FAQs in Nanotechnology

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FAQS IN NANOTECHNOLOGY

By Don Norman, Kul Bhushan Anand

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CHAPTER 1
AN APPROACH TO TREATING TUBERCULOSIS BASED ON NANOTECHNOLOGY

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ABSTRACT

The Mycobacterium tuberculosis bacteria, which causes tuberculosis, is the second most lethal infectious disease after AIDS. Long-term therapy, a heavy pill load, limited compliance, and strict administration schedules are all variables that contribute to the development of MDR and XDR tuberculosis patients. As of now, the only vaccine that can protect against adult pulmonary TB, the disease's most prevalent form, is BCG. To combat medication resistance, shorten the course of treatment, and improve adherence to it, numerous novel antibodies have been created. Therefore, we require a strong and reliable system to overcome technological limitations and enhance the efficacy of therapeutic medications, which continues to be a significant problem for pharmaceutical technology. Ideology based on nanoparticles has demonstrated effective treatment and encouraging results for infectious chronic diseases. Numerous kinds of nanocarriers have been considered to be effective drug delivery systems for a range of administration methods. One benefit of antituberculosis medications based on nanoparticles over free pharmaceuticals is controlled and prolonged drug release. Additionally, it lowers dosage frequency and tackles the problem of low poor compliance. This paper discusses a number of TB therapy options based on nanotechnology.

KEYWORDS
Compliance, contribute, methods, nanotechnology.

INTRODUCTION

Although medical research and medicines have come a long way, tuberculosis (TB) continues to be the leading cause of death and social catastrophe for millions of people worldwide. Throughout recorded history and human prehistory, it has affected humanity. The bacteria Mycobacterium tuberculosis is the primary cause of the lethal infectious illness tuberculosis. In 1882, Robert Koch received the Nobel Prize for his outstanding discovery. Mycobacterium tuberculosis is an intracellular pathogen and an acid-fast bacillus that has evolved a number of defense mechanisms against macrophage eradication. It is regarded as the most successful pathogen since it may live for years in a host without causing illness. One of the leading causes of death and disease worldwide is tuberculosis. The World Health Organization (WHO) estimates that approximately one-third of the world's population is infected with M. tuberculosis which results in more than 9 million new cases and 2 million deaths each year. The remaining infected individuals do not exhibit any symptoms. After AIDS among infectious diseases, tuberculosis is the infectious disease that causes the most fatalities each year. As a result, WHO deemed tuberculosis a global health emergency in 1993. Mycobacterium mostly affects the lungs, but it can also harm the kidney, lymphatic system, central nervous system, circulatory system, genitourinary system, joints, and bones.

The success or failure of treating tuberculosis depends on a number of variables, including patient adherence to the prescribed medication malnutrition smoking co-occurring diseases

like HIV, and insufficient professional supervision.The main issue with the current tuberculosis chemotherapy is that the majority of molecules do not reach their targets and, as a result, stay in the body causing negative side effects. This occurs whether the drug is administered orally or intravenously. Drugs' efficacy is constrained by their brief plasma half-lives and quick elimination. We need new tuberculosis therapies that can overcome these obstacles provided by antituberculosis medications in order to fight them and restore the success rate of tuberculosis treatment.

TB medications are being developed

Clinical TB management is still a challenging task. Antitubercular therapy (ATT) is being provided in numerous tuberculosis-endemic regions under directly supervised treatment. The World Health Organization's (WHO) short course (DOTS) program has had mixed results in reducing the major burden of TB in developing nations in Africa and the Indian subcontinent Long treatment periods and frequent, continuous administration of several medications provide the biggest challenges in treating TB. These factors contribute to patients' poor compliance with their existing therapies. Low patient compliance is the primary cause of the disease's recurrence and the creation of extensively drug-resistant (XDR) and multidrug-resistant (MDR) tuberculosis, which are more severe forms of the disease. Additionally, multidrug-resistant tuberculosis (MDR-TB and XDR-TB) is becoming more common in underdeveloped nations. The medical sciences are challenged by this, and it has become a major problem. Once more, AIDS plays a significant role in the rise in tuberculosis cases by fostering the growth of Mtb in immunocompromised hosts. To combat the issue of drug resistance, reduce the treatment course, and improve compliance, new and effective anti-TB medications must be developed. This is made even more necessary by the alarming rise of MDR and XDR strains and the dearth of viable treatment choices. The use of nanotechnology in medicine is known as nanomedicine. Nanomaterials, biological devices, nanoelectronic biosensors, and even potential future uses of molecular nanotechnology, including biological machines, are all included in the field of nanomedicine. Understanding the toxicity and environmental impact of nanoscale materials—materials whose structure is on the scale of nanometers, or billionths of a meter—is a current problem for nanomedicine.

Nanomaterials can be given additional functionality by interacting with biological molecules or structures. Nanomaterials can be valuable for both in vivo and in vitro biomedical research and applications since their size is comparable to that of the majority of biological molecules and structures. The combination of nanomaterials and biology has so far resulted in the creation of drug delivery systems, contrast agents, analytical tools, and diagnostic gadgets.In the near future, nanomedicine aims to provide a helpful collection of research instruments and clinically practical gadgets. The National Nanotechnology Initiative anticipates new commercial uses for nanotechnology in the pharmaceutical sector, including in vivo imaging, novel therapeutics, and enhanced drug delivery systems. Four nanomedicine development institutes are supported by funds from the US National Institutes of Health Common Fund program.

With an annual minimum investment in nanotechnology R&D of $3.8 billion, sales of nanomedicine surpassed $16 billion in 2015. Recent years have seen a 45% annual rise in global funding for developing nanotechnology, with 2013 seeing product sales surpass $1 trillion. The economy is anticipated to be significantly impacted by the nanomedicine sector's continued growth. The use of nanoparticles to deliver medications to certain cells is now possible because to nanotechnology. By placing the active pharmaceutical ingredient solely

in the morbid region and in no more than the necessary dose, the overall drug intake and adverse effects may be greatly reduced. Targeted drug distribution aims to lessen therapeutic side effects while concurrently reducing drug intake and treatment costs. Additionally, focused medication delivery minimizes unintended exposure to healthy cells, reducing the negative effects associated with crude drug use. The goal of drug delivery is to increase bioavailability at specified locations and over an extended length of time in the body. This may be accomplished by the use of nanoengineered devices that target certain molecules.Smaller devices are less intrusive and may be placed inside the body, and biochemical reaction times are significantly sped up by applying nanoscale technologies in medical applications. Compared to conventional drug delivery, these devices are quicker and more sensitive.The successful delivery of the drug to the desired area of the body, the efficient encapsulation of the drug, and the successful release of the drug all contribute to the effectiveness of drug delivery by nanomedicine. a number of medications using nano-delivery were available.

polymer-based nanoparticle-based drug delivery systems can be created to enhance the medication's pharmacokinetics and biodistribution. Nanomedicine's pharmacokinetics and pharmacodynamics, however, vary greatly between patients. Nanoparticles can be used to enhance drug delivery because they have advantageous features that can be leveraged to circumvent the body's defense mechanisms. Complex drug delivery systems that can penetrate cell membranes and enter the cytoplasm of cells are currently being developed. Drug molecules can be used more effectively one way to trigger response. Drugs are injected into the body, and they only become active in response to a certain signal. For instance, a drug's solubility may be improved by using a drug delivery system that has both hydrophilic and hydrophobic environments. Using controlled drug release, lowering drug clearance rates, lowering the volume of distribution, or lowering the influence on non-target tissue are other ways that drug delivery systems can prevent tissue harm. Due to the intricate host interactions to nano- and microsized materials and the challenge of specifically targeting certain organs in the body, the biodistribution of these nanoparticles is still not perfect.

However, there is still more to be done in order to improve and comprehend the capabilities and restrictions of nanoparticulate systems. The concerns of nanotoxicity become a crucial next step in deeper knowledge of nanoparticles' medicinal applications, even when research advancements show that targeting and dispersion can be enhanced by them. Nanoparticles' toxicity varies according to their size, shape, and composition. The accumulation and potential organ damage are likewise impacted by these variables. Since they cannot be broken down or eliminated, nanoparticles are made to be long-lasting, which leads them to become lodged within organs, particularly the liver and spleen. In mice, organ injury and inflammation have been linked to the accumulation of non-biodegradable substances. Increased tumor growth may result from the magnetic targeted delivery of magnetic nanoparticles to the tumor location while being affected by inhomogeneous stationary magnetic fields. Alternating electromagnetic fields should be employed to avoid the pro-tumorigenic effects.

DISCUSSION

Imaging

Another area where techniques and equipment are being created is in vivo imaging. Images like ultrasound and MRI have a favorable distribution and better contrast when using

nanoparticle contrast ants. Nanoparticles may help see blood pooling, ischemia, angiogenesis, atherosclerosis, and focal regions of inflammation in cardiovascular imaging.Nanoparticles' small size gives them characteristics that make them particularly suitable for imaging in oncology. When combined with MRI magnetic resonance imaging), quantum dots (nanoparticles with quantum confinement qualities, such as size-tunable light emission, can produce outstanding images of tumor spots. When exposed to UV light, cadmium selenide nanoparticles also known as quantum dots illuminate. They seep into cancerous tumors when injected. The glowing tumor is visible to the surgeon, who can utilize it as a reference point for more precise tumor excision. Compared to organic dyes, these nanoparticles are significantly brighter and only require one light source for excitation. This indicates that compared to the organic dyes employed as contrast media today, the introduction of fluorescent quantum dots could result in images with stronger contrast and at a lower cost. The drawback, however, is that fluorescent dopants can be used to mitigate this issue because quantum dots are typically formed of quite poisonous materials[1]–[3].

Monitoring movement can be used to assess how efficiently medications are dispensed or how chemicals are digested. A tiny collection of cells is challenging to follow throughout the body, therefore researchers used to color the cells. These dyes could only light up when they were stimulated by light of a specific wavelength. There was a need for as many light sources as there were cells, even though different color dyes absorb different frequencies of light. Tags that glow in the dark can be used to solve this issue. These tags are proteins with attached quantum dots that can cross cell membranes. The dots exhibit the nanoscale trait that color is size-dependent, can be manufactured of bio-inert material, and can be of arbitrary size. Sizes are chosen as a result so that the frequency of light needed to cause one group of quantum dots to fluoresce is an even multiple of the frequency needed to cause another group to incandece. A single light source can then be used to illuminate both groups. They have also discovered a means to introduce nanoparticles into the damaged bodily sections, causing those parts to glow in order to demonstrate tumor development or decrease as well as organ difficulty.

Sensing

A further aspect of lab-on-a-chip technology is nanotechnology. Specific chemicals, structures, or microbes are labeled using magnetic nanoparticles attached to an appropriate antibody. Silica nanoparticles in particular are photophysically inert and have the potential to amass a lot of dye(s) inside the nanoparticle shell. The detection of genetic sequence in a sample can be done using gold nanoparticles tagged with brief DNA fragments. It has become possible to create multicolor optical coding for biological experiments by incorporating various-sized quantum dots into polymeric microbeads. Strings of nucleotides used in nucleic acid analysis using nanopore technology are converted into electronic signatures.A few drops of a patient's blood could be used to detect and diagnose cancer in its early stages using sensor test chips with thousands of nanowires that can identify proteins and other biomarkers left behind by cancer cells. Arthroscopes, which are pencil-sized devices with lights and cameras used in surgeries so that surgeons may do the surgeries with tiny incisions, are being utilized more frequently because to nanotechnology. The healing process moves more quickly with smaller incisions, which is beneficial for patients. It is also assisting in the development of arthroscopes that are smaller than a strand of hair[4]–[6].

Cancer diagnostics based on nanoelectronics may one day be performed in pharmacies, according to research. The device promises to be reasonably priced, and the results promise

to be extremely accurate. With a sensitivity a thousand times greater than a standard laboratory test, they were able to identify cancer anywhere in the body in just five minutes using a very small volume of blood. Each nanowire detector used in these devices is set up to be sensitive to a different cancer marker in order to detect cancer proteins. The main benefit of the nanowire detectors is their ability to screen for ten to one hundred comparable medical disorders without increasing the cost of the testing apparatus. In order to better identify, diagnose, and treat cancer, oncology has been personalized with the aid of nanotechnology. It may now be customized to the tumor of each individual for improved performance. They have devised strategies that would enable them to focus on a particular area of the body that is being impacted by cancer.

Cellular repair devices

A speculative branch of nanotechnology called molecular nanotechnology explores the potential for creating molecular assemblers, or devices that could rearrange matter on a molecular or atomic scale. These nanorobots would be used in nanomedicine to treat or find infections in the body after being injected. Molecular nanotechnology is largely theoretical; it aims to predict the kinds of innovations that might result from the field and to lay out a plan for future research. The elements of molecular nanotechnology that have been proposed, including molecular assemblers and nanorobots, are much beyond what is currently possible. Future developments in nanomedicine may lead to life extension through the repair of numerous aging-related processes. In his 1986 book Engines of Creation, K. Eric Drexler, one of the pioneers of nanotechnology, proposed the existence of cell repair robots, including those that operate inside cells and make use of hypothetical molecular machines. Robert Freitas published the first technical analysis of medical nanorobots in 1999. In his book The Singularity Is Near, futurist and transhumanist Raymond Kurzweil predicted improved medical nanorobotics would be able to entirely reverse the ravages of agingHibbs opined that certain repair devices might one day be made so small that, in theory, "swallowing the doctor" (to borrow Feynman's phrase) might be feasible. The concept was used in Feynman's essay There's Plenty of Room at the Bottom from 1959[7]–[9].

Significantly Drug-Resistant

A variant of tuberculosis known as extensively drug-resistant tuberculosis is brought on by germs that are resistant to some of the most potent anti-TB medications. Following the improper handling of people with strains have emerged.Nearly one out of every four persons on the planet has TB bacterium. People only contract TB once the germs are active. Any factor that can lower a person's immunity, such as HIV, growing older, or certain medical conditions, can cause bacteria to become active. Four first-line, or standard, anti-TB medications—namely, isoniazid, rifampin, and any fluoroquinolone—can typically treat TB. Multidrug-resistant TB (MDR-TB) can emerge if these medications are abused or improperly administered. Second-line medications (such as amikacin, kanamycin, or capreomycin), which are more expensive and have more adverse effects, take longer to treat MDR-TB. When these second-line medications are also abused or improperly handled and lose their effectiveness, XDR-TB may form. According to the World Health Organization (WHO), XDR-TB is MDR-TB that is resistant to amikacin, capreomycin, or kanamycin as well as at least one fluoroquinolone[10], [11].

In addition to jeopardizing the significant advancements made in TB control and the progress gained in lowering TB fatalities among persons living with HIV/AIDS, XDR-TB raises

concerns about a future TB epidemic with limited treatment choices. Therefore, it is crucial that TB control be adequately handled that new instruments be created to prevent, cure, and diagnose the illness.The real scope of XDR-TB is unknown since many nations lack the tools and expertise needed to properly diagnose it. 49 nations had confirmed XDR-TB infections as of had been reported by 127 WHO Member States by the end of 2017, and 8.5% of MDR-TB cases that year were thought to have been XDR-TB cases.

Diagnosis

Access to high-quality medical services is essential for the successful diagnosis of XDR-TB in the patient. The diagnosis of TB can be made in a day or two if TB bacteria are discovered in the sputum, however this discovery will not be able to differentiate between drug-susceptible and drug-resistant TB. The bacteria must be grown and examined in an appropriate laboratory in order to determine their medication susceptibility. It may take between 6 and 16 weeks to reach a final diagnosis for TB using this method, especially for XDR-TB.The Drug Susceptibility Testing (DST) procedure was the first technique used to screen for MDR-TB and XDR-TB. The effectiveness of four main antitubercular medications in preventing Mycobacterium TB development can be assessed using DST. The four main antitubercular medications are pyrazinamide, isoniazid, rifampin, and ethambutol. Making a Lowenstein-Jensen medium plate and distributing the bacteria over it is how drug susceptibility testing is carried out The plate is examined for clean areas surrounding the disk after allowing the bacteria to develop for a few weeks. If there is a clear area, the medicine has likely killed the germs, and they are most likely not drug-resistant.

New resistant bacterial strains, such XDR-TB, were discovered as Mycobacterium tuberculosis changed throughout time. Primary DST had the drawback of being unsuitable for detecting bacteria strains with high levels of antibiotic resistance. When supplementary medications began to be included in drug susceptibility testing in addition to the four primary drugs, this issue was beginning to be resolved. The Bactec MGIT 960 System is the name of this second examination. Bactec MGIT 960 System was precise, although it took a while to calculate the degree of resistance.It can be difficult to diagnose MDR and XDR-TB in children. Better diagnostic techniques for pediatric children are urgently needed because there are more cases being reported globally.

Drug-resistant tuberculosis testing has advanced significantly in recent years. From smear-positive samples, an internal assay has been developed that can quickly identify medication resistance to those used to define XDR-TB. Reverse Line Blot Hybridization Assay, or RLBH, is the name of the test. The study demonstrated that RLBH results were as accurate to other drug susceptibility tests while also providing results in a shorter period of time. Finding out how resistant the bacteria strain was simply required three days of RLBH testing. The testing of medication resistance has advanced thanks to recent research. The rapid and simultaneous detection of resistance to the drugs isoniazid (INH), rifampicin (RIF), kanamycin (KAN), and ofloxacin (OFL) exhibited efficient accuracy, according to a new study on the research technique known as direct nitrate reductase assay (D-NRA). Results for D-NRA were acquired in 16.9 days which was significantly faster than for other medication susceptibility testing. The study also discussed how D-NRA is an inexpensive technology that is simple to set up in clinical labs and appropriate for application in DST of M. tuberculosis in all smear-positive samples.

CONCLUSION

Inhaling droplets produced by someone with active tuberculosis triggers the first stage of the disease. These droplets have a longer airborne lifetime. One droplet may be sufficient to spread the illness when inhaled. Fewer droplets reach deeper tissues than the upper respiratory tract, where the majority of them settle and destroy the germs. The alveolar macrophages in the lungs phagocytose the germs when they get to the alveoli. Mannose receptors, Toll-like receptor 2 (TLR2) and Toll-like receptor 4 (TLR4), surfactant protein A receptors, CD14, scavenger receptors, complement receptors, and immunoglobulin receptors are a few of the receptors involved in the uptake process. Sometimes, macrophages are unable to eliminate the germs, either because the bacterium's own chemicals render them inactive or because M. tuberculosis inhibits the mechanisms that promote phagosome-lysosome union, protecting phagolysosomes from hydrolysis and low pH exposure.In the second stage, the macrophage's mycobacterium grows there and eventually results in its lysis. Cellular damage is the outcome, and the inflammatory cells and blood monocytes are drawn to the location. When monocytes develop into macrophages, they make an attack on the microorganism that has been consumed by the macrophages and is continuing to proliferate inside the phagocyte. Due to the bacterial burden, these macrophages once more lyse and perish. The third stage starts two to three weeks following infection. As T cell immunity grows, lymphocytes go toward the site of the infection. The T cells are stimulated when mycobacterial antigens are presented to them, which triggers the production of -interferon and other cytokines.

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CHAPTER 2
CANCER DRUG DELIVERY AND SELECTIVE TARGETING USING NANOTECHNOLOGY

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Abstract
To get around some of the drawbacks of conventional drug delivery systems, nanoparticles are being designed and tested quickly. They are also emerging as a unique therapy for the treatment of cancer. Due to nonspecific targeting, lack of solubility, and inability to reach the core of the tumours, conventional chemotherapeutics have some serious side effects, including damage to the immune system and other organs with rapidly proliferating cells. This results in impaired treatment with reduced doses and low survival rates. Through improved drug localization and cellular uptake, nanotechnology has made it possible to selectively gain direct access to malignant cells. Nanoparticles can be trained to identify malignant cells and deliver drugs precisely and selectively without interfering with healthy cells. This review focuses on nanoparticles' capacity to recognize cells using a variety of identifying tactics that set them apart from earlier anticancer treatments. Additionally, it addresses how targeted cancer treatment uses nanoparticles to reduce the adverse effects of conventional medicines by delivering specific drugs directly into cells, citing numerous successful studies in the process.

KEYWORDS
Concentration, drawbacks, localization, possible.

INTRODUCTION

One of the deadliest diseases in the modern world, cancer claims the lives of millions of people each year. One of the biggest health issues of the twenty-first century, it has no geographical boundaries and can damage any organ in a person from anywhere. Cancer, which is characterized by unchecked cell division and a significant loss of apoptosis, necessitates a very involved therapeutic approach. It displays clinical variability and treatment resistance because to complexity at the genetic and phenotypic levels. There are many different methods used to treat cancer, each of which has important drawbacks and adverse effects. Surgery, chemotherapy, radiation therapy, and hormone therapy are all used in cancer treatment. Chemotherapy, a widely used therapy, administers anticancer medications systemically to patients, quelling the unchecked growth of malignant cells. Unfortunately, nonspecific targeting of anticancer drugs results in a number of side effects, and those agents' poor drug delivery in most situations prevents them from producing the intended results. The process of developing a cancer medicine is extremely difficult and is linked to cutting-edge polymer chemistry and electronic engineering. Differentiating between dangerous and healthy bodily cells is the fundamental problem with cancer therapies. Because of this, the primary goal is to develop a medication that can recognize cancer cells and inhibit their development and multiplication. Conventional chemotherapy falls short of selectively targeting malignant cells without interfering with healthy body cells. As a result, they have severe adverse effects, such as organ destruction, which makes it difficult to treat patients and eventually leads to low survival rates.

Depending on their intended function, nanotechnology often deals with sizes between a few nanometers (nm) and several hundred nm. Over the past ten years, the development of precise drug delivery systems has drawn attention because it provides a number of advantages over standard formulations' drawbacks. Since it may reach the tissues at the molecular level, it is particularly promising in both the detection and therapy of cancer. Cancer nanotechnology is being enthusiastically assessed and applied in cancer treatment, indicating a significant advancement in the disease's detection, diagnosis, and care. Numerous studies are being conducted to find more precise cancer treatments based on nanotechnology while reducing their negative effects. In the present, nanoparticles are being developed to mediate molecular interactions, detect molecular changes, and help medicinal medicines cross biological boundaries. Compared to macroparticles, they have a higher surface area and adjustable optical, electrical, magnetic, and biological properties.

Liposomes, polymeric micelles, dendrimers, nanospheres, nano capsules, and nanotubes are some of the currently available nanotechnology-based drug delivery systems for the treatment of cancer that are both commercially available and being researched and evaluated [8, 9]. DOXIL (liposomal doxorubicin) and Abraxane (albumin bound paclitaxel) are two nanotechnology-based formulations that have already been commercialized. Targeted drug administration, also known as smart drug delivery, is a technique for administering medication to a patient in such a way that the medication is more concentrated in some areas of the body than others. This method of delivery is mostly based on nanomedicine, which aims to use medication administration via nanoparticles to counter the drawbacks of traditional drug delivery. These drug-loaded nanoparticles would be directed to specific areas of the body that only contain diseased tissue, avoiding contact with healthy tissue. A targeted medicine delivery system aims to extend, localize, target, and engage with the sick tissue in a safe manner. While the targeted release system delivers the medicine in a dose form, the traditional drug delivery system involves the drug being absorbed through a biological membrane. The patient will need to take fewer doses more frequently, the drug will have a more consistent impact, there will be fewer adverse effects, and there will be less fluctuation in the drug levels in the blood. The system's drawbacks include a high price tag that makes productivity more challenging and a limited ability to change dosages.

To maximize the effectiveness of regeneration methods, targeted medication delivery systems have been created. The system is based on a technique that delivers a specific quantity of a therapeutic agent to a particular sick location of the body over an extended period of time. This aids in maintaining the necessary plasma and tissue drug levels in the body, preventing any drug-induced harm to healthy tissue. The medication delivery system is extremely interconnected, so it takes experts from several fields—such as chemists, biologists, and engineers—working together to make it as efficient as possible. The effects of passive targeting are enhanced by active targeting of drug-loaded nanoparticles, which increases the target site specificity of the nanoparticle. Active targeting can be achieved in a variety of ways. Knowing the characteristics of a cell's receptor for the medicine that will be used to target it is one technique to actively target just sick tissue in the body.The nanoparticle can then selectively connect to the cell that contains the complementary receptor by using cell-specific ligands, according to research.

Transferrin has been proven to work well as the cell-specific ligand in this type of active targeting. To target tumor cells with transferrin-receptor mediated endocytosis pathways on their membrane, the transferrin was conjugated to the nanoparticle. Comparing this method of

targeting to non-conjugated nanoparticles, it was discovered to improve absorption. The RGD motif, which binds to the integrin v3 protein, is another cell-specific ligand. Tumors and activated endothelial cells have increased levels of this integrin. It has been demonstrated that adding RGD to chemotherapeutic-loaded nanoparticles increases both the therapeutic efficacy in vivo and cancer cell uptake in vitro.Magnetoliposomes, which are often used in magnetic resonance imaging as a contrast agent, can also be used to perform active targeting.[9] Magnetic placement could therefore help with this process by grafting these liposomes with a chosen medicine to deliver to a specific area of the body.

Additionally, a nanoparticle might be able to be activated by a trigger that is unique to the target region, such as using pH-responsive materials. The pH of the body is generally constant and neutral. To compensate for the fact that some parts of the body are naturally more acidic than others, nanoparticles can release a medicine when they come into contact with a particular pH. Redox potential is the basis for another particular triggering mechanism. Hypoxia, which affects the redox potential in the tumor's proximity, is one of the side effects of tumors. Different tumor types can be targeted specifically by vesicles by altering the redox potential that causes the release of the payload.A drug-loaded nanoparticle offers a greater advantage over a traditional drug by using both passive and active targeting. Until it is effectively drawn to its target by the use of cell-specific ligands, magnetic placement, or pH responsive materials, it can circulate throughout the body for a considerable amount of time. Because the drug-loaded nanoparticles only influence sick tissue as a result of these benefits, side effects from traditional medications will be significantly decreased. However, the growing science of nanotoxicology is concerned that the nanoparticles themselves may have adverse consequences on the environment and human health. Peptide-based medication targeting systems can also achieve active targeting.

DISCUSSION

Drawbacks of traditional chemotherapy

The primary characteristic of neoplastic cells is their propensity for quickly dividing cells, which is how traditional chemotherapy treatments function. Because of this, chemotherapy also harms quickly dividing healthy cells that are normally found in the bone marrow, immune system, digestive system, and hair follicles. The primary flaw in traditional chemotherapy is its inability to target only malignant cells for treatment. As a result, the majority of chemotherapy drugs have common side effects like myelosuppression (reduced production of white blood cells, which suppresses the immune system), mucositis (inflammation of the digestive tract lining), alopecia (hair loss), organ dysfunction, and even anemia or thrombocytopenia. These side effects can sometimes force dose decrease, treatment postponement, or therapy termination Cell division may be successfully stopped towards the heart of solid tumors, rendering chemotherapy drugs ineffective. Additionally, chemotherapy generally fails to destroy malignant cells because it cannot reach the core of solid tumors.

When macrophages ingest traditional chemotherapeutic drugs, they frequently wash them out of the circulation. As a result, they are only in the bloodstream for a very little period of time and are unable to interact with malignant cells, rendering chemotherapy utterly ineffective. In conventional chemotherapy, the medicines' poor solubility is also a significant issue because it prevents them from penetrating cellular membranes. P-glycoprotein, a multidrug resistance protein that is overexpressed on the surface of malignant cells and prevents drug

accumulation inside the tumor by serving as the efflux pump, is also an issue since it frequently facilitates the emergence of resistance to anticancer medications. As a result, the medications given remain ineffective or are unable to produce the expected results.

