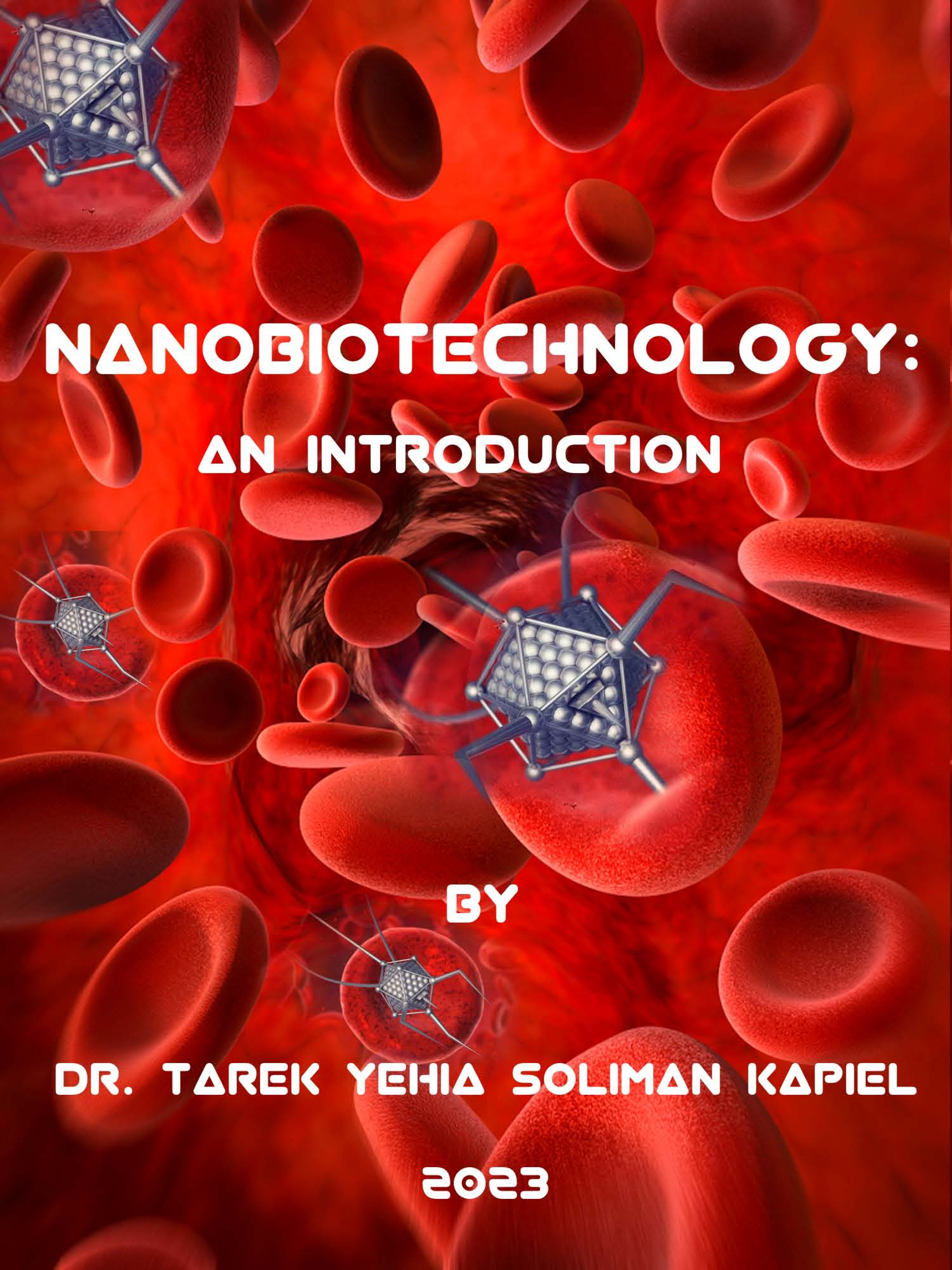

NANOBIOTECHNOLOGY:

AN INTRODUCTION

BY

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1. Introduction: Nanotechnology.. The Future of Science

Nanotechnology is a field of science that deals with the manipulation of matter on an atomic and molecular scale. **It is a multidisciplinary field** that combines physics, chemistry, biology, engineering, and computer science to create new materials and devices with unique properties. The prefix "**nano**" refers to one billionth of a meter, which is the scale at which nanotechnology operates.

Nanotechnology is a rapidly growing field that involves the manipulation of matter at the nanoscale level. This technology has the potential to revolutionize various industries, including medicine, electronics, energy, and materials science.

Nanotechnology involves designing and creating new materials and devices with unique properties that are not found in their bulk counterparts.

The field of nanotechnology has already produced many breakthroughs, such as **improved drug delivery systems**, **more efficient solar cells**, and **stronger and lighter materials**.

The concept of nanotechnology was first introduced by physicist **Richard Feynman** in his famous lecture "**There's Plenty of Room at the Bottom**" in **1959**. However, it was not until the **1980s** that scientists were able to manipulate individual atoms and molecules using **scanning tunneling microscopy** (STM) and **atomic force microscopy** (AFM). Since then, nanotechnology has grown rapidly and has become one of the most promising fields in science.

