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NANOTECHNOLOGY USED IN CURRENT SENARIO

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ABSTRACT:-

Nanotechnology is nothing but a branch of technology smaller in size, lighter in weight, stronger in strength due to its large surface area to volume ratio. Applications of nano particles in drug delivery, protein and peptide delivery, cancer are explained. Applications of various nano systems in cancer therapy such as carbon nano tube, dendrimers, nano crystal, nano wire, nano shells etc. The advancement in nano technology helps in the treatment of neuro degenerative disorders such as Parkinson's disease and Alzheimer's disease. In tuberculosis treatment, the clinical application of nanotechnology in operative dentistry, in ophthalmology, in surgery, visualization, tissue engineering, antibiotic resistance, immune response also. Nano pharmaceuticals can be used to detect diseases at much earlier stages. The applications of nanotechnology have been widely used by several industries globally, especially in the development of innovative products using novel materials in cosmetics, paints, ceramic, textile coatings and pharmaceuticals. Nanoparticles have been designed in different morphological structures at the microscopic level such as nanospheres, nanotubes, nanorods, nanowires, nanoplatelets, nanoparticles and nanoneedle.

INTRODUCTION:-

Nanoscience and Technology deal with the materials within the dimension 1 – 100 nm. Nano science gave a new pathway for new dimensions to basic science leading to a range of new technologies. Nanotechnology is the principle of atom manipulation atom by atom, through control of the structure of matter at the molecular level. It is well known that Nanotechnology is broadly defined as the understanding and control of matter at dimensions of roughly 1-100 nm, where unique phenomena enable novel applications. It entails the ability to build molecular systems with atom by atom precision, yielding a variety of Nano machines. Nano science is nothing but manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at larger scale. Nanotechnologies deal with the design, characterization, production and application of structures, devices and systems by controlling shape and size at nanometer scale. The prefix nano is derived from Greek word dwarf. Technology means the building of useful thing from the scientific principles. One nanometer (nm) is equal to onebillionth of a meter. A human hair is approximately 80,000 nm wide, and a red blood cell approximately 7000 nm wide. Due to their high surfaceto-volume ratio, metallic nanoparticles show unique physical, chemical and biological properties when compared with the macro scale. Nanomaterials are classified as:Quantum dots, Nanodots, Inorganic macromolecules,Nanocrystals, Nanophases, Nanostructures, (Nanoparticles, Nanointermediates, Nanocomposites), Nanorods, Nanoplatelets, Nanotubes, Nanofibrills, Quantum wires, Nanoholes, Composite. The term "Nanomaterials" covers materials in one dimension (thin films), two–dimension (nanofibers, nanowires, nanotubes, etc.) and three-dimension (nanopowders, nanocapsules, fullerenes, dendrimers, precipitates, colloids, quantum dots, nanostructured materials, nanoporous materials, etc.).

PROPERTIES OF NANO PARTICLES:

Mechanical properties, Thermal properties, Biological properties, Optical properties, Chemical properties. Synthesis of nanoparticles include two main routes, they are Top-down method and Bottomup method. Top-down method include Mechanical milling/Ball milling, Chemical etching, Laser ablation, Sputtering. Bottom-up method include Chemical/Electrochemical method (Chemical precipitation, Electrochemical), Vapor