Using Nanotechnology to Target Cancer

Selective cancer targeting has undergone a major transformation thanks to nanotechnology. Nanoparticles can be programmed to target certain cells by making numerous alterations to their size, shape, chemical, and physical properties, among other things. They have the option of actively or passively targeting the cancerous cells.In the case of active targeting, chemotherapeutic agent-containing nanoparticles are created in a way that they interact with the damaged cells directly. Molecular recognition is the foundation of active targeting. As a result, the nanoparticles' surface has been altered to specifically target malignant cells. For molecular recognition, targeted chemicals are typically added to the surface of nanoparticles. By interacting with ligands and receptors or being recognized by antibodies and antigens, designed nanoparticles can kill malignant cells.

Three key components make up a targeted delivery system based on nanotechnology: a carrier, a targeting moiety-penetration booster, and an apoptosis-inducing substance (anticancer medication). A nanoparticle is made of a number of materials. Ceramic, polymers, lipids, and metals are often used materials. Lipids and polymers, both natural and artificial, are frequently utilized as drug delivery vectors. Phagocytes absorb chemotherapeutic agent-containing particles, which are then swiftly eliminated by the reticuloendothelial system (RES). A number of methods were discovered to keep the nanoparticles in the blood stream, one of which involves changing the carrier's polymeric makeup. In order to avoid washing away and to stay in the bloodstream for a longer amount of time so that they can effectively target malignant cells, nanoparticles are coated with hydrophilic polymers. Plasma proteins are repelled by the hydrophilic polymer covering on nanoparticle surfaces, preventing them from being opsonized and eliminated. Referred to as a "cloud" effect. Polyethylene glycol (PEG), polo amines, poloxamers, polysaccharides, and other hydrophilic polymers are frequently utilized. At the molecular level, healthy cells and cancerous cells are distinguished from one another by specific characteristics. On their surface, a few receptors that serve as a defining characteristic are overexpressed. Nanoparticles can only target malignant cells because of the complimentary ligands attached to their surfaces. The encapsulated medication is quickly internalized by cells once the nanoparticles engage with the receptors and conduct receptor-mediated endocytosis or phagocytosis. Many studies are being conducted to better understand these ligand-receptor interactions and utilise them in clinical settings.

Target specific receptor

Receptor for folate. Many neoplastic cells overexpress folate receptors, making them a potential target for several anticancer treatments. Researchers are using the idea to build folic acid-containing surfaces for nanoparticles In four murine tumor models, Russell-Jones et al. looked at the possibility of utilizing folic acid as a targeting agent for the administration of pHPMA conjugated daunomycin. Folic acid targeting daunomycin-HPMA conjugates were reported to prolong tumor-bearing mouse survival time and to improve the number of survivors. According to the research, folic acid might be very good at increasing the effectiveness of other polymer-bound cytotoxins The folate-linked methotrexate dendrimers are tested in another investigation by a group led by Kukowska-Latalloto et al. using

immunodeficient athymic nude female mice. The mice received two weekly injections of the nanoconjugates through a lateral tail vein. The findings demonstrated that, as compared to free methotrexate at an equivalent cumulative dose, conjugated methotrexate in dendrimers dramatically reduced toxicity and produced a 10-fold greater efficacy. Mice lived longer as a result For the treatment of cancer, doxorubicin aggregates that are targeted at the folate receptor at the nanoscale were investigated. Micelles of doxorubicin-polyethylene glycol-folate conjugate with an average diameter of 200 nm were created. In vitro, the polymeric micelles showed improved and focused targeting of folate receptor positive cancer cells. The nanoaggregates significantly suppressed tumor growth, according to in vivo animal

Other formulations include poly-lactic acid nanoparticles modified with hydrazine as well as nanoparticles to which folate was covalently attached utilizing surface carboxyl groups. The preparation and coating of isobutyl-cyanoacrylate (IBCA) nanocapsules with folate resulted in a noticeably improved efficacy of nanocapsules targeted to the tumor. The research demonstrated that nanoparticles conjugated to folic acid can target folate receptors very effectively for selective medication deliveryReceptor for transferrin. Since some tumor cells overexpress the transferrin receptors to boost their ability to absorb iron, nanoparticles are being studied extensively to target these structures for binding and cell entry.

For the purpose of targeting cancer, transferrin (Tf) can be coupled to a number of substances, such as m chemotherapeutic agents, toxic proteins, RNases, antibodies, and peptides Tf-lytic hybrid peptide can specifically target malignant cells, according to research by Kawamoto et al. Tf-lytic peptide was given to mice used in an athymic mouse model using MDA-MB-231 cells. When compared to normal cells, which were less sensitive to this compound, the Tf-lytic hybrid peptide demonstrated effective cytotoxic activity. Additionally, it was discovered that this preparation can effectively kill T47D cancer cells by causing about 80% of them to undergo apoptosis while having no effect on healthy cells. As a result, the intravenous delivery of Tf-lytic peptide dramatically slowed the growth of the tumor in the athymic mouse model. Bellocq et al. discovered that the nanoparticles remain stable in physiologic salt concentrations and more effectively transfect leukemia cells at low transferrin modification levels. The systemic administration of nucleic acid therapies for metastatic cancer using the transferrin-modified nanoparticles is successful.

Hormone-Releasing Hormone Receptor for Luteinizing. As a targeting moiety (ligand) for LHRH receptors that are overexpressed in the plasma membrane of numerous types of cancer cells, including breast cancer, ovarian cancer, and prostate cancer, luteinizing hormone-releasing hormone (LHRH) is used in many ongoing studies. A novel method was created by Farokhzad, Langer, and others to deliver the medications to the interior fluid of cancer cells. They added docetaxel to specially created, small nanoparticles that resembled sponges. The particles were specifically created to dissolve the medication in the fluids inside a cell, regulating the release rate. The nanoparticles were "decorated" on the outside with targeting molecules known as aptamers, which are little pieces of genetic material, for selective targeting. The surface chemicals on cancer cells are recognized precisely by the aptamers. To prevent them from being quickly killed by macrophages, the nanoparticles additionally contained polyethylene glycol molecules.

Prasad led a team that created a technique for using ferric oxide nanoparticles made using a reverse micelle colloidal process to target the LHRH receptor. In a reverse micelle system generated by a surfactant, continuous oil phase, and water, the hydrophilic groups were trapped in the micelle core and the hydrophobic groups remained solvent exposed on the

surface of the micelle. Two-photon dye ASPI-SH, a tracking agent, was adhered to the iron oxide's surface. Before more silica shell was generated via tetraethylorthosilicate hydrolysis, silica was added to establish the structure of the silica shell. In order to avoid stearic interference during the targeting agent's interaction with its counterpart molecule on cells, the targeting agent LHRH was attached to the silica shell through carbon spacers. Patients were exposed to a DC magnetic field after receiving the nanoparticles. Utilizing oral epithelial carcinoma cells that express LHRH receptors, the selective interaction, internalization, and other phenomena were studied. Data unambiguously demonstrated that the nanoparticles interacted with particular cell types in a selective manner.

Asialoglycoprotein. Another overexpressed receptor in hepatoma is asialoglycoprotein (ASGP), which is used by nanoparticles to target cancer and deliver anticancer drugs. In order to manufacture biodegradable nanoparticles with a mean size of 140 nm that may be used to target hepatoma cells, Sung and colleagues came up with a novel method. They were made utilizing the emulsion solvent evaporation process from poly(--glutamic acid)-poly(lactide) block copolymers loaded with paclitaxel. The ASGP receptors were the target of the nanoparticles' galactosamine (GAL) conjugation, which improved hepatoma HepG2 cell uptake. The high degree of selectivity of the nanoparticles to hepatic tumors was discovered through immunofluorescence analysis using a rhodamine-123 probe that was encapsulated in the hydrophobic core of the gal-nanoparticles. This enhanced cellular uptake through receptor-mediated endocytosis led to the subsequent release of the encapsulated paclitaxel inside the cytoplasm. In comparison to free paclitaxel, the nanoparticles reduced systemic toxicity by preventing the development of the cells.

To specifically stop hepatoma angiogenesis, a dual-particle tumor targeting method was created. The first component of the dual-particle tumor targeting system was a nanoparticle encapsulating ganciclovir coupled with galactosamine, and the second was an increased permeability and retention (EPR) mediated targeting nanoparticle harboring an HSV thymidine kinase (TK) gene. It was said that after cancer cells internalized the first and second nanoparticles simultaneously, thymidine kinase would break down ganciclovir to cause lethal effects. So, it eradicates the cancer cells that were targeted.

Mediated by an antibody

Due to genetic flaws, many tumour cells exhibit atypical antigens that are either unsuitable for the cell type, environment, or stage of organism development. Tumor antigens trigger weak immune reactions because the body recognizes them as its own cells. Monoclonal antibodies (mAbs) with high specificity are utilized to boost the immune response and the immune system's potential to fight tumors. These antibodies target proteins that are crucial for the development of cancerous cells and are abnormally expressed in those cells. For targeted medication delivery, nanoparticles coupled with antibodies against certain tumor antigens are created. Clones of a single hybridoma cell create the majority of the mAbs. The hybridoma cell is created when a myeloma that produces antibodies fuses with a normal plasma cell that has been induced by antigens to bind particularly to tumor cell antigens. After interacting with tumor antigens, mAbs can kill cancer cells in a number of ways, including by directly triggering apoptosis, obstructing growth factor receptors, and forming anti-idiotypes. By triggering complement-mediated cellular cytotoxicity and antibody-dependent cell-mediated cytotoxicity, they can subtly destroy cancer cells. As a result of the development of antibodies having both animal and human origins, such as chimeric mAbs, humanized mAbs (those with a stronger human contribution), and antibody fragments,

antibody engineering has recently blossomed. Both the whole antibody and its fragments can be utilized to target malignancy. However, the availability of two binding sites (inside a single antibody) results in a higher chance of binding and makes using intact mAbs preferable. Moreover, when macrophages connect to the Fc portion of the antibody, a signaling cascade that kills the cancer cells is started. In addition to increasing the ability to elicit an immune response, the Fc component of an intact mAb can also connect to the Fc receptors on normal cells, causing the liver and spleen to take up the nanocarrier. Their additional benefit is stability in long-term storage.

However, because they have less non-specific binding, antibody fragments such antigen-binding fragments (Fab), dimers of antigen-binding fragments -chain fragment variables (scFv), and other designed fragments are thought to be To quickly choose antibodies or their fragments that bind to and internalize within cancer cells, phage display libraries may be employed. By using this technique, many potentially helpful antibodies are produced that bind to distinct epitopes—a region of a receptor that antibodies can recognize—on the same target cells. As a result, numerous antibodies will each bind a different epitope of a single receptor, resulting in more precise and focused activit. A medicinal substance can be directly conjugated to antibodies to boost their effectiveness. When mAbs are linked to nanoparticles, they can function as highly specific probes that help with the targeted delivery of different anticancer cytotoxic drugs. By identifying a particular conformation of a target receptor, one can also improve the binding affinity and selectivity of engineered proteins to cell surface targets. In a recent work, Peer et al. found that a fusion protein made of a scFv antibody fragment that was used to target and deliver small interfering RNA (siRNA) to lymphocytes had a 10,000-fold higher affinity for the target receptor, integrin LFA-1.

CONCLUSION

The formation of new blood vessels from existent vessels is referred to as angiogenesis. Without angiogenesis, tumors cannot enlarge beyond a 2 mm diameter uncontrolled production of angiogenic growth factors by cancerous cells causes an excessive angiogenesis that overwhelms the activities of natural angiogenesis inhibitors, leading to the formation of leaky, convoluted capillaries that are constantly inflamed Angiogenesis has been linked to increased metastasis, tumor recurrence, and shorter survival times in studies of breast cancer [56, 59]. medications that block the growth of new blood vessels that supply the tumor (such as TNP-470, endostatin, and angiostatin) or medications that obliterate the existing blood vessels (such as combretastatin) are the two methods used in the design of antiangiogenesis therapy [60]. Antiangiogenic therapy aims to slow the growth of both primary and metastatic tumors by preventing the delivery of vital nutrients and eliminating chemicals that inhibit tumor growth, preventing tumor spread and promoting tumor shrinking. Antiangiogenic medications either directly target endothelial receptors or indirectly target angiogenic cytokines to exert their antiangiogenic effects [62–64]. Targeting the VEGF receptors (VEGFRs), integrin receptors, and other angiogenic factors allows nanoparticles to actively target the tumor vasculature. Integrins are the primary element in the angiogenesis process; their proliferation promotes the survival, expansion, and invasion of both tumor and endothelial cells Integrins mediate the attachment between a cell and its environment. Due to its pleitropic overexpression in numerous tumor contexts, integrin antibody has been frequently employed as a targeted moiety on nanovectors for anti-angiogenesis therapy. Many of them have successfully completed clinical trials Perfluorocarbon nanoparticles

attached to various contrasting agents linked to an integrin antibody were successful in detecting tumor angiogenesis in rabbit and mouse models.

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CHAPTER 3
HUMAN HEALTH APPLICATIONS OF NANOTECHNOLOGY A REVOLUTION IN BIOMEDICAL SCIENCES

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Abstract
At the intersection of the physical sciences, molecular engineering, biology, biotechnology, and medicine, recent research on nanoscale biosystems has produced one of the most active science and technology sectors. Improved comprehension of living and thinking systems, ground-breaking biotechnology techniques, the creation of novel medications and their targeted administration, regenerative medicine, neuromorphic engineering, and the creation of a sustainable environment are all included in this field. Research on nano biosystems is a top priority in many nations, and its importance to nanotechnology is predicted to grow in the next years. The motivation behind nanomedical research is the realization that the nanoscale possesses certain features required to address significant medical issues and unmet medical needs. The importance of the most recent nanotechnologies and nanoscience to human health is examined in the current review. The study discusses the potential it presents and offers advice on how to handle significant advancements in these fields.

KEYWORDS
Biotechnology, environment, nanomedical, significent.

INTRODUCTION

Significant scientific and technological advancements in a variety of sectors, including medicine and physiology, are expected to be produced via nanotechnology and nanoengineering. They can be broadly categorized as the science and engineering involved in the design, synthesis, characterization, and application of materials and devices whose smallest functional organization is on the nanometer scale, ranging from a few to several hundred nanometers, in at least one dimension. In terms of size, a nanometer is one billionth of a meter, or three orders of magnitude, smaller than a micron. For example, a DNA molecule is 2.5 nm long, whereas a sodium atom is 0.2 nm.The spatial and temporal scales being considered directly determine the potential effects of nanotechnology: materials and devices engineered at the nanometer scale imply controlled manipulation of individual constituent molecules and atoms in how they are arranged to form the bulk macroscopic substrate. This implies that, as a result of the control over their molecular synthesis and assembly, nanoengineered substrates can be made to display very particular and controlled bulk chemical and physical properties.

These materials and devices can be created to interact with cells and tissues at a molecular (i.e., subcellular) level with a high degree of functional specificity for applications in medicine and physiology, enabling a level of technological and biological system integration that was previously unachievable. In order to bring together the necessary collective expertise needed to develop these novel technologies, traditional sciences such as chemistry, physics, materials science, and biology have come together to form the emerging field of nanotechnology. The significance of nanoscience and the most recent nanotechnologies for human health are examined in this review The study discusses the potential it presents and

offers advice on how to handle significant advancements in these fields. Nanotubes can aid in the treatment of cancer. They have been demonstrated to be potent tumor destroyers in patients with breast or renal cancer. A particular kind of laser that emits near-infrared light for around 30 seconds is used to treat multi-walled nanotubes put into a tumor. The laser causes these nanotubes to vibrate, which produces heat. The tumor cells start to die once it has been sufficiently heated. These kinds of procedures have the potential to reduce kidney cancers by up to 45%.

In space, where there is more light than is practical to deal with, ultrablack materials constructed of "forests" of carbon nanotubes are crucial. To cut down on light and capture more detailed images, ultrablack material can be used to camera and telescope systems. Cardiovascular disease treatment with nanotubes appears promising. They can be crucial in cleaning the blood vessels. Theoretically, macrophages would be instructed to remove plaque from blood arteries by nanotubes with SHP1i molecules attached to them without harming healthy tissue. In studies using mice with severe plaque buildup, researchers evaluated this kind of modified nanotube; the treated mice displayed statistically significant decreases in plaque buildup when compared to the mice in the placebo group. Before this medication may be administered to humans, more research is required.

Future soldiers' body armor might incorporate nanotubes. The body of a soldier would be shielded from bullets and electromagnetic radiation by this sort of armor, which would be extremely durable and effective. Additionally, it's conceivable that the nanotubes in the armor may help monitor the health of the soldiers. The ability of nanotechnology to view and manipulate the material world at a nanoscopic level can hold significant promise for the advancement of construction. Construction materials including cement, steel, wood, and glass can all benefit from nanotechnology's increased strength and tensile durability. Nanotechnology can be used to give materials a variety of new features. A new generation of materials with characteristics such as water resistance, self-cleaning property, wear resistance, and corrosion protection are produced as a result of the discovery of a highly ordered crystal nanostructure of amorphous C-S-H gel and the application of photocatalyst and coating technology. High-strength fibers with extraordinary energy absorption capabilities and superplasticizers for concrete are two examples of the latest nanoengineered polymers

According to experts, nanotechnology is still in the exploration phase but has the potential to improve common materials like steel. The development of novel materials with extended qualities, such as electrical conductivity as well as temperature-, moisture-, and stress-sensing capabilities, may result from understanding the composite nanostructures of such materials and from studying the various applications of nanomaterialsNanomaterials are more expensive than conventional materials due to the complexity of the equipment, hence it is unlikely that they will be used as high-volume building materials. Nanotechnology occasionally enables the cost-reduction of complex issues. However, the conventional approach to construction is still generally more economical. The cost of incorporating nanotechnology into building has been falling over time and is projected to continue to do so as manufacturing technologies advance. The concepts, methods, and sciences of biology and nanotechnology are combined under the titles nanobiotechnology and bionanotechnology. More specifically, bionanotechnology refers to the use of biological elements in nanotechnology, whereas nanobiotechnology refers to the application of nanoscale items for biotechnology

The topic of nanomedicine, where the use of nanoparticles and nanodevices has many clinical applications in the delivery of therapeutic medications, monitoring of health states, and disease diagnosis, is where nanotechnology and biology most prominently converge. The small size of nanomaterials makes it possible for them to be employed as tools that may easily circulate within the body and directly interact with intercellular and even intracellular settings because many biological processes in the human body take place at the cellular level. Additionally, due to their small size, nanomaterials can have physiochemical properties that are distinct from those of their bulk form, allowing for a range of chemical reactivities and diffusion effects that can be researched and altered for a variety of applications.

Nanoparticles holding medications for the treatment of disease are injected into the body and function as delivery systems for the medications, which is a popular application of nanomedicine. By modifying the nanoparticle vessels' size, shape, surface charge, and surface attachments (proteins, coatings, polymers, etc.), which can be formed of organic or synthetic materials, the nanoparticle vessels can be further functionalized. When targeting parts of the body with specific physiochemical characteristics that prevent the intended drug from reaching the targeted area alone, such as the brain, the possibility of functionalizing nanoparticles in such ways is especially advantageous. For instance, some nanoparticles are able to bypass the Blood Brain Barrier to deliver therapeutic drugs to the brain. Recently, vaccinations and cancer therapies have both incorporated nanoparticles.

Nanoparticles can be employed as contrast agents in popular imaging procedures including computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET), which makes in vivo imaging an important component of nanomedicine It is possible to research pharmacokinetics or visually diagnose diseases using nanoparticles' capacity to locate and circulate in particular cells, tissues, or organs. This capability can produce high contrast and higher sensitivity imaging.

DISCUSSION

Diagnostics

As our understanding of the human genome (genomics) and of the products of protein expression (proteomics) has greatly increased, we are increasingly able to link diseases to aberrations at the molecular level. Theoretically, this opens up the prospect of getting a diagnosis very early on—and perhaps even beginning treatment—even before the disease's initial symptoms manifest As a result, prevention is getting more attention in medicine. A good example of this is newborn metabolic illness screening (using a heel prick) . To find these molecular biomarkers, the medical community has access to an expanding set of scientific instruments. The impact of nanotechnologies will likely be felt in this field first (within five years) The diagnostic study can be carried out in a lab with samples from the human body (in vitro research), or it can be done on the patient themselves (in vivo). This distinction is crucial because the tools/agents in the latter scenario must adhere to stricter standards.

Inside the lab

To evaluate gene expression, or the amount of RNA produced in diseased tissue, or to determine the version of a certain gene a person possesses, research into patients' genetic material (DNA) is possible. There are several versions of many human genes that only differ by one nucleotide pair. SNPs, or single nucleotide polymorphisms, are what these are. The

related protein variations may vary from one another by a single amino acid and subsequently show a significant functional difference. SNPs impact a person's sensitivity to chemicals, including medicines, and are the cause of a wide range of hereditary illnesses. This relates to both their side effects and therapeutic impact. Major opportunities for identifying gene types that predispose a person to specific diseases and for improving the match between each patient's genetic makeup and the medications they are administered are presented by genetic research.

Since a few years ago, DNA chips used for DNA analysis have been available. Although they are frequently utilized in scientific and biological research, clinical application is uncommon. The chips consist of a base-sequence-differentiated microarray containing hundreds to thousands of single-strand DNA molecules. The location on the chip where the DNA from a tissue sample that has been labeled with a radioactive or fluorescent substance bonds to the chip DNA can be used to identify the DNA from that sample. Since 2003, the Dutch Cancer Institute has used a DNA chip to use gene expression profiles to forecast the spread of breast tumors. Finding individuals who would benefit from additional chemotherapy after the tumor has been surgically removed is now much simpler than it always was because to this information. Leukemia diagnosis chips as well as chips to diagnose tumors of the mouth and throat are being developed. Originally a product of microtechnology, DNA chips and other biochips are now being miniaturized, just like computer chips. The production of the chips as well as improving their detection sensitivity and dependability depend increasingly on nanotechnologies.

Quantum dots are used in a novel nanotechnological analytical technique. The identification of DNA in a sample is based on its interaction with DNA molecules of known composition that are contained in micrometer-sized polymer spheres containing different quantum dot mixes, each of which produces a distinct spectral bar code (color code). This approach has been utilized by American researchers to examine SNPs in genes that produce the cytochrome P450 family of enzymes, which are involved in the body's breakdown of chemicals, including medications. Multiple SNPs can be studied simultaneously in huge numbers of samples using this method (multiplex analysis).In theory, pushing DNA molecules through membrane nanopores using an electric potential difference is another way to determine the makeup of the molecules. This technique has now been utilized by researchers to pinpoint a mutation in an HIV gene that causes the virus to become resistant to a certain treatment. This technique, which is still under development, could lead to a considerably quicker method than what is currently available for figuring out the base sequence of DNA. In order to do this, a chip would need to have hundreds of pores.

The methods stated above might theoretically be used to detect additional biopolymers, like proteins and carbohydrates. However, American scientists have been successful in creating a chip that can identify prostate cancer. The chip has about 100 cantilever sensors, which are tiny levers that are micrometers in size and nanometers thick. One side of the sensors is coated with antibodies to prostate-specific antigen (PSA), a biomarker for the condition. Cantilevers bend several nanometers when PSA from a sample placed on the chip bonds to them; this can be seen optically. This makes it possible to determine PSA concentrations that are clinically relevant. Similar techniques, such as using antibodies on nanowires to identify viruses in a blood sample, have been proposed. The electric conductivity of the nanowire changes when a single viral particle binds to an antibody. Because of the technique's high sensitivity, an infection can be found relatively early on. Additionally, it works well for

multiplex analyses. Additionally, efforts are being made to develop carbon nanotube-based microarray sensors. Cantilever, nanowire, and nanotube-based detection techniques also have the benefit of not requiring labeling of the sample.

Small-scale laboratories are called labs-on-a-chip. They can be applied to cell manipulation, research, and biopolymer analysis. They are anticipated to be crucial in the advancement of biosensors for the discovery of harmful microorganisms. Point-of-care applications, in which straightforward analyses can be done in the doctor's office or in the patients' homes and completed by the patients themselves, will also be possibilities in the future. A lab-on-a-chip for determining blood levels of lithium is now being developed by researchers at the University of Twente. Such a chip would make it possible for those who use lithium-based psychopharmaceuticals to maintain the proper level of lithium in their blood. The ease of use would be similar to that of the present tools used by diabetic patients to assess blood glucose levels. Another example is photonic explorers for bioanalysis with biologically localized embeddings. These nanometer-sized sensors are made of an inert capsule made of polymers that contains an indicator colorant that emits light as soon as the substance being studied diffuses through the capsule and binds with the colorant. In order to measure the concentrations of tiny ions and chemicals in living cells, such as glucose, calcium, magnesium, and zinc ions, PEBBLEs were created. A microscope can be used to track the light emission (and cessation of emission) of the nanocapsules after they have been added to a cell. These kinds of instruments are helpful while researching particular disorders. For instance, brain illnesses including Alzheimer's disease and Parkinson's disease are known to have improper zinc balance.

Imaging and Diagnostics Done In Vivo

Patients are administered contrast agents or radiopharmaceuticals in the case of in vivo diagnostics. These agents can be used to image pathophysiological alterations and functional changes, such as variations in blood flow in cells, tissues, and organs, thanks to their unique features. The phrase "molecular imaging" is frequently used since modern imaging techniques are more and more focused with illuminating molecular indicators of disease processes, such as a receptor protein on a cancer cell's surface. To do this, a carrier molecule or particle is also given a molecule that selectively attaches to the biomarker, such as an antibody (the targeting component), in addition to a contrast agent (the imaging component). Techniques based on ultrasonic vibrations, radioactive substances (including positron emission tomography, or PET), magnetic resonance imaging (MRI), and fluorescent substances have all been created, each with their own contrast agents and imaging tools. Each has its own limitations as well as potential applications. Early illness detection is made feasible and information on suitable treatments is provided by molecular imaging. Imaging is also excellent for assessing, monitoring, and enhancing the delivery of treatment. Numerous opportunities exist for developing new and better imaging techniques thanks to nanotechnologies.

Perfluorohydrocarbon nanoparticles and a lipid layer have a variety of applications. As an ultrasonic contrast agent, they are suitable. They can also be used for MRI or scintigraphic imaging if gadolinium compounds or radioactive materials like technetium-99 are mixed with the lipid layer of the nanoparticles. The particles can make pathogenic alterations in blood arteries evident with the correct targeted chemical. The application of the nanoparticles as a contrast agent for the diagnosis of atherosclerosis, thrombosis, and (tumor) angiogenesis is currently being explored. Within a few years, a clinical investigation is anticipated to begin.

MRI contrast agents made of superparamagnetic iron oxide nanoparticles are increasingly being employed in clinical settings. They build up in the liver, spleen, and lymph glands following intravenous delivery, making it possible to study those organs . According to patient-based study, they can also make tumor metastases in lymph nodes more detectable. The particles can be utilized to label living cells when combined with dendrimers Such magnetodendrimers enable, for instance, the observation of cell transplantation-related processes such as cell migration and division. The technique, which has already been applied successfully on lab animals may prove to be helpful in stem cell therapy in the future. For usage as contrast agents, gadolinium dendrimers are also being researched The launch of the first of these agents is almost complete. They are suitable for evaluating blood arteries, kidneys, liver, or lymph glands depending on their size and solubility in water or fat.

