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**Review Article**

# A Review on Treatment for Neurodegenerative disease with the help of Nanosciences

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## ABSTRACT

Neurodegenerative disorders are those type of diseases which are responsible for malfunctioning of brain and peripheral nervous system. The therapeutic drugs which are being commonly utilized for the treatment for these disorders are not able to pass through the Blood Brain Barrier (BBB) as this barrier only permits specific nutrients which are helpful for growth. Thus Nanotechnology (NT) can be very much valuable in solving this problem as there are different forms of Nanomaterials which can act as efficient drug delivery systems which could help in crossing the BBB and providing effective treatment for Neurodegenerative disorders like Alzheimer's disease, Parkinson's disease and many more. Thus, in this review we tried to collaborate all the recent developments done in treating patients suffering with neurodegenerative disorders and also tried to brief about the importance of Nanotechnology in varied biomedical applications.

**Keywords:** Neurodegenerative disease; Nanoparticles; Nanogels; Nanospeheres; Nnaorobots; Autophagy; Parkinson's disease; Lipid NPs

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## INTRODUCTION

***Nanotechnology and Nanoparticles***: The term "Nano" was said to be derived from Greek word called "dwarf" initially. On a metric scale, 1nm was said to be approximately equal to the width of six carbon atoms. Feynman was the person who introduced the concept of Nanotechnology(NT) in his lecture entitled "There's Plenty of Room at the Bottom". His main intention was manipulate individual atoms and molecules. The term Nanotechnology was coined by Norio Taniguchi who described it as the processing, separation, consolidation and deformation of materials by one atom or one molecule. The fundamentals of NT was also described by Feynman which were modified by Erick Drexler in his writings entitled "Vehicles of Creation: The coming Era of Nanotechnology". The birth of cluster science and invention of the scanning tunnelling microscope(STM) were the two milestones in development of NT which further lead to discovery of fullerenes in 1986 and carbon nanotubes(CNTs). Semiconductor Nanocrystals were also synthesised from quantum dots which were nothing but metal oxides.

Nanotechnology is said to be defined as "The understanding and control of matter at dimensions between 1 and 100 nanometers in which a versatile phenomenon enables novel applications which includes imaging, modelling and manipulation of matter at a particular length scale"

NPs are one of the type of nanostructures whose physical properties are dominated by their surfaces because of their small size and vast surface which further lead to disparate behaviour from the bulk materials. Basing on the inorganic materials such as ceramics, metals, oxides and salts NPs are developed in varied ways. NPs are having different essential applications in drug delivery, separation technology, nanoelectronics and catalysis.

Versatile properties such as large specific surface area and pore volume make the Silica NPs most commonly used NPs out of all types. Mesoporous silica NPs (MSNPs) with a pore size of about 2-50nm which are synthesized from supramolecularly arranged surfactant which acts as structure directing template were said to be very effective candidates for drug delivery systems and various biomedical applications.

Gold NPs are said to be the most extensively studied NPs and applied most importantly in Cancer Biology and Medicine. Gold NPs have varied biomedical applications such as genomics, immunoassays, microorganisms detection and control, photo thermolysis of cancer cells , targeted drug delivery, optical imaging and monitoring of biological cells and tissues by resonance scattering. Au Nanospheres were the first GNPs to be discovered which were followed by various forms such as nanorods, nanoshells and nanocages[1]

Polymer NPs are said to be a better type of Nanocarriers as they have greater biocompatibility and biodegradability than others. These NPs are synthesised from a wide range of polymers which involves both natural and synthetic substances which are made up of poly(lactide-coglycolide), poly(lactic acid) and many more. With respect to the delivery of drugs to various specific cells in the body, the composition of GNPs vary from one drug delivery system to other. These type of Nanocarriers are also very cheap and economical when compared with that of other types of NPs.