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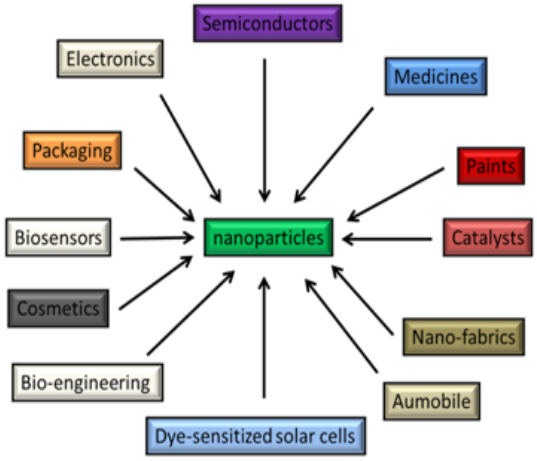
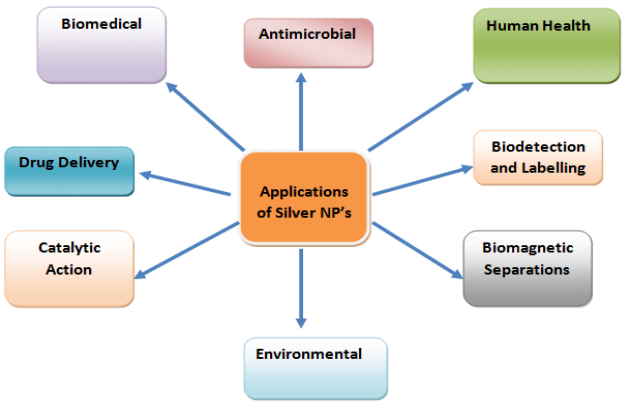
Deposition Method [Chemical vapor deposition (CVD), Physical vapor deposition (PVD)], Atomic/Molecular Condensation, Sol-gel processes, Spray pyrolysis, Laser Pyrolysis, Aerosol Processes and Bioreduction Method. The green method has proved to be better than the chemical methods due to slower kinetics, which offers a better control over crystal growth and reduced capital involved in production of nanoparticles. In addition, the green synthesis of nanoparticles using microorganism fungus, plants and plant extracts, has been suggested as possible eco-friendly alternatives to chemical and physical method. The use of plants in the synthesis of nanoparticles is quite rapid, low cost, eco-friendly and a single-step method for biosynthesis process.



APPLICATIONS OF NANOPARTICLES:

Potential applications of nanoparticles have been exploited in various fields such as Biomedical devices, Drug-delivery, etc. Nanoporous is used as aerogels for thermal insulation in the areas of electronics, optics and bio-medical field for tracing or even implants type applications. Nanotubes are used as electrical conductive nanocomposites, structural materials, single-walled nanotubes used in conductive adhesives and connectors, tyre and optic industries. Massive nanomaterials are used as hard coatings, structural components for the pipes for oil and gas, sport or even anti-corrosion sector industries. Dendrimers are used in medical field (administration of drugs, rapid detection), cosmetic preparations. Quantum dots are used in photovoltaic cells, inks and paints. Fullerenes are used in sport materials, development of photovoltaic solar cells, used as hardening agents for the development of light weight materials and also several applications in health care sectors, used as excellent anti oxidants, anti viral agent, drug delivery and gene delivery, photo sensitizers in photo dynamic therapy and polymers with optical limiting properties (surface coating and phtotoconducting devices in particular for applications in artificial photosynthesis). Nanowires are used in the conductive layers of screens, solar cells and electronic devices.



1. Nanoparticles in material science: Application of Nanoparticles in Cosmetics many types of nanoparticles are commonly used in cosmetic preparations especially in sunscreen lotion, moisturizers, nail polish, hair care products and makeup creams. In cosmetics formulation nanoparticles work as UV filters. Zinc oxide and titanium oxide nanoparticles have been used for a long time in sunscreen preparation because of its ability to absorb or scatter the sun's ultraviolet radiation and prevent sunburn. Nanoemulsions are used in hair care products to encapsulate active ingredients and carry them deeper into hair shafts. The average size of nanoparticles used in UV filters is around 40nm. The direct integration of Laser-generated nanoparticles can be used in transparent nail polishes. when nanosilver is incorporated in cosmetic products they can easily penetrate through the skin. Due to their smaller size, nanoparticles can easily permeate through skin, then to the various organs which may damage the cell and DNA rendering to organ death. As the human skin is semi permeable in nature, they will not allow nanomaterials passage through it easily. Some investigators concluded that nanoparticles incorporated cream does not penetrate through the skin. The ratio of nanoparticles penetration is less than 2% and penetrates to 0.002-0.02 ppm. They confirmed that no toxicity was observed when the bulk metals were turned to trace element. Nanoparticles ranging from 20 to 200 nm size cannot penetrate skin barrier until they are partially damaged. There are some specific nanoparticles like chromium, silver, TiO2, and ZnO which do not penetrate deeper than the stratum corneum. The antimicrobial and antioxidant potentials of the biosynthesized colloidal zinc oxide nanoparticles are used for a fortified cold cream formulation. The zinc oxide nanoparticles (ZnO) were synthesized using Adhatoda vasica(Malabar nuts) leaf extract and characterized. The antibacterial and antifungal activities of biosynthesized ZnO nanoparticles were evaluated. The formulated ZnO nanoparticles infused cold cream showed antioxidant properties and also tested against clinical skin pathogens.