CONCLUSION

Fluorescent colorants are administered orally or intravenously and then accumulate, for example, in tumors, in optical imaging techniques. When laser light is used to irradiate the tumor cells, they glow. This technique can only be used to image tumors in or just below the skin or in tissue, that is, accessible using an endoscope, because the laser light cannot penetrate deep into New optical techniques based on the utilization of nanoparticles are the subject of extensive research that has been going on for a while. The development of quantum dots has reached its most advanced stage. Compared to coloring chemicals, these nanocrystals fade less quickly over time and do not interact with cell components. Additionally, it is feasible to have quantum dots of several colors glow when exposed to laser light of the same wavelength, enabling multiplex applications. Nanoparticles have already been employed successfully in cell cultures and lab animals to color biomarkers on the surface of cancer cellsto track the development of cell lines in a frog embryo and to highlight blood arteries and lymph glands in mice The latter application is anticipated to eventually increase the likelihood of tracing tumor metastases. Due to their small size and ease of entry into even the smallest compartment of the cell, nanoparticles form the basis for all of these applications.

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CHAPTER 4
FACE MASKS ENHANCED BY NANOTECHNOLOGY FUTURE PROSPECTS

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ABSTRACT
A disposable surgical face mask is an effective barrier against infection thanks to its capacity to stop virus transmission from ill to healthy persons, as the disease pandemic has demonstrated. However, these surgical masks are single-use, disposable, and not environmentally friendly. Traditional mask usage and disposal include significant secondary concerns, such as user pain, disease transmission, and environmental contamination. One of the 21st century's most researched methods for securely and affordably reusing masks is nanotechnology. These tactics are founded on the following four crucial components: Masks have four different types of filtration: triboelectric (TE) filtration, an electric charge controller, super mechanical properties that give them triboelectric (TE) filtration, high thermal properties that give them heat self-sterilization, and response to the antimicrobial effect that remains in the mask before, during, and after safe use. These characteristics enable new-generation surgical masks to overcome the shortcomings of conventional surgical masks, including microbial growth and poor filtering performance. The self-sterilization and TE effects of surgical masks have been made possible by the graphene family. Antimicrobial properties of silver nanoparticles have been supported. The increased surface area of nanofiber membranes increases the fiber diameter and porosity ratio. A nanofiber-based mask has been tested to intercept 90% to 99% of particle viruses while being used, whereas a conventional mask could only stop a maximum of 50% of the inhaled viruses. Complex nanocomposite materials were able to amass all these benefits.

KEYWORDS
Controller, dimeter, increased, nanocomposite.

INTRODUCTION

All medical personnel must take into account that all materials obtained from patients are potential sources of infections, according to the World Health Organization's (WHO) standard precautions. Sadly, there are other sources of infections as well, including air, droplets from the nose and mouth, and even intimate touch. These are referred to as "additional" sources transmission-based. However, when a person is in danger, they make an unconscious movement; they pull down the mask covering their face so that it only covers their mouth and exposes their nose. As a result, the mask is a crucial element of protection that should always be kept on. It is the most straightforward component of a thorough "Do it all!" . Failure to stop viruses or bacteria from entering the nose or mouth is the direct cause of infection.

Considered a global health emergency, the coronavirus disease pandemic may prove to be the biggest threat the world has faced since the Second World War. Speaking, coughing, or sneezing can through respiratory contact. It raised demand for personal protective equipment (PPE) on a global scale. The WHO advised using all PPE, including masks, to prevent the infection from spreading. Additionally, PPE like masks are the main emphasis of the standard

system utilized in healthcare Numerous of these research examined the effectiveness and safety of masks and respirators while focusing on their reuse. These research employed a variety of techniques, including heat drying, autoclaves, ovens, and hydrogen peroxide plasma vapor. However, some organizations advise against doing so and encourage the extended use of single-use surgical masks over their reuse in times of urgent shortage.

Millions of tons of plastic trash, subject to daily growth, are released into the environment as a result of the prolonged usage of disposable surgical masks. As a result, there will be an excess of plastic waste that poses health risks. illustrates how the massive amount of plastic masks being thrown away will worsen environmental contamination on land and at sea. Biodegradable fibers can be used to create biomask filters. To stop the pollution that traditional masks cause, polysaccharides like coffee, hemp, bamboo, and sugar fibers can be created; they are secure and recyclable. These biomasks must, however, be antibacterial. Antibiotics and bacteria have a long history together. Bacteria can be managed with judicious antibiotic use. Unfortunately, overuse of antibiotics may promote the creation of super bacteria, which are more virulent bacteria and have negative effects on the environment. Unless in a totally sterile environment, germs are typically constantly present on surfaces in hospital and industrial settings. Numerous studies have demonstrated that using a face mask while speaking or breathing might cause bacteria to grow on the mask. According to some research, the surgeon's body rather than the hospital's surroundings is the primary site of the infection because, as illustrated in Figure 2, the inner layers of the mask are more contaminated than the outside layers. As a result, the risk of bacterial infection increases significantly. It has increasingly been the norm on several occasions. When people take off and then put back on their masks, such as when eating or perspiring, they provide the ideal conditions for these bacteria to flourish. [Traditional masks are constructed of several layers of cotton gauze, occasionally with the addition of a layer of waterproof material, held together by a metal frame. The primary objective is to stop respirable droplets from spreading to and from the wearer. Surgical masks, on the other hand, are made of a nonwoven fabric that was produced by the melt-blowing technique. In affluent nations, they have essentially supplanted cotton face masks since they were introduced in the 1960s. Due of their well-known traits, nanotechnology has just entered the process of making these surgical face masks. In order to increase the effectiveness of infection prevention, nanofibers are utilized in the production of masks.

The biological and biomedical fields are among the most significant areas where nanotechnology is being applied. Applications of nanotechnology are moving away from information technology and electronics and toward biology and biomedicine. In every field of research, nanotechnology has emerged as a new technology. Building novel materials with distinctive properties to solve complex scientific conundrums at the atomic level would not be conceivable without the development of nanotechnology. These materials are utilized to create biomaterials and devices that can interact with tissues and even cells at the molecular level with a high degree of interaction in biomedical applications such as medicine and physiology. As a result, this makes it possible to integrate technology and biological systems to a high degree that was not before possible.

Nanoparticles' (NPs) antibacterial qualities are one of their cutting-edge features. Numerous studies have been conducted and NPs are currently being evaluated as an alternate approach to deal with the problems brought on by bacterial multidrug resistance. NPs have gained popularity as a fresh approach to combat bacterial multidrug resistance and inappropriate

usage of antibiotics. Without making an effort to enter the cell, NPs can harm the microbial cell by coming into close contact with the bacterial cell membrane. In contrast, the toxicity of NPs is poorly understood and requires further research. For commercially available antibacterial skin products, the U.S. Food and Drug Administration has promoted the use of many NPs, including silver NPs and titanium dioxide NPs, for instance, are employed in cardiology, dermatology, and dentistry and exhibit antibacterial action [24, 25]. Nanomaterials used in the construction of new masks have been compared to those used in the past, and the results reveal that they enhance comfort, permeability efficiency, and worker performance. The utilization of matter on an atomic, molecular, and supramolecular scale for industrial purposes is known as nanotechnology, or just nanotech. The first and most popular definition of nanotechnology, currently known as molecular nanotechnology, focused on the specific technological objective of accurately manipulating atoms and molecules for the creation of macroscale objectsThe National Nanotechnology Initiative later created a more broad definition of nanotechnology, defining it as the manipulation of matter with at least one dimension scaled from 1 to 100 nanometers (nm). This definition changed from a specific technological goal to a research category inclusive of all types of research and technologies that deal with the unique properties of matter that occur below the specified size threshold in order to reflect the importance of quantum mechanical effects at this quantum-realm scale. As a result, the term "nanotechnologies" or "nanoscale technologies" is frequently used to refer to a wide range of research and applications that share the characteristic of being small.

DISCUSSION

Origins

History of nanotechnology, in the mainRichard Feynman, a renowned physicist, originally presented the ideas that gave rise to nanotechnology in 1959 in his lecture There's Plenty of Room at the Bottom, when he described the prospect of synthesis via direct atom manipulation.Although it was not well known, Norio Taniguchi coined the phrase "nano-technology" in 1974. K. Eric Drexler coined the term "nanotechnology" in his 1986 book Engines of Creation: The Coming Era of Nanotechnology, which put forth the concept of a nanoscale "assembler" capable of creating copies of itself and other objects of arbitrary complexity with atomic precision. Drexler was inspired by Feynman's ideas. In an effort to promote a better understanding of the concepts and implications of nanotechnology among the general public, Drexler also co-founded The Foresight Institute in 1986. He is no longer a part of this organization.

Drexler's theoretical and public work, which developed and popularized a conceptual framework for nanotechnology, and high-profile experimental advancements, which attracted additional wide-scale attention to the prospects of atomic control of matter, came together to create the field of nanotechnology in the 1980s. The development of nanotechnology in the current period was launched by two significant discoveries in the 1980s. The scanning tunneling microscope was first created in 1981, allowing for the first-ever visualization of individual atoms and bonds. In 1989, it was also successfully utilized to manipulate individual atoms. Gerd Binnig and Heinrich Rohrer, who created the microscope at the IBM Zurich Research Laboratory, were awarded the 1986 Nobel Prize in Physics. In the same year, Binnig, Quate, and Gerber also created a similar atomic force microscope.

The buckyball, sometimes referred to as buckminsterfullerene C60, is an example of the class of carbon compounds called fullerenes. The fullerene family is a key focus of research that

falls under the category of nanotechnology.Second, Harry Kroto, Richard Smalley, and Robert Curl, who collectively received the 1996 Nobel Prize in Chemistry, made the discovery of fullerenes in 1985. The term "nanotechnology" was first used in relation to later research on closely related carbon nanotubes (also known as graphene tubes or Bucky tubes), which showed possible uses for nanoscale electronics and gadgets. C60 was not first described as nanotechnology. Sumio Iijima of NEC is primarily credited for discovering carbon nanotubes in, for which Iijima received the first Kavli Prize in Nanoscience in 2008.The field attracted more scientific, political, and commercial attention in the early 2000s, which resulted in debate and advancement. The Royal Society's study on nanotechnology serves as an example of the debates that have arisen around the definitions and potential consequences of nanotechnologies. Advocates of molecular nanotechnology faced difficulties with the viability of their proposed applications, which led to a public argument between Drexler and Smalley between 2001 and 2003.

While this was going on, commercialization of goods based on developments in nanoscale technologies started to emerge. These goods do not involve atomic manipulation of matter and are restricted to mass uses of nanomaterials. Examples include the Silver Nano platform, which uses silver nanoparticles as an antibacterial agent, transparent sunscreens based on nanoparticles, silica nanoparticles used to reinforce carbon fiber, and carbon nanotubes used in stain-resistant textiles.The National Nanotechnology Initiative in the United States, which formalized a size-based definition of nanotechnology and established funding for research on the nanoscale, and the European Framework Programmes for Research and Technological Development in Europe are two examples of how governments have taken action to promote and fund research into nanotechnology.the middle of the 2000s, new and significant scientific interest started to take off. The creation of roadmaps for nanotechnology, which focus on the atomically precise manipulation of matter and outline current and projected capabilities, aims, and applications, has become a priority.

Fundamental ideas

Engineering functional systems at the molecular level is known as nanotechnology. This covers both the most recent research and more complex ideas. In its original sense, the term "nanotechnology" refers to the anticipated capacity to build things from the ground up utilizing currently being developed methods and tools to create finished, high-performing products. One billionth of a meter, or 109, is a nanometer (nm). Comparatively, a DNA double helix has a diameter of around 2 nm, and average carbon-carbon bond lengths, or the spacing between these atoms in a molecule, are in the range of 0.12-0.15 nm. The bacteria belonging to the genus Mycoplasma, on the other hand, are the smallest known cellular life forms and measure about 200 nm in length. According to custom, nanotechnology is understood to cover the size range of 1 to 100 nm, as per the National Nanotechnology Initiative's definition in the US. Since nanotechnology must construct its gadgets from atoms and molecules, the lower limit is set by the size of atoms (hydrogen contains the smallest atoms, which are around a quarter of a nanometer kinematic diameter). The top limit is more or less arbitrary, although it roughly corresponds to the size below which phenomena not seen in bigger structures start to emerge and can be utilized in the nano device. These novel phenomena set nanotechnology apart from devices that are essentially scaled-down counterparts of a comparable macroscopic device; these larger-scale devices fall under the category of microtechnology.

To put that scale in another context, a marble's comparative size to the size of the earth is the same as a nanometer's relative size to a meter. Or, to put it another way, a man's typical beard grows one nanometer in the time it takes him to bring the razor to his faceIn nanotechnology, there are two main methods. In the "bottom-up" method, materials and gadgets are constructed from molecular building blocks that chemically assemble themselves according to molecular recognition principles. The "top-down" method involves building nano-objects from larger things without using atomic-level control.Over the past few decades, fields of physics like nanoelectronics, nanomechanics, nanophotonics, and nanoionics have developed to provide a fundamental scientific foundation for nanotechnology.

From larger to smaller: a look at materials

Scanning tunneling microscopy image of reconstruction on a pure Gold(100) surface. It is possible to see the locations of the individual atoms that make up the surface.As the system gets smaller, a number of phenomena become more obvious. These include statistical and quantum mechanical effects, such as the "quantum size effect," which modifies the electrical characteristics of solids when particle size is drastically reduced. Going from macro to micro dimensions has no impact on this effect. However, when the nanoscale size range is reached, often at distances of 100 nanometers or less, the so-called quantum domain, quantum effects can become substantial. When compared to macroscopic systems, a number of physical (mechanical, electrical, optical, etc.) attributes also alter. One illustration is how changing the surface area to volume ratio can change a material's mechanical, thermal, and catalytic properties. Nanoionics is the broad term for nanoscale diffusion and reactions, nanostructured materials, and nanodevices with quick ion transport. The study of nanomechanics is interested in the mechanical characteristics of nanosystems. Nanomaterials' catalytic activity makes their interactions with biomaterials potentially dangerous.

Materials that have been scaled down to the nanoscale can display different properties from those that they do at the macroscale, opening up new uses. For instance, stable materials such as aluminum might become flammable; opaque substances such as copper can become translucent; and insoluble substances such as gold may become soluble. At nanoscales, a substance like gold, which is chemically inert at larger dimensions, can act as a powerful chemical catalyst. These quantum and surface phenomena that matter demonstrates at the nanoscale are a large part of what attracts people to nanotechnology.

From simple to complex viewpoint

Today's synthetic chemistry has advanced to the point where practically any structure can be created for tiny molecules. Today, a large range of valuable compounds, including medicines and commercial polymers, are produced using these techniques. This raises the question of how to take this level of control even further, looking for ways to put these single molecules together into supramolecular assemblies, which are made up of many molecules arranged in a specific way.These methods take a bottom-up approach and make use of the ideas of molecular self-assembly and/or supramolecular chemistry to automatically arrange themselves into some useful conformation. The idea of molecular recognition is crucial because some configurations or arrangements of molecules can be made to be preferred by non-covalent intermolecular forces. This has a direct impact on the Watson-Crick basepairing rules, the ability of an enzyme to target a single substrate, and the way that a protein folds. As a result, it is possible to create two or more components that complement one another and are attractive to one another, creating a more complex and valuable whole.

Such bottom-up approaches could possibly be overwhelmed as the size and complexity of the desired assembly develops, but they should be able to produce devices in parallel and be far less expensive than top-down methods. The majority of useful structures need intricate and thermodynamically improbable atom configurations. But there are numerous instances of molecular recognition-based self-assembly in biology, most notably Watson-Crick basepairing and enzyme-substrate interactions. The test for nanotechnology is whether these principles can be applied to artificially create new structures in addition to those found in nature.

A long-term perspective on molecular nanotechnology

Molecular nanotechnology, often known as molecular manufacturing, refers to molecular-scale machines that are engineered nanosystems. The molecular assembler, a device that can create a desired structure or device atom-by-atom utilizing the concepts of mechanosynthesis, is particularly connected with molecular nanotechnology. The conventional technologies used to create nanomaterials like carbon nanotubes and nanoparticles are unrelated to manufacturing in the context of productive nanosystems and should be clearly segregated from them.The term "nanotechnology" originally referred to a future manufacturing technology based on molecular machine systems when it was independently invented and popularized by Eric Drexler (who at the time was not aware of an earlier usage by Norio Taniguchi). Because there are so many examples of complex, stochastically tuned biological machines in biology, it is known that molecular-scale biological parallels of conventional machine parts can show that molecular machines are feasible.

It is envisaged that advancements in nanotechnology may enable their production through alternative methods, possibly utilizing biomimetic principles. However, Drexler and other researchers have suggested that advanced nanotechnology, although it may be initially implemented through biomimetic methods, ultimately could be based on mechanical engineering principles. Specifically, they suggested that a manufacturing technology based on the mechanical functionality of these components (such as gears, bearings, motors, and structural members) would enable programmable, positional assembly to atomic specification. Drexler's book NanosystemsMolecular Machinery, Manufacturing, and Computation examined the physics and engineering performance of exemplary designs.

since atoms of same size and stickiness must be positioned on other atoms of similar size and stickiness, it is often highly challenging to manufacture electronics on the atomic scale. Carlo Montemagno offers a different perspective, arguing that future nanosystems would combine silicon technology with biological molecular machines. Richard Smalley stated that the challenges of mechanically manipulating individual molecules make mechanosynthesis impractical.This resulted in a correspondence that was published in 2003's Chemical & Engineering News, an ACS magazine. Although molecular machine systems are demonstrably conceivable in biology, non-biological molecular machines are still in their infancy. Alex Zettl and his team at UC Berkeley and Lawrence Berkeley National Laboratory are pioneers in the study of non-biological molecular machines. In order to regulate the motion of at least three different molecular devices, they have built nanotube nanomotors, molecular actuators, and nanoelectromechanical relaxation oscillators. There are more instances in the nanotube nanomotor.

CONCLUSION

Reusable surgical face masks with high-density edges of standing structured graphene nanosheets have been successfully made in several investigations using graphene nanosheet-embedded carbon (GNEC) fil. Additionally, professionals in the medical field are unable to quickly replace their masks. The inside of the mask's relative humidity (RH) rises to a high-risk level as a result (RH 75%). Lung irritation could result from this. GNEC-modified surgical face masks have a high degree of hydrophobicity. NEC has a high level of filtration effectiveness, achieving 100% photosterilization of bacterial filtration, which may reach temperatures of more than 100°C when exposed to solar irradiation. This impressive performance might aid in limiting outbreaks. The economic consumption of masks is thereby decreased. Additionally, customized surgical masks with graphene can be recycled with good salt rejection capability in water desalination. Surgical masks' hydrophobic surfaces can be made superhydrophobic by applying an ultrathin graphene layer on top of them. By including NPs, such as AgNPs, copper oxide NPs or anthraquinone-2-sodium sulfonate, graphene's antibacterial function can be improved.Triboelectric (TE) face masks are created to increase effectiveness and capture TE nanogenerators (TENG), which are backed by an electrocution layer (EL) that has the potential to inactivate germs and viruses. The inner three layers of this mask's multilayer filters provide TE filtration, while the outer layer serves as an EL filter.

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CHAPTER 5
CONCEPT TO MARKET DOMINATION NANOTECHNOLOGY IN MEDICAL APPLICATIONS

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ABSTRACT
Nanomedicine, a product of the union of nanotechnology and medicine, promises to be beneficial in the fight against unmet medical needs. Numerous international research and commercial initiatives are in place to secure a large market position because the field is acknowledged as a global concern. Nanomedicine is one of those newly developing industries, nonetheless, for which corporate growth strategies have not yet been defined. There are still questions regarding the optimal business model for these organizations and the best growth tactics for them. In order to enter the market effectively, capture a sufficient market share, and create and preserve a competitive, defendable advantage, nanomedicine start-ups made a number of financial and strategic decisions. These decisions are described in this study. We investigated the technical transfer process, which links laboratories or research institutions to the market, by physically transferring nanomedicine products from the inventor's hands to the hands of the doctor. In order to consider a potential market entry and the market share that managers might reasonably obtain at various time horizons, the process entails extensive analysis to assess the potentials of end goods as well as research to identify market segment, size, structure, and rivals. Getting funding is important yet difficult. Investors, drawn by the "nano" industry, are beginning to see the promise of this subject, though.

KEYWORDS
Competive, corporate, getting, promise.

INTRODUCTION

Nanomedicine, which is often described as the application of nanotechnology to the clinical setting, has its origins in the same fundamental ideas and principles as nanotechnology, namely that materials with nanoscale features exhibit distinctive properties that are not present at a macroscopic level. Nanomedicine is multidisciplinary in nature, using ideas and methods taken from biology, chemistry, and physics, just as nanotechnology benefits from mathematics and engineering. As a result of this fruitful union, nanostructure materials exhibit novel properties that have extraordinary advantages when used in medical technology.The ability to operate at the same scale of various biological processes, cellular mechanisms, and organic molecules is what drives nanotechnology's success in the healthcare industry. As a result, medicine has viewed nanotechnology as the ideal solution for the detection and treatment of many diseases. Drug delivery is one of the various ways that nanotechnology is used in the medical industry. New therapeutic approaches, ranging from molecular targeting to radiofrequency ablation and from personalized therapies to minimally invasive procedures, have flooded the scientific and clinical communities as a result of the development of protocols and methods for the synthesis, functionalization, and use of nanoparticles and nano-carriers.

Although the majority of people in the investment community are able to understand what nanotechnology is and can competently launch and manage a viable product into the market, they are conceptually limited when it comes to this scientific field and the complex inner workings of the product's functionality. On the other hand, scientists engaged in scientific research are aware that nanomedicine is an extension of nanotechnology, but they have little business knowledge necessary to turn their technologies into commercial products. Therefore, collaboration between the two groups is essential to the commercialization of inventions based on nanomedicine. The use of nanotechnology in medicine is known as nanomedicine. Nanomaterials, biological devices, nanoelectronic biosensors, and even potential future uses of molecular nanotechnology, including biological machines, are all included in the field of nanomedicine. Understanding the toxicity and environmental impact of nanoscale materials—materials whose structure is on the scale of nanometers, or billionths of a meter—is a current problem for nanomedicine.

Nanomaterials can be given additional functionality by interacting with biological molecules or structures. Nanomaterials can be valuable for both in vivo and in vitro biomedical research and applications since their size is comparable to that of the majority of biological molecules and structures. The combination of nanomaterials and biology has so far resulted in the creation of drug delivery systems, contrast agents, analytical tools, and diagnostic gadgets.In the near future, nanomedicine aims to provide a helpful collection of research instruments and clinically practical gadgets. The National Nanotechnology Initiative anticipates new commercial uses for nanotechnology in the pharmaceutical sector, including in vivo imaging, novel therapeutics, and enhanced drug delivery systems. Four nanomedicine development institutes are supported by funds from the US National Institutes of Health Common Fund program.

With an annual minimum investment in nanotechnology R&D of $3.8 billion, sales of nanomedicine surpassed $16 billion in 2015. Recent years have seen a 45% annual rise in global funding for developing nanotechnology, with 2013 seeing product sales surpass $1 trillion. The economy is anticipated to be significantly impacted by the nanomedicine sector's continued growth.The use of nanoparticles to deliver medications to certain cells is now possible because to nanotechnology. By placing the active pharmaceutical ingredient solely in the morbid region and in no more than the necessary dose, the overall drug intake and adverse effects may be greatly reduced. Targeted drug distribution aims to lessen therapeutic side effects while concurrently reducing drug intake and treatment costs.

Additionally, focused medication delivery minimizes unintended exposure to healthy cells, reducing the negative effects associated with crude drug use. The goal of drug delivery is to increase bioavailability at specified locations and over an extended length of time in the body. This may be accomplished by the use of nanoengineered devices that target certain molecules.Smaller devices are less intrusive and may be placed inside the body, and biochemical reaction times are significantly sped up by applying nanoscale technologies in medical applications. Compared to conventional drug delivery, these devices are quicker and more sensitive. The successful delivery of the drug to the desired area of the body, the efficient encapsulation of the drug, and the successful release of the drug all contribute to the effectiveness of drug delivery by nanomedicinea number of medications using nano-delivery were available.

polymer-based nanoparticle-based drug delivery systems can be created to enhance the medication's pharmacokinetics and biodistributionNanomedicine's pharmacokinetics and

pharmacodynamics, however, vary greatly between patients. Nanoparticles can be used to enhance drug delivery because they have advantageous features that can be leveraged to circumvent the body's defense mechanisms. Complex drug delivery systems that can penetrate cell membranes and enter the cytoplasm of cells are currently being developed. Drug molecules can be used more effectively one way to trigger response. Drugs are injected into the body, and they only become active in response to a certain signal. For instance, a drug's solubility may be improved by using a drug delivery system that has both hydrophilic and hydrophobic environments. Using controlled drug release, lowering drug clearance rates, lowering the volume of distribution, or lowering the influence on non-target tissue are other ways that drug delivery systems can prevent tissue harm. Due to the intricate host interactions to nano- and microsized materials and the challenge of specifically targeting certain organs in the body, the biodistribution of these nanoparticles is still not perfect.

However, there is still more to be done in order to improve and comprehend the capabilities and restrictions of nanoparticulate systems. The concerns of nanotoxicity become a crucial next step in deeper knowledge of nanoparticles' medicinal applications, even when research advancements show that targeting and dispersion can be enhanced by them. Nanoparticles' toxicity varies according to their size, shape, and composition. The accumulation and potential organ damage are likewise impacted by these variables. Since they cannot be broken down or eliminated, nanoparticles are made to be long-lasting, which leads them to become lodged within organs, particularly the liver and spleen. In mice, organ injury and inflammation have been linked to the accumulation of non-biodegradable substances. Increased tumor growth may result from the magnetic targeted delivery of magnetic nanoparticles to the tumor location while being affected by inhomogeneous stationary magnetic fields. Alternating electromagnetic fields should be employed to avoid the pro-tumorigenic effects.

The potential of nanoparticles to reduce antibiotic resistance and serve a variety of antimicrobial purposes is currently being studiedUsing nanoparticles to get around mechanisms of multidrug resistance (MDR) is another possibility. Lipid nanotechnology developments were essential for creating novel drug delivery methods, medical nanodevices, and sensing applications. Nanoparticles created by the self-assembly of two separate microRNAs that are unregulated in cancer represent another strategy for the delivery of microRNAs that is now the subject of exploratory investigation. Small electromechanical systems, such as the nanoelectromechanical systems being researched for the active release of medications and sensors for future cancer treatment with iron nanoparticles or gold shells, are one prospective.

DISCUSSION

Market for Nanomedicine

Systems for targeted administration and controlled release of medicinal drugs using nanoparticles are known as nanoparticle drug delivery systems. A modern drug delivery system should lower dosage and frequency while minimizing negative effects. Nanoparticles have received interest recently because of their potential role in efficient medication delivery.Nanomaterials differ from their larger-scale counterparts in terms of their chemical, physical, or biological characteristics, which makes them advantageous for drug delivery systems. The high surface-area-to-volume ratio, chemical and geometric tunability, and ability to interact with biomolecules to enhance absorption through the cell membrane are

some significant advantages of nanoparticles. For the aim of targeting and regulated release, the vast surface area also has a high affinity for pharmaceuticals and small molecules, such as ligands or antibodies.

