

**A REVIEW: GENERAL PERSPECTIVES AND PHARMACEUTICAL APPLICATIONS
OF NANOTECHNOLOGY**Vishal Sapkal^{*1}, Vaishnavi Raskar², Sejal Kolhe³, Pratik Uchale⁴, Prasad Pathak⁵, Sakshi Mulay⁶,
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Article Received on 07/04/2024

Article Revised on 28/04/2024

Article Accepted on 19/05/2024

ABSTRACT

Nanotechnology is the observe of extraordinarily small structures, having length of 0.1 to a hundred nm. Nano medication is a noticeably new field of science and era. quick explanation of diverse varieties of pharmaceutical nano systems is given. class of nano materials primarily based on their dimensions is given. An utility of Nanotechnology in diverse fields which include health and medicinal drug, electronics, electricity and environment, is mentioned in detail. programs of nano particles in drug delivery, protein and peptide transport, most cancers are defined. applications of various nano structures in most cancers therapy including carbon nano tube, dendrimers, nano crystal, nano wire, nano shells and many others. are given. The advancement in nano era facilitates inside the remedy of neuro degenerative disorders such as Parkinson's sickness and Alzheimer's disease. programs of nano era in tuberculosis remedy, the medical application of nanotechnology in operative dentistry, in ophthalmology, in surgical procedure, visualization, tissue engineering, antibiotic resistance, immune response are mentioned in this newsletter. Nano prescription drugs can be used to stumble on illnesses at tons in advance degrees.^[17]

KEYWORDS: Nano devices, Nano material, Nano medicine, Nanopharmaceutics and Drug delivery.**INTRODUCTION**

Nanotechnology is the have a look at of the controlling the matter on an atom and molecular scale. Typically nanotechnology deals with systems sized among 1-one hundred nanometers in as a minimum one size, and contain enhancing or growing materials within that size. It makes the fabric lighter, stronger, quicker, smaller and extra-long lasting.^[1-4]

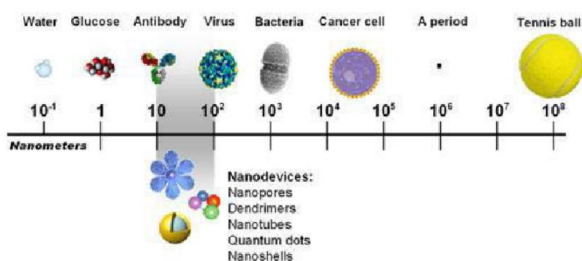


Figure 1: Nanoscale and nanostructures.

Nanotechnology obligates the ability to border components of molecular length and particular device. In different words, 'nanotechnology' refers back to the contrived capability to assemble gadgets from the lowest

up, using tools and techniques which are being defined to make high overall performance products. In 1959, a physicist R. Feynman anticipated this theoretical capability. consistent with national technology foundation, Nanotechnology is the capability to apprehend, control and control be counted at the level of individual atoms and molecules. science and engineering are the primary operators of worldwide technological opposition. modern-day science primarily based at the unifying features of nature at the nano scale contributes a new foundation for innovation, knowledge, and integration of era.^[5-8]

Nanotechnology deals with materials within the length of 0.1 to a hundred nm however it's also inherent that these materials have to display distinctive homes which includes electrical conductance chemical reactivity, magnetism, optical outcomes and physical power, from bulk materials because of their small size.

Nanotechnology works on count number at dimensions within the nanometer scale duration (1-100 nm), and as a result can be used for an extensive variety of packages and the introduction of diverse styles of nano materials and nano gadgets.^[9-12]

History of nanotechnology

Despite the fact that nanotechnology looks as if a budding component of technological know-how, its usage with the aid of humanity isn't always novel in any respect. The history of nanomaterials utilization in production dates returned to 4500 years ago while natural asbestos nanofibres have been applied for ceramic matrices. one of the oldest, richest, and modern cultures globally, Egyptians, realized the abilities of nanomaterials 4000 years ago. The journey of nanomaterials and nanotechnology made all through records earlier than millennial.^[13-15]

Recent development

Nanotechnology has led to the development of smaller and more green gadgets in electronics. Nanoscale transistors and reminiscence chips have elevated.

Nanotechnology has brought about the development of smaller and more efficient devices in electronics. Nanoscale transistors and reminiscence chips have extended computing energy and storage capacity. additionally, nanomaterials like carbon nanotubes and graphene have proven promise in growing bendy and obvious electronics.

