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Pharmaceutical Nano technology and Application:A Short Review

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ABSTRACT
"Nanotechnology" covers a very wide field in modern science. The sphere of nanotechnologyin the pharmaceutical industry is very wide, and it finds application in various fields, such astissueengineering,nanotechnology,diagnostictools ,imageenhancementdevices,nanorobots, implant technologies, biosensors, biomarkers, biologically active surfaces and ascarriers of diagnostic and therapeutic methods. Nanotechnology is a field of applied science,focused on the design synthesis, characterization and application of materials and devices onthe nanoscale. This branch of knowledge is a sub-classification of technology in colloidalscience, biology, physics, chemistry and other scientific fields and involves the study ofphenomena and manipulation of materials in the nanoscale. In this Review Article we ReviewaboutthePharmaceuticalNanotechnology,by severalangles,definition,techniques,weexhibitingso metypeof Nano-particlesand Application.
Keywords:Nanotechnology,Nanoparticles,Nano-systems,Nanodevices,

I. INTRODUCTION

Nanotechnology is a rapidly growing science of producing and utilizing nano-sized particles,that measure in nanometer.In other words, nanotechnology istheartof characterizing,manipulating and organizing matter systemically, at the nanometer scale, which has created arevolution in science, engineering, technology, drug delivery and therapeutics. The size oftypical accessible structures is in the sub-micrometer range, being within the limits of opticalresolution and barely visible with a light microscope.This scale is about 1/1000 smaller thanstructures thatcould beresolved by thenaked eye, butstill 1000times larger than anatom.Recentdevelopmentsareaddressing thesizerangebelowthesedimensionsandbecause a typical structure size is in the nanometer range, the methods and techniques aredefined as nanotechnology.Thereare many treatmentstoday thattake a lotof time andarealso very expensive. Usingnanotechnologyin pharmaceutical field, quicker and muchcheapertreatmentscanbedeveloped.Thereisano theraspectforusingpharmaceuticalnanotechnology. Normally, drugs work through the entire body before they reach the diseaseaffected area. Using these nanotechnology pharmaceuticals , the drug can be targeted to aprecise location which would makethedrugmuch moreeffectiveandreduce thechancesof possibleside-effects Pharmaceutical Nanotechnologyprovidesaunique approachandcomprehensivetechnology against cancer through early diagnosis, prediction, prevention,personalizedtherapyandmedicine.Target -specificdrugtherapyandmethodsforearlydiagnosis of pathologies are the priority research areas in which nanotechnology would play avitalpart.

NANO-DEFINITIONS:-

Nanoscience: Can be defined as study of phenomenon and manipulation of materials atatomic andmolecular scales.

Nanotechnology: Isrelatedtodesigncharacterization, productionandapplicationsofstructures,devicesand systemsbycontrollingshapeandsizeatnanometer scale.

Pharmaceutical Nanotechnology: Embraces applications of nanoscience to pharmacy asnanomaterials,andasdeviceslike drugdelivery,diagnostic, imagingandbiosensor.

Nanomedicine: Is defined as submicron size (<1um) modules, used for treatment, diagnosis,monitoring,andcontrol of biologicalsystem.

PHARMACEUTICALNANOTECHNOLOGYBASEDSYSTEMS:-

Pharmaceutical nanotechnology consisting of two basic types, which are nano-materials andnanodevices,whichplaya keyrole in

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pharmaceuticalnanotechnologyand otherfields.

Nanomaterials:-

These are made from biomaterials; these are used in orthopedic or dental implants or asscaffolds for tissue engineered products. Their surface can be modified or coatings can bedone which enhances biocompatibility with the living cells. These are further classified intotwotype'snanocrystallineandnanostructurematerials.