An extensive family of organic and inorganic materials is referred to as nanoparticles. Each material can be specifically developed for particular uses because each one has individually customizable qualities. Nanoparticles have many benefits, but there are also many disadvantages, such as nanotoxicity, biodistribution and accumulation, and human body clearance of nanoparticles.The following are prospective directions for study into nanoparticle drug delivery systems, according to the National Institute of Biomedical Imaging and Bioengineering:

Characterization

The goals of nanoparticle drug delivery are to increase drug efficacy and reduce cytotoxicity. The following parameters need to be taken into consideration while fine-tuning nanoparticle characteristics for efficient medication delivery. To promote greater ligand binding to the surface, nanoparticles' surface-area to volume ratio can be changed. Minimizing nanoparticle toxicity and dose can both be accomplished by improving ligand binding effectiveness. Reduced dosage or dosage frequency also results in a reduction in the mass of nanoparticles per mass of medication, increasing efficiency.Another crucial component of design is surface functionalization of nanoparticles, which is frequently achieved through bioconjugation or passive adsorption of molecules onto the nanoparticle surface. Greater efficacy and less toxicity are obtained by functionalizing the surfaces of nanoparticles with ligands that improve drug binding, inhibit immune response, or enable targeting/controlled release. More medicine is delivered to the target site, increasing efficacy, and less drug overall is present in the body, reducing severe side effects.

The intended environment or desired outcome can influence the nanoparticle's composition. In order to reduce the risk of buildup and toxicity after the therapeutic payload has been discharged, liposome-based nanoparticles, for instance, can be biologically destroyed after deliveryNanomaterials also explain the optical properties of metal nanoparticles, such as gold nanoparticles, which enable less invasive imaging methods. Additionally, tumor therapy can directly benefit from the photothermal reaction of nanoparticles to optical stimulation.

Nanoparticles made of polymers

Synthetic polymers with sizes ranging from 10 to 100 nm are known as polymeric nanoparticles. Chitosan, polyacrylamide, polyacrylate, and polyacrylate are examples of typical synthetic polymeric nanoparticles. Drug molecules may be added before or after the polymerization process. The drug may be covalently bound, enclosed in a hydrophobic core, or conjugated electrostatically, depending on the polymerization chemistry.Microfluidic techniques, electrodropping, high pressure homogenization, and emulsion-based interfacial polymerization are examples of common synthetic methods for polymeric nanoparticles.The ability of a polymer to degrade is a crucial factor to take into account while deciding on the best nanoparticle chemistry. In the body, hydrolysis of biodegradable polymer-based nanocarriers yields biocompatible small molecules like lactic acid and glycolic acid.Self-assembly and other techniques, such as particle replication in nonwetting templates (PRINT), can be used to make polymeric nanoparticles, which can then be customized in terms of composition, size, and form using microscopic molds.

Dendrimers

Uniquely hyper-branched synthetic polymers known as dendrimers have monodisperse size, a clear structure, and a highly functionalized terminal surface. They often contain nucleic acids, carbohydrates, and synthetic or natural amino acids. By using electrostatic interaction, hydrophobic interaction, hydrogen bonds, chemical linkages, or covalent conjugation, therapeutics can be relatively easily loaded into the inside of dendrimers or the terminal surface of the branches. The half-life of pharmaceuticals can be prolonged through drug-dendrimer conjugation. Due to dendrimer toxicity and restrictions in their production processes, dendrimer usage in biological systems is currently restricted. Additionally, dendrimers are restricted to a small size range (15 nm), and existing synthetic techniques have a low yield. The de Gennes dense packing limit will be reached by the surface groups at a high generation level, which closes the interior from the bulk solution and is advantageous for encasing hydrophobic, insoluble drug molecules. A property that can be used to customize the encapsulation and controlled release properties is the seal, which can be regulated by intramolecular interactions between neighboring surface groups. These interactions can change depending on the solution's pH, polarity, and temperature.

Nanocrystals and inorganic nanoparticles

Due to their well-defined and highly programmable characteristics, including size, shape, and surface functionalization, inorganic nanoparticles have become extremely valuable functional building blocks for drug delivery systems. The use of inorganic nanoparticles in biological and medical applications, including imaging, diagnosis, and medication administration, has become widespread.Iron oxide nanoparticles have also become a possibility. Inorganic nanoparticles are often made of inert metals like gold and titanium that form nanospheres.Due to their distinct size-dependent optical characteristics and adaptable surface chemistry, quantum dots (QDs), or inorganic semiconductor nanocrystals, have also become important instruments in the field of bio nanotechnology. They provide quantum confinement effects similar to those of the "particle-in-a-box" concept because their diameters (2–10 nm) are on the order of the exciton Bohr radius. Because of this, the optical and electrical characteristics of quantum dots vary with their size: larger nanocrystals will release lower energy light when excited by fluorescence.

For the development of hybrid nanoparticle-biomolecules capable of taking part in biological processes, surface modification of QDs is essential. Changes in the composition, size, and structure of nanocrystals QD photophysical characteristics Nanocrystals can be made biocompatible by designing coating materials that encase the QD core in an organic shell. QDs can then be further adorned with biomolecules to enable more targeted interaction with biological targets. The optical features of the QDs and the biological activities of the ligands attached can be combined by the creation of an inorganic nanocrystal core with an organic shell and surface ligands that are compatible with living things.

Stability

Nanocrystal stability is a drawback of employing nanocrystals for drug delivery. Nanocrystalline structural instability issues are caused by thermodynamic processes such particle aggregation, amorphization, and bulk crystallization. Due to their larger surface area to volume ratio, particles of the nanoscopic scale exhibit a relative excess of Gibbs free energy. It is normally advantageous for aggregation to take place in order to eliminate this extra energy. As a result, individual nanocrystals are generally unstable and will agglomerate.

This presents a special challenge for top-down nanocrystal manufacturing. By increasing surface areas, techniques like high-pressure homogenization and bead milling tend to exacerbate instabilities; as a countermeasure or in response to high pressure, individual particles may coalesce or develop an amorphous structure. By exceeding the solubility beyond the saturation point (Ostwald ripening), such techniques may also result in the drug's reprecipitation.

Utilizing stabilizer molecules is one way to prevent aggregation and maintain or improve nanocrystal stability. They comprise surfactants and are often helpful for stabilizing nanocrystal solutions because they interact with the surface of the nanocrystals and inhibit aggregation via ionic repulsion or steric barriers between the individual nanocrystals.[30] However, excessive surfactant concentrations may impede nanocrystal stability and promote crystal growth or aggregation. Certain surfactants have been demonstrated to self-assemble into micelles at a certain concentration, where they subsequently compete with nanocrystal surfaces for additional surfactant molecules. Crystal growth and aggregation is said to occur more frequently when there are fewer surface molecules interacting with the nanocrystal surface. According to reports, using surfactant at the right concentrations promotes greater stability, increased drug capacity as a carrier, and sustained drug release. It was discovered in a study employing PEG as a stabilizer that nanocrystals treated with PEG had increased blood circulation and had enhanced accumulation at tumor locations.

Top-down production techniques are susceptible to amorphization. Amorphization of nanocrystals results in distinct thermodynamic and kinetic properties that have an impact on drug delivery and kinetics. It has been suggested that manufacturing procedures including spray drying, lyophilization, and mechanical processes like milling can lead to the transition to amorphous structures.[30] In a dry milling process, this amorphization has apparently been seen both with and without stabilizer. However, amorphization was greatly reduced when using a wet milling process with a surfactant, indicating that a solvent—in this example, water—and a surfactant could prevent amorphization for some top-down production techniques that are otherwise said to promote it.

CONCLUSION

The knowledge that the innovator initially possesses is the main result of innovation. Unfortunately, the secrecy of this information can be compromised, and the use of it by one company does not prohibit the use of it by another. Investors entering into fresh initiatives are therefore conscious that they won't be able to readily appropriate the whole profits of their investment. Because of this, financing creative projects is not very appealing. A competitive market makes it difficult to find finance for innovative ideas, according to economic theory. There is evidence of resource shortages even in large companies, which would prevent managers from pursuing creative ideas. This phenomena can be attributed to a number of factors, including poor expected returns caused by an inability to benefit from an invention, exaggerated optimism when investing in ground-breaking ventures, and most importantly, the uncertainty and danger involved with these projects. Technology-based businesses might also think about copying rivals' innovations. However, Edwin et al. discovered that copying is not free and could result in costs between 50% and 75% of the original invention's cost, which does not solve the underinvestment issue. By easing the invention process, rationalizing government interventions through encouragement of innovative activities, upholding the intellectual property system, allowing tax incentives for R&D, and encouraging research collaborations, policymakers are attempting to change the funding situation. However, the

process that takes a nanoscale product from the lab to the market is costly and time-consuming, which disadvantages the innovator.

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CHAPTER 6
NANOTECHNOLOGY AND NANOMATERIALS FOR THE PRODUCTION OF BIODIESEL AND PROPERTY IMPROVEMENT

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Abstract
Due to their enticing properties, applications of nanotechnology and nanomaterials are currently piqueing interest across a wide range of research fields. Globally, research is concentrating on the application of nanotechnology and nanomaterials in the production and processing of biodiesel. The use of advanced nanotechnology is receiving greater attention in order to increase the development and production of biodiesel and achieve the highest yield at the lowest cost. As a result, this study will examine the use of various nanomaterials and nanocatalysts for the synthesis of biodiesel from a variety of feedstocks. The use of nanomaterials in the production of algae and the extraction of lipids will also be a key component of this investigation. The current study will also provide a thorough analysis of the biodiesel combined with nanoadditives in diesel engines, as well as the major difficulties and promising future prospects. Additionally, this study will concentrate on issues related to the safety of large-scale biodiesel production based on nanotechnology for both humans and the environment. Therefore, this study will give future manufacturers, researchers, and academicians an understanding of the scope of research in the use of nanotechnology and nanomaterials to assist in the manufacturing of biodiesel and to increase its efficiency.

KEYWORDS
Academicians, enticing, manufacturing, production.

INTRODUCTION

The field of nanotechnology can be broadly defined as the development of molecular-scale machines and devices that are a few nanometers (109 m) wide, much smaller than a cell. Currently, a variety of nanomaterials, including as nanofibers, nanotubes, and nanometals, are used to assess the impact of nanoparticles on the development and production of biofuels/biodiesels.The application of nanotechnology and nanomaterials in biodiesel research has proven to be a practical tool for providing effective ways to improve production quality at an affordable price. Nanoparticles (NPs) have various advantages over biodiesel synthesis due to their small size, unique properties, and qualities, including a high surface area to volume ratio, significant crystallinity, catalytic activity, adsorption capacity, and stability. Metal oxide nanoparticles and carbon nanotubes are frequently used as nanocatalysts in the production of biofuel and biodiesel because they have additional properties that support high potential recovery. This study critically examines the use of nanotechnology in the production and advancement of biodiesel, as well as the major challenges and encouraging future advancements.

A promising feedstock for the production of biodiesel is microalgae. Diverse nanoparticles could improve the microalgae harvesting process' efficiency right away. Costs can also be reduced by reusing nanomaterials and incorporating cell harvesting, disruption, and extraction. Additionally, a number of nanocatalysts have the potential to increase the efficiency of biodiesel conversion.However, in the engine sector and associated industries, improving combustion efficiency and reducing hazardous emissions have emerged as hot

research topics. Nanoadditives to diesel-biodiesel fuel blends have reportedly shown noteworthy results, according to numerous studies. Numerous studies and research findings on nanoparticles have demonstrated the crucial role that nanoadditives play in improving internal combustion engine efficiency and reducing the emission of hazardous pollutants.

The applications of nanotechnology and nanomaterials assisted biodiesel production and its efficiency increase have received substantial investigation, which will be summarized in this review paper. Because of this, this review investigates the application of nanotechnology in a number of biodiesel production process phases, such as microbial culture, lipid extraction, hydrocarbon purification from oil, and transesterification. This study will also discuss the usage of nanoparticles as fuel additives for diesel-biodiesel fuel mixes. The advantages and disadvantages of applying nanotechnology at various phases of the process are also covered in this review. The development of more effective and sustainable technologies for generating and storing energy is becoming more and more crucial as the world's energy demand rises. Energy will be the most significant issue for humanity in the next 50 years, and nanotechnology has the capacity to address this problem, according Wade Adams of Rice University.The relatively new scientific and engineering subject of nanotechnology has the potential to significantly alter the energy sector. Any technology that uses particles with a single dimension smaller than 100 nanometers is considered to be a form of nanotechnology. A single virus particle measures roughly 100 nanometers in width.

Scientists and engineers have already started to create strategies for applying nanotechnology to the creation of consumer goods. higher lighting and heating efficiency, higher electrical storage capacity, and less pollution from energy use are all advantages that have previously been noted as a result of the design of these items. These advantages highlight the importance of investing money in the study and advancement of nanotechnology.The usage of materials based on graphene for energy storage has sparked a lot of attention. Although research on the use of graphene for energy storage is still in its early stages, it is expanding quickly.

Due to a number of characteristics, including its low cost, chemical inertness, and low weight, graphene has recently gained attention as a promising material for energy storage. Carbon atoms are arranged in a hexagonal lattice to form the two-dimensional sheet known as graphene, an allotrope of carbon. The research community refers to a group of graphene-related compounds as "graphenes"; these materials are structurally or chemically linked to graphene Graphene oxide, which is described as a single layer of graphite oxide is the most significant chemically generated form of graphene. Strong oxidizers, such as a mixture of sulfuric acid, sodium nitrate, and potassium permanganate can be used to produce graphite oxide from graphite, which is typically made by oxidizing it to graphite oxide and then exfoliating it. The fabrication process has a significant impact on the characteristics of graphene. For instance, the reduction of graphene oxide to graphene yields a structure of graphene that is one atom thick but has a high density of flaws, such as nanoholes and Stone-Wales defects. Additionally, carbon compounds with varied structures and a relatively high electrical conductivity are widely used in the alteration of sulfur. It is essential for battery design that sulfur-carbon composites with a variety of structural elements be used since they display significantly better electrochemical performance than pure sulfur. The modification of a sulfur cathode for high performance Li-S batteries with graphene has received a lot of attention recently.The usage of materials based on graphene for energy storage has sparked a lot of attention. Although research on the use of graphene for energy storage is still in its early stages, it is expanding quickly.

Due to a number of characteristics, including its low cost, chemical inertness, and low weight, graphene has recently gained attention as a promising material for energy storage. Carbon atoms are arranged in a hexagonal lattice to form the two-dimensional sheet known as graphene, an allotrope of carbon. The research community refers to a group of graphene-related compounds as "graphenes"; these materials are structurally or chemically linked to graphene. Graphene oxide, which is described as a single layer of graphite oxide is the most significant chemically generated form of graphene. Strong oxidizers, such as a mixture of sulfuric acid, sodium nitrate, and potassium permanganate can be used to produce graphite oxide from graphite, which is typically made by oxidizing it to graphite oxide and then exfoliating it. The fabrication process has a significant impact on the characteristics of graphene. For instance, the reduction of graphene oxide to graphene yields a structure of graphene that is one atom thick but has a high density of flaws, such as nanoholes and Stone-Wales defects. Additionally, carbon compounds with varied structures and a relatively high electrical conductivity are widely used in the alteration of sulfur. It is essential for battery design that sulfur-carbon composites with a variety of structural elements be used since they display significantly better electrochemical performance than pure sulfur. The modification of a sulfur cathode for high performance Li-S batteries with graphene has received a lot of attention recently.The ability to carefully manipulate a two-dimensional nanomaterial's characteristics is its key characteristic. Thus, it is simple to alter and engineer 2D nanomaterials on nanostructures. For nonlayered materials known as 2D nanofluidic channels, the interlayer space can also be altered. By using simple charge and mass transport, 2D nanomaterials can also be built into porous structures for use in energy storage and catalytic applications.

Additionally, 2D nanomaterials face several difficulties. When materials' characteristics are altered, there are various unintended consequences that may threaten their activity and structural stability. For instance, adding flaws can increase the number of active sites for better catalytic performance, but doing so may also cause side reactions that could endanger the structure of the catalyst. Another illustration is the catalytic reaction's ion diffusion barrier, which can be lowered by interlayer expansion but may also lose some structural stability. Because of this, performance and stability are traded off. Consistency in design techniques is a second problem. For instance, heterostructures are the primary catalyst structures used in energy storage devices and interlayer space, however these structures might not fully comprehend the processes underlying catalytic reactions or charge storage. Because foundational knowledge will result in dependable and effective techniques of constructing these structures, a deeper comprehension of 2D nanomaterial design is necessary. The practical implementation of these technologies poses a third difficulty. Due to their inherent instability during storage and processing, 2D nanomaterial applications varies greatly between those used in laboratories and those used in industries. For instance, it is challenging to pack porous 2D nanomaterial structures into dense films due to their low packing densities. For the industrial application of these materials, new procedures are continuously being developed.

DISCUSSION

Synthesis Techniques for Nanomaterials

A fluid made by equally dispersing nanoparticles in a liquid is known as a nanofluid. The dispersion and stability of different nanomaterials have a considerable impact on the creation and characterization of nanofluids. Numerous studies have been conducted recently on the

utilization of nanoparticles. The manipulation of the physical and chemical properties of nanoparticles, including their size, shape, and porosity, has advanced. Therefore, for nanofluids, picking the right preparation method is essential. In one or two steps, nanofluids are commonly created, while newer processes have also been devised. To make nanoparticles, a variety of physical, chemical, biological, and hybrid methods can be used. A particle of matter with a diameter of one to one hundred nanometers (nm) is commonly referred to as a nanoparticle or ultrafine particle. When referring to fibers and tubes that are smaller than 100 nm in only two orientations or larger particles up to 500 nm, the phrase is occasionally used. Smaller metal particles are typically referred to as atom clusters at the lowest limit, which is smaller than 1 nm.

In contrast to colloidal particles, which typically range in size from 1 to 1000 nm and are more sensitive to Brownian motion, they typically do not sediment.Nanoparticles are significantly smaller than the visible light spectrum (400–700 nm), making it impossible to observe them with standard optical microscopes. Instead, they must be viewed with electron microscopes or laser microscopes. For the same reason, nanoparticle suspensions in transparent media may be transparent in contrast to suspensions of bigger particles, which often scatter some or all incident visible light. Nanoparticle separation from liquids necessitates unique nanofiltration techniques since nanoparticles readily pass through ordinary filters, such as everyday ceramic candlesWhen compared to bigger particles of the same chemical, nanoparticles frequently exhibit significantly different properties. Since an atom's usual diameter ranges from 0.15 to 0.6 nm, the majority of a nanoparticle's substance can be found within a few atomic distances of its surface. Consequently, it's possible that the surface layer's characteristics will prevail over those of the bulk material. Since the interactions between the two materials at their interface also become relevant, this effect is particularly potent for nanoparticles distributed in a medium of dissimilar composition.

Idealized representation of a platinum nanoparticle with a diameter of roughly 2 nm that reveals individual atoms.Numerous fields, including chemistry, physics, geology, and biology, investigate nanoparticles because they are present in nature on a large scale. They frequently display phenomena that are not seen at either size because they are at the interface between bulk materials and atomic or molecular structures. They are a significant contributor to atmospheric pollution and essential components of a variety of industrial goods, including paints, plastics, metals, ceramics, and magnetic goods. One subfield of nanotechnology is the creation of nanoparticles with particular characteristics.Although nanoparticles tend to sustain a variety of dislocations that may be seen with high-resolution electron microscopes, they often have fewer point defects than their bulk counterparts However, the dislocation mechanics of nanoparticles differ from those of the bulk material, and this, along with their distinct surface structures, gives rise to mechanical properties that are distinct from the bulk material.

Anisotropy is the property of non-spherical nanoparticles, such as prisms, cubes, rods, etc., that depends on both form and size for their (chemical and physical) properties. Due to their intriguing optical properties, non-spherical nanoparticles of gold (Au), silver (Ag), and platinum (Pt) are finding use in a variety of fields. Nanoprisms' non-spherical geometries result in colloidal solutions with high effective cross-sections and richer hues. Utilizing them for molecular labeling, biomolecular assays, trace metal detection, or nanotechnical applications is made possible by the ability to change the resonance frequencies by adjusting the particle geometry. Under unpolarized light, anisotropic nanoparticles exhibit a particular

absorption behavior and stochastic particle orientation, revealing a unique resonance mode for each excitable axis.

Technical characteristics

Since dislocation climb necessitates vacancy migration, the decreasing vacancy concentration in nanocrystals might adversely affect the mobility of dislocations. Additionally, there is a significant internal pressure because of the surface stress in tiny nanoparticles with large curvature radii. In a manner similar to how it affects the work-hardening of materials, this results in a lattice strain that is inversely proportional to the size of the particle As an illustration, gold nanoparticles are much harder than the bulk substance. Furthermore, dislocations are more likely to interact with the particle surface in nanoparticles due to their high surface-to-volume ratio. This specifically alters the dislocation source's characteristics and permits the dislocations to leave the particle before they can accumulate, lowering the dislocation density and, thus, the degree of plastic deformation.

Since typical methods like the universal testing machine cannot be used, measuring mechanical properties at the nanoscale presents special difficulties. As a result, fresh approaches like nanoindentation have been created to supplement current scanning probe and electron microscope techniques. Nanoindentation, which measures the hardness, elastic modulus, and adhesion between a nanoparticle and a substrate, can be carried out using atomic force microscopy (AFM). The deflection of the cantilever tip over the sample allows one to calculate the particle deformation. Calculating elastic modulus can be done using the obtained force-displacement curves. It is not clear, nevertheless, whether particle size and indentation depth have an impact on the elastic modulus of nanoparticles as assessed by AFM.

In nanofabrication, lubrication, device design, colloidal stability, and drug delivery, adhesion and friction forces are crucial factors to take into account Under ambient conditions, the capillary force is the primary source of the adhesive force.If the AFM tip is thought of as a nanoparticle, the adhesion and friction force can be calculated from the cantilever deflection. However, the tip material and geometrical design of this approach have limitations. By affixing a nanoparticle to the AFM tip and giving users control over size, shape, and material, the colloidal probe approach resolves these problems. Even though the colloidal probe approach is a reliable way to measure adhesion force, it is still challenging to attach a single nanoparticle smaller than 1 micron to the AFM force sensor.

Another method is in situ TEM, which offers high resolution imaging of the response of a nanostructure to a stimulus in real-time. For instance, twinned nanoparticles were compressed and their yield strength was assessed using an in situ force probe holder in a TEM. In general, a variety of factors, such as homogeneous nanoparticle dispersion, exact application of stress, minimal particle deformation, calibration, and calculation model, affect the assessment of the mechanical characteristics of nanoparticles.The characteristics of nanoparticles are material-dependent, just like bulk materials. When compared to the bulk material, glass transition temperature and crystallinity may have an impact on deformation and alter the elastic modulus for spherical polymer nanoparticles.

Effects of quantum mechanics

For nanoscale things, quantum mechanics effects become perceptible.They include superparamagnetic in magnetic materials, localized surface plasmons in certain metal

particles, and quantum confinement in semiconductor particles. Quantum dots are semiconducting nanoparticles with quantized electronic energy levels. They are typically sub-10 nm in size or less.The deep-red to black color of gold or silicon nanopowders and nanoparticle solutions is caused by quantum effects. Nanoparticle-based materials absorb solar energy significantly more efficiently than materials that are continuous sheets of thin film. It is feasible to regulate sunlight absorption in solar PV and solar thermal applications by varying the particle size, shape, and composition.

If the resonances are appropriately constructed, core-shell nanoparticles can support concurrently both electric and magnetic resonances, exhibiting completely new features as compared to bare metallic nanoparticles. A change in the emission wavelength spectrum results from the core-shell structure, which is generally present in upconverting and downconverting nanoparticles, being formed from two different metals. This structure allows for an energy exchange between the core and the shell.Plasmonic core (metal)-shell (dielectric) nanoparticles improve light absorption by increasing scattering by adding a dielectric layer. When a surface plasmon is present in front of a solar cell, the metal core-dielectric shell nanoparticle recently demonstrated negligible backward scattering with improved forward scattering on a silicon substrate.

Radiolysis

A TEM picture of Hf nanoparticles produced by inert-gas condensation and magnetron sputtering Radiation chemistry is another method for producing nanoparticles. Strongly active free radicals can be produced in solution by radiolysis from gamma rays. The amount of chemicals required by this rather easy method is little. These include water, an organic capping agent called a surfactant, a soluble metallic salt, a radical scavenger (typically a secondary alcohol), and a radical scavenger. High gamma doses of around 104 gray are necessary. Reducing radicals will lower metallic ions to the zero-valence state throughout this process. To stop the metal from being re-oxidized, a scavenger chemical will interact with oxidizing radicals preferentially. Metal atoms start to agglomerate into particles once they reach the zero-valence state. When a particle is formed, a chemical surfactant envelops it and controls its growth. The surfactant molecules remain affixed to the particle at high enough concentrations. As a result, it can't separate from other particles or group together to create clusters. By varying precursor quantities and gamma dose, radiolysis-based nanoparticle formation enables customization of particle size and shape.

CONCLUSION

The most important benefits of heterogeneous nanocatalysts are their ability to be reused and recovered in the biodiesel synthesis process. In these processes, the nanocatalyst is collected and employed once more for the production of biodiesel after each cycle. Chemical methods are commonly used to recover nanocatalysts. Heterogeneous catalysts make it simple and rapid to recover both the desired end product and byproduct from the reaction mixture. With this form of catalyst, a washing step is not necessary. Numerous advantages of nanocatalysts for the esterification process have been suggested, including quicker reaction times, shorter reaction periods, and simple and quick separation from the reaction mixture. The catalyst may be easily recovered using an external magnetic field and recovered several times without noticeably diminishing its catalytic activity and biodiesel output, according to prior experiments. Certain materials can be converted into nanoparticles by "wet" chemical methods, which involve mixing or otherwise modifying solutions of the right components to

produce an impermeable precipitate of the desired substance. By selecting the reagent concentration and solution temperature, as well as by including suitable inert agents that modify the liquid's viscosity and diffusion rate, it is possible to modify the size of the latter's particle size. The same general technique may produce other nanoscale structures of the same material, such as aerogels and other porous networks, with different parameters.

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CHAPTER 7
A SURVEY ON WASTEWATER BIOREMEDIATION USING NANOTECHNOLOGY

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Abstract
Wastewater is a contaminated sort of water that is produced by the discharge of rainwater and human activity. When there is not enough dissolved oxygen in the water, sediments also release phosphate into the water column. The production of environmentally friendly nanoparticles using nanotechnology could lower the cost incurred by businesses in the removal of such contaminants. Nanoparticles are becoming more popular due to their enhanced physiological, biochemical, and biomechanical properties. In this survey, the significance of the world's wastewater problem is examined. This survey covers the application of nanoparticles in wastewater treatment and heavy metal remediation (HMR). The advantages of using nanotechnology over conventional methods in several fields are also covered in this essay. This study attempts to compile numerous recent studies on the creation of nanoparticles and their advantages as adsorbents in the cleanup of wastewater that have been conducted thus far. In this study, which also covers recent advancements in nanotechnology-mediated remediation techniques, the promising role of nanotechnology in wastewater remediation is explored. This study looks at recent developments in nanotechnology-mediated treatment systems as well as the important potential of nanotechnology in wastewater treatment.

KEYWORDS
Business, contemned, environmentally, mediated.

