo, and Nirvel shampoo. Nanocosmeceuticals strengthen UV protection in sunscreens and skin care formulae, making Chanel's Allure Parfum and Eau Parfum spray linger longer. Small particles enhance surface area, allowing active component absorption into the skin. Cosmeceuticals are stable, sensorial, and entrapment-efficient. Most nanoparticles carry hydrophilic and lipophilic drugs. Anti-aging, moisturizing, skin-lightening, and hair-repairing shampoos, conditioners, and serums employ nanomaterials. Figure 1 outlines nanocosmeceutical advantages.

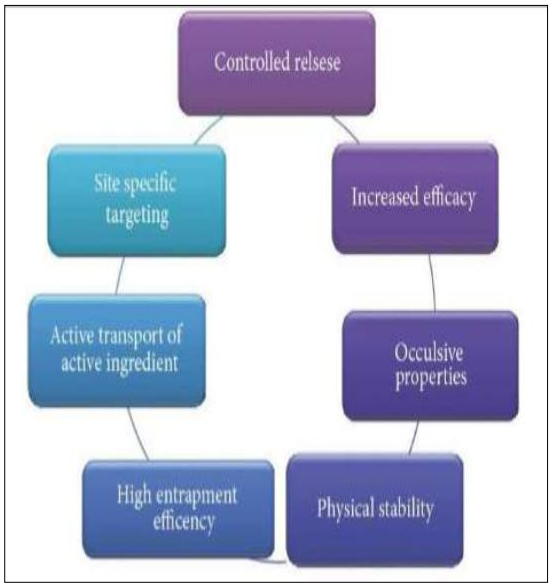

FIGURE NO: 1 PICTORIAL PRESENTATION OF POSITIVE ASPECTS OF NANOCOSMECEUTICALS.

Nature says everything has advantages and drawbacks. Nanocosmeceuticals disadvantages. Nanoparticle oxygen species may induce oxidative stress, inflammation, DNA, protein, and membrane damage. Carbon nanotubes, fullerenes, TiO2, copper nanoparticles, and silver nanoparticles may damage cells and tissues. Sunscreen titanium dioxide destroys DNA, RNA, and lipids. Nanocosmeceuticals were untested by regulators. Nanocosmeceuticals may damage nature. Nanocosmeceuticals are approved without clinical testing, creating toxicity concerns. Figure.No.2 highlights nanocosmeceuticals' disadvantages.

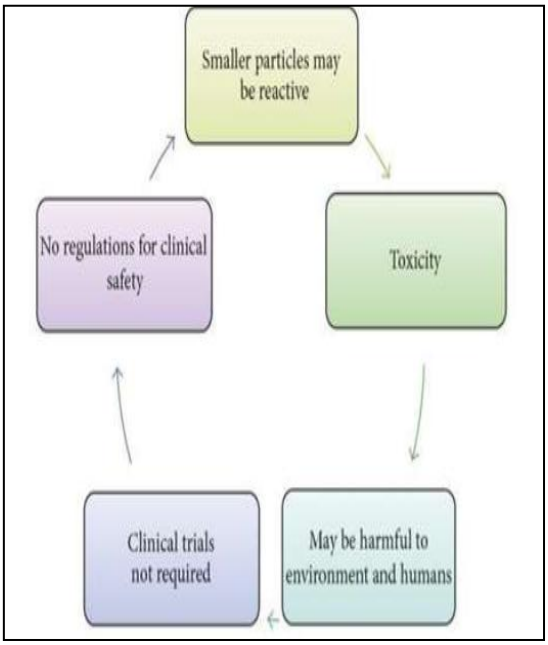

FIGURE NO: 2 PICTORIAL PRESENTATIONS OF NEGATIVE ASPECTS OF NANOCOSMECEUTICALS.

HISTORY

In 1986, Lancôme and Dior launched Niosomes® and Capture®, the first nanotechnology-based cosmetics. Nanotechnology, utilized in cosmetics, allows high-quality product manufacture. These remedies had a confined impact and were less regulated than new medications. Nanoparticles (NPs) as active ingredients and carriers enhance cosmetics. This identifies industrial standards. Nanomaterials' long-term toxicity and

product performance benefits raise concerns. The EU unified cosmetics legislation at the end of 2009. These substances should be minimized because to nanoparticles. Cosmetics companies avoided using nanoparticles while promoting nanotechnology. This research aims to educate readers on nanocosmetics, nanomaterials, and toxicology. Nanotechnology in cosmetics is supported by our skincare studies. New products and technology will drive the beauty and personal care industry to $716 billion by 2025. In the fast-growing cosmetics industry, consumers seek customized, scientifically-based goods. Consumer perceptions affect cosmetics industry trends, as evidenced by the COVID-19 epidemic. The epidemic has shown the need for safer, more transparent goods after years of "clean" and natural product demand.

NANOTECHNOLOGYINCOSMETICS: - WHEREAREWE?