Protein NPs are considered to be most efficient colloidal drug carrier systems which primarily effect the drug targeting system with the help of modified protein NPs by reducing drug toxicity. Prevention of enzymatic degradation by these NPs was considered to be a vital merit for these NPs. These type of NPs are already being extensively used as pharmaceutical carriers in various cancer therapies. Parentral, peroral and ocular types of administration are conducted using Protein NPs inorder to deliver large and small biological molecules.

Lipid NP systems are also extensively being used in cancer therapy in the form of solid NPs(SLNPs) and nanostructured lipid carriers (NLCs). SLNPs were formed from a single purified lipid which forms a crystalline lattice structure which was helpful for the incorporation of small molecular drugs. They are said to have a unique size dependent properties which made them to have varied biomedical applications. Quantum dots are also known as fluorescent semiconducting nanocrystals which have several biomedical applications such as biolabels, sensors, light emitting diodes and medicine[1]

The most frequently used Nanocarriers in recent times has been varied types of Nanogels as they have gained lot of importance in recent times due to their excellent medical applications and properties such as biocompatibility which is vital for clinical treatment of many types of cancers. Due to their high porosity nanogels are widely utilised as reaction vectors in preparation of hybrid NPs which are helpful in capturing metal NPs like $Fe_3O_4$ NPs[1]

Nanomaterials can be classified into 4 types i.e zero dimensional (Eg: NPs,QD),one dimensional (Eg: Nanotubes, Nanowires), two dimensional (Eg:

Ultrathin films) and three dimensional (Eg: Nanocystal grains and clusters). There are various applications of nanomaterials which are illustrated in Fig1 such as Biosensors, Wound healing, Target Imaging etc.

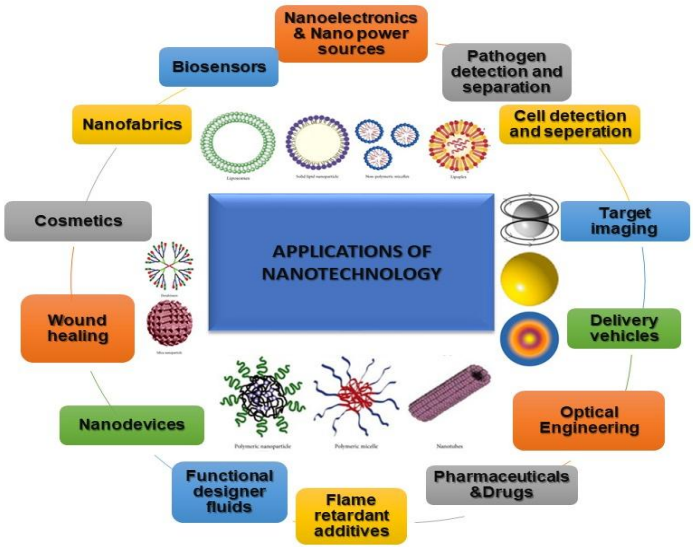


**Fig1: Applications of Nanotechnology**

***Neurodegenerative Disease:*** This are those type of diseases which actually lead to obstruction of permeability of therapeutic drugs to the brain through blood brain barrier. These are Heterogenous type of disorders. These diseases are caused due to malfunctioning of brain or peripheral nervous system. It is a term for a varied range of conditions which majorly effect the neurons in human brain. Neurons are said to be considered as building blocks of the nervous system including the brain and spinal cord. Neurons do not have the capacity to reproduce or replace themselves and Thus, this means that these cannot be replaced by the body. Age factor plays a major role in causing of this disorders. These type of disorders cannot be cured and this always leads to ataxia and dermentias. Alzheimer's disease (AD) and Parkinsons's disease (PD) are most frequently caused disorders of this heinous type of disease. The combinational reaction of gene with the surroundings also lead to these disorders according to recent scientific reports. There are many environmental factors such as Pesticides, metals, chemicals and Biological factors such as endotoxins which cause Neurodegenerative Diseases.