INTRODUCTION

Groundwater and surface water are the most important water sources for domestic and commercial use. Agriculture uses 70% of the groundwater that is readily available. Additionally, it provides the most water for drinking. Water serves a variety of purposes in manufacturing, such as cooling, washing, refining, transporting, and dissolving, in addition to being necessary for livestock and farming. Water is also necessary to meet the hygienic requirements of a company since wastewater containing xenobiotics is discharged into surrounding rivers or sewers. Each year, a range of hazardous pollutants, including dyes, heavy metals, sludge, and other trash, are dumped directly into water systems in amounts of between 300 and 400 megatons. Around 7 lakh tonnes of various extremely carcinogenic pigments and dyes are consumed worldwide each year. Because of this, disposing of these toxic compounds without proper treatment could result in serious health issues. Heavy metals (HM) can dissolve in water and contaminate it. They are also extremely poisonous. The typical amounts of manganese in drinking water are greater than the threshold limit advised by WHO, according to information on groundwater pollution with HMs in rural regions of India in recent years. To protect the public health of vulnerable water sources, programs to measure water quality are becoming required.

Large amounts of wastewater are produced by diverse human activity in businesses, markets, agricultural areas, and regular residential activities. This pollution puts the ecosystem and human health in peril. Towns are growing overcrowded and approaching load capacity as a result of the continual increase in global population. Businesses are growing more quickly in order to meet the growing demand for social beings, which is further exacerbating the problem as they produce much more wastewater than they did previously. As a significant agro-based enterprise, the dairy industry made a significant contribution to industrially-related water contamination. In addition to micronutrients and odorous compounds, dairy wastewater contains a substantial amount of organic pollutants. Wastewater treatment techniques such as sedimentation, screening, oxygenation, filtering, and other physicochemical processes have all been thoroughly studied. However, due to limitations such incomplete treatment, higher cost, the creation of secondary pollutants, considerable solid deposition, and the use of various chemicals, biological techniques are a better option for wastewater treatment.

Phosphorus, nitrogen, and carbon are among the ingredients in wastewater that may promote the growth of undesirable species in the marine ecosystem. There are also dissolved inorganic components such salt, calcium, suspended particles, biodegradable substances, bacteria, and heavy metals. The treatment of wastewater can remedy this issue. One of the most challenging problems to resolve is HM minimization. The traditional methods used for HMR have a number of shortcomings. Organic contaminants are frequently physically removed as part of conventional cleanup techniques. Physical cleansing methods are ineffective and frequently disturb the environment. To solve the problem at hand, a successful heavy metal removal strategy is required. The alternative method for eliminating heavy metals from polluted bodies is nanotechnology. It is a developing sector that is being combined with the most widely used traditional techniques for removing HMs from wastewater. The International Organization for Standardization Technical Committee 229 (Nanotechnologies) is developing a globally accepted nomenclature and lexicon to define nanomaterials. According to nanoparticles are materials with one, two, or three external dimensions and a size between 1 and 100 nm. These compounds can react with contaminants and chemicals. They are more sensitive and therefore more effective in removing impurities because they can penetrate pollutants deeply.

The process of bioremediation involves enhancing currently occurring remedial actions that require living things to break down, change, or eliminate dangerous organic contaminants. This biological technique depends on the catabolic functions of microorganisms and their potential to aid in the decomposition of organic contaminants when they are employed as a source of sustenance and energy. Using bioremediation techniques to dispose of untreated wastewater during crop irrigation is an alternative, but their efficacy depends on a number of factors that should be taken into account when choosing a treatment that provides water of the right quality to meet plant needs. First, the characteristics of the pollutants are evaluated since these affect both their capacity for biodegradation and any potential negative consequences on the locations where pollutants must be removed. A material is considered a heavy metal if its concentration is greater than 6.0 g/cm3. HMs have a considerable biological impact on the functioning of animals and plants, but only at concentrations below the standard intake levels recommended by the WHO. In both developed and developing countries, improper heavy metal disposal is a major source of pollution. Heavy metals in wastewater are mostly produced by industrial and commercial processes. When compared to those that enter the ecosystem through man-made sources like mines, smelters, and foundries,

those that enter through natural processes like forest fires and volcanic eruptions are frequently less detrimental.

They are among the most prevalent toxins in wastewater and are dangerous to aquatic life, plants, people, and the environment. Heavy metal contamination is a result of anthropogenic activities such mining, the release of untreated industrial wastewater, and the use of pesticides and fertilizers containing heavy metals in agricultural operations. A higher concentration of heavy metals may damage cell membranes, reduce seed viability, reduce pollen grains, and have detrimental effects on the flora and fauna. They are extremely toxic and non-biodegradable in nature. The same binding sites that significant metal ions use for various cellular structures have a strong affinity for them. Destabilization results from this, and destabilization results in replication mistakes, cancer, and mutagenesis. Numerous physiological and biochemical processes are impacted by heavy metals, which also denature microorganisms in addition to harming cells by producing more free radicals. They might also reduce microorganisms' capacity for bioremediation.

The following describes the typical mechanism of heavy metal poisoning. When these substances are eaten by people, they interact with biomolecules. Due to a lack of biomolecule antioxidants, oxidative stress may arise during interactions. Reactive oxygen species (ROS) such H2O2, O2, and hydroperoxides are produced more frequently as a result. Lipid peroxidation is caused by an increase in ROS and could damage the plasma membrane. Enzymes, nucleic acids, and lipids may be harmed by ROS, which could affect regular cell function and even cause cell death. Heavy metals bind with substrates, obstructing important enzymatic reactions and changing the structure of the enzyme. Due to their adherence to the surface of cells and penetration through carriers or channels, heavy metals are also known to cause ion imbalance.

DISCUSSION

Traditional Techniques for the Treatment of Wastewater

Wastewater treatment is influenced by the economy, the environment, and the usage of time-tested sewage treatment methods. These factors are considered prior to developing any technique. Due to the difficulties of eliminating these pollutants by biological, physical, or chemical means, heavy metals require both immersion and isolation. Some of the commonly used processes today include reverse osmosis, electrodialysis, photocatalysis, membrane filtration, chemical oxidation, reduction, and precipitation, as well as ion exchange. Researchers have employed a range of methods, including conventional, microbial, plant-based, and nanomaterial-based ones, to clean wastewater that has been contaminated with heavy metals. A thorough explanation of the various methods for removing HMs from wastewater is given in Table 2. This table details all of the variations and identifies ways to enhance current water treatment methods. These methods have a number of benefits, including controllability and resistance to high concentrations of heavy metals.

In the activated sludge process, nitrogen and carbon components are oxidized utilizing suspended bacteria to provide an effect that is within regulatory standards and has minimal environmental impact. Whether chemisorption or physisorption occurs, convenience and electrostatic attraction are crucial components of polymer adsorption. The waste products created by conventional procedures are difficult to dispose of and use a lot of energy. The materials employed in these procedures could be dangerous to the environment because they come from nonrenewable resources. The high cost of physiochemical techniques prevents

them from being employed in underdeveloped and underprivileged countries. These methods reduce soil fertility as a result, making them unsuitable for agricultural use. Traditional technologies have a number of drawbacks, including high energy use, ineffective pollutant removal, and the production of toxic byproducts. The removal of HMs from wastewater may be improved by using microbial techniques in addition to physical techniques as part of a bioremediation plan.

Advanced New Methods Based on Nanoparticles for Heavy Metal Elimination

Scientific teams are also creating novel techniques and materials for the detection and elimination of certain HMs. Another application for nanocomposite or nanoparticles is the removal of harmful chemicals and pollutant substances from wastewater. For the removal of phenazopyridine, a minimal graphene-iron oxide nanocomposite adsorbent was created. With this technique, heavy metals may also be eliminated. As a result, nanomaterial technology has been applied to improve the removal of numerous hazardous substances. The ligand-dependent functional material is additionally suited for heavy metal and other pollution removal from wastewater. Each composite material that makes up the ligand-based functional material has an individual organic functional group attached to the carrier. It possesses a high degree of selectivity for metal ions and a large adsorption capacity when compared to unaltered ion exchange materials. Composite materials made of organic ligands may be utilized to extract HMs from contaminated water. The pH, identification, and reaction duration are all crucial factors in the elimination of HMs utilizing a ligand-based approach.

wastewater contaminated with petroleum products using an embeddable composite adsorbent. The composite adsorbent made of dimethylglyoxime was attached using mesoporous silica. Langmuir's adsorption isotherm equation was used to calculate the dimethylglyoxime ligand composite's adsorption capacity of 198.42 mg/g1. In a different investigation, the removal of Ni from organic ligand-based composite materials was evaluated. Tetramethyl orthosilicate, Pluronic F108, HCL, and water were used to create their mesoporous silica monoliths. The material was dried for 24 hours at 45 °C. The composite material was produced through direct 2-nitroso-1-naphthol ligand immobilization. The identification range for Ni(II) was 0.41%, which implies that increasing pH might make the ion's removal potential more effective. The maximum adsorption capacity, however, of 199.19 mg g1, was reached for the detection and eradication of Ni(II) at pH 7.

A simple composite material with organic ligands and bigger holes was made using a direct anchoring method. This ligand system was used to from the aqueous solution.The greatest adsorption capacity was found to be created a composite mesoporous silica adsorbent with a functional ligand ethoxy benzene for the detection and eradication of) from aqueous samples. Utilizing the ligand may detect concentrations as low as 0.39 g L-1 due to its amino-salicylic acid-base and capacity to detect minimum amounts The ligand's greatest adsorption capacity was 185.23 mg g1. Additionally created an organic ligand for the identification and eradication of included in inorganic-organic mesoporous composite components.The inoperative combined material can also detect pollutants in wastewater. For instance, in order to study the removal of NO2 from water samples, created porous conjugate material functionalized with a 4-nitro-1-naphthylamine ligand. The maximum amount of NO2 that this combination of elements could adsorb was. The removal of heavy metals from water sources is another possible application for these conjugates. They created a better combination of components (ligand coupled), for example, to remove cesium from water sources. They created and added acetyl dibenzo-20-crown-6-ethers into mesoporous inorganic silica to

study how pH, initial cesium concentration, and contact time affected the macrocyclic ligand. The results showed that pH 7 had the highest adsorption capacity (65.06 mg L1) and was the best. This ligand-dependent nanomaterial sensor method is a potential tool for wastewater treatment due to its high selectivity for certain heavy metals also developed a synthetic zeolite-based adsorbent to extract cesium from made-up wastewater. Zeolite adsorbent was produced through hydrothermal alteration from the molten slag of municipal wastewater sludge. At thermodynamic constants of 308 k, the cesium removal efficiency was found to be 97.36 percent. By increasing the zeolite content of bio slug through hydrothermal treatment, radioactive and heavy metals may be removed from wastewater.

Chelating agents have been used to find heavy metals in polluted water. N, N'-ethane-1,2-ions was discovered by researchers to be shared by N,N'-bis methoxybenzene sulphonamide and (ethan-1,2-diyl)bis (3,4-dimethoxybenzene sulphonamide), and chelating agents may help in the identification of certain HMs from water. An electrochemical sensor that can detect heavy metals was built using glassy carbon electrodes, silver oxide, and zinc oxide. These metal oxides were combined to make the sensor. The extraordinarily sensitive sensor, which can detect harmful substances including xanthine, 2-nitrophenol, and hydrazine, was created using the wet chemicals (coprecipitation) method. A nanorod-based sensor was developed by for the identification of 4-4-hexyl resorcinol using cobalt oxide and the combination of erbium oxides below the reduction of alkaline media. Additionally produced silver oxide nanosheets, including lanthanum oxide nanosheets, using a wet chemical method. The authors developed a glassy carbon electrode to remove 3-methoxy aniline using a Nafion glass carbon electrode that had been modified with silver oxide-lanthanum oxide nanosheets and a 5% ethanolic binder. A highly selective electrochemical sensor was produced as a result. As a result, these techniques might be used to create sensors for heavy metal detection. On the other hand, to make an incredibly sensitive HM sensor, which was then added to the carbon electrode with a binding agent, Nafion.

Using Gold-Based Nanomaterials to Remove Heavy Metals

Nanomaterials are being used in a number of applications to identify and remove heavy metals. As a nanomaterial, gold is an excellent choice for removing hazardous metals. Gold nanoparticles have been demonstrated to exhibit strong selectivity for a variety of different species and to be efficient in removing hazardous metals. Analysis was done on how different sized and shaped AuNPs affected the removal of It has been demonstrated that the reusability of AuNPs (gold nanoparticles) is impacted by their lack of surface treatment since they are inclined to clump together. The solution to this issue is to isolate them on Al2O3 surfaces. By using NaBH4 as a reducing agent for Hg2+, the adsorption capacities of AuNPs-polynanocomposite foam has a 6-fold maximal extraction capability against organic compounds in water. Gold nanomaterial adsorbents have a typical affinity for Hg2+ ions with a dispersion constant of 0.4 nM, whereas Al2O3 adsorbents have a somewhat lower dissociation constant of 53.9 nM. Mercuric compounds and several other metal ions have a strong affinity for the hybrid adsorbent made of gold nanoparticles and Al2O3. This might be because of the synergistic effect. The method is costly, effective, and dependable, and the AuNP-Al2O3 adsorbent has a mercury removal rate of about 96 percent.

Nanomaterial Based on Iron for Heavy Metal Elimination

Iron oxide encapsulated in macroporous silica nanocomposites were shown to have a high arsenic absorption capability. Over other nanoadsorbents, iron-dependent composites adsorb

47 times more. For HM ions in wastewater, iron may function as an adsorbent. Iron compounds are efficient HM adsorbents because they have large specific surface areas and high binding energies. Most iron-based nanomaterials remove HMs from wastewater through an adsorption mechanism. The maximal sorption affinity for both types of arsenic is found in nanoscale hydrated iron materials, and the required contact time is also quite brief. According to Reference magnetite derivative nanoparticles are less effective than maghemite nanomaterials at removing chromium from aqueous solutions. Because of this, there is very little interaction between chromium compounds and ions that are frequently found in water, such as sodium, magnesium, nickel, chlorine, copper, calcium, and nitrates. Investigations into the role of Fe3O4 in the removal of Pb ions from contaminated water were conducted. The highest adsorption capacity, measured at 37 mg/g, belonged to Pb. Effective arsenic removal from wastewater was demonstrated by the hydrothermal application of Fe3O4 superparamagnetic nanoparticles coated with ascorbic acid had a higher adsorption capacity of 16.57 mg/g, but As had a higher adsorption capacity of 47.06 mg/g According to analysis Fe3O4 has a greater adsorption capacity of 84 mg/g for Pb ions. Because of the coprecipitation method, metal oxide NPs have a less magnetic behavior, making them simple to separate with magnetic fields. Using a magnetic Fe3O4 nanocomposite wrapped in a Fe-Ti bimetallic oxide, fluoride was removed from the water supply. The coprecipitation method was used to create nanoparticles, and it was discovered that these nanomaterials had a maximum adsorption capability of 58.23 mg/g.

Silver-Based Nanomaterial for the Removal of Heavy Metals

Numerous studies have shown that heavy metals can be removed using nanomaterials. There are numerous studies in the literature that show how contaminants like mercury, cadmium, and chromium react with nanomaterials. A study described the use of silver nanoparticles containing mercaptosuccinic acid and helped by enabling alumina for the removal of mercury ions from polluted waterways. It was shown that silver nanoparticles were more effective at absorbing mercuric ions. Reference used silver-supported nano mesoporous silica to remove mercury ions from wastewater and found the material to be efficient at doing so. Another study suggested using Ficus benjamina leaf extract to produce zero-valent Ag nanoparticles for effective cadmium removal. The removal efficiency increases as the amount of nanomaterials increases. The authors there also created Ag nanoparticles from Piliostigma thonningii leaf extract and assessed its capacity for removing heavy metals from lab effluent. Reference discussed the effectiveness of cotton infused with nanoparticles in the removal of Hg, Ni, and Cr ions from contaminated wastewater and found that mercuric ions had the greatest ability for adsorption on nanomaterial surfaces. The authors there demonstrated how to create chromium-removing nanomaterials from the gums of Azadirachta indica, Araucaria heterophylla, and Prosopis chilensis. Similar Ag nanomaterial production methods using Prosopis julifora leaf extract and chitosan coating were used in that other investigation. Chitosan-enclosed nanoparticles were discovered to have an 82 percent absorption of copper ions.

Nanomaterial Based on Titanium for Heavy Metal Elimination

TiO2 has a wide range of uses in the industry, ranging from cosmetics to the treatment of heavy metals, because of its stability and safety. It also has a steady recombination process and excellent crystallinity with a low bandgap, making it ideal for bioremediation. According to study, TiO2 has an adsorption capacity of 158 mg/g and may also remove lead particles. According to studies, the adsorption capacity of ti for copper, lead, and arsenic was increased

when the pH level was raised. The introduction of mesoporous hybrid particles including ZnO and TiO2 increased the surface area while minimizing the overall cost of the adsorption mechanism due to the nanosorbent's ability to be recycled up to three times due to its reduced shape. TiO2 may destroy or lessen the pollutant by a photocatalytic process rather than just decreasing, trapping, or isolating it. Many young researchers are interested in using TiO2 as a light-responsive component to clean dirty wastewater. It might release potential free radicals when exposed to light, which could reduce the amount of HM ions and degrade a variety of organic contaminants.

Heavy Metal Elimination Using Cerium-Based Nanomaterial

CeO2-CNTs can eliminate arsenic anions, and arsenic-loaded CeO2-CNTs can be quickly and efficiently produced, as per research. At a normal pH limit, CeO2 nanomaterials may effectively eliminate chromium ions from water. Dispersed cerium oxide nanomaterials maintained with hexamethylenetetramine were used to eliminate chromium (VI) from contaminated water and it was indicated that they might also be used to treat wastewater. As per the research, CeO2 nanomaterials had a greater Pb (II) elimination efficiency than Fe3O4 and TiO2. CeO2 has the disadvantage of enhanced phytotoxicity; however, TiO2 and Fe3O4 NPs have no such toxicity. In research, cerium oxide nanomaterials were utilized as nano adsorbents in both single-component and multicomponent aqueous solutions to effectively remove lead, cadmium, and chromium from aqueous solutions. The adsorption capability of lead was not affected by pH, although Cd and Cr were damaged. The greatest adsorption capabilities were 94.4 mg for cadmium at pH 7.1, 129.1 mg for the lead at pH 5.1, and 35.4 mg for chromium at pH 5.

CONCLUSION

Nanomaterials are incredibly tiny molecules that exhibit quantum effects by collectively grouping their electrons. They have a range of distinct and noticeable traits because of their size. These have uses in a variety of industries, including biology, electronics, catalysis, and photonics. In contrast to bulk materials, nanomaterials can have a wide range of characteristics, allowing us to create new materials with a variety of industrial applications. Nanoparticles can increase the effectiveness of wastewater treatment by using a single-stage process that can eliminate a variety of toxins found in polluted water. Nanomaterials are used in wastewater treatment as adsorbents. Numerous studies have found that the structural properties of nanomaterials, such as their high selectivity and adsorption capacity, make them effective at removing heavy metal ions from wastewater at low concentrations. These have a high surface area to volume ratio, making them good for the adsorption of hazardous chemicals or other contaminants. Nanoparticles have improved reactivity, made spaces easier to access, and more effectively removed hazardous metals. Recent research are concentrating on the potential use of particles including nanocomposite, carbon nanotubes, nanofibers, nanospheres, and nanowires in combination with conventional wastewater treatment approaches to help remove various organic and inorganic contaminants, particularly heavy metals. The diffusion capacity of nanoadsorbents is influenced by the quantity of heavy metals available as well as the accessible exterior surface region. Diffusion on the adsorbent's outer surface occurs after dispersion on its pores. The qualities of nanoadsorbents are influenced by the adsorbent size, shape, grouping condition, surface chemistry and fractal dimensions, solubility, and crystal structure. Like bulk materials, nanoparticles allow for atomic-level alterations, which will allow for a variety of novel features that aren't possible with bulk materials.

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CHAPTER 8
GREEN NANOPARTICLE SYNTHESIS MEDIATED BY HONEY A NEW ERA IN SAFE NANOTECHNOLOGY

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ABSTRACT
Since the development of nanotechnology, numerous linked sectors have grown quickly. The two main methods for creating nanoparticles are top-down and bottom-up procedures; the majority of them call for high temperatures, vacuum conditions, and harsh/toxic chemicals. As a result, unfavorable impacts have an impact on species, including people. Certain synthesis techniques are pricy and time-consuming. The notion of "green nanotechnology" thus evolved as a result of the green synthesis of nanoparticles, which marked the beginning of a new era in nanotechnology. This entails creating nanomaterial from biological components such as microbes, macroorganisms, and other biological materials. The oldest known food source in the world, honey has extraordinary medicinal, chemical, physical, and pharmacological benefits. A relatively new technique called honey-mediated green synthesis has been employed in recent years to create gold, silver, carbon, platinum, and palladium nanoparticles. Honey serves as a stabilizing, reducing, and, most critically, a precursor in the creation of nanoparticles. This process typically needs room temperature and doesn't generate any harmful byproducts. Finally, honey-mediated green synthesis of nanoparticles offers a straightforward, economical, reproducible, quick, safe way. Due to the unique properties of honey-functionalized nanoparticles, useful final products with a wide range of applications in various industries may be produced.

KEYWORDS
Applications, development, product, nanometerial.

INTRODUCTION

Nanomaterials have gained popularity as promising products in a variety of industries over the past ten years, including biomedical, food and feed, drug-gene delivery, environment, health, mechanics, and optics. They have also found use in catalysis, light emitters, single electron transistors, nonlinear optical devices, and photoelectrochemical applications.Physicist Richard Feynman introduced the concept of nanotechnology for the first time in 1959. Understanding, controlling, and working with matter at the atomic and molecular level is called nanotechnology. The Greek word nannos is where the prefix nano comes from. A particle must have at least one dimension that is less than 100 nm in order to be considered a nanotechnology object. Recent studies have shown that the phases, sizes, and morphologies of nanoparticles affect their characteristics and prospective uses. Thus, the controlled synthesis of novel nanomaterial morphologies has drawn a lot of interest.

Top-down or bottom-up techniques can be used to synthesize nanoparticles When using a top-down strategy, big structures are broken down into smaller ones. Among the most often used top-down approaches are physical techniques including lithography, laser ablation sputtering deposition pulsed electrochemical etching, and vapor deposition. Atom by atom, molecule by molecule, or cluster by cluster, material is synthesized using bottom-up techniques such sol-gel processing chemical vapor deposition, plasma or flame spraying

synthesis laser pyrolysis and microemulsion. Different chemical and physical techniques for creating nanoparticlesThe majority of them typically demand physical conditions like high temperatures, vacuum conditions, and expensive equipment in addition to toxic and harsh chemical additions like dimethyl formamide, hydrazine, and sodium borohydride. Due to the high surface charge and high surface area of nanoparticles, harsh chemicals may stay adsorbed onto nanoparticles, resulting in poisonous and harsh compounds that may pose biological dangers to the environment. These compounds may have negative impacts on a variety of trophic level creatures, including microbes, plants, invertebrates, and vertebrates, including humans. Optimizing green processes for nanoparticle manufacturing is crucial. Green nanotechnology is the application of nanotechnology to improve the sustainability of processes that have harmful environmental effects. It also refers to the usage of nanotechnology-related products to improve sustainability. It involves developing eco-friendly nanoproducts and utilizing nanoproducts to advance sustainability.

In the term "Green Nanotechnology," the word "GREEN" has two distinct meanings. On the one hand, it highlights the environmentally friendly technology used to create nanoscale particles, while on the other, it relates to the creation of nanoparticles facilitated by chlorophyll plant extracts. The development of clean technologies "to minimize potential environmental and human health risks associated with the manufacture and use of nanotechnology products" has been referred to as "green nanotechnology." Additionally, it promotes the substitution of current products with new nanoproducts that, during their whole existence, are more environmentally friendly.Green nanotechnology aims to create nanomaterials and products that don't affect the environment or people's health, as well as nano-products that solve environmental issues. In order to create nanomaterials and nano-products without harmful components, at low temperatures, using less energy and renewable inputs when possible, and using lifecycle thinking in all design and engineering stages, it uses current ideas of green chemistry and green engineering.

Green nanotechnology refers to using nanotechnology to make present manufacturing processes for non-nano materials and products more environmentally friendly in addition to creating nanomaterials and products with less of an environmental impact. Nanoscale membranes, for instance, can assist in separating desired chemical reaction products from plant waste. Chemical reactions can be improved and used less wastefully with the help of nanoscale catalysts. When used in conjunction with nano-enabled information systems, nanoscale sensors can be a component of process control systems. Another approach to "green" industrial procedures is to use alternative energy sources, which nanotechnology has made possible.The creation of products that either directly or indirectly help the environment is the second objective of green nanotechnology.

Directly treating pollutants, desalinating water, cleaning hazardous waste sites, or sensing and monitoring environmental contaminants are all possible with nanomaterials or goods. Indirectly, self-cleaning nanoscale surface coatings could reduce or eliminate many cleaning chemicals used in routine maintenance routines; lightweight nanocomposites for cars and other forms of transportation could save fuel and reduce materials used for production; fuel cells and light-emitting diodes (LEDs) powered by nanotechnology could reduce pollution from energy generation and help conserve fossil fuels; and improved battery life could result in less material consumption. By taking a comprehensive systems approach to nanomaterials and products, green nanotechnology makes sure that unanticipated effects are minimized and impacts are anticipated across the whole life cycle. Nanomaterials are being studied for

applications such as more effective solar cells, viable fuel cells, and ecologically friendly batteries. The most cutting-edge energy-related nanotechnology projects include energy storage, conversion, manufacturing improvements through lower material and process rates, energy savings (for example, through improved thermal insulation), and improved renewable energy sources.

The advancement of nanotechnology in solar cells is one of the key initiatives now under development Solar energy is a renewable resource, and solar cells are becoming more effective as they become smaller. Solar energy is less expensive per watt than one dollar.In order to produce solar cells that are more affordable and effective than those made of traditional planar silicon, research is being done to utilise nanowires and other nanostructured materials.Another illustration is the usage of hydrogen-powered fuel cells, which may employ a catalyst made of carbon-supported noble metal particles having a diameter of 1–5 nm. Materials having pores as small as a nanometer could be used to store hydrogen. In batteries, where the use of nanomaterials may enable batteries with larger energy content or supercapacitors with a better rate of recharging, nanotechnology may also find applications.

Photovoltaic (PV) and solar thermal panels already have higher performance coatings because to nanotechnology. Solar panels are more effective when they combine hydrophobic and self-cleaning qualities, particularly in bad weather. To retain optimal energy efficiency, PV coated with nanotechnology is supposed to stay cleaner for a longer period of time. For the treatment of surface water, groundwater, wastewater, and other environmental resources contaminated by harmful metal ions, organic and inorganic solutes, and microbes, nanotechnology holds the promise of innovative nanomaterials. Many nanomaterials are actively being researched and developed for application in the treatment of water and contaminated areas due to their special activity against resistant pollutants.The reverse osmosis (RO), nanofiltration, and ultrafiltration membranes are the current market leaders in nanotech-based water treatment technologies. Nanofiber filters, carbon nanotubes, and other nanoparticles are examples of new products.Bacteria, viruses, and heavy metals are just a few of the contaminants that nanotechnology is projected to handle more effectively than convectional water treatment technologies. This effectiveness typically results from the relatively high specific surface area of nanomaterials, which boosts pollutant sorption, dissolution, and reactivity.