2.Nanoparticles in Paints Formulation: It is to be noted that Nanomaterials play a vital role in existing properties of paints due to their large surface to volume ratio and their specific structural characteristics such as shape and size. Potential functional benefits and effects of nanomaterials in paints are mainly dependent on their material type: Titanium dioxide functions as bactericidal, easy to clean, fire retardant, selfcleaning and thermal insulation. Self cleaning is due to hydrophilic property of titanium dioxide and thus it no longer needs regular cleaning because the water and dirt will not stick on it for longer. Silicon dioxide functions as easy to clean, fire retardant, scratch resistance, thermal insulation and water repellent. When silicon dioxide added with polymeric resins, paints shows excellent abrasion properties. Silicon dioxide avoids the swelling and shrinking associated with temperature and humidity changes due to its excellent abrasion properties. They concluded that the paint formulated with silver (10 nm) nanoparticles showed better results than other copper and zinc oxide. The paint was sprayed on metallic and glass substrates and studied different parameters like thickness, adhesion, hardness, electrical conductivity and resistance to environmental degradation.

3. Nanoparticles in Textiles: One of the most important industries for consumer goods is textile industry worldwide generating textiles for clothing, household goods, furnishing and technical purposes. Nanomaterials play a vital role for adding or improving different functionalities of the textiles and also have an adverse effect on humans and environment. Nanomaterials have number of functionalities to textiles such as UV protection, breathability, conductive, antistatic properties, wrinkle resistance or resistance to stains, bacteria or fungi, dirt and water repellence depending on the material. Nanomaterials can be directly applied to the fibre surface or incorporated into fibre coatings (eg., polymers). Silver functions as an antimicrobial, antistatic, electrical conductivity, and self-cleaning. It also reduces microbial growth on the textile (clothing, household, and furnishing) by releasing silver ions, which will react on the surface of the fibre. Zinc oxide functions as abrasion resistance, antimicrobial, dirt repellent, photocatalytic, self-cleaning, UV-absorption, water repellent. Zinc oxide nano-rods considered as great for coating cotton fabric due to its super hydrophobic properties (i.e. waterrepellence). Silicon dioxide functions as abrasion resistance, active substance carriers, chemical resistance, dirt repellent, flame retardant, self-cleaning and water repellent. Hydrophobic property of silicon dioxide nanoparticles makes cotton surface water-repellent. Titanium dioxide functions as antimicrobial, dirt repellent, flame retardant, photocatalytic, self-cleaning, UVabsorption, water repellent. Aluminium oxide functions as abrasion resistance chemical resistance, flame retardant. Nanoclays functions as abrasion resistance, active substance carriers, flame retardant. Carbon black functions as antistatic

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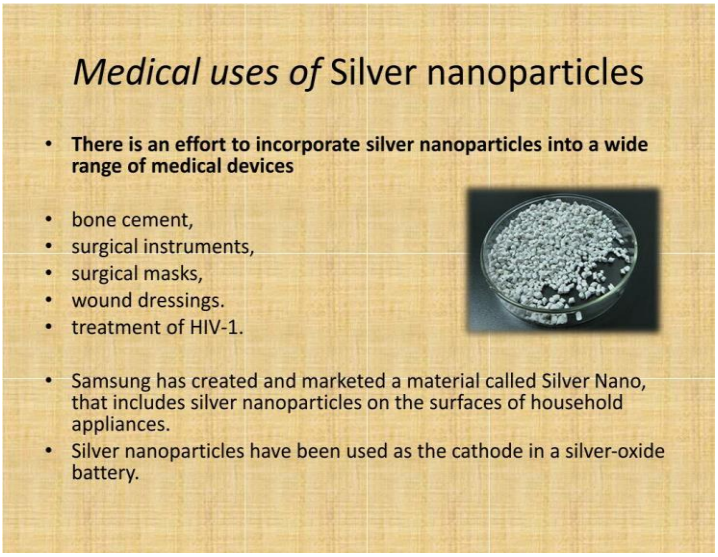
and electrical conductivity. Carbon nanotubes (CNTs) enhance textiles and fibres with flameretardant properties, and also generate electrical conductivity.