***Nanosciences:*** Nanosciences are said to be a rapidly growing science which involves the study of structures and materials always in the scale of nanometers. Specialized methodologies are used to manufacture objects in nanoscale. These structures can also be formed in liquid state. There are various type of nanosubstances formed such as nanofibres, nanocrystals and quantum dots. Nano electro mechanical systems(NEMS) are those devices which are used to carry out tasks which are too small for humans to do by themselves. High powered microscopes are used to magnify nanoparticles. Scanning electron microscopes, nano indenters, electrospinning equipments, optical profilers and atomic force microscopes are generally used in Nanosciences. There are varied type of Metallic and Biosynthesised Nanoparticles (NPs) which are being prepared through varied techniques. Protein Nanoparticles is the new variety of NPs which are produced by the methodology which involves varied processes such as coacervation, PEGylation and Thiolation. This type of science involves manipulation of atomic, molecular and supramolecular scales.

***Autophagy:*** Autophagy is a process of self destruction of cells in the body. It is said to maintain homeostasis by degradation of proteins and turnover of the destroyed cell organelles for new cell formation. During the condition of deprivation of nutrients and growth factors it leads to causing of cell stress which is one of the major reason for the cause of autophagy. This may lead to provision of an alternative source of intracellular building blocks. There has been a lot of interest on Nanoparticles as they would help in inducing autophagy and thusaccording to a study done by J.Wang et;al [2] Silica Nanoparticles would induce Autophagy by verifying with the help of varied methods which also showed that autophagic flux would be blockedat high doses(Fig2).

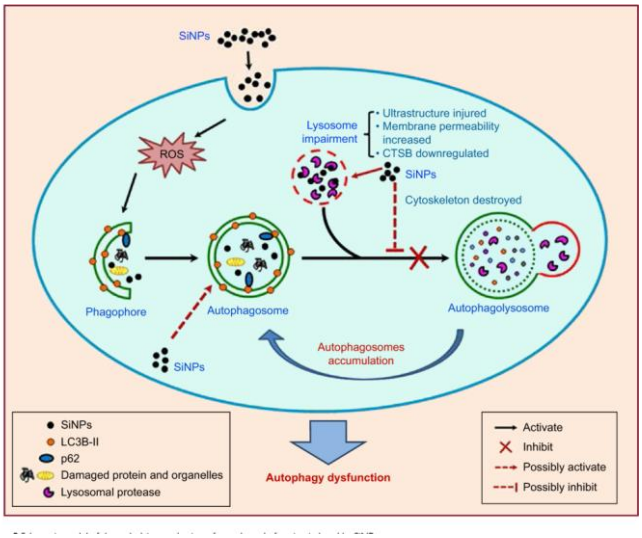


**Fig2: Silica NPs inducing Autophagy [2]**

In a study done by P.-F. Wei et al. [3] reported that Europium Hydroxide ($[Eu^{III}(OH)_3$) nanorods (EHN) which would be helpful in minimising huntingtin protein aggregation which are mainly responsible for neurodegenerative diseases. It would also induce autophagy flux in different cell lines like HeLa and PC 12 cells by expression of autophagy marker protein LC3-II along with degradation of substrate of selective autophagy p62 and cargo receptor SQSTM1. The molecular mechanism of Europium Hydroxide which was unclear in the above study was clarified by the same group done by P.-F. Wei et al. [4] in which we stated that EHNs would not be following classical signalling pathways such as AKT-mTOR and AMPK signalling pathways which clearly demarcates that EHNs are helpful in activating MEK and ERK1/2 signalling pathways during autophagy process which further leads to inhibition of phosphorylation of ERK1/2 by MEK. In this same study it was also reported that trehalose which is another mTOR- independent autophagy was found to be inducing autophagy without activating ERK1/2 signalling pathway.