DISCUSSION

environmental cleanup

The use of nanoparticles in environmental remediation is known as nano remediation. With extra substantial study in wastewater treatment, groundwater treatment has seen the most widespread usage of nano remediation Cleanup of soil and sediment has also been tested using nano remediation. The potential for using nanoparticles to filter out harmful substances from gases is being explored in even more exploratory studies.At large-scale cleanup locations, some nano remediation techniques have been used, particularly the usage of nano zerovalent iron for groundwater cleanup. Nano remediation is a young sector; by 2009, at least 44 cleanup sites around the world, mainly in the United States, had used nano remediation technology. A nanoparticle agent must come into touch with the target contaminant during nano remediation under circumstances that permit a detoxifying or immobilizing reaction. In situ application or a pump-and-treat procedure are frequently used in this method. There are yet undiscovered methodsBuckminsterfullerene may have the

ability to control certain chemical reactions, thus scientists have been investigating its potential for reducing pollution. It has been shown that buckminsterfullerene can trigger the protection of reactive oxygen species and cause lipid peroxidation. This substance might make hydrogen fuel more readily available to customers.

Filtration of water

In order to soften (remove polyvalent cations) and remove disinfection by-product precursors like natural and synthetic organic matter, nanofiltration is a relatively new membrane filtration technique. It is most frequently used with low total dissolved solids water, such as surface water and fresh groundwater. For simultaneous concentration and partial (monovalent ion) demineralization in food processing applications like dairy, nanofiltration is also becoming increasingly popular.Nanofiltration is a membrane-based filtration technique that makes use of cylindrical through-pores that are smaller than a nanometer and pass through the membrane at a 90° angle. Pore diameters on nanofiltration membranes range from 1 to 10 Angstrom, making them slightly larger than reverse osmosis membranes but smaller than those used in microfiltration and ultrafiltration. The most common material used to make membranes is thin polymer films. Metals like aluminum or polyethylene terephthalate are examples of materials that are frequently used.

High energy particles are shot at the polymer thin layer during "tracking". As a result, the membrane develops tracks that are chemically "etched" into the membrane, which are the holes. A thin coating of aluminum oxide is electrochemically grown from aluminum metal in an acidic solution to build metal-based membranes, such as alumina membranes.There are already some nanotechnology-based water treatment products on the market, and more are being developed. In a recent study, it was established that low-cost nanostructured separation membrane techniques may successfully produce drinkable water.

Nanotechnology to purify water

Nanotechnology offers an alternate method for removing germs from water, a problem that has gotten worse as a result of population growth, increased demand for clean water, and the appearance of new pollutants. antibacterial nanotechnology, one of the options put up, claimed that a number of nanomaterials exhibited potent antibacterial effects through various processes, such as photocatalytic generation of reactive oxygen species that harm viruses and cell components. Another example is the oligodynamic disinfection produced by synthetically created nanometallic particles, which can inactivate germs at low concentrations. Studies reveal that commercial titanium oxide photocatalysis-based purification systems are presently in use, and that when activated by sunlight, they can completely inactivate fecal coliforms in under 15 minutes.Dendrimers, zeolites, carbonaceous nanomaterials, and metals with nanoparticles are the four kinds of nanomaterials used for water purification. The advantages of shrinking metals such silver, copper, titanium, and cobalt to the nanoscale, including improved contact efficiency, surface area, and elution characteristics.

Removing oil spills

Each year, the U.S. Environmental Protection Agency (EPA) records more than 10,000 oil spills. Oil spills are typically cleaned up using biological, dispersing, and gelling agents. Although these approaches have been employed for many years, none of them can restore the priceless lost oil. Nanowires, on the other hand, can quickly clean up oil spills and also

recover as much oil as they can. These nanowires combine to create a mesh that repels water with a covering while absorbing hydrophobic liquids up to twenty times their weight. The oil can be boiled off the nanowires and both the oil and the nanowires can be reused because the potassium manganese oxide is extremely stable even at high temperaturesNine refineries and more than thirty oil platforms were damaged or destroyed by Hurricane Katrina in 2005. In order to clean up the oil spilt by the damaged oil platforms and refineries, the Interface Science Corporation successfully introduced a novel oil remediation and recovery application.

Controlling air pollution

Nanotechnology is actively enhancing air quality in addition to water treatment and environmental restoration. Nanoparticles can be created to accelerate or speed up the reaction that turns harmful gases into beneficial ones for the environment. For instance, to filter hazardous organic chemicals in the smoke, many industrial facilities that emit huge amounts of harmful gases use a form of nanofiber catalyst consisting of magnesium oxide (Mg2O). The gaseous vapors from autos already contain chemical catalysts, but nanotechnology has a better chance of reacting with the dangerous materials in the vapors. The fact that nanotechnology can interact with more particles due to its larger surface area accounts for this higher chance.

Due of its large surface area, nanotechnology has been utilized to reduce air pollution, particularly that from automobile exhaust and possibly greenhouse gases. According to study by the Environmental Science Pollution study International, carbon-based nanoparticles, greenhouse gases, and volatile organic compounds can all be precisely treated with nanotechnology. Additionally, efforts are being made to create metal oxide nanoparticles, phytoremediation process amendment agents, and antimicrobial nanoparticles. Due to its incredibly small scale, nanotechnology can also offer the prospect of preventing air pollution in the first place. Many industrial and residential areas, including ventilation control, breath alcohol detectors, fire and poisonous gas detectors, and many more, have accepted nanotechnology as a tool. According to some sources, nanotechnology has the potential to improve the methods for sensing and detecting contaminants.

The huge surface area and high surface energy of nanoparticles will enhance the ability to sense contaminants and undesired items. Around 7 million fatalities were attributed to air pollution in 2012, the World Health Organization reported in 2014. This innovative technology may be a key tool in combating the disease. Nanoadsorbents, degradation by nanocatalysis, and filtration/separation by nanofilters are the three methods that nanotechnology is being used to remediate air pollution. The primary solution for many air pollution issues is nanoscale adsorbents. Due to the nature of these materials, they may interact with organic compounds very well while also exhibiting greater selectivity and stability at their maximal adsorption capacity. High strength, high hardness, and high electrical and thermal conductivities are further benefits. The following pollutants are among those that nanomolecules can target:

Particles are selectively removed by carbon nanotubes in numerous ways. One way is to transport the molecules via nanotubes, where they are oxidized and subsequently adsorbed on a nitrate species. At low temperatures of 20° to 100° Celsius, carbon nanotubes containing amine groups offer a large number of chemical sites for carbon dioxide adsorption. Molecules are drawn onto surface functional groups by van der Waals forces and - interactions. A result

of fullerene's strong adsorption ability, carbon dioxide pollution can be eliminated. Functional groups in graphene nanotubes can adsorb gases. There are numerous nanocatalysts that can be utilized to improve the quality and reduce air pollution. TiO2, Vanadium, Platinum, Palladium, Rhodium, and Silver are a few of these materials. Some of the main applications for these nanomaterials are air purification, reduction of catalytic industrial emissions, and reduction of vehicle exhaust. While certain programs are less common, others are more well-liked. Indoor air pollution is a relatively new problem, but because of issues with its health impacts, it is being developed more effectively. Diesel-powered cars are currently one of the more well-liked applications for reducing vehicle exhaust emissions. Reducing industrial emissions is another common practice. It is a crucial technique, particularly at refineries and coal-fired power plants. SEM imaging is used to examine and evaluate these procedures to make sure they are accurate and useful.

Additionally, studies are being done to see if methane or carbon dioxide, which have been proven to harm the ozone layer, can be separated from car exhaust using nanoparticles. In fact, John Zhu, a professor at the University of Queensland, is investigating the development of a carbon nanotube (CNT) that has the potential to trap greenhouse gases in a way that is hundreds of times more effective than the technologies currently in use.

Honey's Chemical Composition

Since ancient times, honey has been considered one of the healthiest food sources. It contains 80–85% carbohydrates mostly glucose and fructose, 15–17% water, 0.1-0.4% protein, 0.2% ash, and trace amounts of vitamins, amino acids, enzymes, and other compounds including phenolic antioxidants. The specific chemical makeup and physical characteristics of natural honey, however, vary depending on the plant species that the bees foraged on as well as variations in climate circumstances and vegetation The two main sugars in honey, glucose and fructose, account for between 85 and 95 percent of the total sugars and are easily absorbed in the gastrointestinal tract. Disaccharides such as maltose, sucrose, isomaltose, are examples of additional sugars. There are also a few oligosaccharides present. Four to five percent of honey contains fructooligosaccharides, which are probiotic agents.

Protein levels in honey range from 0.1% to 0.5%, and they considerably depend on the kind and country of origin . The vitamins C, B1 (thiamine), and B2 complex, which include riboflavin, nicotinic acid, B6, and pantothenic acid, are also abundant in natural honey Nearly all natural honey varieties contain antioxidant enzymes like ascorbic acid, tocopherols, catalase (CAT), superoxide dismutase (SOD), and reduced glutathione (GSH), as well as flavonoids like apigenin, pinocembrin, kaempferol, quercetin, galangin, chrysin, and hesperetin.

Mineral compounds can be found in concentrations of 0.1% to 1.0%. The main metal is potassium, followed by the following elements: calcium, magnesium, sodium, sulphur, and phosphorus. Iron, copper, zinc, and manganese are examples of trace elementsThe main enzymes in honey are invertase (saccharase), diastase (amylase), and glucose oxidase. Other major enzymes are oxidase, invertase, amylase, and catalase. Dextrin and maltose are produced from long starch chains by the activity of amylase enzyme. Each of these minor constituents is known to have distinctive nutritional or medicinal properties and the unique blend accounts for the varied and different applications of natural honey.

CONCLUSION

Honey served as a reducing and stabilizing agent when Bar and colleagues used it to create silver nanoparticles at room temperature. Thus, it took the place of previously utilized poisonous and harsh reducing agents including sodium borohydride, hydrazine, and dimethyl formamide. Without a stabilizer, synthesized nanoparticles remained stable for five months. The concentration of honey used and the pH had an impact on the size and shape of the silver nanoparticles, with a decreasing relationship between pH and particle size. The size of the silver nanoparticles was in the rangewhen 10 g of honey was used, but the size further decreased range with increased honey concentration up to 40 g, according to scanning electron microscopy (SEM) studies.

Honey was used as a reducing and stabilizing agent in a sunlight-mediated approach for the synthesis of Ag nanoparticles. These honey-capped silver nanoparticles worked well as mild steel corrosion inhibitors and were stable for more than six months at room temperature. While fructose served as the reducing agent, it appeared that the proteins in honey served as the capping agent that stabilized the nanoparticles.At pH 8.5 and room temperature, 4 nm-sized, almost spherical, and monodispersed silver nanoparticles were created. Using honey as a reducing and stabilizing agent, the pH of the solution was adjusted to create the desired silver nanoparticles in a range of sizes. High crystalline and face-cantered cubic structure was revealed by TEM and X-ray diffraction (XRD) examinations. XRD patterns were consistent.

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CHAPTER 9
CURCUMIN FOR TREATMENT OF DIFFERENT DISEASES USING NANOTECHNOLOGY

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ABSTRACT
Turmeric, a spice used in cooking and as a herbal treatment, contains the lipophilic chemical curcumin. It is utilized by many people to cure a variety of ailments. Curcumin has a poor bioavailability due to poor absorption, quick metabolism, and rapid systemic clearance, according to recent studies. Using curcumin as a drug delivery system, nanotechnology has the potential to revolutionize the way we treat diseases. Recent studies have revealed a number of methods to boost curcumin's plasma levels, increase its bioavailability, and raise its cellular permeability. It has been discovered that a variety of nanoparticle forms are suitable for encasing or loading curcumin to enhance its therapeutic effects in various disorders. One of the practical alternatives that has been demonstrated to provide therapeutic doses of curcumin is the use of nanoparticles such liposomes, polymeric nanoparticles, micelles, nanogels, noisome, cyclodextrins, dendrimers, silvers, and solid lipids. This review demonstrates that the therapeutic benefits of curcumin may be somewhat enhanced by the presence of nanotechnology. The evidence board that is being provided concentrates on the beneficial unique effects of curcumin on various ailments and recommends it for upcoming clinical investigations in the field of these disorders.

KEYWORDS
Contains, chemical, demonstrated, investigations.

INTRODUCTION

The lipophilic compound curcumin, dione, easily penetrates cell membranes. The typical extract of Curcuma longa L. contains the curcumin compounds I to III desmethoxycurcumin II, 20%, and bisdemethoxycurcumin Turmeric is a nutritional spice and herbal medicine. Its active component is curcumin. It has a long history of use in China, India, and Iran by a variety of people to treat a wide range of illnesses, including cancer, rheumatoid, infectious, and diabetes diseases, as well as digestive disorders like indigestion, dyspepsia, flatulence, and gastric and duodenal ulcer Due to curcumin's numerous therapeutic properties on various ailments, many researchers have studied it. Curcumin has recently gained interest primarily as a result of its purported antioxidant, anti-inflammatory, antitumoral, apoptosis-inducing, and antiangiogenesis activities in numerous studies. This agent can carry out different functions since it works on various targets in cellular pathways. Researchers have a great target for investigations on the structure-activity relationship and lead optimization thanks to curcumin's straightforward chemical structure and the relative density of its functional groups. According to reports, the structural analogues of curcumin have a peak plasma half-life and increase the rate of absorption. Recent studies have looked at curcumin as a potential lead chemical for developing new chemotherapy drugs for the treatment of cancers, such as colon and prostate tumors, as well as other diseases that call for chemotherapy. Although curcumin is surprisingly well tolerated, it has a low bioavailability. Even at high dosages, it does not seem to be dangerous to people or animal. Curcumin has a poor bioavailability due

to poor absorption, quick metabolism, and rapid systemic elimination, according to recent research although complete pharmacokinetic data are still lacking. Yang et al.'s study found that oral treatment of curcumin to rats had a 1% bioavailability. According to research on the elimination of curcumin in rats, after oral treatment of 1 g/kg of curcumin, more than 75% was eliminated in feces and barely any curcumin was found in urine. Furthermore, the FDA has deemed curcumin to be "generally safe." Although curcumin has been determined to be fairly safe in both animals and people and has a wide range of beneficial pharmacological effects, certain investigations have raised concerns about its toxicity. Despite these benefits, curcumin has poor water solubility, which leads to solubility-limited bioavailability and places it in the biopharmaceutics classification system's class II of drugs. Additionally, roughly 60% to 70% of an oral dose of curcumin is excreted due to its quick intestinal and hepatic metabolism.

Curcumin has been shown to be useful in treating a variety of ailments with little toxicity to humans and animals, as was indicated above. Even at very high doses, it is extremely safe when taken orally, but its use is restricted because of its poor bioavailability, instability, low solubility, and quick metabolism and degradation. Over the past three decades, numerous studies have focused on finding solutions to these issues. Numerous analogues of curcumin have been introduced and tested in an effort to assess their activities against recognized biological targets as well as to improve their bioavailability, selectivity, and stability since it was shown that curcumin has poor bioavailability and selectivity. Additionally, a number of methods were developed to boost curcumin's cellular permeability, plasma concentration, bioavailability, and resistance to metabolic processes. Curcumin appeared to have longer circulation, better permeability, and more resistance to metabolic processes when delivered via nanoparticles. Nanotubes can aid in the treatment of cancer. They have been demonstrated to be potent tumor destroyers in patients with breast or renal cancer. A particular kind of laser that emits near-infrared light for around 30 seconds is used to treat multi-walled nanotubes put into a tumor. The laser causes these nanotubes to vibrate, which produces heat. The tumor cells start to die once it has been sufficiently heated. These kinds of procedures have the potential to reduce kidney cancers by up to 45%.

In space, where there is more light than is practical to deal with, ultrablack materials constructed of "forests" of carbon nanotubes are crucial. To cut down on light and capture more detailed images, ultrablack material can be used to camera and telescope systems.Cardiovascular disease treatment with nanotubes appears promising. They can be crucial in cleaning the blood vessels. Theoretically, macrophages would be instructed to remove plaque from blood arteries by nanotubes with SHP1i molecules attached to them without harming healthy tissue. In studies using mice with severe plaque buildup, researchers evaluated this kind of modified nanotube; the treated mice displayed statistically significant decreases in plaque buildup when compared to the mice in the placebo group. Before this medication may be administered to humans, more research is required.

Future soldiers' body armor might incorporate nanotubes. The body of a soldier would be shielded from bullets and electromagnetic radiation by this sort of armor, which would be extremely durable and effective. Additionally, it's conceivable that the nanotubes in the armor may help monitor the health of the soldiers. The ability of nanotechnology to view and manipulate the material world at a nanoscopic level can hold significant promise for the advancement of construction. Construction materials including cement, steel, wood, and glass can all benefit from nanotechnology's increased strength and tensile

durability.Nanotechnology can be used to give materials a variety of new features. A new generation of materials with characteristics such as water resistance, self-cleaning property, wear resistance, and corrosion protection are produced as a result of the discovery of a highly ordered crystal nanostructure of amorphous C-S-H gel and the application of photocatalyst and coating technology. High-strength fibers with extraordinary energy absorption capabilities and superplasticizers for concrete are two examples of the latest nanoengineered polymers.

According to experts, nanotechnology is still in the exploration phase but has the potential to improve common materials like steel. The development of novel materials with extended qualities, such as electrical conductivity as well as temperature-, moisture-, and stress-sensing capabilities, may result from understanding the composite nanostructures of such materials and from studying the various applications of nanomaterials.Nanomaterials are more expensive than conventional materials due to the complexity of the equipment, hence it is unlikely that they will be used as high-volume building materials.Nanotechnology occasionally enables the cost-reduction of complex issues. However, the conventional approach to construction is still generally more economical. The cost of incorporating nanotechnology into building has been falling over time and is projected to continue to do so as manufacturing technologies advance.

DISCUSSION

Curcumin Nanotechnology Approaches

The future of technology is increasingly seen as being in nanotechnology. One of the many uses for nanotechnology is the use of nanoparticles in medication delivery systems to increase the bioavailability and solubility of lipophilic drugs like curcumin. Due to their ability to protect drugs from enzymatic degradation, provide for their controlled release and prolonged blood circulation, change their pharmacokinetics, reduce their toxicity, and restrict their nonspecific uptake, the use of nanoparticles has become extremely popular over the past ten years. Numerous efforts have been made over time to improve the biodistribution of natural curcumin, but it hasn't been until lately that the use of nanotechnology has significantly improved its therapeutic properties. One of the practical alternatives that has been demonstrated to provide therapeutic doses of curcumin is the use of nanoparticles such liposomes, polymeric nanoparticles, micelles, nanogels, niosomes, cyclodextrins, dendrimers, silvers, and solid lipids. The main curcumin issues of low solubility, instability, poor bioavailability, and quick metabolism in malignancies, wound healing, Alzheimer's disease, epilepsy, ischemic disorders, inflammatory diseases, and other conditions have been improved by the employment of the aforementioned nanoparticle.

Nanobiotechnology

The concepts, methods, and sciences of biology and nanotechnology are combined under the titles nanobiotechnology and bio nanotechnology. More specifically, bio nanotechnology refers to the use of biological elements in nanotechnology, whereas nanobiotechnology refers to the application of nanoscale items for biotechnology.The topic of nanomedicine, where the use of nanoparticles and nanodevices has many clinical applications in the delivery of therapeutic medications, monitoring of health states, and disease diagnosis, is where nanotechnology and biology most prominently converge. The small size of nanomaterials makes it possible for them to be employed as tools that may easily circulate within the body and directly interact with intercellular and even intracellular settings because many biological

processes in the human body take place at the cellular level. Additionally, due to their small size, nanomaterials can have physiochemical properties that are distinct from those of their bulk form allowing for a range of chemical reactivities and diffusion effects that can be researched and altered for a variety of applications.

Nanoparticles holding medications for the treatment of disease are injected into the body and function as delivery systems for the medications, which is a popular application of nanomedicine. By modifying the nanoparticle vessels' size, shape, surface charge, and surface attachments (proteins, coatings, polymers, etc, which can be formed of organic or synthetic materials, the nanoparticle vessels can be further functionalized When targeting parts of the body with specific physiochemical characteristics that prevent the intended drug from reaching the targeted area alone, such as the brain, the possibility of functionalizing nanoparticles in such ways is especially advantageous. For instance, some nanoparticles are able to bypass the Blood Brain Barrier to deliver therapeutic drugs to the brain. Recently, vaccinations and cancer therapies have both incorporated nanoparticles.Nanoparticles can be employed as contrast agents in popular imaging procedures including computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET), which makes in vivo imaging an important component of nanomedicine. It is possible to research pharmacokinetics or visually diagnose diseases using nanoparticles' capacity to locate and circulate in particular cells, tissues, or organs. This capability can produce high contrast and higher sensitivity imaging.

Liposomes

Liposomes are artificial, globular vesicles that can be created from phospholipids found in nature. They have a spherical shape with an exterior lipid bilayer encircling a center aqueous region, and they are self-assembling closed colloidal constructs made of lipid bilayers. According to Table 1, the liposome diameter ranges from 25 nm to 2.5 mm. They are said to serve as medication transporters and immunological adjuvants. Drugs having a wide range of solubility or lipophilicity can be contained in liposomes, either at the bilayer interface or in the aqueous core of the phospholipid bilayer. Additionally, they may entrap virtually any medication, regardless of its solubility, and deliver medicines into cells via fusion or endocytosis. Rahman et al. created cyclodextrin-curcumin inclusion complexes that separately encapsulated natural curcumin and the complexes into liposomes in order to increase the solubility of curcumin in this regard.

In vitro cell culture experiments showed that curcumin-containing formulations all effectively inhibited cell growth. In a different study, Shi et al. created a water-soluble liposomal form of curcumin to test the preventative effects of curcumin on lung fibrosis in mice administered intravenously using the ELISA method. According to the results, liposomal curcumin can successfully reduce radiation pneumonitis and lung fibrosis while also making LL/2 cells more sensitive to radiation. These findings imply that systemic delivery of liposomal curcumin with improved solubility is risk-free and merits further study for potential clinical applications. According to certain research, liposome-encapsulated medications are predicted to be delivered without undergoing rapid deterioration, have the fewest negative effects, and exhibit greater signs of stability in their receivers. In this regard, Matabudul et al. questioned whether different durations of intravenous Lipocurc infusions can affect curcumin metabolism and its tissue distribution and whether treating necropsied tissues of Beagle dogs with phosphoric acid can stabilize the compounds and allow for accurate analytical measurements of curcumin and its metabolite.

The results showed that the addition of liposomes might inhibit or saturate a putative reductase enzyme that stabilizes the levels of curcumin by converting it to tetrahydrocurcumin. Tetrahydrocurcumin raised concerns about tissue-specific curcumin and tetrahydrocurcumin stability through a transporter-dependent mechanism that increased tissue concentrations of curcumin in some tissues (lung, spleen, and liver), but not all of the examined tissues (lung, spleen, liver, pancreas, kidney, and urinary bladder). Additionally, Karewicz et al. banded curcumin to egg yolk phosphatidylcholine, dihexadecyl phosphate, and cholesterol in order to better understand the mechanisms by which curcumin interacts with lipid membranes and to increase the stability of curcumin. They then used absorption and fluorescence techniques to determine the curcumin binding constant to liposomes. The egg yolk phosphate system stabilized the system appropriately to its content.

The most promising delivery method for curcumin appears to be the liposome, which has a three-component lipid structure. Furthermore, utilizing Langmuir balance measurements, the interactions of free and liposomal curcumin with egg yolk phosphatidylcholine and mixed monolayers were also investigated. On egg yolk phosphatidylcholine and egg yolk phosphate monolayers, curcumin had while it had a loosening effect on egg yolk phosphatidylcholine monolayers. Additionally, it was shown that curcumin-loaded egg yolk phosphatidylcholine liposomes interact with the model lipid membrane more steadily than their unloaded counterparts. The effects of several liposomal formulations on the stability of curcumin in phosphate buffered saline, human blood, plasma, and culture medium were examined in a different study by Chen et al.

When compared to free curcumin in phosphate buffered saline (PBS), liposomal curcumin had greater stability. Both lipid-bound and free curcumin demonstrated comparable stability in culture medium and human blood plasma. Dimyristoylphosphatidylcholine and were also harmful to lymphoblastoid cell lines, according to research on the toxicity of concanavalin-A. However, the toxicity of lipids to these cells was almost entirely removed by adding cholesterol to the lipids at dimyristoylphosphatidylcholine/ dimyristoylphosphatidylglycerol/ cholesterol. Human lymphocyte, splenocyte, and lymphoblastoid cell proliferation enhanced by concanavalin-A was inhibited similarly or much more by liposomal curcumin. They came to the conclusion that liposomal curcumin would be helpful for intravenous administration to enhance the bioavailability and effectiveness, facilitating the in vivo research that might eventually result in the clinical application of curcumin.

Additionally, Dhule et al tested the efficacy of curcumin-loaded cyclodextrin liposomal nanoparticles against osteosarcoma and breast cancer cancer models. The results demonstrated promising liposomal curcumin anticancer potential against osteosarcoma and breast cancer cell lines both in vitro and in vivo via the caspase cascade that results in apoptotic cell death. A xenograft osteosarcoma model in vivo was also used to confirm the efficacy of the liposomal curcumin nanoparticles. For intravenous dosing, Li et al. incorporated curcumin in a liposomal delivery system. They also used human pancreatic cancer cells in vitro and in vivo to demonstrate the effects of liposome-encapsulated curcumin on proliferation, apoptosis, signaling, and angiogenesis. Curcumin encapsulated in liposomes decreased tumor angiogenesis in vivo and suppressed pancreatic cancer development in mice xenograft models. Additionally, it inhibited human pancreatic cell proliferation and promoted apoptosis in vitro and shown anticancer and antiangiogenesis properties in vivo. In vitro skin penetration and in vivo anti-cancer properties of curcumin were investigated by Chen et al. employing liposomes as the transdermal drug-delivery

technology. Curcumin-loaded liposomes showed the potential to stop melanoma cell proliferation. Curcumin-loaded liposomes had a significant impact on antimelanoma activity. These findings, along with those of other investigations, imply that curcumin distribution via liposomes holds promise for the treatment of cancer. According to these findings, liposomal curcumin has a significant potential for use as delivery systems for the treatment of various malignancies.

In a mouse model of renal ischemia, Rogers et al. [38] also gave liposomes containing curcumin to target delivery to renal tubular epithelial and antigen-presenting cells. Liposomal curcumin significantly decreased neutrophil infiltration and inflammatory interleukin expression, decreased histological injury and cellular apoptosis, decreased toll-like receptor-4, heat shock protein-70, and tumor necrosis factor alpha (TNF-) mRNA expression, and improved serum creatinine significantly. In this regard, Basnet et al. created a method for administering liposomal curcumin vaginally. It was discovered that liposomal curcumin was two to six times more powerful than equivalent free curcumin. Results indicated that curcumin's anti-inflammatory effects are enhanced by liposomal delivery systems. Additionally, Mach et al. [88] evaluated the inhibition of cytochrome P450 by liposomal curcumin in liver tissues. The findings showed that at physiologic serum concentrations of liposomal curcumin, there is a limited risk for CYP450-mediated medication interactions. Other chemotherapeutic drugs that are digested and/or removed by the main cytochrome P450 drug metabolizing routes won't interact with it.

Isacchi et al have researched and reported on the therapeutic efficacies of innovative liposomal delivery methods based on artemisinin or artemisinin-based combination therapy with curcumin. Only 7 days after the start of the treatment, they found that artemisinin alone started to lower parasitaemia levels. It also seems to have a fluctuating blood concentration tendency, which is reflected in its antimalarial efficiency. The cure of all malaria-infected mice occurred within the same postinoculation period of time following administration of therapies containing artemisinin loaded with liposomal delivery systems, in contrast. In this murine model of malaria, artemisinin loaded with liposomal curcumin appears to have the most prominent and statistically significant therapeutic effect. The increased blood permanence of liposomal curcumin-loaded artemisinin leads to the suggestion that these nanosystems could be used as passively targeted carriers for parasitic diseases.