One of the most significant advantages of nanotechnology is its **ability to create materials with unique properties that are not found in nature**. For example, **carbon nanotubes** are incredibly strong and lightweight, making them ideal for use in aerospace applications. Nanoparticles can also be used to create materials that are self-cleaning or have antimicrobial properties.

Another area where nanotechnology has shown great promise is in medicine. **Nanoparticles** can be used as drug delivery systems, allowing drugs to be targeted directly to cancer cells or other diseased tissues while minimizing side effects on healthy cells. Nanosensors can also be used for early detection of diseases such as cancer or Alzheimer's disease.

Nanotechnology also has potential applications in energy production and storage. For example, solar cells made from nanoparticles could be more efficient than traditional silicon-based solar cells. Nanomaterials could also be used for energy storage in batteries or supercapacitors.

With continued research and development, nanotechnology promises to bring about significant advancements in various fields that could have a profound impact on society.

Despite its many potential benefits, **there are also concerns about the safety of nanotechnology**. Because nanoparticles are so small, they can easily enter the body through inhalation or ingestion and may have unknown effects on human health. There is also concern about the environmental impact of nanoparticles if they are released into the environment.

To address these concerns, researchers are working to develop safe methods for handling nanoparticles and studying their effects on human health and the environment. Regulatory agencies such as the US Environmental Protection Agency (EPA) have also established guidelines for the safe use of nanomaterials.

In conclusion, ***nanotechnology has enormous potential for creating new materials and devices with unique properties that could revolutionize many fields including medicine, energy production, and electronics***. However, it is essential to ensure that this technology is developed **safely** and responsibly to minimize any potential risks to human health or the environment.

With continued research and development, nanotechnology could become one of the most significant scientific breakthroughs of our time.

2. Definition of Nanobiotechnology

Nanobiotechnology is a relatively new field of science that combines nanotechnology and biotechnology to create new materials, devices, and systems for use in medical and industrial applications.

It is an interdisciplinary field that combines the principles of nanoscience with the tools of biotechnology to create novel materials, devices, and systems for use in medical and industrial applications.

Nanobiotechnology is based on the idea that manipulating matter at the nanoscale can lead to new discoveries in medicine, energy production, environmental protection, and other areas.

Nanoparticles are used to create materials with unique properties such as increased strength or improved electrical conductivity. These particles can also be used to deliver drugs or other therapeutic agents directly to specific cells or tissues.

Nanobiotechnology has been used in a variety of ways including drug delivery systems, tissue engineering, biosensors, diagnostics, gene therapy, and regenerative medicine. In drug delivery systems, nanoparticles are used to deliver drugs directly to specific cells or tissues. This allows for more precise targeting of drugs which can reduce side effects and improve efficacy. In tissue engineering, nanomaterials are used to create artificial tissues or organs that can be implanted into patients. Biosensors are devices that detect biological molecules such as proteins or DNA sequences which can be used for diagnostics or disease detection. Gene therapy uses nanoparticles to deliver genetic material into cells which can then be used to treat genetic diseases or disorders. Finally, regenerative medicine uses nanomaterials to stimulate the body's natural healing processes which can help repair damaged tissues or organs.

Nanobiotechnology has the potential to revolutionize many aspects of medicine and industry by providing more precise control over materials at the nanoscale level. This could lead to improved treatments for diseases as well as more efficient production processes in industry. As research continues in this field, it is likely that we will see even more applications for this technology in the future.

3. Nanobiotechnology & Bionanotechnology

Nanobiotechnology, bionanotechnology, and nanobiology are terms that refer to the intersection of nanotechnology and biology. Given that the subject is one that has only emerged very recently, bionanotechnology and nanobiotechnology serve as blanket terms for various related technologies.

This discipline helps to indicate the merger of biological research with various fields of nanotechnology. Concepts that are enhanced through ***nanobiology*** include ***nanodevices*** (such as biological machines), ***nanoparticles***, and ***nanoscale phenomena*** that occurs within the discipline of ***nanotechnology***.

This technical approach to biology allows scientists to imagine and create systems that can be used for biological research. Biologically inspired nanotechnology uses biological systems as the inspirations for technologies not yet created.

However, as with nanotechnology and biotechnology, ***bionanotechnology*** does have many potential ethical issues associated with it.

Terminology

The terms are often used *interchangeably*. When a distinction is intended, though, it is based on whether the focus is **on applying biological ideas** or on **studying biology with nanotechnology**.

Bionanotechnology generally refers to the study of how the goals of nanotechnology can be guided by studying how biological "**machines**" work and adapting these biological motifs into improving existing nanotechnologies or creating new ones.

Nanobiotechnology, on the other hand, refers to the ways that nanotechnology is used to create devices to study biological systems.

In other words, **Nanobiotechnology** is essentially miniaturized biotechnology, whereas **Bionanotechnology** is a specific application of nanotechnology.

For example, **DNA nanotechnology** or cellular engineering would be classified as *bionanotechnology* because they involve working with biomolecules on the nanoscale.

Conversely, many new medical technologies involving *nanoparticles as delivery systems* or as *sensors* would be examples of **Nanobiotechnology** since they involve using nanotechnology to advance the goals of biology.

The definitions enumerated above will be utilized whenever a distinction between ***nanobio*** and ***bionano*** is made in this course.