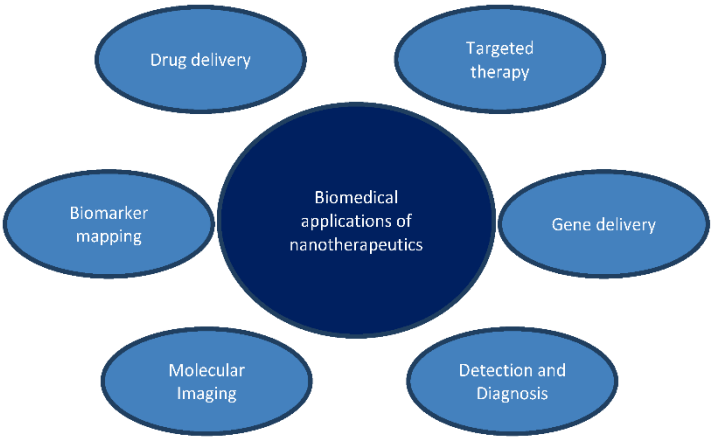
4.Nanoparticles in medical science:

A. Wound dressings: The world's first commercially available nanosilver product was developed by Robert Burrell to treat various wounds in clinic, including burns, chronic ulcers, toxic epidermal necrolysis. Recently, new antibacterial dressings are being fabricated for the promotion of wound healing and increasing antibacterial efficacy. The cytotoxicity was correlated with the silver released from the dressings as measured by silver concentration in the culture medium. The results show that silver dressings resulted in a significant delay of reepithelialization. Silver nanoparticles were synthesized by gamma irradiation at doses of 50 kGy in the presence of sodium alginate as stabilizer. The methods of dispersing silver in dressings include coating or spraying silver-containing solution on the wound dressing surface, padding the wetted dressing with pressure, embedding silver nanoparticles in non-woven fibers. Silver foam dressings and silver alginate dressings are the most popular antimicrobial absorbent dressings, producing in many health care companies.



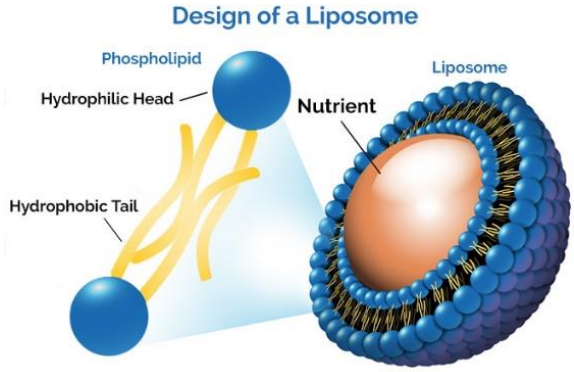
B.Bio-diagnosis: Nanoparticles play a major role in bio-diagnosis .Nanoparticle array biosensor for clinical detection of serum, nanoshells to locate cancer cells and destroy them through photothermal therapy.

C.Nanocrystal: A nanocrystal is a crystalline material with dimensions measured in nanometers; a nanoparticle with structure that is mostly crystalline. The nanocrystallization is defined as a way of diminishing drug particles to the size range of 1-1000 nanometers. Nanocrystallization is thought to be an universal method that can be applied to any drug. There are two distinct methods used for producing nanocrystals; 'bottom-up' and 'top-down' development. The top-down methods (i.e. Milling and High pressure homogenization) start milling down from macroscopic level. In bottom-up methods (i.e. Precipitation and Cryo-vacuum method), nanoscale materials are chemically composed from atomic and molecular components.



D.NanoMorph: The NanoMorph technology is to convert drug substances with low water-solubility from a coarse crystalline state into amorphous nanoparticles. A suspension of drug substance in solvent is fed into a chamber, where it is rapidly mixed with another solvent. Immediately the drug substance suspension is converted into a true molecular solution. The admixture of an aqueous solution of a polymer induces precipitation of the drug substance. The polymer keeps the drug substance particles in their nanoparticulate state and prevents them from aggregation or growth. Water redispersable dry powders can be obtained from the nanosized dispersion by conventional methods, e.g. spray-drying.