This potent formulation effect is added to the mechanism of action of artemisinin, which functions as a blood schizonticide throughout the erythrocyte cycle stage of the human host. Agarwal et al. examined the acute effects of liposome-entrapped curcumin on rats with status epilepticus, seizures brought on by pentylenetetrazole, and increasing current electroshock seizures. Curcumin encapsulated in liposomes significantly increased the seizure threshold current and the latency to myoclonic and generalized seizures, respectively, as well as the current required to cause seizures by electroshock and pentylenetetrazole. Additionally, it reduced the duration of seizures when in status epilepticus and lengthened the latency to onset. Therefore, curcumin liposomally encapsulated can have anticonvulsant effects in mice with status epilepticus

In a nutshell, the aforementioned studies indicate that liposomal curcumin treatment offers a variety of positive benefits that may necessitate therapeutic applications. The improved solubility, increased safety and minimal side effects, increased bioavailability and efficacy, potential use as delivery systems for the treatment of various cancers, strong anti-

inflammatory and antimalarial response, and, finally, anticonvulsant activity are the reasons for these better results.

CONCLUSION

Different factors, such as drug diffusion, copolymer biodegradation, and micelle stability, all influence how quickly drugs are released from micelles. Regarding the effectiveness and stability of curcumin encapsulation, Sahu et al. reported the potential of the two most popular Pluronic triblock copolymer micelles, Pluronic F127 and F68. Pluronic F127 outperformed Pluronic F68 in terms of encapsulation effectiveness and long-term storage stability. AFM analysis showed that the drug-encapsulated micelles are spherical in shape and have diameters under 100 nm. When compared to free curcumin in an in vitro cytotoxicity investigation, pluronic-encapsulated curcumin showed a slower, more prolonged release of curcumin from the micelles and significant anticancer action. Additionally, Podaralla et al. described a polymeric micelle with a natural protein core and showed how it might be used to deliver hydrophobic anticancer medicines, specifically curcumin. Methoxy polyethylene glycol was combined with zein, a biodegradable hydrophobic plant protein found in maize, to create unique biodegradable micelles, which were then enclosed in curcumin. With a 3-fold decrease in curcumin's IC50 value, polyethylene glycol zein micelles dramatically improved the water solubility and stability of curcumin while sustaining its release for up to 24 hours in vitro. The retention and bioavailability of the curcumin can therefore be improved because it is delicately shielded from potential inactivation by its micellar environs

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CHAPTER 10
NANOTECHNOLOGY'S POTENTIAL FOR TREATING ALZHEIMER'S DISEASE

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ABSTRACT
A neurodegenerative ailment called Alzheimer's is brought on by the buildup of beta-amyloid plaques in the brain. There is currently no known effective treatment for Alzheimer's disease. The drugs that are now on the market can only stop it from progressing. The therapy of Alzheimer's disease, specifically in the illness diagnosis and giving an alternative strategy to treating Alzheimer's disease, however, has a significant potential thanks to nanotechnology, which has demonstrated its superiority that may be implemented for medical purposes. This is accomplished by breaking through the blood-brain barrier and improving the effectiveness of drug delivery. Having said that, there are still some issues that require additional study and research in order to reduce side effects and potential toxicity while enhancing drug bioavailability. Recent developments in nanotechnology-based Alzheimer's disease treatment include neuroprotection, nanomedicine, and stem cell regeneration. The development of nanotechnology, its obstacles, and how it aids in the detection and treatment of neurodegenerative diseases like Alzheimer's disease, will be covered in this is a neurological condition that typically develops gradually and worsens over time it accounts for 60–70% of dementia cases. The most prevalent initial sign is trouble recalling recent events. As the illness worsens, symptoms may include behavioural problems, linguistic difficulties, disorientation (including a tendency to get lost easily), mood swings, a lack of desire, and self-neglect. As a person's health deteriorates, they frequently isolate themselves from friends and relatives. As physical functions gradually deteriorate, death eventually results. The typical life expectancy following diagnosis is three to nine years, though the rate of progression can vary.

KEYWORDS
Ailment, currently, demonstrated, development.

INTRODUCTION

Alzheimer's disease (AD) is an acquired neurological condition that impairs cognitive function and behavior over time and is incurable. Amyloid-(A) plaques and neurofibrillary tangles both form intracellularly and extracellularly throughout the pathophysiology of AD. These cause synapse loss and neuronal cell death, which begin first before gradually causing a cognitive deficiency. Although AD is the most prevalent type of dementia in the elderly population, it can also manifest in one of two ways: the rare early-onset dementia leading to AD occurs before the age of 65, or the more common late-onset AD (LOAD), also known as senile dementia, which develops after the age of 65 as a result of aging. The hippocampus, which stores memories, and other regions of the cerebral cortex, which are essential for making accurate judgments and decisions, frequently develop plaques as a result of AD. The impairment in behaviors can be recognized in addition to cognitive impairment, such as memory loss, through typical neuropsychiatric symptoms such depression, agitation, delusion, and hallucinations.

In America, there were an estimated 5.7 million AD patients of all ages in 2018. Of these, more than half of the estimated cases were thought to be caused by LOAD. Patients with AD are now just receiving symptomatic treatment because there are no viable therapeutic medications available to treat AD. The advancement of nanotechnology, however, has recently demonstrated considerable promise in circumventing this restriction. Nanotechnology entails the production or modification of desirable materials with structures that range in size from 1 to 100 nanometers.. Nanomaterials have a huge amount of surface area, and their high surface to volume ratio is very beneficial because it has a big impact on their structure. Nanomaterials' lighter, stronger, faster, smaller, and more durable characteristics make them potentially a promising drug delivery medium, particularly for the treatment of cancer and Alzheimer's disease. As a result, we will talk about how nanotechnology may be employed as a potential treatment for Alzheimer's disease in this review.

It is unclear what causes Alzheimer's disease.There are numerous genetic and environmental risk factors connected to its development . The most potent genetic risk factor originates from an APOE allele.A history of head trauma, severe depression, and high blood pressure are further risk factors Amyloid plaques, neurofibrillary tangles, and the loss of neuronal connections in the brain are substantially linked to the disease process. A probable diagnosis is made using the patient's medical history, cognitive testing, and blood tests to rule out any other potential reasons Initial symptoms are frequently confused with aging of the brain.For a certain diagnosis, brain tissue examination is required, but this can only be done after someone has passed Although certain treatments may momentarily lessen symptoms, none can stop or reverse the disease's course. Affected individuals become more and more dependent on others for help, which frequently puts a strain on carers. There may be social, psychological, physical, and economic components to the stresses.Exercise regimens may be advantageous in terms of daily activities and may even increase results.Antipsychotics are frequently used to treat behavioral issues or psychosis brought on by dementia, but this is not typically advised due to the limited benefits and increased risk of premature death.

Around 50 million people will have Although up to 10% of cases have an early beginning and affect persons in their 30s to mid-60s, it most frequently affects people over the age of 65.About 6% of those 65 and older are affected by and women are more frequently affected than males. Alois Alzheimer, a German pathologist and psychiatrist, originally identified the illness in 1906, earning him the moniker Alzheimer. Alzheimer's disease places a heavy financial burden on society; it is thought to cost $1 trillion year globally. It is listed as the seventh most common cause of death in the US. The initial signs are frequently wrongly attributed to stress or aging. Up to eight years before a person meets the clinical requirements for an Alzheimer's disease diagnosis, thorough neuropsychological testing can identify modest cognitive impairments.Even the most complicated daily routines might be impacted by these early symptoms. The most obvious memory impairment is short-term memory loss, which manifests as difficulties recalling previously learned material and a failure to learn new knowledge.

The early stages of Alzheimer's disease can also be characterized by subtle difficulties with executive skills such as flexibility, planning, attention, and abstract thought, as well as impairments in semantic memory (memory of meanings and idea links). At this stage, apathy and despair are visible, with apathy continuing to be the disease's most enduring symptom. It is frequently discovered that mild cognitive impairment (MCI) occurs as a step between

healthy aging and dementia. Memory loss is the most common symptom of MCI, which is known as amnestic MCI. This condition is generally thought of as the prodromal stage of Alzheimer's disease. More than 90% of the time, amnestic MCI is connected to Alzheimer's.The progressive loss of learning and memory in those with Alzheimer's disease eventually results in a conclusive diagnosis. Memory issues are less common than challenges with language, executive functioning, perception (agnosia), or movement execution (apraxia) in a tiny number of people. Not all memory functions are adversely affected by Alzheimer's disease. Episodic memory, semantic memory, and implicit memory—the body's recall of how to perform actions, such eating with a fork or drinking from a glass—are all impacted less than new information or memories.

Language impairment is primarily characterized by a loss of vocabulary and a decline in word fluency, which impoverishes both spoken and written language in general. The Alzheimer's patient is typically able to appropriately communicate fundamental thoughts at this stage. Certain movement coordination and planning issues (apraxia) may be evident while executing fine motor tasks like writing, sketching, or dressing, although they are frequently overlooked. People with Alzheimer's disease can frequently still complete many chores on their own as the condition develops, although they may require aid or supervision with the most cognitively demanding activities.

DISCUSSION

Delivery of Proteins and Peptides

Similar to how AD medications are delivered, the distribution of therapeutic proteins or peptides involves encapsulation, integration, or attachment to polyethylene glycol (PEGylation) of the protein or peptide in question. The delivery works on the same principles as the nanodrug delivery system, which allows molecules of a protein or peptide to traverse the BBB by binding to NPs. The most effective method of delivering proteins or peptides to the site of action is thought to be intranasal administration. This method protects the therapeutic material from proteolytic degradation by allowing direct delivery to the CNS without going through the gastrointestinal system or bloodThe delivery of proteins or peptides via NPs has been decisively demonstrated to be a stable, efficient, and secure treatment for AD based on numerous studies conducted utilizing AD rat models. However, this administration method has a number of drawbacks of its own, including high cost, low or unpredictable bioavailability, and potentially adverse consequences.

Mitochondrial Targeting Therapy

According to several studies, the mitochondria are thought to be crucial to the pathogenesis of AD. Reduced brain metabolism or elevated reactive oxygen species (ROS) accelerate neurodegeneration by causing mitochondrial malfunction, which finally triggers the death of brain nerve cells. As a result, one strategy being employed to treat AD is to target the neuronal mitochondria's generation of reactive oxygen species (ROS) Most chemicals cannot enter the mitochondria because of how selective the inner membrane is. Some possible tactics include encapsulating antioxidants in lipidic NP to encourage antioxidant intake via micropinocytosis; conjugating therapeutic agents with mitochondrial signal peptide to improve the recognition of transporters for mitochondrial delivery; and conjugating ROS scavengers to a mitochondrion penetrating short peptide sequences that have distinct physicochemical properties.

Ceria (CeO2) NPs are the antioxidant NPs that are utilized to treat AD. Research has shown that positively charged TPP-ceria NPs may effectively scavenge mitochondrial ROS to minimize oxidative stress, localize into the mitochondria in a variety of cell lines, and suppress neuronal mortality in a mouse model under test. Gene therapy.The goal of gene therapy is to explain a healing effect by compensating the defective gene, such as DNA or RNA, intracellular delivery of genetic materials. Through a single delivery of the target gene, this type of therapy aims to replace or fix the faulty gene. In order to deliver the appropriate genetic materials into the targeted cell, where the gene can be produced safely, a vector is frequently utilized. Adenovirus, retrovirus, and lentivirus are a few examples of modified and redesigned viral vectors that enable expression without the ability to replicate. However, due to the immunogenicity and toxicity of the viruses utilized as the vector, this technique has several limitations.

Since nonviral gene carriers may be created in a variety of forms, including cationic lipids, polymers, ceramic-based nanomaterials, and silica-based NP, they are being employed as vectors. The organically modified silica (ORMOSIL) nanoparticles can transport, compress, and protect DNA plasmid inside of cells.The cationic amino groups of the ORMOSIL NPs are electrostatically linked to the anionic phosphate groups present in the plasmid DNA. For maximum transfection effectiveness, the ORMOSIL-DNA complex's average diameter should be less than 60 nm To verify that a gene has been successfully transfected into the cells, the ORMOSIL NPs can be fluorescently labeled. The use of corrosive solvents and other intricate purification techniques can be avoided because they are able to precipitate in the oil-in-water microemulsion. Additionally, the hydrophobic and hydrophilic groups in ORMOSIL help them function as reverse micelles and regular micelles that can hold biomolecules. Additionally, the NPs' organic groups can be changed to improve both their stability in aqueous systems and their degree of flexibility for attaching targeted molecules.

Therapeutics for anti-amyloid

In the hippocampus and cerebral cortex, where neurons are particularly vulnerable to loss of synaptic terminals and neuronal impairment, Alzheimer's disease (AD) is caused by an excessive production of the -amyloid (A) peptide, which also reduces the levels of some neurotransmitters like acetylcholine. Amyloid precursor protein (APP), a membrane protein, is proteolytically broken down by - and -secretases to produce the peptide known. The majority of the APP protein can be found localized in the synapses of neurons and astrocytes. APP is an integral transmembrane protein. The generation of A can be stopped by specifically inhibiting the - and -secretases, but doing so can have a number of undesirable effects As a result, the iA-5 peptide has been identified as a novel antiamyloid therapeutic agent. Because it binds to A and stops it from further assembling into amyloid fibrils, the iA5 peptide suppresses the development of A fibrilli. It was discovered that the iA-5 peptide is unstable and is quickly broken down by proteases. Therefore, polyethylene glycol (PEG) and charged sequences can be added to create an iA-5 derivative with improved properties such as greater proteolysis endurance, stability, and solubility. However, the limited BBB permeability-surface area of this medication prevents it from penetrating the brain.

A nanotechnology-based intervention that enables the medicine conjugated to poly (lactic-co-glycolic acid) (PLGA) to flow across the BBB can get around this restriction. The versatility of the PLGA NPs' structure, which enables surface functionalization, biocompatibility, and lower toxicity, as well as their improved drug loading capacity, are just a few of their benefits. The surface of the NP can have more ligands linked to it in order to boost its affinity

for the specific cell surface. Antitransferrin receptor monoclonal antibody (OX26) and anti-A (DE2B4) that can deliver the iA5 peptide in an encapsulated form are positioned around the PLGA NP surface 3.Nanotechnology in immunotherapy

An emerging possibility for the treatment of cancer is immunotherapy. The fundamentals and structure of immunotherapy are simple since it starts with the removal of cancer patients' T cells for in vitro rebuilding, which enables them to be targeted to certain cancer receptors. After being reintroduced into the patient, these modified T cells cause tumor cells to undergo apoptosis in the blood circulation without generating any negative side effects. However, due to the advancement of tumor malignancy followed by the patient's immune system being suppressed, immunotherapy has the potential to inhibit the immune system from eliminating tumors. In addition, it's possible that the altered and rebuilt T cells are not entirely secure for usage in people. An solution that has been proposed to address these issues and thereby increase the success rate of immunotherapy by making it safe and efficient is nanotechnology or nanoparticles.

Safe Sterilization

In the medical industry, silver nanoparticles are widely employed in pharmaceutical formulations and medical equipment. Direct sterilization using -radiation and an autoclave is possible for citrate-stabilized silver NPs with a size range of 20 to 80 nm. The sterilization-based alterations in size and shape that suggested a free radical mechanism of action may be replicated by adding silver nanoparticles to a chemical that produces hydroxy radicals. In addition, it was found that compared to the unsterilized silver NPs used as controls, sterilized silver NPs are more likely to result in platelet accumulation, an in vitro predictor of thrombogenicity.

Approaches to Early Disease Diagnosis

The application of nanotechnology in medical imaging for disease diagnosis as well as in the treatment of diseases has received extensive research. In spectroscopic imaging, the superparamagnetic iron oxide NPs have the capacity to improve contrast. Additionally, NPs can be coupled to particular biomarkers, allowing for the assessment of the biomarkers as well as the ultrasound identification of particular tumor morphologies. Nanotechnology is known for its stability and dependability in performance features and, in addition to its role in advanced medical imaging-based detection, it also serves as a high-sensitivity disease detector for early diagnostics purposes.

Biosensors

A biosensor is a device that uses a physical transducer, nucleic acids, enzyme antibodies, and a sensitive biological recognition to detect analytes. The outcomes are then put to use for both qualitative and quantitative conclusions. Due to the need for biosensors to have high sensitivity and selectivity, quick detection, and low cost, nanomaterials such gold nanoparticles, graphene, carbon nanotubes, and photonic crystals are widely used. In addition, the use of nanotechnology into biosensors has led to numerous new developments in signal transduction. The development of tools and techniques to measure and visualize items at the nanoscale has facilitated the development of biosensors that interact with tiny molecules and need to be assessed Due to the enormous potential benefits, nanotechnology is frequently seen as one of the catalysts for sustainable development, such as boosting the

effectiveness of numerous production systems. Because there are still gaps and repercussions that need to be thoroughly researched, nanotechnology is still not being applied broadly.

After the initial hoopla, attention waned, but in-depth study and product development were still going on, yielding fresh and intriguing findings and goods every year. Engineered nanoparticles are a brand-new class of materials with exceptional qualities. A growing number of patents have been issued for these materials, and many more are currently being developed. There are numerous examples of nontechnological applications that are currently in use or that have the potential to be used in a variety of scientific fields, particularly in the fields of medicine, pharmaceuticals, and biology, such as cell sorting, DNA diagnostics, kidney dialysis, tips for scanning probe microscopes, targeted drug delivery systems, pharmaceutical purification, lab-on-a-chip, proteomics, single-cell analysis, BioMEMS, CytoSensing, enzymes, identification of toxic compounds, cancer treatment, Bioavailability.

The bioavailability of the medicine that is administered to the body may vary depending on how NPs are administered. Given that it is one of the least invasive ways to administer medications into the human body, the nasal administration route is the most practical and legal. The bioavailability of the medication can, however, be significantly impacted by enzymes found in the nasal cavity. Because the nasal cavity has a limited capacity for drug concentration, this may require raising the dosage of the medications when giving, which can induce unpleasant reactions in the nasal mucosa. As a result, it's crucial to take medications via the nasal route at a low concentration. In addition, the introduction of a large number of poorly accessible medications might have detrimental effects on the respiratory system, including oxidative stress, peribronchial inflammation, and chronic inflammatory reactions.

CONCLUSION

Despite the fact that there are many advantages to using NPs, many of their constituent parts, including nucleic acids, antibody fragments, peptides, and proteins, might act as antigens, increasing immunotoxicityAlthough clinical experiments can be used to determine the acute toxicity brought on by NPs, it is also important to take into account the possibility of chronic toxicity brought on by prolonged exposure and NP buildup. There are currently no experimental tests performed on living species to ascertain the longterm toxicity and harmful effects of NPs. Due to the poor encapsulation efficacy and loading capacity of NPs, consuming large quantities of nanocarriers containing surfactants and cosurfactants might have substantial negative effects. Certain NPs that have been injected into the body can be difficult for different clearing systems to remove. This could lead to an accumulation of NPs within the brain system, which would result in cytotoxicity. Brain damage may result from NP buildup in the brain over time.One restriction that needs to be taken into account is the sink impact of NP-mediated initiation, as well as the frequency and intervals between injections. An excessive dose may have negative effects, which in turn trigger an immune response, altering the pharmacokinetics of the NP and reducing its efficacy. In addition, NP neurotoxicity may result from its physicochemical characteristics, including as size, shape, and surface area. These elements might alter or obstruct the transit of haemostatic mediators. The size of NPs might make it more likely that they will aggregate, which could interfere with and obstruct blood flow and cause unfavourable effects on the heart, lungs, and other microinfarctions.

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CHAPTER 11
DEVELOPMENT AND CURRENT SITUATION OF NANOTECHNOLOGY IN THE FOOD AND AGRICULTURE SECTORS

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ABSTRACT
An developing technology in the food and agricultural industries, nanotechnology allows for the modification or control of each and every molecule and atom. Atoms and molecules make up every element of the universe. It is simple to solve issues in all fields by adjusting or changing their nanosized. Similar to how it could solve many problems in the food and agriculture sectors. In the place of insecticides, fertilizers, and biosensors, nanomaterials play a significant role. The use of nanotechnologies has made it easier to improve nutrition, provide micronutrients and bioactive components safely, and preserve food. It is necessary to make an effort to raise public knowledge of this area of nanotechnology. The review recommended future research directions to enhance the nano embedded agriculture system. This article examines recent advances in the food and agricultural industries brought about by nanotechnology, as well as the backlog of unfinished research in these fields. Research has demonstrated that nanoparticles are a game-changing tool for addressing many emerging global concerns, and the agricultural sector is no exception. A nanoparticle is generally understood to be any particle with one characteristic dimension of 100 nm or smaller. These particles start to display characteristics that their larger counterparts would not due to their particular size. Due to its scale, quantum mechanical interactions take precedence over classical mechanical forces, enabling the predominance of unique physical and chemical properties because of their incredibly high surface-to-body ratio. When working at the nanoscale, properties including cation exchange capacity, improved diffusion, ion adsorption, and complexation are boosted.

KEYWORDS
Components, developing, examines, nanotechnology.

INTRODUCTION

The world's population is growing quickly.it is anticipated to reach around six billion. Due to unique biotic and abiotic pressures, climatic changes, and water scarcity, crop yield is declining. They obstruct the expansion of the agricultural sector. There is a need for a novel technology called nanotechnology to overcome all of these obstacles. Nano, which meaning one billionth of something, is a Greek word. One nanometer is defined as one billionth of a meter. The science of nanotechnology is concerned with the creation and modification of materials having a size between one and one hundred nanometers. The agricultural industry and the food chain may be completely transformed by nanotechnology. When compared to bulk particles, the attributes of nanoparticles, such as an increase in surface area and physical strength, perform bette. Zinc nanoparticles, for instance, are transparent, yet their bulk particles are opaque and whitish depicts the surface area difference between the nanoparticle and standard particle. This is mostly due to a high concentration of atoms on the surface,

where a greater percentage of sites operate with higher reactivities for processes like adsorption and electrochemical interactions.

Nanoparticles provide promising applications in agriculture. Nanomaterials provide a toolkit that operates at just the appropriate scale to give effective, targeted delivery to living cells since many organic functions, like ion exchange and plant gene expression, operate on small scales The agricultural sector is currently focusing on the development of environmentally friendly nano fertilizers to deliver ions and nutrients to plant cells efficiently as well as plant gene engineering to create plants with desirable genes, such as drought resistance and accelerated growth cycles. As the world's population grows, it is essential to develop sustainable agricultural practices that produce larger yields in order to fulfill the expanding need for food. It must be done, though, without having any long-term negative effects, including the depletion of water or arable land, toxic runoff, or bioaccumulative toxicity. Research is being done on the incorporation of nanotechnology in agriculture to address these demands.The usage of nanofertilizers is one area of this field that is actively being researched. The aforementioned unique characteristics of nanoparticles allow nanofertilizers to be tailored for customized plant delivery. Due to the massive amount of runoff they create, conventional fertilizers can be harmful to the environment. In order to improve quality of life for millions of people throughout the world, it is crucial to be able to reduce runoff from agriculture, which has a negative impact on everything from water quality to air particulate matter. In Florida, for instance, runoff from sugar plantations has generated the iconic "red tide" algae bloom in water streams all over the state, causing respiratory problems in people and decimating essential ecosystems for years.

Studies have revealed that, on average, more than 50%, and in some circumstances up to 90%, of the fertilizer given to the soil is lost to the environment. This exhibits the enormous waste associated with conventional fertilizers while also posing severely unfavorable environmental impacts. However, thanks to their great absorption efficiency into the targeted plant and their exceptionally high surface area to volume ratios, nanofertilizers are able to address this problem. Absorption efficiencies of up to 90.6% were attained in a study on the usage of phosphorus nano-fertilizers, making them a highly sought-after fertilizer component. The capacity to offer delayed nutrient release into the plant over a 40–50 day period with nanofertilizers, as opposed to the 4–10 day timeframe with conventional fertilizers, is another advantageous feature of employing them. Once more, this is advantageous economically because it uses less resources to transport fertilizer and reduces the overall amount of fertilizer required.

Crops have been observed to show improved health when employing nanofertilizers over conventional ones, as expected given their greater ability to absorb nutrients. In one study, the impact of a nanofertilizer designed specifically for potatoes was compared to a control group using traditional fertilizers made up of K, P, N, and Mg. The research discovered that the nano-fertilized potato crop had higher crop yields than the control crop, as well as more efficient water use and agronomic efficiency, which is measured by the increase in yield per unit of applied nutrient. The study also discovered that the potatoes that had received nano fertilization contained more nutrients, including more starch and ascorbic acid. Another study examined the use of iron-based nanofertilizers in black-eyed peas and found that the use of nano fertilizer significantly boosted root stability and leaf chlorophyll content, which improved photosynthesis. According to a different study, zinc nanofertilizers increased the

rate of photosynthesis in maize crops as determined by the concentration of soluble carbohydrates. This is probably because zinc is involved in the photosynthesis process.

Future research will be necessary to make nano fertilizers a reliable and practical substitute for traditional fertilizers. Legislation that effectively controls the use of created, along with standards for their consistent quality and nutrient release. Further research is required to fully grasp the advantages and potential drawbacks of nanofertilizers and to acquire a complete understanding of the best strategy for applying nanotechnology to agriculture in a constantly changing is a prime contender for the optimization and manipulation of cultivated plants because of its vital position in the fields of genetic engineering and plant transformations. The majority of plant genetic modifications in the past have been carried out using Agrobacterium or tools like the gene however, these older techniques for implementing genes face challenges due to low species compatibility, a lack of versatility/compatibility with chloroplast/mitochondrial gene transformations, and the possibility of cell or organelle damage Despite the and Agrobacterium are effective in certain plant species, more sophisticated methods are being investigated through the use of nanomaterials, allowing for a less obtrusive and forced delivery approach. These techniques use porous nanoparticles (NPs) and carbon nanotubes (CNTs) to enable delivery mechanisms, which may enable higher-throughput plant transformation while evading governmental GMO Since standard methods of plant transformation run the risk of DNA incorporation in the plant genome, which would make them transgenic and qualify them as a GMO, the study of non-incorporative/DNA-Free genetic alterations has grown significantly.

DISCUSSION

A unique method for non-transgenic, non-destructive plant transformation makes use of highly-tailorable diffusion-based nanocarriers for the transfer of genetic material. Size, polarity, and surface chemistry are important characteristics of the material being used, which have a significant impact on the specificity of the approach. Nano-Structured-DNA, carbon nanotubes, and other nanoparticles have all been used in several diffusion-based delivery methods as vesicles for the transport of genetic data. To improve the loading and delivery of genetic information, these techniques frequently depend on functionalizing the surface or modifying the porosity of a nanocarrier. It has been demonstrated that DNA nanostructures provide a highly customizable medium for small interfering RNA (siRNA) delivery, exploring the ideal design parameters required for plant cell internalization. In a recent work, DNA-loaded CNTs were effectively used to express desired features in a variety of mature model plant systems, including separated Eruca sativa protoplasts, all while safeguarding the integrity of the transferred genetic information. Last but not least, it has been demonstrated that porous nanoparticles may transfer DNA to plants efficiently, depending on the pore size and strand length.Overall, these diffusion-based gene transformation technologies provide a more affordable approach of plant gene transformation with little to no risk of DNA inclusion, lesser impact on plant tissue, and lower transformation efficiencies.