One of the most passionate early users of nanotechnology is the cosmetics sector. Due to their small size and extremely high surface area to volume ratio, nano-sized materials frequently have chemical or physical properties that may differ from those of their larger counterparts, including increased adverse biological activity. This is one of the reasons why nano-scale ingredients are becoming more and more popular in the cosmetic industry. Increased efficiency, transparency, distinctive texture, protection of active ingredients, and improved customer compliance are some suggested advantages of using nanoparticles in cosmetics. For instance, whereas titanium dioxide and zinc oxide are white and opaque at larger scales, they are transparent at the nanoscale. Because of this, they may be used in foundations and moisturizers. A "soft focus" effect created by other nanoparticles, such aluminum oxide, hides wrinkles. These are used in high-end foundations, face powders, and concealer sticks. Because carbon "fullerene" nanoparticles penetrate skin so well, they are used in anti-aging lotions and moisturizers. Thus, nano-scale compounds are often used in the cosmetics business.

Almost all types of personal care products on the market, including toothpaste and anti-aging lotions, employ engineered nanoparticles. The cosmetics sector, however, has been reticent to disclose the fact that it employs materials with manufactured nanoscales. Friends of the Earth published a paper titled "Nanomaterials, sunscreens, and cosmetics: small Ingredients - big risks" in May 2006 in response to the need for further knowledge. The following concrete applications were included in the study and were drawn from the Wilson Center Inventory:

Deodorants, soap, toothpaste, shampoos, conditioners, sunscreens, anti-wrinkle creams, moisturizers, foundations, face powders, lipstick, blush, eye shadow, nail polish, fragrances, and after-shave lotions are among the products mentioned in this database. diverse metal oxides and diverse lipid formulations with nanoscaled droplets are among the materials used.

In 2006, the world's largest cosmetics company, Estee Lauder, introduced a variety of products utilizing nanoparticles. According to the Scientific Committee for Consumer Products, the formulations' nano-sized particles allow the products, particularly anti-wrinkle creams, to be

absorbed deeper into the skin. The biggest cosmetics firm in the world, L'Oreal, is investing around $600 million of its $17 billion in revenue on nanopatents and has patented the usage of hundreds of "nanosome particles" that are 800 times smaller than a human hair as nutrient delivery systems. L'Oreal now has the sixth-most nanotechnology patents in the United States, with 192. In L'Oreal plants, high-pressure equipment that fires material droplets at the speed of sound is used to make nanosize pieces. Competitors of L'Oreal, including Christian Dior of France, Procter & Gamble, Shiseido, Estee Lauder, and others, also use nanoparticles in cosmetics. 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:-

Carrier technology, which provides an intelligent strategy for the distribution of active substances, is used for the delivery of nanocosmeceuticals. Figure No. 3 shows many innovative nanocarriers for the delivery of cosmetics.

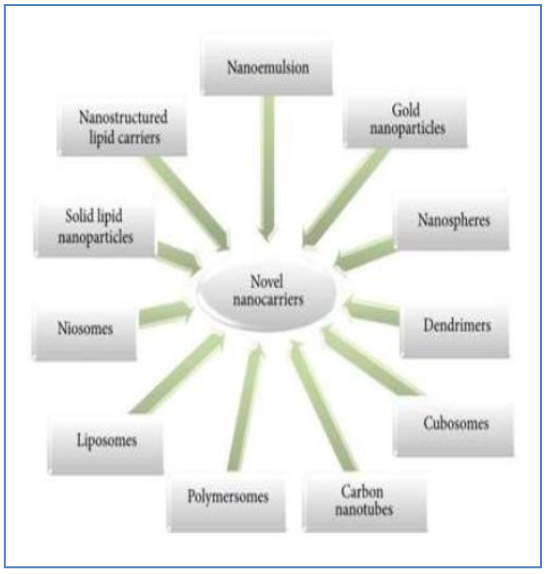

FIGURE NO: 3 PICTORIAL PRESENTATION OF NANO CARRIERS FOR COSMECEUTICALS TYPES OF NANO MATERIALS USED IN COSMETICS:-

LIPOSOMES:-

Liposomes are concentric bilayered vesicles formed of natural or synthetic phospholipids that fully encapsulate the aqueous volume. They are GRAS. Liposomes may bond with other bilayers like the cell membrane to release their contents, making them useful for aesthetic delivery. Because of their ease of manufacture, enhanced skin absorption of active compounds, and sustained cell delivery, they are valuable in cosmetics. Transferosomes, niosomes, and ethosomes may improve skin penetration.

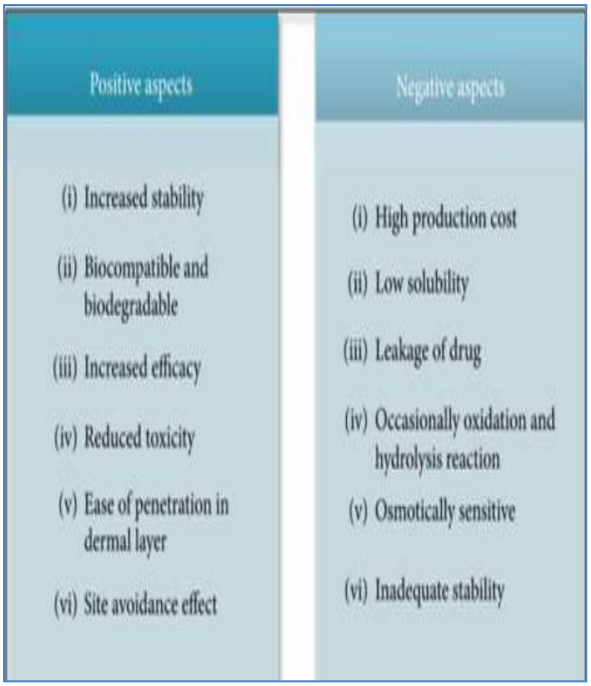

FIGURE NO: 4 PICTORIAL PRESENTATION OF POSITIVE & NEGATIVE ASPECTS OF LIPOSOME

NANOEMULSIONS:-

They are nanoscale droplets of one liquid dispersed across another. They are metastable systems whose structure may vary depending on how they were made. The ingredients utilized in their production are safe to use and GRAS-certified goods. They help extend the product's shelf life. Their smaller particle size offers greater stability and better appropriateness to contain active chemicals.