Nanocrystalline:-

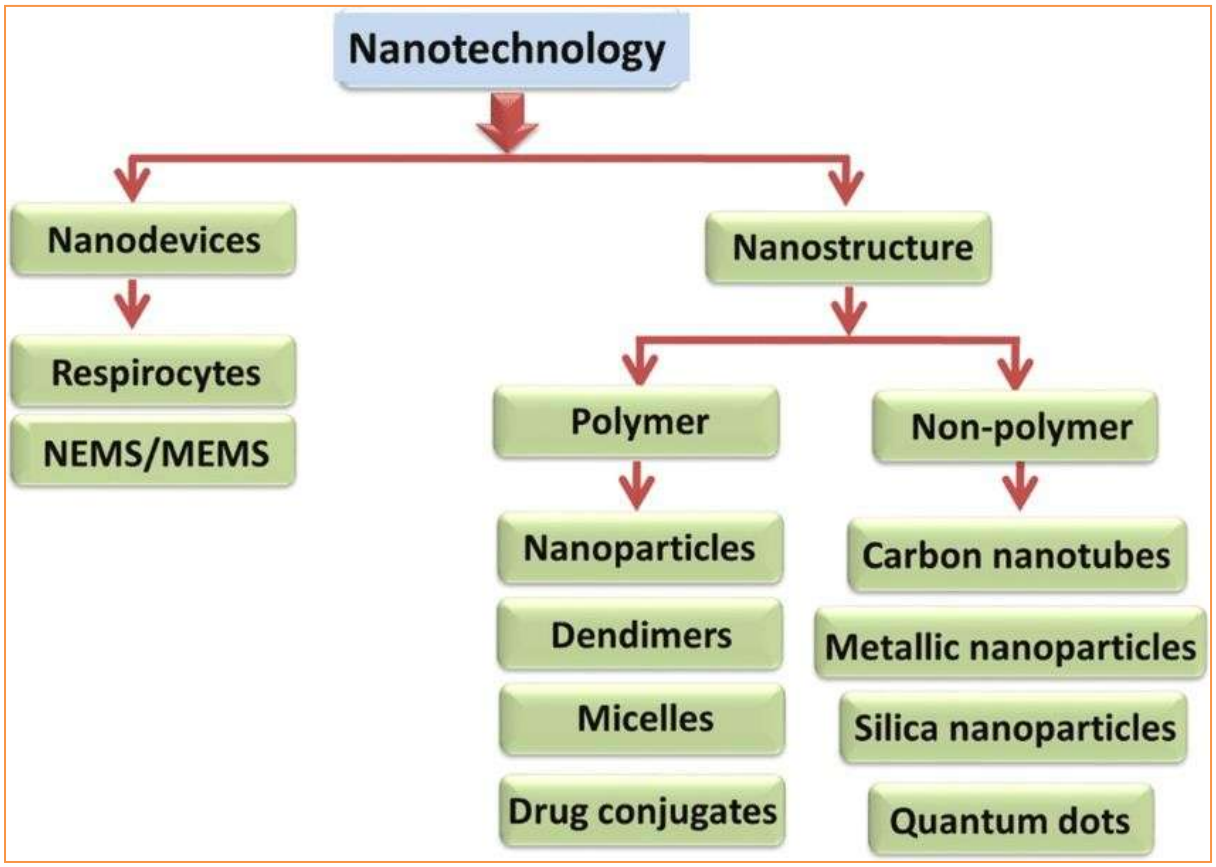
These are readily manufactured and can substitute the less performing bulk material. Thesematerialsare directlyusedindrugencapsulation,bonereplacement, prothecesandimplants.

Nanostructuredmaterials:-

These are processed forms of nanomaterials with special shapes and functions. These includequantumdots, dendrimers, fullerenesandcarbon nanotubes.

Nanodevices:-

Thesearethesmalldevicesinthenanoscale.Theseincludenanoandmicroelectromechanical systems (NEMS/MEMS), micro fluidics and micro assays. These alsoinclude biosensorsanddetectors, whichare used in diagnosis.



Figno:-1.Schematicdiagramofvarioustypesofpharmaceuticalnano-systems.