The main strategy for plant transformation is biolistics. In order to impart genetic change, the biolistic technique requires firing microprojectiles (often gold microparticles) through the cell membranes and cell walls. As was already said, biolistics may cause damage to the targeted cells or organelles; therefore, nano-biolistic approaches have been created to reduce possible cell damage. While offering a similar efficiency of genetic transformation to conventional biolistics, the impact can be lessened due to the particle being fired into the cell being substantially smaller than before. However, as animal cells are the focus of the majority of

studies utilizing nanoscale biolistic techniques, implementation in plant transformation is still relatively young and may run into difficulties not present in animal cell studies Overall, plant genetic modification is made competitive and innovative by nanotechnology. Future studies on the applicability of these methods will focus on a wider range of crops, try to use less expensive, more scalable techniques, and investigate potential environmental implications. If nanomaterial plant transformations are adopted widely in the future of agriculture, it will ultimately depend on these design criteria.

Public perception

An increasing number of governmental, scientific, and independent institutional bodies have recently recognized the potential of nanotechnology to significantly lessen the burden on the world's food supply as applications of the technology have shown promise in many fields of study. Public opinion on the application of nanotechnology in agriculture is currently divided. The current public opinion appears to be relatively neutral when considering the potential benefits and risks, as detractors see the technology as more beneficial and less risky than some other technologies, such as pesticides and chemical disinfectants, but as riskier and less beneficial than solar technologies and vaccinations.

Fertilizers and the genetic engineering of living things still carry a bad reputation among the general population. There are worries that, despite the advantages of larger yields and shorter growing cycles, fertilizers are linked to harmful runoff that contaminates water sources and may cause acid rain. Additionally, there is the erroneous concern that eating genetically modified food is 'unnatural' and hazardous, which has given rise to several legislative initiatives that have restricted the sector to non-transgenic alterations. While most public anxieties and concerns about new technology being introduced to an established business like agriculture are baseless, they are more often the product of poor communication and a lack of public awareness. Due to the high frequency of consumption and close relationship people have with their food, many people believe that producing clean and wholesome food is of utmost importance.

Nano fertilizers

Crop production has increased significantly over the last few decades. They are emphasizing how the global demand for food was significantly influenced by the expansion of grains. The increased usage of chemical fertilizers significantly increases crop yields. The variety of fertilizer-responsive crops is increasing the use of chemical fertilizers. However, utilization of chemical fertilizer has decreased as a result of its low effectiveness. The leaching and volatilization of polluted chemical fertilizers raises the cost of crop production. According to DeRosa et al, chemical fertilizers lose 50 to 70 percent of the nitrogen they contain to the environment. As a result, the research community is focusing on the creation of new generalship. In these situations, nanotechnologies must be used to create slow-release fertilizers, lessen the loss of mobile nutrients, and increase the accessibility of the nutrients that are now insufficiently available. All of these benefits are greatly facilitated by the nanoparticles' surface area. There are two sorts of nanofertilizers: those that are nutrients by themselves and those that are added to other nutrients. The use of nanofertilizer on plants is demonstrated in By increasing crop output, enhancing crop quality with superior nutrients, and, most importantly, lowering crop production costs, nanofertilizers play a critical role in agricultural sustainabilit. Singh studied the new techniques for improving crop production

efficiency. It has been determined that the use of several nanofertilizers to the crops boosted their productivity.

These nanofertilizers will lower production costs while minimizing population dangers. In terms of the best use of nanofertilizers, it is stated that crop growth would be enhanced. Crop yield will be decreased if the concentration and dosages of nanofertilizers are used in excess of what is ideal. According to Kah et al.'s research, utilizing nanofertilizers instead of traditional fertilizers increases median efficacy by 18–29% [58]. According to Liu and Lal's research, using phosphatic nanofertilizers instead of conventional fertilizers improved growth by 32%. Plant metabolism is enhanced by nanofertilizers, which aid in nutrient uptake through nanocuticle pores. Conventionally applied nitrogenous fertilizer has a 30–60% efficiency rate. 8–90% of the phosphatic fertilizers are lost because of chemical interaction in the soil.

It is noted that the nitrogen release is controlled, ammonia volatilization is constrained, and the phosphorus is sustainably available even after the four weeks of incubation when the fertilizers are utilized as a nanocomposite of hydroxyapatite and urea. In conventional fertilizer, the majority of fertilizers are released into the environment by leaching and volatilization. However, the amount of them is decreased in nano fertilizers by the use of slow-release products. When and where the plants need the nutrients, it can release them to them. This characteristic reduces fertilizer volatilization that is harmful to the environment. By understanding how plant roots and soil bacteria communicate, such intelligent fertilizers are made conceivable. According to Syu et al., the internal root signals are changed when nanoparticles are used. It will have an impact on how much ethylene the roots of Arabidopsis produce. When roots are internally stimulated to release nutrients in response to P and N deprivation, controlled release of nano fertilizers would represent a substantial advancement. According to a study by Adisa nano fertilizers are not causing any problems for conventional agencies.

Nanostructured substances like chitosan, zeolite, polyacrylic acid, clay minerals, and hydroxyapatite are used to create Nano fertilizers. They can be sprayed on the leaves of the plants or added to the soil as fertilizer. Comparing nano fertilizer to conventional fertilizers, the plant can receive nitrogen for 60 days from the composite of modified urea nanoparticles of hydroxyapatite. This is made possible by the hydroxyapatite's enormous surface area and the tight link that exists between them, which causes the gradual escape of nitrogen from urea [67–69]. According to a report, when the polyacrylamide polymer is placed on the potassic fertilizer, the potassium is released gradually. To reduce leaching, sandy soils require potassium that releases slowly. Nanotechnology may play a key role in the manufacture of compost and the improvement of the breakdown of organic wastes in the agricultural sector. Although they haven't yet produced any notable outcomes, they will undoubtedly govern the planet in the future The fact that nanofertilizers are highly effective and require less fertilizer is evident from the facts, and the main benefit is a decrease in nutrient losses in the environment. Nevertheless, it is crucial to thoroughly research the economic viability of nanofertilizers in order to achieve lucrative and sustainable agriculture.

Soil-plant systems with nano biosensors

measuring physical quantities and converting them into signals that can be recognized and studied, nanosensors are tiny devices. Several methods, including top-down lithography, bottom-up assembly, and molecular self-assembly, have been put forth today to create

nanosensors. Various kinds of nanosensors are available on the market and are being developed for a variety of applications, most notably in the healthcare, environmental, and defense sectors. These sensors have a similar fundamental workflow that involves the selective binding of an analyte, signal production from the nanosensor's interaction with the bio-element, and signal processing into meaningful measures.Due to nanomaterial characteristics that occur at the nanoscale and are absent in bulk materials, sensors based on nanomaterials have significant advantages over sensors produced from standard materials in terms of sensitivity and specificity. Because nanosensors act at a scale close to that of natural biological processes, they can be functionalized with chemical and biological molecules and recognize events that result in observable physical changes. This allows for enhanced specificity. The high surface-to-volume ratio of nanomaterials and their new physical features, such as nanophotonics, which can serve as the basis for detection, contribute to improvements in sensitivity. Nanoelectronics and nanosensors may be combined in the future to give nanosensors native processing capabilities.

Nanosensors are ideal for high-throughput applications due to their sensitivity and specificity as well as their significant cost and reaction time advantages. As opposed to more conventional detection techniques like chromatography and spectroscopy, nanosensors offer real-time monitoring. These conventional techniques frequently demand an investment in capital costs as well as time for sample preparation, and they may take days to weeks to produce results.As opposed to bulk or thin-film planar devices, one-dimensional nanomaterials like nanowires and nanotubes are well suited for usage in nanosensors. They can act as cables to transfer the signal as well as transducers. When an analyte binds to them, their high surface area can result in significant signal alterations. Due to their tiny size, numerous independently addressable sensor units can be multiplexed into a small device. Additionally, its functioning is "label free" in the sense that the analytes do not need to have fluorescent or radioactive Due to its high sensitivity to low gas concentrations in ambient circumstances and ease of fabrication at low cost, zinc oxide nanowire is employed in gas sensing applications.

Nanosensors face a number of difficulties, such as avoiding drift and fouling, creating repeatable calibration procedures, utilizing preconcentration and separation techniques to achieve an analyte concentration that avoids saturation, and integrating the nanosensor with other components of a sensor package in a way that is trustworthy and scalable.4-10 Due to the fact that nanosensors are a relatively new technology, their use in biological systems is currently restricted due to the large number of unresolved problems surrounding nanotoxicologyNanosensors have the potential to be used in a variety of fields, including medicine, the detection of pollutants and pathogens, and the monitoring of production and transportation Nanosensors may be able to distinguish between and recognize particular cells at the molecular level in order to deliver medication or monitor development to particular locations in the body by measuring changes in physical properties (volume, concentration, displacement and velocity, gravitational, electrical, and magnetic forces, pressure, or temperature). The primary classification scheme for nanosensors is determined by the type of signal transduction. The most common readouts for nanosensors include those that are optical, mechanical, vibratory, or electromagnetic.

Nanosensors that make use of molecularly imprinted polymers (MIP) can be categorized into three groups: electrochemical sensors, piezoelectric sensors, and spectroscopic sensors. Charge, conductivity, and electric potential are only a few of the electrochemical properties

of the sensing material that electrochemical sensors cause to alter. Mechanical force is converted into electric force or vice versa via piezoelectric sensors. A signal is then produced by this force. Chemiluminescent sensors, surface plasmon resonance sensors, and fluorescence sensors are the three subcategories of MIP spectroscopic sensors. These sensors produce light-based signals in the forms of fluorescence, resonance, and chemiluminescence, as their name would imply. The examples show that depending on the type of sensor, the sort of change the sensor detects and the type of signal it generates.

CONCLUSION

Nanotechnologies have significantly advanced the field of food preparation. The separation process in the food sectors needs to be enhanced by nanomaterials since the food products must meet a high standard of quality and there is an increasing demand for new products like low-calorie and low-fat foods due to dietary requirements. One of the most useful techniques based on nanotechnology, called nanofiltration, has enormous potential for processing food. Examples of applications for nanoporous membranes include water filtration and softening. As a result, the nanofillers can eliminate the divalent ions. The dairy sector can use this nanotechnology in a variety of ways. The dairy industries use nanotechnologies to standardize milk, fractionate the milk's accessible proteins, and improve the microbiological quality. When compared to the standard filtration procedure, this approach has a number of benefits. Less processing steps, less energy use, better end product quality, and higher separation efficiency are a few of these benefits.The field of food safety has significantly advanced because to this nanotechnology. Food contamination procedures have a significant demand for a fast, reliable, and sensitive detection technology.

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CHAPTER 12
A NANOTECHNOLOGY HYPOTHESIS TO IMPROVE QUASI-PHOTOSYNTHETIC CO2 ABSORPTION

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ABSTRACT

This study promotes the hypothesis of "nano deserts"hierarchically organized polymeric nanoparticles that could be used to improve abiotic CO2 fixation in the soil-groundwater system below deserts (also known as quasi-photosynthetic CO2 absorption). Given the huge potentials of such CO2 absorption to expand insights into the long-missing CO2 sink and the naturally unavoidable turbulence in temperature sensitivities of soil respiration it produced, arid and semiarid desert ecosystems, which make up about one-third of the Earth's land surface, play an underappreciated role in the carbon cycling. "Nano deserts" as a unified concept aim to give desert researchers a better understanding of the footprints of abiotic CO2 transport, conversion, and assignment in the soil-groundwater system beneath deserts. They also suggest a conjecture in nanotechnology to enhance quasi-photosynthetic CO2 absorption. By significantly limiting CO2 emission above the desert's surface and emphasizing the abiotic CO2 fixing beneath the desert, nano deserts, on the other hand, provide a stable temperature sensitivity of soil respiration in deserts. It's possible that in the future, this won't be novel.

KEYWORDS
Conjecture, produced, respiration, temperature.

INTRODUCTION

Quantifying CO2 sources and sinks in an effort to account for the global atmospheric CO2 fluxes has shown an unavoidable missing CO2 sink. Numerous studies have asserted to have located the "missing sink," but none of these assertions have received widespread support [4, 5]. Research attention has recently been focused on arid and semiarid desert ecosystems as the location of the long-sought "missing CO2 sink, which was termed as quasi-photosynthetic CO2 absorption. Reports of carbon uptake by arid and semiarid desert ecosystems recently revealed rates of carbon uptake in many forests (i.e., the CO2 absorption rate is up to the photosynthetic absorption level). Strong data point to a large contribution of absorbed CO2 to the overall soil CO2 flux. About one-third of the Earth's land surface is made up of dry and semiarid desert ecosystems, which are underappreciated players in the carbon cycle. However, it is still unknown where the absorbed CO2 has gone. The intensity of CO2 absorption and dissolution, as well as the degree to which it regulates the global C balance, are still up for debate. A recent study stated that such absorption can be attributable to geochemical CO2 dissolution in saline aquifers under deserts.

In the engineering and natural sciences, differential, difference, and dynamic equations are employed for quantitative analysis. This implies that we try to create some differential equations to explain the dynamics of CO2 dissolution and absorption under deserts. The dynamic equations for groundwater dissolved in CO2 (DIC) are representative for both dissolution and absorption because most absorbed CO2 is dissolved in saline aquifers. The

potential challenges and uncertainties must be theoretically analyzed before to this modeling task. In particular, the quasi-photosynthetic CO2 absorption, which is a part of soil respiration in deserts, is abundant in producing turbulence in temperature-sensitive soil respiration. The initial assessment of the absorption intensity is highly encouraging, but the next task is to figure out how to decrease CO2 emission above the surface of the deserts and increase abiotic CO2 fixation beneath them. The abiotic CO2 fixation cannot be used otherwise. In comparison to physisorption, hierarchical structured polymeric materials showed superior adsorption selectivity, high adsorption capacity, water tolerance, and low energy consumption, showing great promise for CO2 capture. The capture may therefore be used in the future to improve quasi-photosynthetic CO2 absorption beneath deserts. It can be hypothesized that there are opportunities for the creative design of self-assembling polymeric materials for the separation of aboveground CO2 release and underground CO2 fixation given the rapid development of nanotechnology and the wide applications of hierarchically structured polymeric materials.

This paper advances the notion of "nano deserts" as a conjecture in nanotechnology for modulating abiotic CO2 fixation in the soil-groundwater system, and hypothesizes that in the future it may be possible to develop some hierarchically structured polymeric materials to enhance quasi-photosynthetic CO2 absorption in deserts. The effects of quasi-photosynthetic CO2 absorption on temperature sensitivities of soil respiration are specifically examined to demonstrate the need for adopting this idea. a viewpoint The hierarchically structured polymeric materials physically reduce soil surface CO2 release and enhance abiotic CO2 fixation beneath Nano deserts, allowing a stable temperature sensitivity of soil respiration in deserts and a reliable quantification of CO2 absorption intensity on regional and global nano deserts, according to the established Riccati Equation for the quasi-photosynthetic CO2 absorption in the soil-groundwater system. A particle of matter with a diameter of one to one hundred manometers (nm) is commonly referred to as a nanoparticle or ultrafine particle.The word may also refer to fibers and tubes that are smaller than 100 nm in only two directions, or larger particles up to 500 nm. At the smallest level, metal atom clusters less than 1 nm are typically referred to.

Since their smaller size influences very different physical or chemical properties, such as colloidal properties, ultrafast optical effects or electric properties, nanoparticles are typically distinguished from microparticles In contrast to colloidal particles, which typically range in size from 1 to 1000 nm and are more sensitive to Brownian motion, they typically do not sediment.Nanoparticles are significantly smaller than the visible light spectrum (400–700 nm), making it impossible to observe them with standard optical microscopes. Instead, they must be viewed with electron microscopes or laser microscopes. For the same reason, nanoparticle suspensions in transparent media may be transparent in contrast to suspensions of bigger particles, which often scatter some or all incident visible light. Nanoparticle separation from liquids necessitates unique nanofiltration techniques since nanoparticles readily pass through ordinary filters, such as everyday ceramic candles.

When compared to bigger particles of the same chemical, nanoparticles frequently exhibit significantly different properties. Since an atom's usual diameter ranges from 0.15 to 0.6 nm, the majority of a nanoparticle's substance can be found within a few atomic distances of its surface. Consequently, it's possible that the surface layer's characteristics will prevail over those of the bulk material. Since the interactions between the two materials at their interface also become relevant, this effect is particularly potent for nanoparticles distributed in a

medium of dissimilar composition.Idealized representation of a platinum nanoparticle with a diameter of roughly 2 nm that reveals individual atoms.

Numerous fields, including chemistry, physics, geology, and biology, investigate nanoparticles because they are present in nature on a large scale. They frequently display phenomena that are not seen at either size because they are at the interface between bulk materials and atomic or molecular structures. They are a significant contributor to atmospheric pollution and essential components of a variety of industrial goods, including paints, plastics, metals, ceramics, and magnetic goods. One subfield of nanotechnology is the creation of nanoparticles with particular characteristics.Although nanoparticles tend to sustain a variety of dislocations that may be seen with high-resolution electron microscopes, they often have fewer point defects than their bulk counterparts However, the dislocation mechanics of nanoparticles differ from those of the bulk material, and this, along with their distinct surface structures, gives rise to mechanical properties that are distinct from the bulk material.

Anisotropy is the property of non-spherical nanoparticles, such as prisms, cubes, rods, etc., that depends on both form and size for their (chemical and physical) properties. Due to their intriguing optical properties, non-spherical nanoparticles of gold (Au), silver (Ag), and platinum (Pt) are finding use in a variety of fields. Nano prisms' non-spherical geometries result in colloidal solutions with high effective cross-sections and richer hues.Utilizing them for molecular labelling, biomolecular assays, trace metal detection, or nanotechnical applications is made possible by the ability to change the resonance frequencies by adjusting the particle geometry. Under unpolarized light, anisotropic nanoparticles exhibit a particular absorption behavior and stochastic particle orientation, revealing a unique resonance mode for each excitable axis.

DISCUSSION

Importance of Introducing "Nano deserts"

Whether widespread use of quasi-photosynthetic CO2 absorption is practical and accurate estimation of its overall importance is conceivable will determine whether "nanodeserts" need to be introduced. Widespread use of quasi-photosynthetic CO2 absorption is not feasible unless nanodeserts are introduced because it has been shown that the current soil-groundwater system in arid and semiarid desert ecosystems contributes both positive and negative CO2 fluxes, and the magnitudes of these two fluxes components are almost the same. Nanodeserts as an emerging technology might not be as unique in the future given the rapid development of nanotechnology and its applications in CO2 capture and storage technology since deserts are piqueing more and more interest in the globe that is becoming more urbanized. We can speculate that there is an ideal size of nanoparticles to significantly reduce CO2 release while enhancing the abiotic CO2 dissolution and fixation beneath nanodeserts because the wide range of nanomaterials and particle sizes offers optional sizes of nanoparticles in the fabrication of nanomaterials.

The values are clearly in flux. It has been shown that quasi-photosynthetic CO2 absorption has a considerable impact on the temperature sensitivity of soil respiration (), which emphasizes the need to create "nanodeserts." When using positive values, the relative change in with each 10°C increase of in the salty desert and cropped farmland mainly dropped into and, respectively, whereas the relative change in with 10°C increases of largely fell into and, respectively, were determined. The alkaline terrain was far more sensitive to than to, as

evidenced by the fact that the mean value of was nearly three times more than the mean value To indicate that the desert was more responsive to than agriculture, the mean value of to in the desert (= 6.83) was greater than the mean value of to in the latter (= 2.95). The sensitivity to was, however, lower in the desert (mean = 1.33) than in farming (mean = 1.98). They nonetheless had a considerable impact on the reaction to, even though those negative values were removed and only the positive values were utilized in the computations of. At both sites, the estimated also uniformly dropped with temperature (= or). This demonstrated that temperature changes in alkaline lands were comparable to those in other terrestrial ecosystems.

Technical characteristic

Since dislocation climb necessitates vacancy migration, the decreasing vacancy concentration in nanocrystals might adversely affect the mobility of dislocations. Additionally, there is a significant internal pressure because of the surface stress in tiny nanoparticles with large curvature radii. In a manner similar to how it affects the work-hardening of materials, this results in a lattice strain that is inversely proportional to the size of the particle As an illustration, gold nanoparticles are much harder than the bulk substance. Furthermore, dislocations are more likely to interact with the particle surface in nanoparticles due to their high surface-to-volume ratio. This specifically alters the dislocation source's characteristics and permits the dislocations to leave the particle before they can accumulate, lowering the dislocation density and, thus, the degree of plastic deformation.

Since typical methods like the universal testing machine cannot be used, measuring mechanical properties at the nanoscale presents special difficulties. As a result, fresh approaches like nanoindentation have been created to supplement current scanning probe and electron microscope techniques. Nanoindentation, which measures the hardness, elastic modulus, and adhesion between a nanoparticle and a substrate, can be carried out using atomic force microscopy (AFM). The deflection of the cantilever tip over the sample allows one to calculate the particle deformation. Calculating elastic modulus can be done using the obtained force-displacement curves. It is not clear, nevertheless, whether particle size and indentation depth have an impact on the elastic modulus of nanoparticles as assessed by AFM.

In nanofabrication, lubrication, device design, colloidal stability, and drug delivery, adhesion and friction forces are crucial factors to take into account. Under ambient conditions, the capillary force is the primary source of the adhesive force. If the AFM tip is thought of as a nanoparticle, the adhesion and friction force can be calculated from the cantilever deflection. However, the tip material and geometrical design of this approach have limitations. By affixing a nanoparticle to the AFM tip and giving users control over size, shape, and material, the colloidal probe approach resolves these problems. Even though the colloidal probe approach is a reliable way to measure adhesion force, it is still challenging to attach a single nanoparticle smaller than 1 micron to the AFM force sensor.

Another method is in situ TEM, which offers high resolution imaging of the response of a nanostructure to a stimulus in real-time. For instance, twinned nanoparticles were compressed and their yield strength was assessed using an in situ force probe holder in a TEM. In general, a variety of factors, such as homogeneous nanoparticle dispersion, exact application of stress, minimal particle deformation, calibration, and calculation model, affect the assessment of the mechanical characteristics of nanoparticles.The characteristics of nanoparticles are material-

dependent, just like bulk materials. When compared to the bulk material, glass transition temperature and crystallinity may have an impact on deformation and alter the elastic modulus for spherical polymer nanoparticles. However, it was not possible to generalize the size-dependent behaviour of elastic moduli across polymers. In contrast to the widely held belief that dislocations are not present in crystalline nanoparticles, dislocations were discovered to affect the mechanical properties of crystalline metal nanoparticles.

Footprints of CO2 in Nano deserts

The carbon footprint, also known as the greenhouse gas footprint, is a measurement of the total amount of greenhouse gases released by a particular activity, good, entity, or nation. Carbon footprints are typically expressed in tons of emissions (CO2-equivalent) per comparative unit, such as per person, year, protein kilogram, or kilometre traveled. The emissions for a product's complete life cycle, from manufacturing along the supply chain to consumption and disposal, are included in the product's carbon footprint. Similar to an individual, an organization's carbon footprint comprises both direct and indirect emissions that the organization is responsible for (referred to as Scope 1, 2, and 3 in the Greenhouse Gas Protocol, which is used for carbon accounting of companies). Depending on whether the focus is on a nation, company, product, or individual person, there are several approaches and online tools available to assess the carbon footprint. Customers may choose a product based on its carbon footprint, for instance, if they want to be environmentally conscious. The carbon footprint can be used to distinguish between economic activities with high and low carbon footprints in the context of reducing climate change. In other words, the idea of a carbon footprint enables everyone to compare the effects that different people, things, businesses, and nations have on the climate. Creating goals and plans for minimizing the carbon footprint is aided by this.

The carbon dioxide equivalent (CO2eq) per unit of comparison is a standard way to express the carbon footprint. It totals all greenhouse gas emissions—not just carbon dioxide—that are produced by various organizations, events, businesses, and other activities. Other definitions simply consider carbon dioxide emissions, leaving out emissions of other greenhouse gases such nitrous oxide and methane.The following techniques are employed to determine each entity's carbon footprint: The Greenhouse Gas Protocol is frequently utilized by organizations. It consists of three carbon emission scopes The distinction between Scope 2 and Scope 3 emissions is that Scope 3 emissions are those indirect emissions that result from an organization's operations but come from sources that they neither own nor control. Consumption-based emissions accounting can be used to determine a country's carbon footprint for a specific year.

Based on input-output analysis, this strategy. Input-output analysis employing consumption-based accounting and the power of today's supercomputers, for instance, can be used to analyze worldwide supply networks. In contrast, nations also create their own national inventories These national inventories solely include GHG emissions from domestic sources (also known as territorial-based accounting or production-based accounting). They don't account for resident production of goods and services (which may be imported), which is known as consumption-based accounting.One advantage of complete carbon footprint reporting (including emissions under Scope 3) is that it closes gaps in existing frameworks: Currently, international transportation is not counted in a country's GHG inventory for the

carbon footprint reporting (also known as consumption-based carbon accounting) assigns ultimate demand, or the people who use the goods and services, as the source of emissions.

Definition

A measure of the total amount of carbon dioxide (CO2) and methane (CH4) emissions of a defined population, system, or activity, considering all relevant sources, sinks, and storage within the spatial and temporal boundary of the population, system, or activity of interest," according to a widely used definition of the term. utilizing the appropriate 100-year global warming potential (GWP100), it is converted to carbon dioxide equivalent. Typically, carbon footprints are expressed in tons of annual emissions CO2-equivalentCarbon footprints are typically expressed in tons of emissions CO2-equivalent per comparative unit, such as per person, per year, per kg of proteinwhen comparing animal products, per km traveled, and similar units.Some scientists just include CO2 when defining carbon footprint, however it's more typical to include several of the significant greenhouse gases. By comparing carbon dioxide equivalents over a relevant time period, say 100 years, the various greenhouse gases can be compared. To indicate that all greenhouse gases, not simply carbon dioxide, are included, some organizations use the terms greenhouse gas footprint or climate footprint.

All of the most significant greenhouse gases are covered by the Greenhouse Gas Protocol as well: "The standard covers the accounting and reporting of seven greenhouse gases covered by the Kyoto Protocol - carbon dioxide In contrast, the IPCC employs a definition for carbon footprint in 2022 that solely takes carbon dioxide into account: According to that definition, the carbon footprint is the "measure of the exclusive total amount of emissions of carbon dioxide (CO2) that are directly and indirectly caused by an activity or are accumulated over the lifecycle stages of a productThe writers of the IPCC report used the definition that was put forth in Only carbon dioxide was used to define the term "carbon footprint" in that article since other greenhouse gases had a wider range of global warming potential and were therefore more challenging to measure. Additionally, they had argued that the carbon footprint indicator would be less useful if all greenhouse gases were included. One drawback of excluding methane from the research is that certain goods or industries such as cattle, which has a high methane footprint might appear better or less bad for the environment than they actually are.

CONCLUSION

As a unified concept, "nanodeserts" aim to give desert researchers a better understanding of the footprints of abiotic CO2 transport, conversion, and assignment in the soil-groundwater system beneath deserts. They also suggest a conjecture in nanotechnology to enhance quasi-photosynthetic CO2 absorption. By significantly limiting CO2 emission above the desert's surface and emphasizing the abiotic CO2 fixing beneath the desert, nanodeserts, on the other hand, provide a stable temperature sensitivity of soil respiration in deserts. If/when the dream comes true, it won't be hard to make extensive use of the quasi-photosynthetic CO2 absorption in the soil-groundwater system and present more explicit modeling findings in order to establish a trustworthy estimate of the quasi-photosynthetic CO2 absorption beneath nanodeserts. Future generations may not find this novel because of the growing interest that deserts are receiving in an increasingly urbanized world.

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