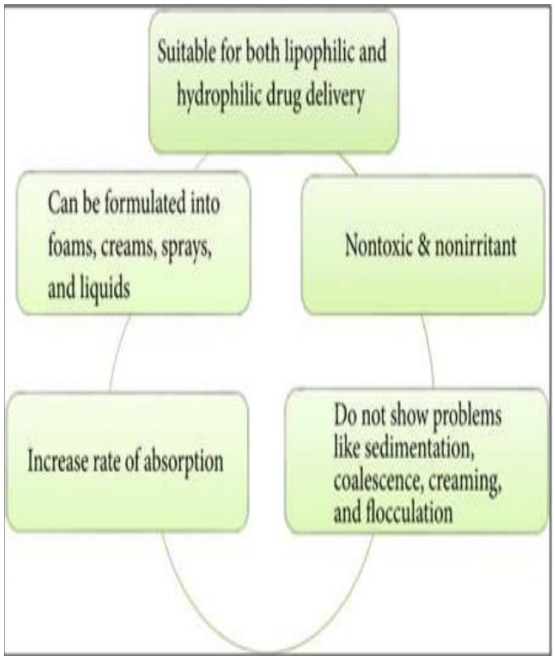

FIGURE NO: 5 MERITS OF NANO EMULSION

NANO CAPSULES:-

Nanocapsules are submicroscopic particles with an aqueous or oleic core encased in a polymeric shell. When compared to traditional emulsions, it has been discovered that the usage of nanocapsules reduces the penetration of UV filter octyl methoxy cinnamate in pig skin.

SOLID LIPID NANOPARTICLES:-

They are solid, oily lipid droplets that are stabilized by surfactants and are solid at body temperature. They have been shown to enhance the penetration of active compounds into the stratum corneum, preserve the encapsulated substances from deterioration, and be employed for the regulated administration of cosmetic agents over an extended period of time. An SLN-containing formulation is more effective in hydrating skin than a placebo, according to in vivo experiments. Incorporating and testing a molecular sunscreen improved their UV-resistant qualities, which were also discovered in them. When added to SLNs, the UV

absorber 3, 4, and 5-trimethoxybenzoylchiti showed improved UV blocking.

FIGURE NO: 6 BENEFITS AND DRAW BACKS OF SLNS.

NANOCRYSTALS:-

These are collections of several hundred to tens of thousands of atoms that come together to form a "cluster". These aggregates typically range in size from 10 to 400 nm, and their physical and chemical characteristics fall between those of bulk solids and molecules. They provide efficient and safe transit through skin.

NANOSILVER AND NANO GOLD PARTICLES:-

Cosmetic makers are using nano silver's increased antibacterial qualities for a variety of purposes. Some producers of underarm deodorants already make the promise that the product's silver content will provide up to 24 hours of germ prevention. Similar to nanosilver, nanosized gold has been put to toothpaste and is said to be very efficient in killing oral germs.

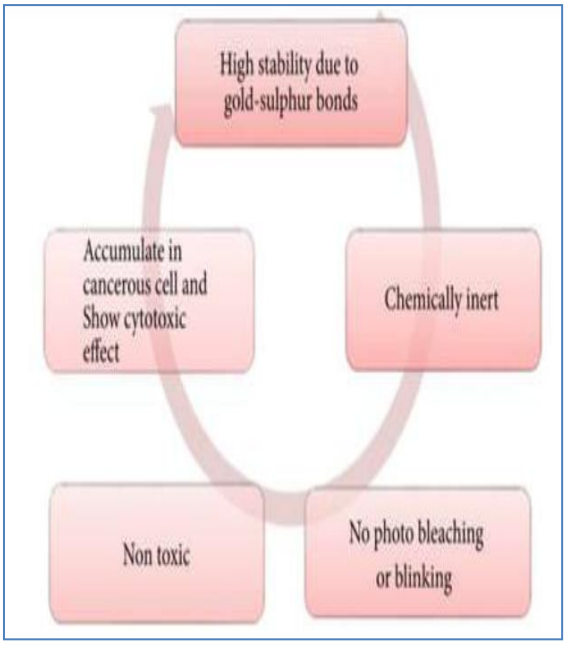

FIGURE NO: 7 VARIOUS POSITIVE ASPECTS DEPICTION OF NLC

Dendrimers:-

Unimolecular, monodisperse, micellar dendrimers have a well-defined, regularly branching symmetrical structure with a high density of functional end groups at their perimeter. They are around 20 nm in size. They have a significant number of external groupings that may be multifunctionalized.