TYPESOFPHARMACEUTICALNANOSYSTEMS:-

Carbonnanotubes:-

These are hexagonal networks of carbon atoms. Length and diameter of these tubes are 1nmand 1-100nm in length. Nanotubes are of two type's single walled nanotubes (SWNTS) andmulti walled nanotubes (MWNTS). These are small macro molecules have unique size, shapeandremarkablephysical properties

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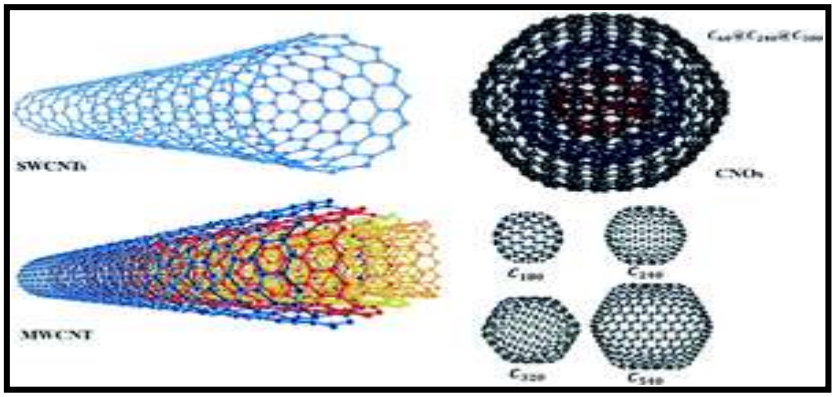
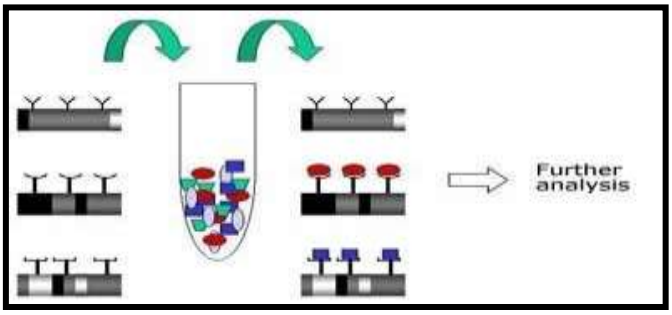


Figno:-2.Carbonnanotubes

QuantumDots:-

These are semi conducting materials consisting of a semiconductor core coated by a shell toimprove optical properties. Their properties originate from their physical size which rangesfrom10-100A^{0}inradius.Thesehavealargeimpactonimaging,in-vitroandin-vivodetection and analysis of biomolecules, immunoassay, and DNA hybridization and in non-viral vectors for gene therapy. It has main function in labelling of cells and therapeutic toolsfor cancer treatment.



Figno:-3.QuantumDots

Dendrimers;-

Thesearehyperbranched,tree-likestructuresandhavecompartmentalizedchemicalpolymer. It contains three different regions core, branches and surface. The core forms thecentral part and the branches radiates from it forming an internal cavity and a sphere ofgroups. The branches can be altered or modified according to requirements. The dendrimerscan be made more biocompatible compounds with low cytotoxicity and high biopermeabilityaccording to the requirements. These can deliver bioactive s like drug,vaccines, materialsandgenesto desired sites.