***Nano biomaterials:*** Biomaterials are said to be a biological substance which are introduced into the body as part of a medical device which replaces an organ or any body function. According to their bioactivity biomaterials can be classified into Bioinert Alumina Dental Implant, Bioactive hydroxyapatite[$Ca_{10}(PO_4)_6(OH)_2$] which are coated on a metallic dental implant, Surface active bioglass and Bioresorbable Tricalcium phosphate ($[Ca_3(PO_4)_2]$ implant.Bioinert biomolecules have very less interaction with the surrounding tissue where as bioactive biomolecules undergo greater interaction with surrounding tissues including the softer ones. There is a lot of scope of manufacture of Nanoparticles from biomaterials. Thus according to a study done by Han GZ et;al [5] stated that Silver Nanoparticles can be produced by following Green synthesis in which reduction of silver nitrate in the presence of water soluble polymer such as Poly-L-Lysine. This study brings water soluble polymers into limelight as an effective Biomaterials in production of varied type of Nanoparticles. With the help of Nanoparticles we can also test the efficiency of varied biomaterials. A study which supports the above statement that was performed by Attia YA et;al [6] produced Hyaluronic Acid (HA) by adding Amino acid which are said to be Bio additives and was also prepared in the presence of Magnetic Nanoparticles (Fig3) and the results were compared. In the presence of Bio additives it showed highest dry weight of HA by adding Glutamic Acid (GA) where as the preparation done in the presence of Magnetic NPs showed highest dry weight of HA after addition of $Fe_3O_4$ NPs which helped in evaluating the efficiency of NPs in preparation of HA.

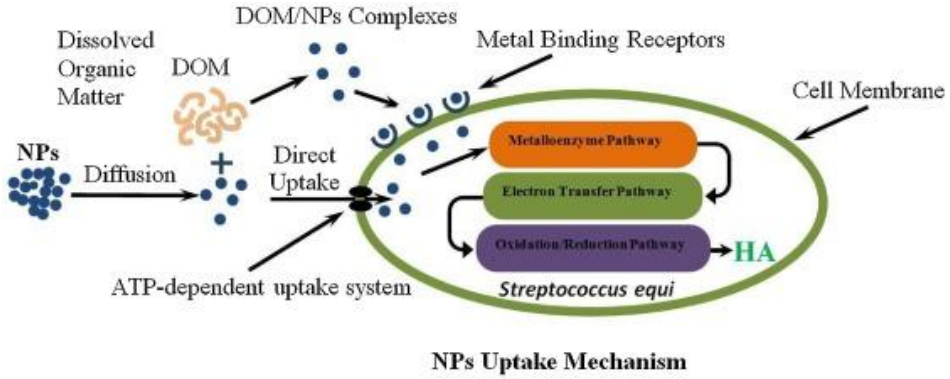


**Fig3: Magnetic NPs Uptake by Streptococcus equi [6]**

***Disease Therapy:*** The main role of utilising autoimmune disease therapy is to block pathological infection without disturbing the immunity of our body towards varied infections. Various studies have been performed which gave a clarification about the role of Nanoparticles in Autoimmune disease therapy. These studies which were compiled in a review by Pau Serra et;al [7] in which they stated that NPs act as vehicles for immune modulators and also for antigen delivery to APCs. This study also revealed that act as direct T-cell targeting compounds. There have been many more studies which have showed the importance of certain types of Nanoparticles effective as carriers of therapeutic drugs to the target cells of the body. The above statement can be justified by a study done by Shyam et;al [8] which briefed the importance of carbon nanotubes and graphenes in biomedical applications which minimized drug loss and drug degradation. This study also proved the uniqueness of these NPs as they were functionalised with specific biomolecules.