E. Liposomes: These have been extensively explored and most developed nano carriers for novel and targeted drug delivery due to their small size, these are 50-200 nm in size. Liposomes are biocompatible, versatile and have good entrapment efficiency. It finds application as long circulatory and in passive and active delivery of gene, protein and peptide.



F. Dendrimers: Dendrimers are hyper branched, tree-like structures. It contains three different regions: core moiety, branching units, and closely packed surface. It has globular structure and encloses internal cavities. Its size is less than 10 nm. These are used for long for their size, shape, and have unique physical properties. Nano tubes have some special advantages over other drug delivery and diagnostic systems due to their unique physical properties.

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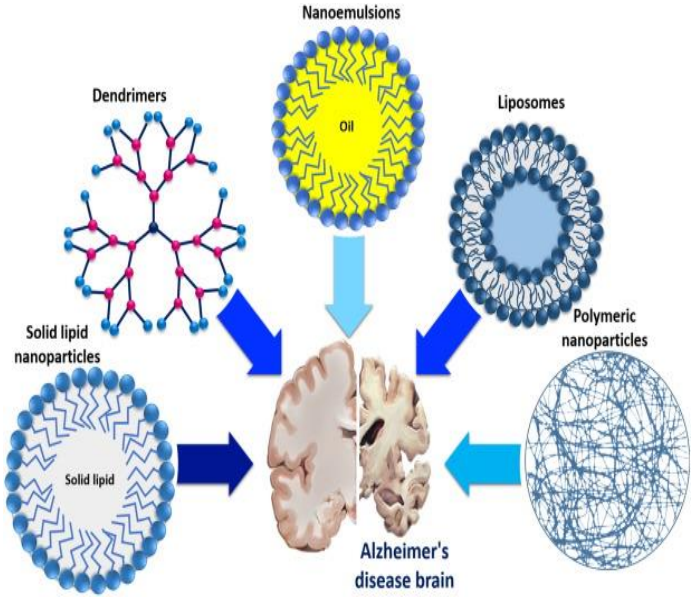
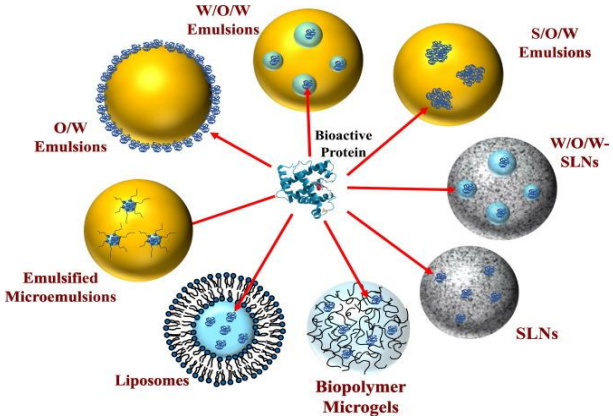
5.Nanotechnology in health and medicine: Even today various disease like diabetes, cancer, Parkinson's disease, Alzheimer's disease, cardiovascular diseases and multiple sclerosis as well as different kinds of serious inflammatory or infectious diseases (e.g. HIV) constitute a high number of serious and complex illnesses which are posing a major problem for the mankind. Nanomedicine is an application of nanotechnology which works in the field of health and medicine. Nano-medicine makes use of nano materials, and nano electronic biosensors. With the help of nanotechnology, damaged tissue can be reproduced or repaired. These so called artificially stimulated cells are used in tissue engineering, which might revolutionize the transplantation of organs or artificial implants. Advanced biosensors with novel features can be developed with the help of Carbon nano tubes. This technology is also being used to develop sensors for cancer diagnostics. Though carbon nano tubes is inert, it can be functionalized at the tip with a probe molecule. Probe molecule to serve as signature of leukemia cells identified. Nanotechnology has made excellent contribution in the field of stem cell research. For example, magnetic nanoparticles (MNPs) have been successfully used to isolate and group stem cells. Quantum dots have been used for molecular imaging and tracing of stem cells, for delivery of gene or drugs into stem cells, nano materials such as carbon nano tubes.