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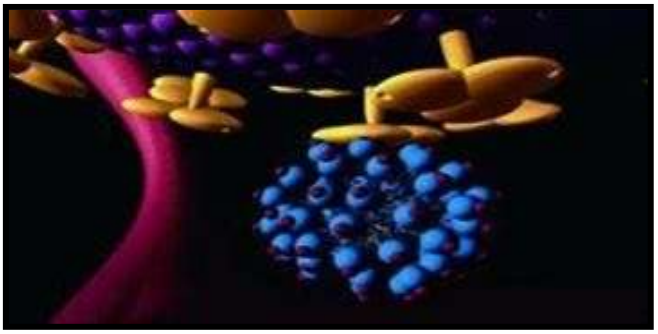
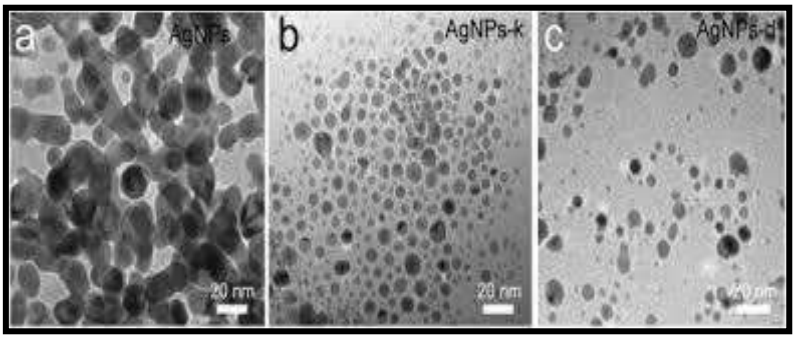


Figno:-4.Dendrimers

Polymericnanoparticles:-

These are colloidal carrier, 10nm-1µm in size consisting of synthetic or natural polymers.These nanoparticles provide alternative to above mentioned nanosystems due to inherentpropertieslikebiocompatibility,non-immunogenicity,non-toxicityandbiodegradability.Polymericnanoparticles areclassifiedandcomprisedofnanocapsulesandnanosphere.Nanocapsulesaresystemsinwhichdrug isconfinedtoacavity surroundedby uniquepolymericmembrane,whereasnanospheresare systemsinwhichthedrugisdispersedthroughout thepolymer matrix. Natural polymers used aregelatin, albumin and alginateinthe preparation of nanoparticles synthetic polymers used for nanoparticles preparation ofnanoparticles synthetic polymers used for nanoparticles of preparation may be in the form ofpreformedpolymer. e.g.:-polyesterslikepolycarpolactone.



Figno:-5.Polymericnanoparticles

Silicananoparticles:-

The most widely available materials of the Earth's crust include natural silica and silicates,which are primarily crystalline. Because of their excellent biocompatibility, heat resistance,lowtoxicity,simplesyntheticapproach,and massivesyntheticsupply,silicondioxidenanoparticles ,frequentlyreferredtoassilicananoparticles,areattractiveforbiologicalapplications. The size of the particles, porosity, crystallinity, and form of silica nanoparticlescan all be carefully controlled, allowing them to be used in a wide range of industrial andresearch uses. Notably, the multiple surface changes accessible enable them to alter surfacechemistryfor drugloading, sturdy, andsite-specifictargeting.

This nanomaterial consistently features in research, though conflicting toxicity results havecomplicateditsapplicationsandnecessitatedfurtherrigorousanalysis.Still,substantialresearch into silica nanoparticles for therapeutic, diagnostic, and imaging reasons is on-going;forexample,hydrophilicmedicinescanbedeliveredtoselecttissuesusingsilicananoparticles.

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Figno:-6.Silicananoparticles

II. APPLICATIONS OF PHARMACEUTICAL NANO TECHNOLOGY

Cancernanotechnology:-

Cancer nanotechnology isemerging asanewfield ofinterdisciplinary research,cuttingacross the disciplines of biology, chemistry, engineering, and medicine, and is expected tolead to major advances in cancer detection, diagnosis, and treatment. The basic rationale isthat metal, semiconductor, and polymeric particles have novel optical, electronic, magnetic,and structural properties that are often not avail able from individualmolecules or bulksolids Recent research has developed functional nanoparticles that are covalently linked tobiological molecules such as pep tides, proteins, nucleic acids, or small-molecule ligandsMedical applications have also appeared, such as the use of super paramagnetic iron oxidenanoparticles as a contrast agent for lymph node prostate cancer detection and the use ofpolymeric nanoparticles for targeted gene delivery to tumour vasculatures . New technologiesusingmetalandsemiconductornanoparti clesarealsounderintensedevelopmentformolecularpr ofilingstudiesand multiplexedbiologicalassays.