**RECENT DEVELOPMENTS IN TREATING NEURODEGENERATIVE DISEASES WITH THE HELP OF NANOMATERIALS:**

Neurodegenerative disorders are mainly caused due to poor delivery of therapeutic drugs into the brain. Thus, Nanosciences helps in preventing this problem in many ways which were proved with the help of various studies. A study done by Amanda Cano et;al [9] which stated that Drug delivery into brain to treat temporal epilepsy can be increased by preparing PEGylated PLGA nanoparticles of Epigallocatechin 3-gallate with the help of double emulsion method and along with this immunohistochemistry, cytotoxicity and behavioural tests were carried out in order to know the efficiency of drug delivery of these type of Nanoparticles (NPs). The results of these studies showed that they were monodisperse NPs with a negative surface charge. According to the reports the average size of NPs was about 169nm and Encapsulation efficiency was about 95%.The study also concluded that these Nanoparticles were non toxic through cytotoxicity studies which proved that it was safe to use. Neurotoxicity studies were also carried out which showed decrease in neuronal death and neuro inflammation. Thus, this study proved that Epigallocatechin 3-gallate PEGylated PLGA NPs was found to be the best alternative for therapeutic drugs such as Phenytoin, Carbamazepine which are being used to treat Temporal epilepsy.

Blood brain barrier is considered to be a functional barrier which does permits only selective essential nutrients to the brain which made us to know the importance of designing an effective route of administration of drugs to treat Neurodegenerative diseases. A study done by Battaglia L *et al* [10] briefed about the importance of intra nasal drug delivery system of Lipid NPs to treat Neurodegenerative disorders such as Parkinson's disease and Alzheimer's disease as it was said to be a non-invasive type of drug delivery system and directly provides drug to the brain through intra and extra neuronal pathways. This study has also proved that most of the therapeutic drugs have failed to cure neurodegenerative diseases. Intranasal drug delivery with the help of Lipid NPs was said to be the most effective and simplest methodology of drug administration as utilisation of lipid NPs helps by enhancing bio adhesion to nasal mucosa and providing protection to the encapsulated drug. Another study which was performed by Fabio Sonvico et;al [11] briefed about intra nasal delivery of insulin using NPs would help in treatment of Alzheimer's disease as it showed promising results in clinical trials. The biocompatibility and stability of these NPs proved to be helpful for the design of an effective Intra Nasal Drug delivery system.

There have been many findings by various researchers all over the world about the importance of NPs in varied biomedical applications. When it comes to treatment for Neurodegenerative diseases there is an alarming need to know the combinational effects of Neurotoxicology and Nanotoxicology, Thus A study done by Anna Bencsik et;al [12] stated the importance of

evaluating both neuro and nano toxicity as NPs may effect the human brain health due to large amount of Industrial production. This study also briefs about the essential need for innovating specialised tools to carry out an effective evaluation of both neuro and nanotoxicology.

There are certain types of cytokines which help in preventing Neurodegenerative diseases from attacking our body. A study which was performed by Davis et;al [13] which helped in evaluating biological activity of NPs which contained Leukemia Inhibitory Factor (LIF). Initially packaging of LIF was done in nanoparticles which were comprising of poly(ethylene glycol)-poly(lactic acid) (PEG-PLA) whih lead to formation of LIF-loaded NPs which were also known as NanoLIF. In order to increase the cytokine delivery to inflammatory macrophages, the surface of Nano LIF was made to undergo changes with the help of CD11b antibody which targets the activated peripheral macrophages. ELISA was used to evaluate the release of cytokine from NanoLIF. M1 murine leukemia cell proliferation Assay was helpful in measuring the biological activity of NanoLIF. The results from this study showed that the average diameter of NanoLIF was found to be 30nm and had a neutral surface charge. This study also proved that NanoLIF could release LIF at rapid rate at about 0 to 6 hours after incubation at $37^0$C initially and slows down within 72 hrs. This study was very much helpful in proving that NanoLIF and CD11b-NanoLIF was responsible for minimising M1 cell proliferation in a larger amount and thereby blocking Neurodegenerative diseases from attacking our body.

In one of the studies various insilico techniques were employed to make the therapeutic drugs which are commonly employed in the treatment of Neurodegenerative disorders cross the Blood brain barrier (BBB) using Nanotechnology[14]. There is a vital need in designing a methodology which would exploit the BBB cells at molecular without disturbing the normal functioning of the barrier. Receptor and adsorptive mediated Transcytosis were considered to be one of the most valuable mechanisms which would help in transport of Nanomaterials from the blood to the brain by passing through BBB [15].Electrostatic interaction of a ligand including the charges expressing at the luminal surface of endothelial cells is said to be completely dependent on Adsorptive mediated Transcytosis [15].