Innovation Map outlines the top nine Nanotechnology developments & 18 Promising Startups For this in-intensity research at the top trends in nanotechnology and revolutionary startups, we analyzed a pattern of 1628 global startups & scaleups. This facts-driven research offers innovation intelligence that enables you enhance strategic choice-making by way of providing you with an outline of rising technologies across numerous industries. inside the Nanotechnology Innovation Map beneath, you get a comprehensive evaluate of the innovation traits & startups that impact your company.^[16-17]

Latest Invention of Nanotechnology

1. The world's smallest (and most useful) hacky sacks.
2. A spray-drying technique making noise in gene silencing.
3. Charging the electric vehicle revolution.
4. Printing nanoporosity for a renewable future.
5. A fireproof nanomaterial bringing the heat.
6. A targeted solution to the silent pandemic.

Discover the Top 9 Nanotechnology Trends in 2024, Explore our in-depth research on 1628 nanotechnology startups and scaleups and get data-driven insights into solutions including carbon nanomaterials, nanofilms, nanosensors, green nanotech and more.

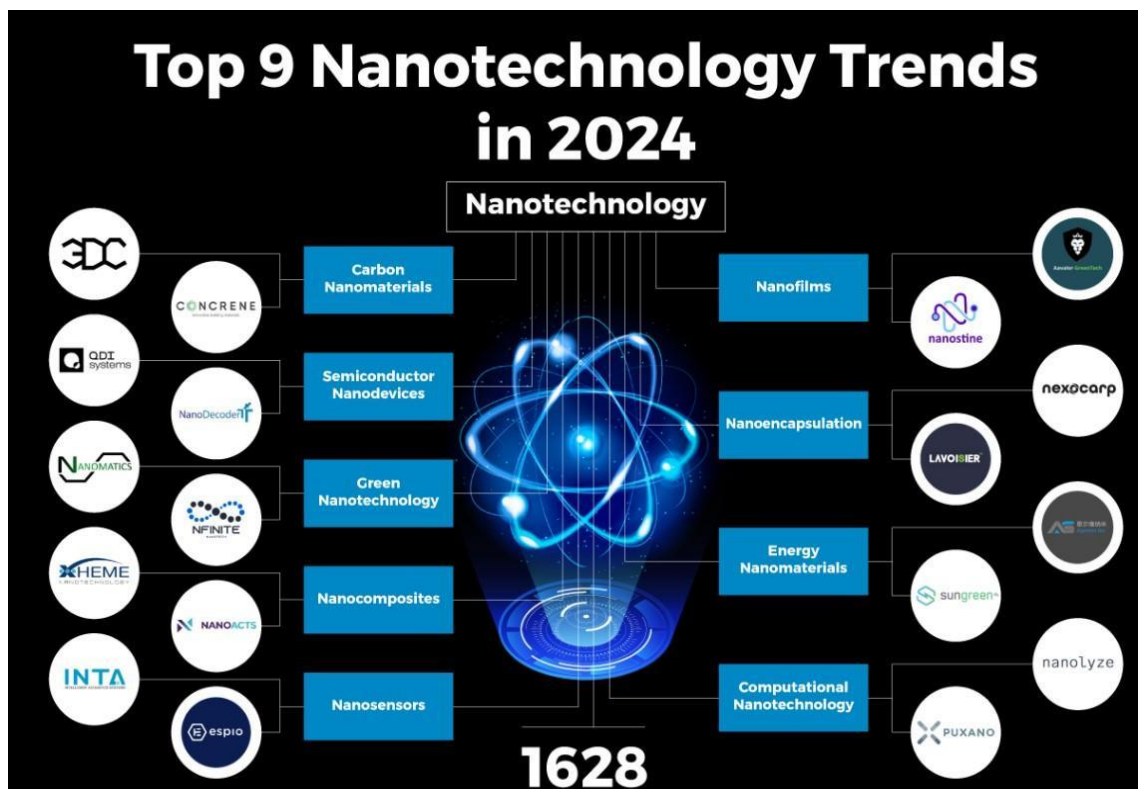


Figure 2: Latest Invention of Nanotechnology.

Nano sponge: Nanosponges are frequently used in medication as focused drug delivery structures, detoxing techniques, or as a manner of damage manage after an damage. They can also be used in environmental programs to clean up ecosystems by using performing responsibilities like purifying water or steel

deposits. Nanosponges are non-poisonous and strong at better temperatures compared to other nanoparticles.