Concepts

Most of the scientific concepts in ***bionanotechnology*** are derived from other fields. Biochemical principles that are used to understand the material properties of biological systems are central in bionanotechnology because those same principles are to be used to create new technologies.

Material properties and applications studied in ***bionanoscience*** include mechanical properties (e.g. deformation, adhesion, failure), electrical/electronic (e.g. electromechanical stimulation, capacitors, energy storage/batteries), optical (e.g. absorption, luminescence, photochemistry), thermal (e.g. thermomutability, thermal management), biological (e.g. how cells interact with nanomaterials, molecular flaws/defects, biosensing, biological mechanisms such as mechanosensation), nanoscience of disease (e.g. genetic disease, cancer, organ/tissue failure), as well as biological computing (e.g. DNA computing) and agriculture (target delivery of pesticides, hormones and fertilizers.

The impact of bionanoscience, achieved through structural and mechanistic analyses of biological processes at nanoscale, is their translation into synthetic and technological applications through nanotechnology.

Nanobiotechnology takes most of its fundamentals from nanotechnology. Most of the devices designed for nano-biotechnological use are directly based on other existing nanotechnologies.

Nanobiotechnology is often used to describe the overlapping multidisciplinary activities associated with biosensors, particularly where photonics, chemistry, biology, biophysics, nanomedicine, and engineering converge. Measurement in biology using wave-guide techniques, such as dual-polarization interferometry, is another example.

Applications

Applications of bionanotechnology are extremely widespread. Insofar as the distinction holds, nanobiotechnology is much more commonplace in that it simply provides more tools for the study of biology. Bionanotechnology, on the other hand, promises to recreate biological mechanisms and pathways in a form that is useful in other ways.

A ribosome is a biological machine

The most important objectives that are frequently found in nanobiology involve applying nanotools to relevant medical/biological problems and refining these applications. Developing new tools, such as peptoid nanosheets, for medical and biological purposes is another primary objective in nanotechnology.

New nanotools are often made by refining the applications of the nanotools that are already being used. The imaging of native biomolecules, biological membranes, and tissues is also a major topic for nanobiology researchers. Other topics concerning nanobiology include the use of cantilever array sensors and the application of nanophotonics for manipulating molecular processes in living cells.

Recently, the use of microorganisms to synthesize functional nanoparticles has been of great interest. Microorganisms can change the oxidation state of metals. These microbial processes have opened up new opportunities for us to explore novel applications, for example, the biosynthesis of metal nanomaterials. In contrast to chemical and physical methods, microbial processes for synthesizing nanomaterials can be achieved in aqueous phase under gentle and environmentally benign conditions. This approach has become an attractive focus in current green bionanotechnology research towards sustainable development.

Nanomedicine

Nanomedicine is a field of medical science whose applications are increasing.

Nanobots

The field includes nanorobots and biological machines, which constitute a very useful tool to develop this area of knowledge. In the past years, researchers have made many improvements in the different devices and systems required to develop functional nanorobots – such as motion and magnetic guidance. This supposes a new way of treating and dealing with diseases such as cancer; thanks to nanorobots, side effects of chemotherapy could get controlled, reduced and even eliminated, so some years from now, cancer patients could be offered an alternative to treat such diseases instead of chemotherapy, which causes secondary effects such as hair loss, fatigue or nausea killing not only cancerous cells but also the healthy ones.

Nanobots could be used for various therapies, surgery, diagnosis, and medical imaging – such as via targeted drug-delivery to the brain (similar to nanoparticles) and other sites. Programmability for combinations of features such as "tissue penetration, site-targeting, stimuli responsiveness, and cargo-loading" makes such nanobots promising candidates for "precision medicine".

At a clinical level, cancer treatment with nanomedicine would consist of the supply of nanorobots to the patient through an injection that will search for cancerous cells while leaving the healthy ones untouched. Patients that are treated through nanomedicine would thereby not notice the presence of these nanomachines inside them; the only thing that would be noticeable is the progressive improvement of their health. Nanobiotechnology may be useful for medicine formulation.

"Precision antibiotics" has been proposed to make use of bacteriocin-mechanisms for targeted antibiotics.

Artificial cells

Artificial cells such as synthetic red blood cells that have all or many of the natural cells' known broad natural properties and abilities could be used to load functional cargos such as hemoglobin, drugs, magnetic nanoparticles, and ATP biosensors which may enable additional non-native functionalities.

Other

Nanofibers that mimic the matrix around cells and contain molecules that were engineered to wiggle was shown to be a potential therapy for spinal cord injury in mice.

Technically, gene therapy can also be considered to be a form of nanobiotechnology or to move towards it. An example of an area of genome editing related developments that is more clearly nanobiotechnology than more conventional gene therapies, is synthetic fabrication of functional materials in tissues. Researcher made C. elegans worms synthesize, fabricate, and assemble bioelectronic materials in its brain cells.

They enabled modulation of membrane properties in specific neuron populations and manipulation of behavior in the living animals which might be useful in the study and treatments for diseases such as multiple sclerosis in specific and demonstrates the viability of such synthetic in vivo fabrication. Moreover, such genetically modified neurons may enable connecting external components – such as prosthetic limbs – to nerves.