Drugdeliverysystems

Conventional drug delivery systems have various limitations of lack of specificity,greaterrateofdrugmetabolism,cytotoxicit y,highdoserequirement,poorpatientcomplianceetc.a nd these can be overcome by drug delivery systems formulated using the principles inpharmaceuticalnanotechnology.

Nanomaterialsfortissueengineering

Thenanomaterialsareusedfortissuerepairan dreplacement,Implantcoatings,Tissueregeneration,S tructuralimplantmaterials,Bonerepair,Bio-resoursablematerials,Implantable devices (sensory aids, retina implants), Surgical aids, Operating tools and also inSmart instruments.

Moleculardiagnostics:-(molecularimaging)

It is representing, characterizing and quantifying sub cellular biological processes includegene expression, proteinprotein interaction, signal transduction, cellular metabolism. Theyare used in magnetic resonance imaging, optical imaging, ultrasonic imaging and nuclearimaging. Other applications are specific labeling of cells and tissues, useful for long-termimaging,multicolormultiplexing,dynamicimagingofsubcellularstructuresandfluorescence resonance energy transfer (FRET) and magnetic resonance imaging (MRI). MRIagents are replaced by nanomaterials like dendrimer, quantum dots, carbon nanotubes andmagnetic nanoparticles. They are very efficient, stable, intense, clearer image due to highintensity,photostability,resolution,resistance.Quantumdots,ironoxidenanocrystalandmetallic nanoparticles.

Diseasediagnostics

In veterinary medicine, diagnosing a disease may take days, weeks, or even months as in thecase of chronic diseases without any clinical symptoms. Hence, an infection may have grownby that time with the need to kill the entire herd. Nanotechnology operates on the same scaleas a virus or disease-infecting particle and therefore has the potential to be detected anderadicateveryearly.Hence,nanotechnology,forsensitiveclinicaldiagnosiscanbeasuccessful tool. In the one health thought, the use of nanotechnology instruments for theexamination of animal diseases

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or as animal simulations for the diagnosis of human diseasesis remarkable. Latest studies propose the use of quantum dots in small animal models for invivoimaging.

Single-PhotonEmissionComputedTomography(SPECT) and PositronEmissionTomography (PET) are nuclear medicine imaging techniques, which provide metabolic andfunctional information unlike the Computed Tomography (CT) and Magnetic ResonanceImaging (MRI), which provide only anatomical information. However, the combining ofSPECTandPETwithCTandMRIprovidesbothdetailedanatomicalandmetabolicinformation.

To control disease progression before it becomes apparent with conventional morphologicalimagingtechniquesorlaboratorytests,itisnecessarytoperformfunctionalmolecularalterations in vivo by using non-invasive, specific molecular imaging modalities providinganatomical and physiological in vivo information. Nuclear medicine offers these molecularimaging methods by observing the body delivery of radiopharmaceutical compounds (gammaand positron-emitters) delivered to the patient and can be visualizedby SPECT or PETscanners.

III. CONCLUSION

Pharmaceutical nanotechnology has emerged as a discipline having enormous potential as acarrier for spatial and temporal delivery of bioactives and diagnostics and provides smartmaterials for tissue engineering. It offers new tools, opportunitiesand scope, which areexpectedtohaveagreatimpactonmanyareasindisease,diagnostics,prognosticandtreatmentofdiseasesthroughitsnano-engineeredtools.Pharmaceuticalnanotechnologyraisesnewhopetopharmaceuticalindustriesbyprovidingnewcuttingagepatentabletechnologies in view of revenue loss caused due to off-patent drugs. Scientific societies,industriesandgovernmentsalloverworldarelookingwithgreatanticipationandcontributingtheirbesttoclutchthepotentialofthistechnology.Pharmaceuticalnanotechnology is stillin infancy.Someconcerning issues likesafety,toxicity hazards,bioethical issues, physiological and pharmaceutical challenges get to be resolved by thescientists.

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