Amongst those diverse varieties of nanosponges are Cyclodextrins and their types (α , β , γ CDs), Titanium and Silicone primarily based NS, Hyper-linked polystyrene-

based NS, Cellulose primarily based nanosponges, metallic ion based totally nanosponge, Polymer Nanosponge, Glycopolymer Nanosponges, Polyol functionalized mesoporous nanosponges. Nanosponges used in toxin absorption any other ability use for nanosponges is in toxin absorption. a number of viral and bacterial infections may be treated by means of concentrated on the toxins launched into the frame via pathogens. Pathogens which includes Staphylococcus aureus, Escherichia coli, Listeria monocytogenes, Bacillus anthracis, and Streptococcus pneumoniae create pollutants that may be centered through nanosponges treatment.

Pathogens synthesize and launch a number of virulence elements that allow them to occupy the host's frame advert induce mobile harm. those virulence elements encompass pore forming pollution (PFTs) that have an effect on mobile membrane integrity. by means of capturing and neutralising the PFTs launched by using bacterial cells, nanosponges can useful resource inside the remedy without the risk of micro organism developing further drug resistance.^[18-22]

Application of nanosponges

- 1) Cancer, enzyme and biocatalyst carrier, oxygen delivery, solubility enhancement, enzyme immobilization, and poison absorbent are some of the applications for nanosponges.
- 2) The nanosponge drug delivery system possesses various applications in various ailments such as cancer, autoimmune diseases, theranostic applications, enhanced bioavailability, stability.^[12]

Nano clay

Nanoclay is another widely used nanomaterial considerably studied due to its high surface location to quantity ratio and high chemical reactivity, promoting the pozzolanic reaction. however, constrained studies investigated the consequences of nanoclay debris on the reaction kinetics of geopolymers.

Nano Gel

Nanogels are crosslinked polymer networks which might be nanoscale in length and able to absorbing huge amounts of water. Nanogels are hydrogels with a size of nanometers or much less. A hydrogel is a polymer-based gel that is made by means of connecting polymer chains to shape a macromolecular network.^[15]

Features of Nano gel

- 1) **Targeting Delivery** Nanogels carriers are frequently delivered at specific sites by binding to their surface due to its dependency and focusing on variables of their responsiveness to local factors, or by other "passive" techniques that involve retention inside the physiological spaces.
- 2) **Low Level of Toxicity** The nanogels must be biofriendly and non-toxic, as well as perishable with

non-toxic breakdown products which can be eliminated swiftly out from body.

- 3) **Controlled and Sustained Medication Delivery** Drug delivery should occur at the target location, ensuring that each treatment is delivered efficiently with fewer side effects. To achieve therapeutic aims, drug loading should be high.
- 4) **High Encapsulation Stability** Drug molecules embedded in nanogels must not be transported out or leaked prematurely while delivering the most significant therapeutic benefit with the least amount of toxicity or side effects.
- 5) **Size Control** Physicochemical strategies are often employed to adjust nanogel size and surface features to minimize somatic cell clearance and change active cell targeting or the passive one.^[16-17]

Survey of some major nanotechnology domains

The first step in this process is to gain some understanding of where nanotechnology development and applications may be heading.

Report produced by venture-capital company '3i', in association with the UK's Institute of Nanotechnology and the Economist Intelligence Unit discussed the prospects for commercial applications of nanotechnology, based on a survey of almost 100 nanotechnology experts worldwide.

- Miniature electromechanical systems, similar to our daily machines in structure comprising integrated mechanical and electronic components, which can be divided into:
 - 1) Microelectromechanical systems^ (MEMS) - small-scale (at the micron level)
 - 2) Nanoelectromechanical systems (NEMS) -similar to MEMS, but at the nanoscale.

Nanomaterials

Nanomaterials can be defined as materials possessing, at minimum, one external dimension measuring 1-100nm. A nanoparticle is a very small particle that ranges between 1 to 100 nanometres in size.