Nanosensors based on e.g. nanotubes, nanowires, cantilevers, or atomic force microscopy could be applied to diagnostic devices/sensors

Nanobiotechnology (sometimes referred to as nanobiology) in medicine may be best described as helping modern medicine progress from treating symptoms to generating cures and regenerating biological tissues.

Three American patients have received whole cultured bladders with the help of doctors who use nanobiology techniques in their practice. Also, it has been demonstrated in animal studies that a uterus can be grown outside the body and then placed in the body in order to produce a baby. Stem cell treatments have been used to fix diseases that are found in the human heart and are in clinical trials in the United States. There is also funding for research into allowing people to have new limbs without having to resort to prosthesis. Artificial proteins might also become available to manufacture without the need for harsh chemicals and expensive machines. It has even been surmised that by the year 2055, computers may be made out of biochemicals and organic salts.[38]

In vivo biosensors

Another example of current nanobiotechnological research involves nanospheres coated with fluorescent polymers. Researchers are seeking to design polymers whose fluorescence is quenched when they encounter specific molecules. Different polymers would detect different metabolites. The polymer-coated spheres could become part of new biological assays, and the technology might someday lead to particles which could be introduced into the human body to track down metabolites associated with tumors and other health problems. Another example, from a different perspective, would be evaluation and therapy at the nanoscopic level, i.e. the treatment of nanobacteria (25-200 nm sized) as is done by NanoBiotech Pharma.[citation needed]

In vitro biosensors

"Nanoantennas" made out of DNA – a novel type of nano-scale optical antenna – can be attached to proteins and produce a signal via fluorescence when these perform their biological functions, in particular for their distinct conformational changes. This could be used for further nanobiotechnology such as various types of nanomachines, to develop new drugs, for bioresearch and for new avenues in biochemistry.

Energy

It may also be useful in sustainable energy: in 2022, researchers reported 3D-printed nano-"skyscraper" electrodes – albeit micro-scale, the pillars had nano-features of porosity due to printed metal nanoparticle inks – (nanotechnology) that house cyanobacteria for extracting substantially more sustainable bioenergy from their photosynthesis (biotechnology) than in earlier studies.

Nanobiology

While nanobiology is in its infancy, there are a lot of promising methods that may rely on nanobiology in the future. Biological systems are inherently nano in scale; nanoscience must merge with biology in order to deliver biomacromolecules and molecular machines that are similar to nature. Controlling and mimicking the devices and processes that are constructed from molecules is a tremendous challenge to face for the converging disciplines of nanobiotechnology. All living things, including humans, can be considered to be nanofoundries. Natural evolution has optimized the "natural" form of nanobiology over millions of years. In the 21st century, humans have developed the technology to artificially tap into nanobiology. This process is best described as "organic merging with synthetic". Colonies of live neurons can live together on a biochip device; according to research from Dr. Gunther Gross at the University of North Texas. Self-assembling nanotubes have the ability to be used as a structural system. They would be composed together with rhodopsins; which would facilitate the optical computing process and help with the storage of biological materials. DNA (as the software for all living things) can be used as a structural proteomic system – a logical component for molecular computing. Ned Seeman – a researcher at New York University – along with other researchers are currently researching concepts that are similar to each other.

Bionanotechnology

Distinction from nanobiotechnology

Broadly, bionanotechnology can be distinguished from nanobiotechnology in that it refers to nanotechnology that makes use of biological materials/components – it could in principle or does alternatively use abiotic components. It plays a smaller role in medicine (which is concerned with biological organisms). It makes use of natural or biomimetic systems or elements for unique nanoscale structures and various applications that may not be directionally associated with biology rather than mostly biological applications. In contrast, nanobiotechnology uses biotechnology miniaturized to nanometer size or incorporates nanomolecules into biological systems. In some future applications, both fields could be merged. additional citation(s) needed]

DNA

DNA nanotechnology is one important example of bionanotechnology. The utilization of the inherent properties of nucleic acids like DNA to create useful materials or devices – such as biosensors – is a promising area of modern research.

DNA digital data storage refers mostly to the use of synthesized but otherwise conventional strands of DNA to store digital data, which could be useful for e.g. high-density long-term data storage[53] that isn't accessed and written to frequently as an alternative to 5D optical data storage or for use in combination with other nanobiotechnology.

Membrane materials

Another important area of research involves taking advantage of membrane properties to generate synthetic membranes. Proteins that self-assemble to generate functional materials could be used as a novel approach for the large-scale production of programmable nanomaterials. One example is the development of amyloids found in bacterial biofilms as engineered nanomaterials that can be programmed genetically to have different properties.

Lipid nanotechnology

Lipid nanotechnology is another major area of research in bionanotechnology, where physico-chemical properties of lipids such as their antifouling and self-assembly is exploited to build nanodevices with applications in medicine and engineering.[55] Lipid nanotechnology approaches can also be used to develop next-generation emulsion methods to maximize both absorption of fat-soluble nutrients and the ability to incorporate them into popular beverages.

Computing

"Memristors" fabricated from protein nanowires of the bacterium Geobacter sulfurreducens which function at substantially lower voltages than previously described ones may allow the construction of artificial neurons which function at voltages of biological action potentials. The nanowires have a range of advantages over silicon nanowires and the memristors may be used to directly process biosensing signals, for neuromorphic computing (see also: wetware computer) and/or direct communication with biological neurons.