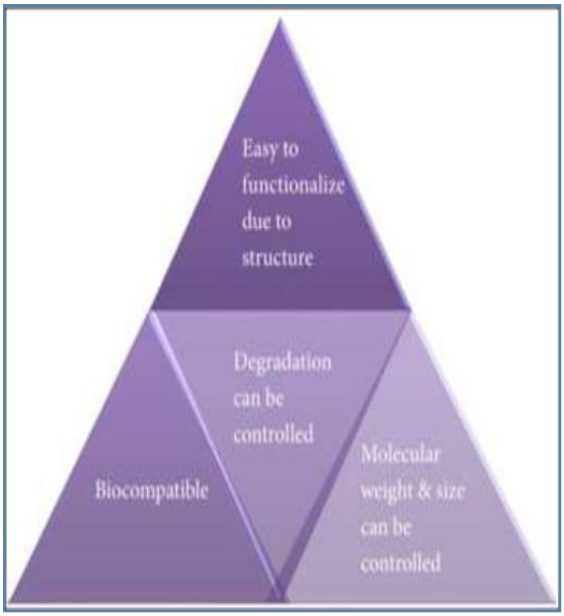

FIGURE NO: 8 ADVANTAGES OF DENDRIMERS

NANOSPHERES:-

The spherical particles with a core-shell configuration are known as nanospheres. The size has a diameter that varies from 10 to 200 nm. The medicine is entrapped, dissolved, connected, or encapsulated in nanospheres, where it is shielded from enzymatic and chemical deterioration. The medication is physically and evenly disseminated throughout the polymer matrix structure. The nanospheres' composition might be either crystalline or amorphous. This technology is capable of transforming poorly absorbed, labile physiologically active material, and poorly soluble active substance into the favorable deliverable medication, which has enormous promise. Different enzymes, genes, and medications may be encapsulated in the center of nanospheres.

40 Biodegradable nanospheres and nonbiodegradable nanospheres are the two categories into which nanospheres may be separated. Gelatin nanospheres, modified starch nanospheres, and albumin nanospheres are examples of biodegradable nanospheres, whereas Polylactic acid, the sole authorized polymer, is an example of a nonbiodegradable nanosphere. To more accurately and effectively transfer active chemicals to the afflicted region of the skin and their therapeutic effects, nanospheres are utilized in skin care products in the cosmetics industry. These little pieces are beneficial in the defense against actinic aging. The use of nanospheres in cosmetics is growing, particularly in skin care products including anti-aging, hydrating, and anti-acne creams.

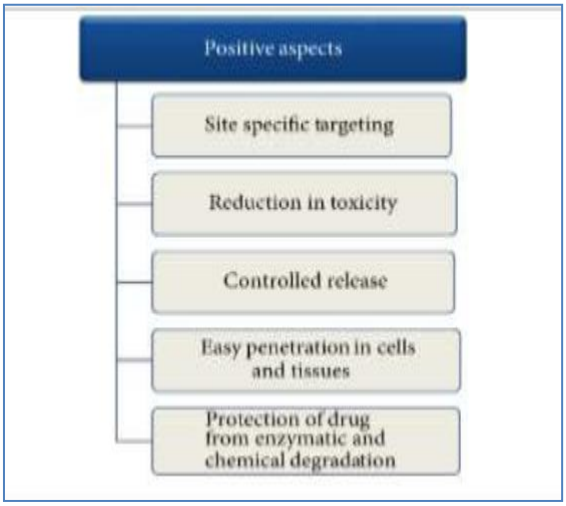

FIGURE NO: 9 FAVORABLE ASPECTS OF NANOSPHERE

CARBON NANOTUBES:-

CNTs are SP2-hybridized rolled graphene. These exact "chiral" angles roll graphene-walled cylindrical hollow fibers. Pi-stacking keeps carbon nanotube "ropes" together. Lengths are 10s of microns and widths are 0.7 to 50 nm. Carbon nanotubes are light. Single-, double-, and multiwalled CNTs are available. Single-walled carbon nanotubes are made of a folded graphene sheet with a diameter of 1-2 nm. Double-walled carbon nanotubes have two concentric tubes, whereas multiwalled ones have multiple layers of graphene tubes with a diameter of 2 to 50 nm.

WHAT ARE NANO MATERIALS?

Nanomaterials work how? Nanomaterials aren't legally defined. They are purposely manufactured materials with at least one dimension between 1 and 100 nanometers, about 1/8000 the diameter of a human hair. Materials' physics, chemistry, and biology start to change at this scale. Nanomaterials are diverse. Composition, primary particle size, shape, surface coatings, and particle bond strength vary. Carbon and silver nanoparticles are present in nature. Most nanoscale materials cannot be seen with the naked eye or ordinary lab microscopes. Engineered nanomaterials (ENMs) are nanoparticles that strengthen and lighten electronics, pharmaceuticals, and textiles.

Transparent materials absorb UV light at the nanoscale. UVA radiation protection is increasingly using UV-filtering materials.

TITANIUM DIOXIDE(TIO2):-

TiO2 nanoparticles may injure humans more than larger particles. Numerous studies have proven that non-nanoized TiO2, a mineral UV filter used in cosmetic sunscreen products, does not penetrate healthy skin and poses no health risks. Nanoized TiO2 (100 nm) causes DNA damage and severe lung inflammation in rats and mice. Human exposure to TiO2 may also be detrimental.