- i) A sheet of chicken wire.
- ii) Multi-wall nanotubes (MWNT).
- iii) Nano-scale silver.
- iv) Dendrimers.
- v) Fullerenes.
- vi) Carbon molecules in the form of a hollow sphere.
- vii) Ellipsoid or tube.
- viii) Gold.
- ix) Silver.
- x) Platinum

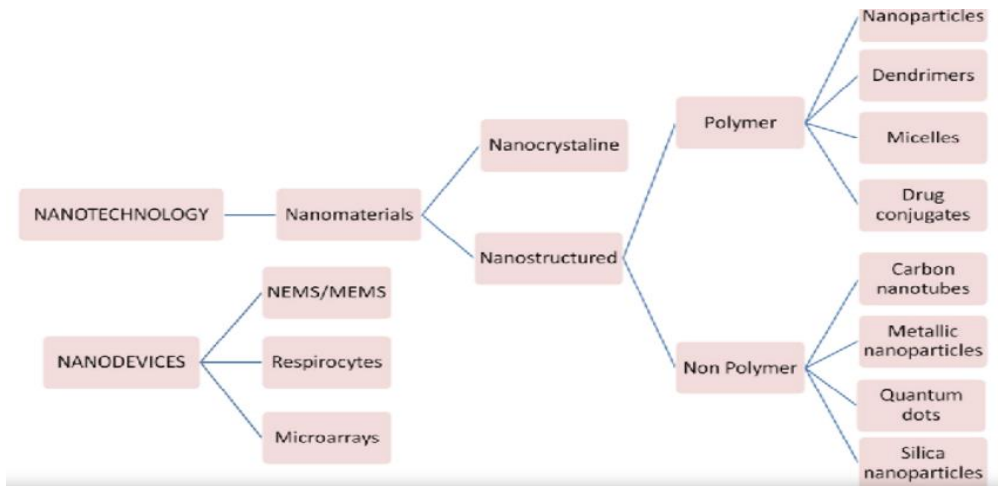
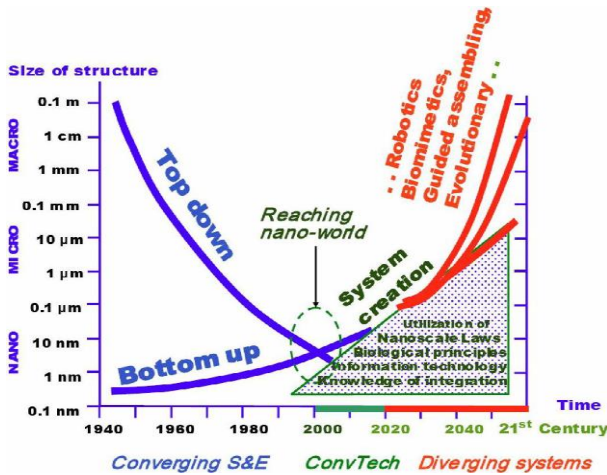


Figure 3: Nanomaterials.

Branches of nanotechnology

A number of Nanotechnology products are available and still a formidable amount of researches are going on in research laboratories & universities.

derived from the nanometer, a unit of measurement equaling one billionth meters. This branch accentuates the engineering rather than the applied science aspect of the field.



1. Nano engineering

Nano engineering is the branch nanotechnology practice on the nanoscale. The name ‘Nano- engineering’ is

2. Green Nanotechnology

Green nanotechnology is the branch of nanotechnology that enhances the environmental sustainability of processes producing negative facet. It includes manufacturing green Nano-products and then using these Nano-products in support of sustainability.

3. Wet Nanotechnology

Wet nanotechnology refers to working up with large masses from small ones. W. Eric Drexler put forth the idea of Nano-assemblers working dry. The wet nanotechnology comes out to be the first area in which a Nano-assembler attains the trading results.



Figure 4: Application of nanotechnology.

Limitations of nano-particals

The usage of NPs is beneficial, but on the other hand, it has some limitations and demerits in the field of

medicine. A comparative chart of merits and demerits is given below in the tabular form.