Other

Protein folding studies provide a third important avenue of research, but one that has been largely inhibited by our inability to predict protein folding with a sufficiently high degree of accuracy. Given the myriad uses that biological systems have for proteins, though, research into understanding protein folding is of high importance and could prove fruitful for bionanotechnology in the future.[citation needed]

Agriculture

In the agriculture industry, engineered nanoparticles have been serving as nano carriers, containing herbicides, chemicals, or genes, which target particular plant parts to release their content.

Previously nanocapsules containing herbicides have been reported to effectively penetrate through cuticles and tissues, allowing the slow and constant release of the active substances. Likewise, other literature describes that nano-encapsulated slow release of fertilizers has also become a trend to save fertilizer consumption and to minimize environmental pollution through precision farming. These are only a few examples from numerous research works which might open up exciting opportunities for nanobiotechnology application in agriculture. Also, application of this kind of engineered nanoparticles to plants should be considered the level of amicability before it is employed in agriculture practices. Based on a thorough literature survey, it was understood that there is only limited authentic information available to explain the biological consequence of engineered nanoparticles on treated plants. Certain reports underline the phytotoxicity of various origin of engineered nanoparticles to the plant caused by the subject of concentrations and sizes . At the same time, however, an equal number of studies were reported with a positive outcome of nanoparticles, which facilitate growth promoting nature to treat plant.[62] In particular, compared to other nanoparticles, silver and gold nanoparticles based applications elicited beneficial results on various plant species with less and/or no toxicity.[63][64] Silver nanoparticles (AgNPs) treated leaves of Asparagus showed the increased content of ascorbate and chlorophyll. Similarly, AgNPs-treated common bean and corn has increased shoot and root length, leaf surface area, chlorophyll, carbohydrate and protein contents reported earlier.[65] The gold nanoparticle has been used to induce growth and seed yield in Brassica juncea.

Tools

This field relies on a variety of research methods, including experimental tools (e.g. imaging, characterization via AFM/optical tweezers etc.), x-ray diffraction based tools, synthesis via self-assembly, characterization of self-assembly (using e.g. MP-SPR, DPI, recombinant DNA methods, etc.), theory (e.g. statistical mechanics, nanomechanics, etc.), as well as computational approaches (bottom-up multi-scale simulation, supercomputing).

Risk management

Further information: Technological fix § Concerns, and Differential technological development

As of 2009, the risks of nanobiotechnologies are poorly understood and in the U.S. there is no solid national consensus on what kind of regulatory policy principles should be followed.[33] For example, nanobiotechnologies may have hard to control effects on the environment or ecosystems and human health.

Bonin notes that "Nanotechnology is not a specific determinate homogenous entity, but a collection of diverse capabilities and applications" and that nanobiotechnology research and development is – as one of many fields – affected by dual-use problems.

Nanoparticles

Nanoparticles are already widely used in medicine. Its applications overlap with those of nanobots and in some cases it may be difficult to distinguish between them. They can be used to for diagnosis and targeted drug delivery, encapsulating medicine.[21] Some can be manipulated using magnetic fields and, for example, experimentally, remote-controlled hormone release has been achieved this way.

On example advanced application under development are "Trojan horse" designer-nanoparticles that makes blood cells eat away – from the inside out – portions of atherosclerotic plaque that cause heart attacks and are the current most common cause of death globally.

Properties of nanoparticles

Nanoparticles are particles that measure between 1 and 100 nanometers in size. They have unique properties that make them useful in a variety of applications, from medical treatments to industrial processes. In this article, we will explore some of the properties of nanoparticles and how they can be used.

One of the most important properties of nanoparticles is their size. Because they are so small, they can penetrate deep into tissues and organs, making them ideal for targeted drug delivery. They can also be used to create nanostructures with precise shapes and sizes, which can be used for a variety of purposes such as creating sensors or catalysts.

Another important property of nanoparticles is their surface area-to-volume ratio. This ratio is much higher than that of larger particles, which means that more molecules can interact with the surface area at any given time. This makes them ideal for chemical reactions as well as adsorption and desorption processes.

Nanoparticles also have unique optical properties due to their small size. They scatter light differently than larger particles, which makes them useful for optical applications such as solar cells or displays. They also have high thermal conductivity, making them useful for heat transfer applications such as cooling systems or thermal insulation materials.

Nanoparticles are highly reactive due to their large surface area-to-volume ratio and high reactivity at the surface level. This makes them ideal for catalytic reactions or chemical synthesis processes where high reactivity is desired.

In conclusion, nanoparticles have a wide range of unique properties that make them useful in many different applications ranging from medical treatments to industrial processes. Their small size allows them to penetrate deep into tissues and organs while their large surface area-to-volume ratio allows for high reactivity at the surface level. Additionally, they have unique optical properties that make them useful for optical applications as well as high thermal conductivity which makes them ideal for heat transfer applications.

Nanoparticles

Nanoparticles are particles with a size of 1-100 nanometers, and they have unique properties that make them useful in a variety of applications. Synthesizing nanoparticles is an important process for creating these materials, and there are several different methods available for doing so. In this article, we will discuss some of the most common methods for synthesizing nanoparticles.