6.Proteins and Peptide Delivery: Protein and peptides are macromolecules and are called biopharmaceuticals. These have been identified for treatment of various diseases and disorders as they exert multiple biological actions in human body. Nano materials like nano particles and dendrimers are called as nano biopharmaceuticals, are used for targeted and/or controlled delivery.



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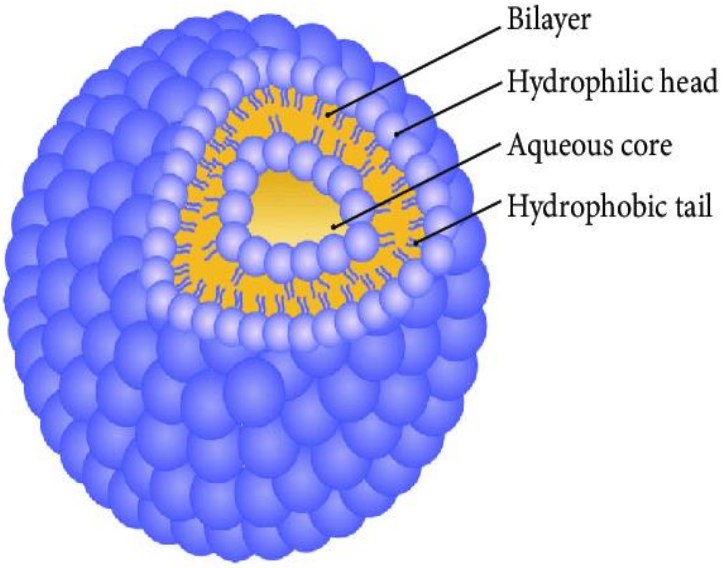
7. Tissue engineering: In tissue engineering, nanotechnology can be applied to reproduce or repair damaged tissues. By using suitable nanomaterial-based growth factors, artificially stimulated cell proliferation, in organ transplants or artificial implants therapy nano technology can be useful, which can lead to life extension.

8. Antibiotic resistance: Antibiotic resistance can be decreased by use of nano particles in combination therapy. Zinc Oxide nano particles can decrease the antibiotic resistance and enhance the antibacterial activity of ciprofloxacin against microorganism, by interfering with various proteins that are interacting in the antibiotic resistance or pharmacologic mechanisms of drugs.

9.Immune response: The nano device bucky balls have been used to alter the allergy/ immune response. They prevent mast cells from releasing histamine into the blood and tissues, as these bind to free radicals better than any anti-oxidant available, such as vitamin E.

10. Nano pharmaceuticals: Nano pharmaceuticals can be used to detect diseases at much earlier stages and the diagnostic applications could build upon conventional procedures using nanoparticles. Nano pharmaceuticals can reduce toxic systemic side effects thereby resulting in better patient compliance. The pharmaceutical companies are using nanotechnology to enhance the drug formulation and drug target discovery. Nano pharmaceutical makes the drug discovery process cost effective, resulting in the improved Research and Development success rate, thereby reducing the time for both drug discovery and diagnostics.



CONCLUSION: -

The development and applications of Nano Science and technology has widened the platforms of Physics, Chemistry, Biology, Biotechnology etc.Nano particles can be used to produce exceptional images of tumor sites; singlewalled carbon nanotubes, have been used as high-efficiency delivery transporters for biomolecules into cells. The properties of nano materials can greatly influence their interactions with bio molecules and cells, due to their peculiar size, shape, chemical composition, surface structure, charge, solubility and agglomeration. There is a very bright future to nano technology, by its merging with other technologies and the subsequent emergence of complex and innovative hybrid technologies. Due to their much smaller size and large surface area modification possibilities, it has a greater scope in Nano materials and medical diagnosis technology. The basic knowledge about the synthesis of some metal oxide based semiconducting Nano dimensional materials along with their applications in materials and medicine discussed in detail. Still, there are some remarkable drawbacks in Nano science and technology in reproducing the end products and to know the complete mechanism involving during the synthesis of the materials.

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