There have been many studies in which combination of various drugs with Nanomaterials has helped in treating various Neurodegenerative disorders. In a study performed by Gobbi *et al* proved that Nanoliposomes (NL) when functionalized with Phosphatidic or with cardiolipin was found to be helpful in treatment of Alzheimer's Disease (AD) [16]. Along with the use in treatment for AD, NPs can also be used in protecting neuronal cells against oxidative stress. Due to toxic effects metal chelators are not being employed in recent times to prevent oxidation damage and as NPs are free from toxicity these can be used as a best alternative to metal chelators [17]. Nanotechnology has been the most rapidly growing sciences which have also produced invitro diagnostic tools for varied Neurodegenerative diseases like AD by measuring known pathogenic markers such as tau proteins and ADDLs of human Cerebral Spinal Fluid (CSF). One of the studies Georganopoulou et al. [18] used bio barcode of GNPs in determination of ADDL concentration in order to diagnose the disease early. A study introduced another invitro technique in which Quantum Dots were conjugated with streptavidin which lead to easy recognition of APPwhich was found to be highly sensible when compared with that Fluoroimmunoassay. [19]

Parkinsons's disease [PD] is said to be a Progressive neurological disorder generally affecting old age people. Nanotechnology plays a major role in release of Dopamine from brain which is helpful in treating PD [20]

In another study done by Trapani et al. [21] they prepared chitosan NPs along with which DA was adsorbed on to the external surface. Then they were administered Intra Peritoneally into the mice whose results showed less cytotoxicity when they were compared with that of only DA administered mice. In a recent study done by Huang *et al* [22] when lactoferrin was initially made to modify NPs which were then injected into rats suffering with PD resulted in showing increased locomotor activity and enhanced DA levels in rats suffering with PD.
There are invivo diagnostic techniques for early detection and diagnosis of PD with the help of Nanotechnology. In a study which was reported by an *et al* [23] designed a highly sensitive immunosensor for early PD detection with the help of Au doped–$TiO_2$ nanotubes arrays.

CNS injuries are commonly caused during Neurodegenerative disorders which are generally followed by accumulation of reactive oxygen species. Thus inorder to minimize these levels Fullerenes are utilized which would act as radical sponges which has the capacity to incorporate multiple radicals in a single molecule which there by leads to removal of superoxide oxygen radicals by dismutation catalytic mechanism. [24] One of the main reasons excluding BBB for the poor treatment for Neurodegenerative disorders is that

the therapeutic drugs which are being used for treatment are only symptomatic as they do not reduce the progressive pathological condition of the patient. Tosi G *et al* [25] in a review study stated that Nanomedicine for every CNS disorder does not exist which clearly shows that though Nanomedicine is useful for treatment and early diagnosis of Neurodegenerative disorders available Nanomedicines are not enough to prevent all types linked to this disorder. Thus, there is an alarming need to try to produce new Nanomedicines which could be metallic, polymer or biosynthesised which would be helpful in treating these kind of heinous disorders.

The transport mechanisms which are involved in BBB could be manipulated which were proved by various studies which were related to kinetic flux that disclosed unidirectional, concentration dependent movements of compounds across the BBB. [26] Various studies have reported that Polymeric NPs(PNPs) have the capability of delivering varied CNS drugs such as Doxrubicin which proves that PNPs could play a vital role in treatment of different CNS disorders in near future[27];[28];[29];[30]

Another study tries to prepare Nanospheres by micro emulsion polymerization methodology by dispersing the drug molecule in it which leads to formation dense polymeric matrices.[31] Nanocapsules and Nanospheres are the types of NPs which are commonly being used in transport of therapeutic drugs into brain though BBB. In a study done Vinagradov *et al* [32] tried to create a new combination with NPs by encapsulating oligonucleotides in nanogels which led to absorption of oligonucleotides into brain through BBB by reducing the amount of absorption of oligonucleotides in liver and spleen.