Methods of synthesizing of nanoparticles

Nanoparticles are particles with a size of 1-100 nanometers. They have unique properties that make them useful for a variety of applications, including medical diagnostics, drug delivery, and energy storage. Synthesizing nanoparticles is an important step in the development of these applications, and there are several methods used to do so.

Physical vapor deposition (PVD) is one of the most common methods used to synthesize nanoparticles. In this process, a material is heated until it vaporizes and then deposited onto a substrate.

This method can be used to create thin films or coatings on surfaces, as well as nanoparticles with specific shapes and sizes. PVD can also be used to create nanostructures such as nanowires or nanotubes.

Chemical vapor deposition (CVD) is another popular method for synthesizing nanoparticles. In this process, a gas containing the desired material is passed over a heated substrate, causing the material to deposit onto the surface in the form of particles or thin films. CVD can be used to create nanoparticles with precise shapes and sizes, as well as complex structures such as nanowires or nanotubes.

Solution-based synthesis is another method used to synthesize nanoparticles. In this process, chemicals are mixed together in solution to form the desired material in particle form. This method can be used to create particles with specific shapes and sizes, as well as complex structures such as nanowires or nanotubes. Solution-based synthesis is often used when creating particles from metals or semiconductors that cannot be created using PVD or CVD methods.

Laser ablation is another method for synthesizing nanoparticles that involves using a laser beam to vaporize a target material into tiny particles that are then collected on a substrate or in solution. This method can be used to create particles with specific shapes and sizes, as well as complex structures such as nanowires or nanotubes. Laser ablation has been successfully used for creating metal oxide nanoparticles for use in medical diagnostics and drug delivery applications.

These are just some of the methods commonly used for synthesizing nanoparticles today. Each method has its own advantages and disadvantages depending on the application it's being used for, so it's important to choose the right one for your needs before beginning any project involving nanoparticle synthesis.

Biological synthesizing of nanoparticles

Nanoparticles are particles that measure between 1 and 100 nanometers in size. They have unique properties that make them useful for a variety of applications, including medical diagnostics, drug delivery, and environmental remediation.

In recent years, there has been an increased interest in the biological synthesis of nanoparticles due to their potential for use in a wide range of applications.

Biological synthesis of nanoparticles involves ***the use of living organisms or their components to produce nanoparticles.*** This method has several advantages over traditional chemical synthesis methods, such as being more cost-effective and environmentally friendly. Additionally, biological synthesis can be used to produce particles with specific shapes and sizes that are not achievable with chemical methods.

One method of biological synthesis is ***microbial-mediated synthesis***. This involves using microorganisms such as bacteria or fungi to produce nanoparticles from metal ions or organic compounds. The microorganisms can be genetically modified to increase their efficiency at producing the desired particles. This method is particularly useful for producing metal oxide nanoparticles, which have a wide range of applications in medicine and industry.

Another method is ***plant-mediated synthesis***, which uses plants as bioreactors to produce nanoparticles from metal ions or organic compounds. This method has the advantage of being able to produce particles with specific shapes and sizes that are not achievable with chemical methods. Additionally, it is more cost-effective than microbial-mediated synthesis since it does not require genetic modification of the microorganisms used.

A third method is ***enzyme-mediated synthesis***, which uses enzymes to catalyze the formation of nanoparticles from metal ions or organic compounds. This method has the advantage of being able to produce particles with specific shapes and sizes that are not achievable with chemical methods. Additionally, it is more cost-effective than microbial-mediated or plant-mediated synthesis since it does not require genetic modification or bioreactors respectively.

Overall, biological synthesizing offers several advantages over traditional chemical methods for producing nanoparticles due to its cost effectiveness and ability to produce particles with specific shapes and sizes that are not achievable with chemical methods. As research into this field continues, we can expect to see an increased use of biological synthesizing in a variety of applications in the near future.

Classification of nanoparticles

Nanoparticles have unique properties due to their small size, which makes them useful in a variety of applications. Nanoparticles can be classified into two main categories: ***organic*** and ***inorganic***.

Organic nanoparticles are made up of carbon-based molecules and can be further divided into three subcategories: polymeric, liposomal, and dendrimeric. Polymeric nanoparticles are composed of polymers such as polyethylene glycol (PEG) or polylactic acid (PLA). These particles can be used for drug delivery, as they can encapsulate drugs and protect them from degradation. Liposomal nanoparticles are composed of lipids and proteins that form a bilayer structure. These particles are used for drug delivery as well as gene therapy. Dendrimeric nanoparticles are composed of branched molecules that form a three-dimensional structure. These particles can be used for drug delivery, gene therapy, and imaging agents.

Inorganic nanoparticles are made up of metal oxides or other inorganic materials such as silica or titanium dioxide. These particles can be further divided into four subcategories: quantum dots, nanorods, nanowires, and nanotubes. Quantum dots are semiconductor crystals that emit light when excited by an external source such as UV light or electricity. They have applications in medical imaging and sensing devices due to their unique optical properties. Nanorods are cylindrical structures made up of metal oxides or other materials that have applications in catalysis and sensing devices due to their large surface area-to-volume ratio. Nanowires are long wires made up of metal oxides or other materials that have applications in electronics due to their high conductivity. Finally, nanotubes are hollow tubes made up of metal oxides or other materials that have applications in electronics due to their high strength-to-weight ratio and electrical conductivity.