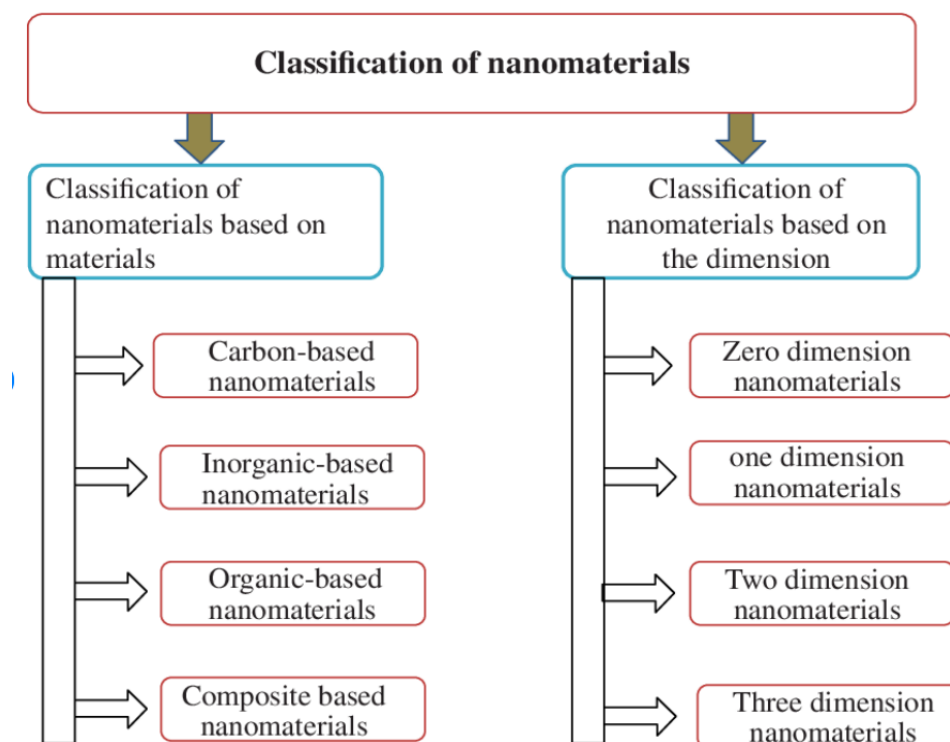
Classification of Nano Materials

Figure 5: Classification of Nano Materials.

Nano materials can be classified dimension wise into following

Categories

Classification Examples

- Nano rods, nano wires have dimension less than 100 nm.
- Tubes, fibers, platelets have dimensions less than 100 nm.
- Particles, quantum dots, hollow spheres have 0 or 3 Dimensions < 100 nm.

On the basis of phase composition, nano materials in different phases can be classified as,

- The nano material is called single phase solids. Crystalline, amorphous particles and layers are included in this class.
- Matrix composites, coated particles are included in multi-phase solids.
- Multi-phase systems of nano material include colloids, aero gels, Ferro fluids, etc.

Nanotechnology in health and medicine

Even these days numerous disorder like diabetes, most cancers, Parkinson's disease, Alzheimer's disease, cardiovascular sicknesses and multiple sclerosis in addition to extraordinary types of extreme inflammatory or infectious sicknesses (e.g. HIV).

Constitute a excessive range of great and complicated illnesses which might be posing a primary hassle for the mankind. Nano-medicinal drug is an application of nanotechnology which goes inside the field of fitness and medication. Nano-medicine uses nano materials, and nano digital biosensors. in the future, nano medication will gain molecular nanotechnology. The clinical location of nano technology application has many projected blessings and is probably precious for all human races.

With the assist of nano medicine early detection and prevention, progressed analysis, proper treatment and follow-up of sicknesses is viable. positive nano scale debris are used as tags and labels, organic may be completed speedy, the trying out has come to be more touchy and greater flexible. Gene sequencing has become greater green with the invention of nano devices like gold nano particles, these gold particles while tagged with short segments of DNA can be used for detection of genetic series in a pattern.^[19-20]