Nanosuspensions were considered to be an excellent nanocarriers because of their effective properties which were evaluated in various studies done till date on simplicity, high drug loading capacity and application to various number of CNS drugs[33];[34].Electrical stimulation is another type of methodology which is being adopted in recent times to treat CNS disorders. In a recent study carbon nanotubes were used to enhance chronic electrical stimulation of CNS which would be helpful in treating Neurodegenerative disorders. [35]

There have been various studies which were adopted to modify the concept of electrical stimulation in CNS with an aim to prevent these diseases and by doing these studies they could identify that nanofibers would also be helpful in treating Neurodegenerative diseases. In a study which they reported that carbon nanofiber based electrode arrays had the capability to provide both physical substrate and molecular signals when they were injected at the degenerative sites of brain. [36] Polymeric nanomicelles have also been one of the promising type of nanomaterials which can be utilised for treatment in CNS disorders in near future as some of the studies have proved that Nanomicelles can transport DNA to the CNS by performing both invitro and invivo studies [37];[38];[39];[40] but there is still a lot of scope to exploit this type of nanomaterial which has the capability to produce several biomedical applications.

A study has reported that N-butylcyanoacrylate (PBCA) NPs was combined with clioquinol (CQ) which is said to be a quinoline derivative was injected into a transgenic mice and the results showed that this type of NPs which were used to deliver clioquinol to the brain helped in solubilization of Beta-amyloid plaques which were responsible for the cause of AD and thus it lead to inhibition of these structures which further caused prevention of AD. [41] Similarly there have been many studies which are helpful in proving that PBCA NPs are helpful in transporting varied number of drugs to the CNS in an effective manner. [42];[43];[44]

A study done by Ritchie et;al reported that Thioflavin-T NPs (ThT) was helpful in detection of AD by identifying B-amyloid in senile plaques of AD.[45]The above study was followed by another study done by Hartig who tried to induce ThT NPs which were comprising of PBCA into the brains of transgenic mice and results showed that photo conversion of ThT occurred from the fixed tissues and transmission electron microscopy proved the presence of nanocapsules in microglia and neurons of mice. The delivery of ThT from nanocapsules was observed with the help of confocal microscopy.

There have been several studies which reported that accumulation of more number of metal ions which actually gets increased with age was said to be responsible for causing AD or enhancing their effects in patients suffering with AD. [46] Thus in order to prevent this Cui *et al* reported that when Cu (I) chelator d-penicillamine was conjugated with NPs it lead to reversing of metal induced precipitation of B-amyloid protein which finally lead to prevention of AD[47]

A study done by Kogan et;al [48] has reported that GNPs can also be useful in destruction of B-Amyloid plaques by incorporating them into B-amyloid fibrils and then exposing them to weak microwave fields which resulted in producing

energy which was 6 times lower than that of energy produced from cell phones which proved that it was safer to use in the presence of healthy cells.

Several studies have shown that varied number of peptides and proteins which are emerging as nanobiomaterials have the capability of self assembling themselves into various nanostructures such as nanotubes, nanovesicles, helical ribbons and three dimensional scaffolds.[49] This above study was further continued by Stupp *et al* [50] as they injected a nano biomaterial into a lab mice which was suffering with a spinal cord injury and the results showed that the mice which was initially made to get paralyzed was able to walk after injecting with the nanomaterial by regenerating the damaged neurons. This was only possible because of self assembling property of these nano biomaterials.