In conclusion, nanoparticles can be classified into two main categories: organic and inorganic. Organic nanoparticles include polymeric, liposomal, and dendrimeric particles while inorganic nanoparticles include quantum dots, nanorods, nanowires, and nanotubes. Each type has its own unique properties which make them useful for different applications such as drug delivery systems, medical imaging agents, sensing devices, catalysis agents, electronics components etc..

Green nanoparticles

Nanoparticles are being used in a variety of industries, from medical to energy, due to their unique properties. Recently, green nanoparticles have been developed that offer a range of environmental benefits.

Green nanoparticles are made from materials such as carbon nanotubes, graphene, and other nanomaterials. These materials are highly efficient at absorbing light and converting it into energy.

This makes them ideal for use in solar cells and other renewable energy sources. In addition, they can be used to create more efficient batteries and fuel cells.

Green nanoparticles also have potential applications in the medical field. For example, they can be used to deliver drugs directly to specific areas of the body with greater accuracy than traditional methods. This could lead to more effective treatments for diseases such as cancer and Alzheimer's disease. In addition, they can be used to create more efficient diagnostic tools that require less invasive procedures.

Green nanoparticles also have potential applications in the field of environmental protection. For instance, they can be used to create more efficient water filtration systems that remove pollutants from water sources with greater accuracy than traditional methods. They can also be used to create better air filters that remove harmful particles from the air we breathe with greater efficiency than current technologies allow for.

Overall, green nanoparticles offer a range of potential benefits for both industry and the environment alike. As research into their properties continues, we may soon see them being used in a variety of applications across many different industries.

Cell nanoparticles

Cell nanoparticles are a relatively new and exciting field of research that has the potential to revolutionize the way we treat diseases. Nanoparticles are tiny particles, typically measuring between 1 and 100 nanometers in size that can be used to deliver drugs or other therapeutic agents directly to cells. This technology has the potential to provide more targeted and effective treatments for a variety of diseases, including cancer, heart disease, and neurological disorders.

The use of cell nanoparticles is based on the fact that they can be designed to interact with specific cell types or molecules in order to deliver their payloads.

For example, nanoparticles can be designed to target cancer cells while leaving healthy cells unharmed. This allows for more precise delivery of drugs or other therapeutic agents directly to the site of disease without affecting healthy tissue. Additionally, because nanoparticles are so small, they can easily pass through cell membranes, allowing them to reach their targets quickly and efficiently.

In addition to delivering drugs or other therapeutic agents directly to cells, cell nanoparticles can also be used for diagnostic purposes. By attaching fluorescent markers or other imaging agents to the surface of the particles, researchers can track their movement within a cell or tissue sample in order to gain insight into how a particular drug is interacting with its target. This could help scientists better understand how certain drugs work and how they might be improved upon in order to make them more effective treatments for various diseases.

Cell nanoparticles have already been used in clinical trials for a variety of conditions including cancer and heart disease. While these trials have shown promising results so far, there is still much work that needs to be done before this technology can become widely available as a treatment option for patients suffering from these conditions. However, with continued research and development it is likely that cell nanoparticle technology will eventually become an important tool in our fight against disease.

Methods of nanoparticles characterization

Nanoparticles are particles with a size of 1 to 100 nanometers, and they have unique properties that make them useful in a variety of applications. Characterizing nanoparticles is essential for understanding their behavior and properties, as well as for optimizing their use in various applications. There are several methods used to characterize nanoparticles, including physical, chemical, and biological techniques.

Physical techniques are used to measure the size, shape, and surface area of nanoparticles. These techniques include transmission electron microscopy (TEM), scanning electron microscopy (SEM), atomic force microscopy (AFM), dynamic light scattering (DLS), and laser diffraction.

TEM is used to image individual particles at high resolution and can be used to measure particle size and shape. SEM is similar to

TEM but has lower resolution but can be used to measure surface features such as roughness or porosity. AFM is a technique that uses a probe tip to measure the surface topography of particles at nanometer-scale resolution. DLS measures the diffusion of light through a suspension of particles and can be used to determine particle size distribution. Laser diffraction measures the scattering pattern of light from particles suspended in liquid or gas and can also be used to determine particle size distribution.

Chemical techniques are used to analyze the chemical composition of nanoparticles. These techniques include X-ray photoelectron spectroscopy (XPS), energy dispersive X-ray spectroscopy (EDS), inductively coupled plasma mass spectrometry (ICP-MS), Fourier transform infrared spectroscopy (FTIR) and Raman spectroscopy. XPS is an analytical technique that measures the elemental composition of surfaces by detecting electrons emitted from atoms when exposed to X-rays. EDS is similar but uses X-rays instead of electrons for detection. ICP-MS is an analytical technique that measures the elemental composition of samples by ionizing them with an argon plasma before measuring them with a mass spectrometer. FTIR measures the vibrational modes of molecules in samples by passing infrared radiation through them while Raman spectroscopy measures the scattering pattern of light from molecules in samples which can be used to identify them based on their unique vibrational modes.