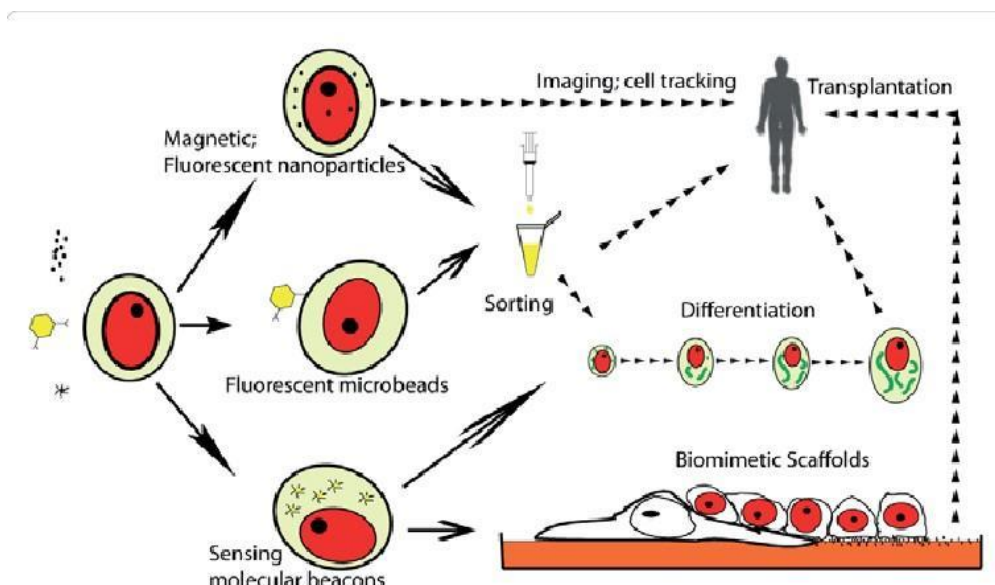


Figure 6: Nanotechnology in health and medicine.

Drug Delivery

In nanotechnology nano particles are used for site unique drug delivery. on this approach the desired drug dose is used and facet-outcomes are reduced substantially because the energetic agent is deposited inside the morbid area only. This highly selective method can reduce fees and ache to the sufferers. thus form of nano particles which includes dendrimers, and nano porous substances locate software. Micelles acquired from block co-polymers, are used for drug encapsulation.

They transport small drug molecules to the favored vicinity. in addition, nano electromechanical systems are applied for the lively launch of medicine. Iron nano particles or gold shells are finding critical software inside the most cancers remedy. A centered medication reduces the drug consumption and remedy prices, making the remedy of patients value effective.^[16-19]

Table 1: Periodical development in nanotechnology.

Year	Development in nanotechnology
1959	R. Feynman initiated thought process
1974	The term nanotechnology was used by Taniguchi for the first time.
1981	IBM Scanning Tunneling Microscope
1985	“Bucky Ball”
1986	First book on nanotechnology Engines of Creation published by K. Eric Drexler, Atomic Force Microscope
1989	IBM logo was made with individual atoms
1991	S. Iijima discovered Carbon Nano tube for the first time
1999	1st nano medicine book by R. Freitas “Nano medicine” was published
2000	For the first time National Nanotechnology Initiative was launched
2001	For developing theory of nanometer-scale electronic devices and for synthesis and characterization of carbon nanotubes and nano wires, Feynman Prize in Nanotechnology was awarded
2002	Feynman Prize in Nanotechnology was awarded for using DNA to enable the self-assembly of new structures and for advancing our ability to model molecular machine systems
2003	Feynman Prize in Nanotechnology was awarded for modeling the molecular and electronic structures of new materials and for integrating single molecule biological motors with nano-scale silicon devices
2004	First policy conference on advanced nanotech was held. First center for nano mechanical systems was established, Feynman Prize in Nanotechnology was awarded for designing stable protein structures and for constructing a novel enzyme with an altered function
2005-10	3D Nano systems like robotics, 3D networking and active nano products that change their state during use were prepared.
2011	Era of molecular nano technology started

Nanotechnology in the treatment of neurodegenerative disorders

One of the maximum critical applications of nanotechnology is inside the treatment of neurodegenerative problems. For the delivery of CNS therapeutics, various nano carriers including, dendrimers, nano gels, nano emulsions, liposomes, polymeric nano debris, solid lipid nano debris, and nano suspensions had been studied.

Parkinson's disease: this could improve cutting-edge therapy of Parkinson's sickness (PD). Parkinson's disease (PD) is the second one maximum not unusual neurodegenerative sickness after Alzheimer's ailment and affects one in every a hundred men and women above the age of 65 years, PD is a ailment of the principal nervous device; neuro inflammatory responses are concerned and results in intense problems with body motions. The current treatments purpose to improve the practical ability of the affected person for so long as possible but can't adjust the progression of the neurodegenerative technique.^[21]