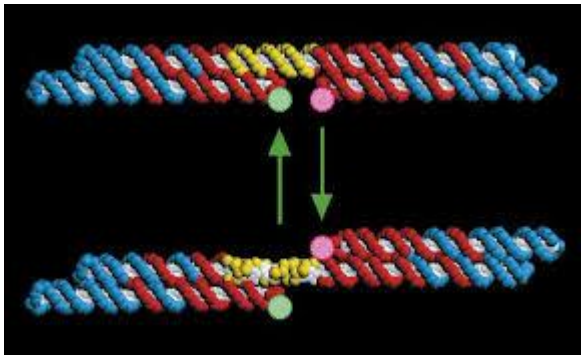

**Fig4: DNA Nanomechanical Devices[49]**

In any nanomaterial self assembling property plays a key role in preventing AD like disorders. Thus there have been several studies made on GNA which is a derivative of DNA (Fig4) that possessed the self assembling property along with some additional properties which was lacking in DNA such as anti-amyloid activity and formation of mirror image structures which were helpful in synthesis of various therapeutic proteins which are useful in vivo gene delivery of AD treatments. [51];[52];[53]

A study done by Simpkins et;al [54] has proven that redox based drug delivery nanosystems was successful in delivering and targeting release of DA into the brain through BBB which generally blocks DA from entering the parenchymal layer of brain and thus this type of nanosystems are helpful in treatment for patients suffering with PD.

Gene therapy with help of non viral vectors have proved to be effective in treatment of PD but various studies in recent times has also proved that NPs based gene therapy can also be developed for treating PD patients in a more safer and economical way. Yurek et;al [55] conducted an experiment on animal model by condensing DNA plasmids into NPs which would help in repairing defective genes and thus finally prevents neurodegeneration in those animals by showing improved symptoms in them which proved that NPs based gene therapy effectively cures Neurodegenerative disorders like PD. This study was followed by Kalpitt et;al [56] who proved that this NPs based gene therapy showed less side effects than that of other types of gene therapy. This study also proved that this type of gene therapy resulted in showing of enhanced clinical symptoms and abnormal metabolism from baseline when measured with the help of tomography.

Nanorobots are considered to be the new design in NT on which there are lot of developments going on in recent times. These are also known as bio machines which can algorithmically respond to stimulation and also have the capability of actuation, sensing, signalling information, processing and intelligence In a recent study it has been reported that Stem cell therapy is useful in preventing the attack of PD by conducting experiments on rats into which they implanted stem cells directly into brain which lead to reinnervation of striatal neurons and partial recovery of motor deficit which are actually related to deficiency of PD. [57]

## CONCLUSION

Nanotechnology has been very much useful as it is having many biomedical applications in drug delivery, separation technology, nanoelectronics and catalysis. Polymer and Protein NPs are said to be very much useful as an excellent nanocarriers to treat various CNS disorders. Several studies have proved that Quantum dots had varied biomedical applications as biolabels, sensors, light emitting diodes and medicine. Autophagy which is a process of self destruction of cells and several studies had proven that Silica NPs are the ones which would help in inducing autophagy. One study has proven that NPs based gene therapy can also be developed for treating PD patients in a safer and economical way. In one of the studies done in recent times it was proved that Lipid NPs when given by Intra Nasal drug delivery system then it was helpful in treatment for various neurodegenerative disorders such as AD and PD. Some of the studies also proved that NPs act as vehicles for immunomodulators and also for antigen delivery to APCs. These studies also revealed that it also acts as direct T-cell targeting compounds. One of the studies stated that Silver Nanoparticles can be produced by following Green synthesis in which reduction of silver nitrate occurs in the presence of water soluble polymer such as Poly-L-Lysine. Some studies proved that stem cell therapy is useful in preventing the attack of PD by conducting

experiments on rats into which they implanted stem cells directly into brain which lead to reinnervation of striated neurons and partial recovery of motor deficit which are actually related to deficiency of PD. Some of them helped in knowing that condensation of DNA plasmids into NPs was also helpful in treating NDs. Thus by this we can clearly understand the importance of Nanotechnology in preventing NDs from attacking our body and there is still a lot of scope to analyse and find more new biosynthesised NPs which have the capability to cure Neurodegenerative disorders in near future.

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