ZINCOXIDE(ZNO):-

ZnO may harm human epidermal cells at even low quantities, according to studies. However, an assessment of the dangers of nanostructured TiO2 and ZnO concluded that because of the way they are bonded, nanoized TiO2 and ZnO are unlikely to enter the skin. The study's findings support the safety of both materials as UV filters.

SILVER:-

Silver that is nanosized may cause oxidative stress and subsequent cell damage. The male reproductive system has been demonstrated to be harmful when exposed to silver nanoparticles. According to research, nanoparticles are able to breach the blood-testes barrier and deposit themselves into the testicles, where they may have an unfavorable impact on sperm cells.

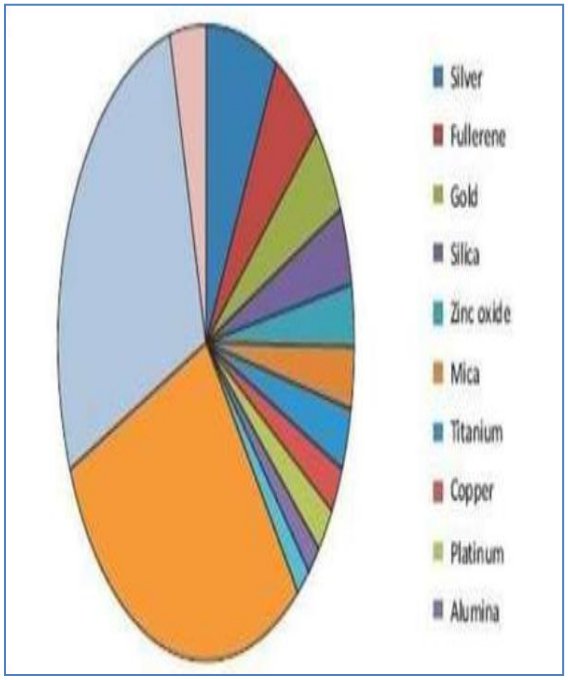

FIGURE NO: 10 PRINCIPLE NANOMATERIALS USED IN COSMETICS.

FULLERENES:-

Fullerenes are carbon tubes used in eye and anti-aging treatments. Fullerene penetrates the epidermis and dermis. They also boost light sensitivity, making cells more vulnerable to UV radiation.

SILICA:-

Nanoized silica may harm pregnant mice when given intravenously. Nanosized silica may cross the placenta and settle in the fetal liver and brain. Ultrafine crystalline silica (SiO2) nanoparticles injure human in vitro cells, causing mutations and two-nucleated cancer cells.

CARBONBLACK:-

Ultrafine carbon black particles may affect lung cell genes, inflammation, and circulatory system cell proliferation. Nanosized carbon black 15 months early may cause lung cell alterations in mice.

HEALTH, RISK AND SAFETY CONSIDERATIONS:-

Scientists are concerned about the cosmetics industry's usage of untested nanoparticles. 5100-nm particles react differently from bigger ones. Poisonous smaller particles have higher surface area to volume ratios. Reactivity and toxicity rise with surface-to-volume ratio. Thus, particle size reduction catalyzes nanoparticle surface chemistry and provides a variety of hazardous surface features. Nanoparticles' ability to pierce epidermis and reach mammalian cells benefits medicinal uses but increases chemical absorption.

Cosmetic nanotechnology may create genetic abnormalities over time. Traditional anti-aging skin care barriered moisture in the skin. Nanoparticles in contemporary cosmetics penetrate the higher layers of the skin and stimulate new skin cell development, giving the skin a fresh, plump, and young look. Nanoparticles may transport compounds into the skin's deeper layers. Irritating compounds. Nanomaterials may injure human cells, although also have numerous advantages. Many nanoparticles are harmful. Like non-NMs, NMs are assessed for exposure utilizing nano-aspects.

NM exposure pathways matter most. The stratum corneum is exposed. Toxic NMs may infiltrate the stratum corneum. Figure 13 shows skin anatomy. Before being used in cosmetics, tiny NMs should be examined.

Sprays and aerosols should be carefully assessed since NMs may be inhaled. NM concentrations should include weight, particle number, and surface area. Exposure causes NM aggregation, deterioration, and disintegration. NMs in toothpaste, mouthwash, and lipstick may be swallowed.

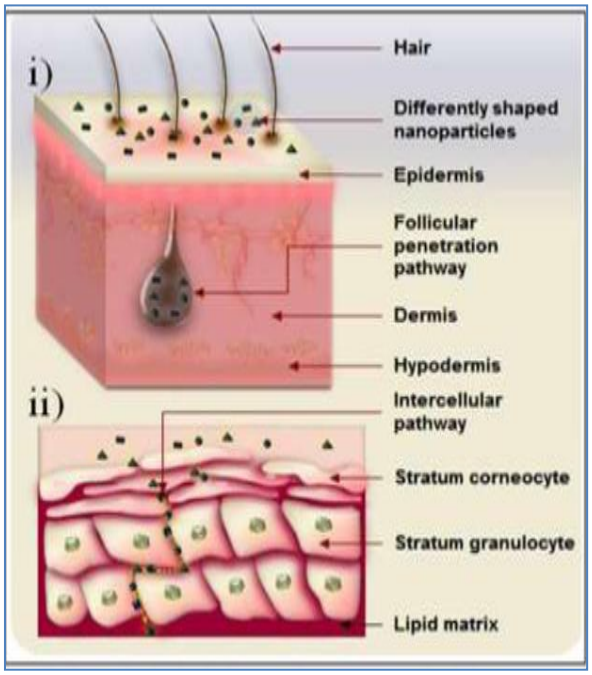

FIGURE NO: 12 TWO MAIN POSSIBLE SKIN PENETRATION PATHWAYS ARE ILLUSTRATED.