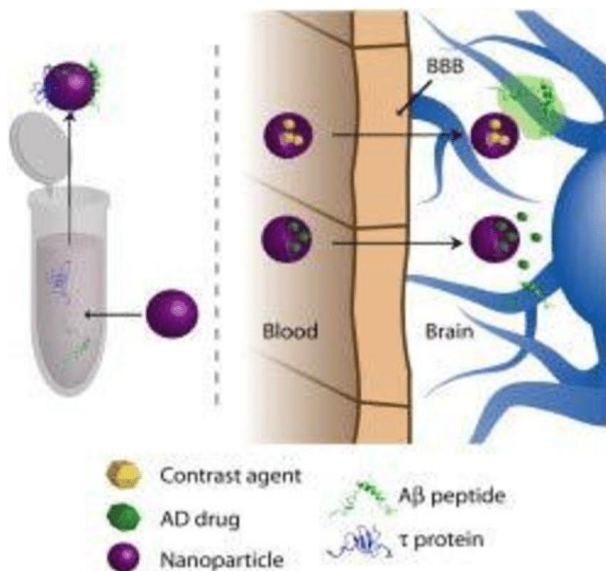


Figure 7: Parkinson's disease.

Alzheimer's disease: global, extra than 35 million human beings are tormented by Alzheimer's disease (advert), that is the maximum common shape dementia. Nano era unearths tremendous packages in neurology.

Tooth renaturalization: This system might also emerge as famous, providing best remedy methods for esthetic dentistry. This fashion may additionally start with patients who desire to have their (1) antique dental amalgams excavated and their teeth remanufactured with native organic materials, and (2) complete coronal renaturalization strategies in which all fillings, crowns, and other twentieth century adjustments to the seen dentition are eliminated with the affected teeth remanufactured to turn out to be indistinguishable from original tooth.

Tuberculosis treatment: Tuberculosis (TB) is the deadly infectious ailment. The long period of the treatment and the tablet burden can impede affected person way of life and result in the improvement of multi-drug resistant (MDR) traces. Tuberculosis in youngsters constitutes a main problem. there may be commercial non availability of the primary-line tablets in pediatric form. Novel antibiotics may be designed to overcome drug resistance, reduce short the duration of the treatment path and to lessen drug interactions with antiretroviral healing procedures.

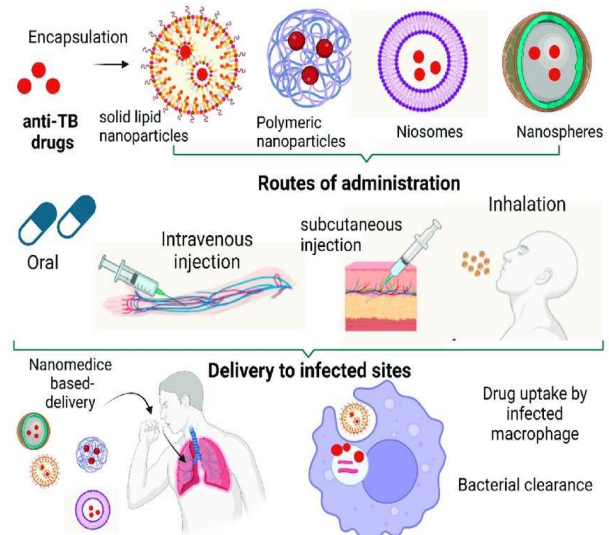


Figure 8: Tuberculosis treatment.

Future prospects: Pharmaceutical nanotechnology is the thrilling, swiftly rising branch of scientific technological know-how that deals with harnessing nanoscale materials as drug transport and/or diagnostic gear. As drug delivery gear, nano-shipping structures can be used to beautify the website-unique, targeted transport of specific medicines.^[22]

Conclusion: Pharmaceutical nanotechnology has a profound impact on sickness prevention efforts because it offers modern equipment for information the cell as well as the difference between normal and abnormal cells. it could insights into molecular basis of ailment there are various packages of nanotechnology consisting of electronics, biology, chemical engineering and robotics electronics. with the aid of the help of nanotechnology, docs detecting disorder at its earliest levels and treating illness together with heart ailment, most cancers and diabetes with greater powerful and safer drugs. Researchers also picture new technology for protective each the civilians and military forces from traditional and chemical guns.

Some of the advantages are

- Identifying, defining and characterization of model nanomaterials.
- Developing toxicity testing protocol.
- Detecting and monitoring exposure level.

- Assessing the impact of environment.
- Developing the biocompatible hybrid system

ACKNOWLEDGE

I would like to express my sincere thanks to Mr. Sudarshan Borkar, Dr. Kiran Shinde and Miss. Tanuja Pawar for their valuable guidance and support and had a great comfort and relief to provide help for this review work. My heartfelt thanks.

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