Biological techniques are also used for characterizing nanoparticles, such as cell culture assays which measure how cells interact with nanoparticles or immunoassays which measure how antibodies interact with nanoparticles. These techniques provide information about how nanoparticles interact with biological systems which can be useful for understanding their toxicity or potential therapeutic effects in humans or other organisms.

In conclusion, there are several methods available for characterizing nanoparticles including physical, chemical, and biological techniques which provide information about particle size, shape, surface area, composition, interaction with cells or antibodies, etc., allowing researchers to better understand their behavior and properties as well as optimize their use in various applications such as drug delivery systems or medical diagnostics tools.

Nanobiotechnology Applications

Nanobiotechnology is a relatively new field of science that combines nanotechnology and biotechnology to create new materials, products, and processes. It has the potential to revolutionize the way we approach medicine, energy production, and environmental protection. In this article, we will explore some of the potential applications of nanobiotechnology.

One of the most promising applications of nanobiotechnology is in the field of medicine. Nanoparticles can be used to deliver drugs directly to specific cells or tissues in the body, allowing for more targeted treatments with fewer side effects. Nanoparticles can also be used to detect diseases at an early stage by detecting biomarkers in a patient's blood or other bodily fluids. This could lead to earlier diagnosis and treatment for many diseases.

Nanobiotechnology can also be used to improve energy production and storage. Nanoparticles can be used to create more efficient solar cells that are able to capture more energy from sunlight than traditional cells. They can also be used in batteries to store more energy for longer periods of time. This could lead to improved renewable energy sources that are more reliable and cost-effective than current options.

Finally, nanobiotechnology has potential applications in environmental protection. Nanoparticles can be used to clean up oil spills or other hazardous materials from water sources quickly and efficiently. They can also be used as sensors to detect pollutants in air or water before they reach dangerous levels, allowing for timely interventions that could prevent long-term damage.

Nanobiotechnology is still a relatively new field with much potential yet untapped. As research continues into its various applications, it is likely that we will see even more innovative uses for this technology in the future. From medical treatments and renewable energy sources to environmental protection, nanobiotechnology has the potential to revolutionize many aspects of our lives for the better.

Mechanisms of nanoparticles entry into the cell

Nanoparticles are increasingly being used in a variety of applications, ranging from drug delivery to medical imaging. However, one of the major challenges in using nanoparticles is their ability to enter cells. This **article** will discuss the various mechanisms by which nanoparticles can enter cells and how they can be used for therapeutic purposes.

The most common way for nanoparticles to enter cells is through endocytosis, a process by which cells take up material from their environment. Endocytosis can occur through either clathrin-mediated endocytosis or caveolae-mediated endocytosis. Clathrin-mediated endocytosis involves the formation of clathrin-coated vesicles that enclose the nanoparticle and bring it into the cell. Caveolae-mediated endocytosis involves the formation of small invaginations in the cell membrane that allow for the uptake of material from outside the cell.

In addition to endocytosis, nanoparticles can also enter cells through transmembrane diffusion or receptor-mediated endocytosis. Transmembrane diffusion occurs when a nanoparticle is small enough to pass through the cell membrane without being taken up by an endocytic vesicle. Receptor-mediated endocytosis occurs when a specific receptor on the surface of a cell binds to a ligand on the surface of a nanoparticle, allowing it to be taken up by an endocytic vesicle.

Once inside a cell, nanoparticles can be used for therapeutic purposes such as drug delivery or gene therapy. In drug delivery, nanoparticles are loaded with drugs and then targeted to specific areas within a cell where they can release their cargo and exert their therapeutic effect. In gene therapy, DNA or RNA molecules are loaded onto nanoparticles and delivered into cells where they can be expressed and produce proteins that have therapeutic effects.

In conclusion, there are several mechanisms by which nanoparticles can enter cells and be used for therapeutic purposes such as drug delivery or gene therapy. Understanding these mechanisms is essential for developing effective strategies for using nanotechnology in medicine and other fields.

Nanotoxicology

Nanotoxicology is an emerging field of study that focuses on the potential health risks posed by nanomaterials. Nanomaterials are materials that are engineered at the nanoscale, meaning they are between 1 and 100 nanometers in size. These materials have unique properties that make them attractive for use in a variety of applications, such as medical devices, electronics, and consumer products. However, due to their small size, nanomaterials can easily enter the body and interact with cells and tissues in ways that are not yet fully understood. As a result, there is growing concern about the potential health risks posed by these materials.

Nanotoxicology is an interdisciplinary field that combines elements of toxicology, nanotechnology, and biology to study the effects of nanomaterials on human health. Researchers in this field investigate how different types of nanomaterials interact with cells and tissues in the body, as well as how they may cause adverse health effects such as inflammation or cancer. They also look at how different environmental factors can affect the toxicity of these materials, such as exposure to sunlight or other pollutants.

In addition to studying the potential health risks posed by nanomaterials, researchers in this field also work to develop safer alternatives. For example, they may look for ways to modify existing materials so that they are less toxic or more biocompatible with human cells. They may also develop new types of nanomaterials that are designed specifically for use in medical applications or consumer products.

Overall, nanotoxicology is an important field of research that will help ensure the safe use of nanomaterials in a variety of applications. By understanding how these materials interact with cells and tissues in the body and what environmental factors can affect their toxicity, researchers can work to develop safer alternatives and minimize any potential health risks associated with their use.