The nanomaterial (i) diffuses across the spaces between corneocytes (the intercellular penetration route) and penetrates through hair follicles (the follicular penetration pathway).

MAJOR CLASSES INNANO COSMECEU TICALS:-

Cosmetics is the fastest-growing personal care category. Nail, hair, lip, and skin products include several nanocosmeceuticals. Figure 14 shows the key nanocosmeceutical categories.

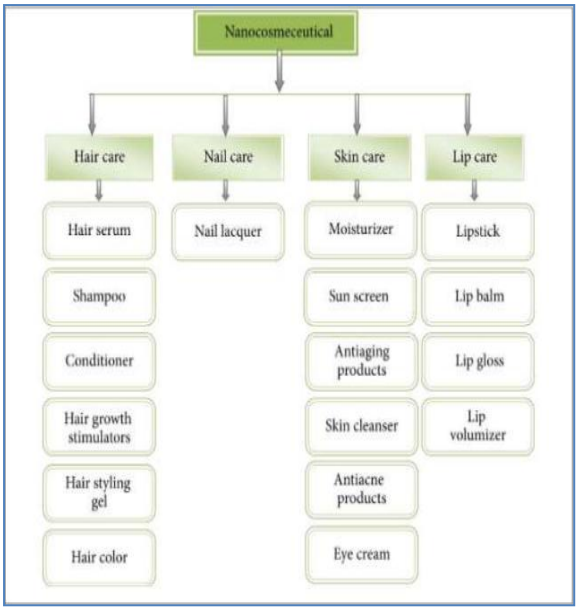

FIGURE NO: 13 MAJOR CLASSES IN NANO COSMECEUTICALS.

SKIN CARE:-

Skincare cosmetics boost skin function and texture with collagen and free radical protection. Keratin structure maintenance improves skin health. Zinc oxide and titanium dioxide nanoparticles protect skin and make sunscreens less oily, odorous, and transparent. SLNs, nanoemulsions, liposomes, and niosomes retain moisture by forming a thin layer of humectants. Nanocosmeceuticals such nanocapsules, liposomes, nanosomes, and nanospheres replenish collagen and firm and lift skin.

HAIR CARE:-

Nanocosmeceuticals include shampoos, conditioners, growth accelerators, coloring agents, and styling products. Nanoparticles target the hair follicle, shaft, and offer more active ingredient due to their properties and sizes. Nanoparticles in shampoos provide a protective coating that traps moisture in the cuticles, maximizing resident contact time with the scalp and hair follicles.Nanocosmeceutical conditioners soften, shine, silken, and detangle hair. Niosomes, microemulsions, nanoemulsions, nanospheres, and liposomes mend damaged cuticles, restore texture and gloss, and make hair less brittle, glossy, and oily.

LIP CARE:-

Nanocosmeceuticals offers lipstick, balm, gloss, and volumizer. Lip gloss and lipstick nanoparticles prevent transepidermal water loss, softening lips. 76 and preserve lip color. Liposome-based lip volumizer moisturizes, defines, and smooths lip contour wrinkles.

NAIL CARE:-

Nanocosmeceuticals improve nail care products. Nanotechnology nail paints are robust, quick-drying, durable, chip-resistant, and flexible, making them easy to apply. Innovative nail paints with antifungal properties include amalgamating silver and metal oxide nanoparticles.

Characterization Methods For Safety Assessment Of Nanoparticlesin Cosmetics:-

The Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) examines nanomaterials and risk assessment methods to analyze the possible health and environmental effects of nanotechnology products. Nanomaterials' unique features need new test techniques to determine damage sources. The main nanomaterial safety requirements are:

PHYSICAL-CHEMICAL PROPERTIES:-

Size, shape, specific surface area, aspect ratio, agglomeration/aggregation state, size distribution, surface morphology/topography, structure, and solubility are physical qualities. Chemical features include structural formula/molecular structure, nanomaterial

composition (purity, known impurities or additions), phase identity, and surface chemistry (composition, charge, tension, reactive sides, physical structure, phot). Fundamental particles share standards. ISO/ASTM nanoparticle characterizations.

MATHEMATICAL MODELLING:-

These prediction models range from basic empirical procedures to complex mathematical equations that need the knowledge and estimation of components not easily accessible via trial. These models cannot predict skin reactions to macromolecular compounds or particle designs since they do not incorporate such data.

IN VITRO METHODS:-

Cosmetics must examine molecular mechanisms of biological activity using approved methodologies. Cosmetic chemical safety testing requires these approaches.

In vitro research matches mammalian toxicity. Genomic and proteomic studies of oxidative assessment are slower.

GLOBAL SCENARIO OF NANOCOSMECEUTICALS:-

Drugs but not cosmetics require FDA clearance. Cosmeceuticals are medicine-cosmetics. The name "cosmeceuticals" is not recognized by the FDA or the Federal Food, Drug, and Cosmetics Act, but the products offer cosmetic and functional advantages without becoming OTC medications. 85 To bypass the costly and long FDA clearance procedure, cosmeceutical manufacturers skip clinical trials and specific claims. Cosmetics firms confront new obstacles.

Major Products And Services Offered By Cosmeceuticalcompanies:-

Ten strong rivals provide comparable products and services to their customers. These are 2018's top 10 cosmetic companies. The top 10 sector companies are listed below:

Sr.No	NameoftheCompan y	Industry	ProductsandServices
1.	Lakme	PersonalCare	Face,Body,Hair,Nailandservices throughLakme BeautySalons,onlineservices.
2.	Lotus	Herbaland Ayurvedic	Facecare,suncare,whiteglow,anti-aging,bathandbodycare,haircare,lipcare,facialkit,eyecare,baby Care.
3.	Biotique	PersonalCare	Menandwomen Ayurvedicskinproducts
4.	L‟Oréal	PersonalCare	Colouringproducts,haircaremakeupandskincareproducts.
5.	Shahnaz Husain	Herbaland Ayurvedic	HerbalproductsandAyurvedictreatment.
6.	RevlonIndia	Personalcare	Makeup Cosmetics, Hair colour, Nailsand Beauty tools and service thoughonlineRevlonProfessionalservices.
7.	Maybelline	Cosmetics	Makeup,Eyebrows,lip,nailcarep

			roducts,onlin esales.
8.	Himalaya	Healthcarep roducts	Pharmaceutical s,personalcare,b abycare, well-being, nutritionandani malhealthprodu cts.
9.	ColorBar	Cosmetics	Beautyandskinc areproducts, onlineservices.
10	Elle18	HealthandB eauty	Cosmetics and onlineservices.

TABLE NO: 1 WORLD'S TO P10 COSMECEUTICAL COMPANIES & THEIR PRODUCTS AND SERVICES.

CONCLUSION:-

Nanotechnology is exciting. Dermatology, cosmetics, and biology employ nanotechnology for decades. Scientists produce cosmeceuticals using unique distribution methods and technologies. As cosmeceuticals usage rises, new delivery techniques are being developed. Liposomes, niosomes, NLC, SLNs, gold nanoparticles, nanoemulsion, and nanosomes are novel cosmeceutical nanocarriers. Innovative delivery methods may provide site specificity, stability, biocompatibility, sustained action, and drug-loading capacity. Businesses must claim efficacy without proof. Nanomaterials, controversial, are being examined for toxicity and health risks. Examine nanoparticle safety. Nanotechnology should benefit users. Manufacturers may save time by skipping clinical studies for cosmeceutical approval. Finally, cosmeceuticals and nanoparticles should be safe and controlled.

REFERENCES:-

[1]. S. Logothetidis, "Nanostructured materials and their applications," Nano Science and Technology, vol. 12, p. 220, 2012.

[2]. A. D. Maynard, Nanotechnology: A Research Strategy for Addressing Risk. PEN, 2006.

[3]. M. S. Bangale, S. S. Mitkare, S. G. Gattani, and D. M. Sakarkar, "Recent nanotechnological aspects in cosmetics and dermatological preparations," International Journal of Pharmacy and Pharmaceutical Sciences, vol. 4, no. 2, pp. 88–97, 2012.

[4]. A. Gautam and R. Singh Vijayaraghavan, "Dermal exposure of nanoparticles: an understanding," Journal of Cell and Tissue Research, vol. 11, no. 1, pp. 2703–2708, 2011.

[5]. R. Sharma, "Cosmeceuticals and herbal drugs: practical uses," International Journal of Pharmaceutical Sciences and Research, vol. 3, no. 1, pp. 59–65, 2012.

[6]. H. Dureja, D. Kaushik, M. Gupta, V. Kumar, and V. Lather, "Cosmeceuticals: an emerging concept," Indian Journal of Pharmacology, vol. 37, no. 3, pp. 155–159, 2005.

[7]. S. Mukta and F. Adam, "Cosmeceuticals in day-to-day clinical practice," Journal of Drugs in Dermatology, vol. 9, pp. 62–69, 2010.

[8]. K. Srinivas, "The current role of nanomaterials in cosmetics," Journal of Chemical and Pharmaceutical Research, vol. 8, no. 5, pp. 906–914, 2016.

[9]. F. S. Brandt, A. Cazzaniga, and M. Hann, "Cosmeceuticals: current trends and market analysis," Seminars in Cutaneous Medicine and Surgery, vol. 30, no. 3, pp. 141–143, 2011.

[10]. L. Mu and R. L. Sprando, "Application of nanotechnology in cosmetics," harmaceutical Research, vol. 27, no. 8, pp. 1746–1749, 2010.

[11]. G. J. Nohynek, J. Lademann, C. Ribaud, and M. S. Roberts, "Grey Goo on the skin? Nanotechnology, cosmetic and sunscreen safety," Critical Reviews in Toxicology, vol. 37, no. 3, pp. 251–277, 2007.

[12]. J. R. Antonio, C. R. Antônio, I. L. Soares-Cardeal, J. M. A. Ballavenuto, and J.R. Oliveira, "Nanotechnologyin dermatology," Anais Brasileiros de Dermatologia, vol. 89, no. 1, pp. 126–136, 2014.

[13]. A. Dahiya and J. F. Romano,

"Cosmeceuticals: a review of their use for aging and photoaged skin," Cosmetic Dermatology, vol. 19, no. 7, pp. 479– 484, 2006.

[14]. E.Starzyk, A. Frydrych, and A. Solyga, "Nanotechnology: does it have a future in cosmetics?" SÖFW Journal, vol. 134, no. 6, pp. 42–52, 2008.

[15]. S. Mukta and F. Adam, Cosmeceuticals in day-to-day clinical practice," Journal of Drugs in Dermatology, vol. 9, pp. 62– 66, 2010.

[16]. J. C. Le Joliff Liposomes and cosmetics – La Cosmétothèque https://cosmetotheque.com/en/2020/02/04/ liposomes-and-cosmetics/ (2020), Accessed 4th Feb 2021. ThreadCollect(2020) https://commonthreadco.com/blogs/coachs-corner/cosmetics-marketing-industry- trends, Accessed 4th Feb 2021

[21]. F. Nozaki General Aspects of Cosmetics in Relation to Science and Society: Social, Cultural, Science, and Marketing Aspects K. Sakamoto, R.Y. Lochhead, H.I. Maibach, Y. Yamashita (Eds.), Cosmet. Sci. Technol. Theor. Princ. Appl, Elsevier (2017), pp. 3-14, & C. Hennigan COVID-19 increases demand for safe BPC Products Mintel(2020) https://www.mintel.com/blog/beauty- market-news/covid-19-increases-demand- for-safe-and-reliable-bpc-products, Accessed 4th Feb 2021

[22]. Katie, B. 2007. Nanocarrier molecules increase UV protection in suncare. http://www.cosmeticdesign-europe.com (accessed September 03, 2012).

[23]. Environmental Working Group (EWG). 2006. A survey of ingredients in 25,000 personal Care products reveals widespread use of nano-scale materials not assessed for safety, in Everyday products. Washington, D.C. http://www.ewg.org/node/21738 (accessed September 03, 2012).

[17]. B.S. Li, J.H. Cary, H.I. MaibachScience [24]. Friends of the Earth (FOEM). 2006. Behind Cosmetics and Skin Care. J. Nanomaterials, sunscreens and cosmetics: Cornier, C.M. Keck, M. Van de Voorde Small ingredients, Big risks,friends of the (Eds.), Nanocosmetics, Springer Earth Australia International Publishing, Cham (2019), http://www.foe.org/camps/comm/nanotech pp. 3-15, 10.1007/978-3- 030-16573- 4_1 / (accessed September 03, 2012).

[18]. A. Mihranyan, N. Ferraz, M. Strømme [25]. Scientific Committee on Consumer Current status and future prospects of Products (SCCP). 2007. Safety of nanotechnology in cosmetics Prog Mater nanomaterials in Cosmetic products,pp.Sci, 57 (2012), pp. 875-910, 10.1016/j.pmatsci.2011.10.001 Article 19. Lorna Brazell International initiatives Nanotechnol. Law Best Pract, Kluwer Law International (2012) & B. Sandoval Perspectives on FDA"s 33– http://ec.europa.eu/health/ph_risk/committ ees/04_sccp/docs/ Sccp_o_099.pdf (accessed September 03, 2012)

[26]. A. Nasir, "Nanotechnology and dermatology: Part II-risks of regulation of anotechnology:Emerging nanotechnology," Clinics in Dermatology, challenges and potential solutions Compr vol. 28, no. 5, pp. 581–588, 2010. & Rev Food Sci Food Saf, 8 (2009), pp. 375-C. Fox, Cosmetic and Pharmaceutical 393 Vehicles: Skin Care, Hair Care, Makeup

[19]. D.M. Bowman, G. Van Calster, S. and Sunscreens, vol. 113, Cosmetics Friedrichs Nanomaterials and regulation & Toiletries, 1998. of cosmetics Nat Nanotechnol, 5 (2010), [27]. Cevc G. Transfersomes, p. 92 liposomes and other lipid suspensions on the skin:

[20]. R. Roberts Cosmetics marketing & Permeation enhancement, vesicle industry trends: a 2020 ecommerce report penetration, and transdermal drug on the state online beauty Common delivery. Crit Rev Ther Drug Carrier Syst.1996; 13:257–388.

[28]. Nanoemulsion based on phosphoric acid fatty acid esters and its uses in the cosmetics, dermatological, pharmaceutical, and/or ophthalmological fields. L"Oréal, US Patent 6274150

Medicinal applications of fullerenes. Int J & onneville-Aubrun O, Simonnet Nanomedicine. 2007; 2:639–49. JT, L"Alloret F. Nanoemulsions: A new [38]. K. Dilip, T. Surendra, K. N.

Suresh, and vehicle for skincare products. Adv Colloid K. Roohi, "Nanostructured lipid carrier Interface Sci. 2004; 108-109:145–9. (Nlc) a modern approach for topical

[29]. Hwang SL, Kim JC. In vivo hair growth delivery: a review," World Journal of promotion effects of cosmetic preparations Pharmacy and Pharmaceutical Sciences, containing hinokitiol-loaded Poly vol. 2, no. 3, pp.921–938, 2013. &A. (epsilon-caprolacton) nanocapsules. J Saupe, S. A. Wissing, A. Lenk, C. Microencapsul. 2008; 25:351–6. Schmidt, and R. H. Müller, "Solid Lipid