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Nanotechnology based Drug Delivery for Brain Targeting

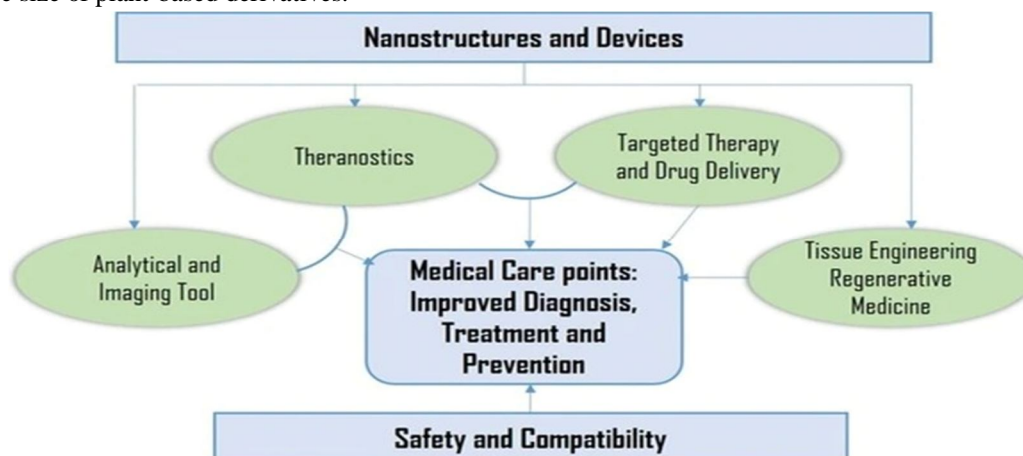
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Abstract: Nanotechnology is an excellent and evolving technology that can be used in the field of healthcare, engineering, environmental science, etc. There is a protective barrier around the brain called the blood brain barrier (BBB) which prevents the entry of larger molecules inside the brain, maintaining brain homeostasis and this poses as a problem because the drugs implemented during any CNS disorder cannot reach the brain. Nanoparticles are solid particles that range from 1-100nm in diameter and are used as a carrier for drug delivery. Nanoparticles are used because of their various characteristics like biocompatibility, prolonged blood circulation, bioavailability and non-toxicity. The functional characteristics and its size are both suitable for acting as a drug delivery carrier for carrying therapeutic agents to the brain. Nanotechnology is expected to reduce the invasive procedures for delivering therapeutic agents to CNS. Nanoparticles are effective as well as safer for acting as a drug delivery carrier targeting the brain. Some devices like implanted catheters are still needed for effective drug delivery to CNS. Nanoparticles deliver drugs at cellular levels through non-fluidic channels. Nanoparticles can avoid phagocytosis by the reticuloendothelial system thereby increasing the concentration of drugs. Polymeric nanoparticles are used and are widely in development to effectively deliver drugs across BBB. Polymeric nanoparticles have also shown effectiveness in the treatment of Alzheimer's disease and brain cancer. Polymeric nanoparticles provide enhanced drug delivery to the brain, with reduced oxidative stress, inflammation and plaque load through the improved delivery of curcumin for treating Alzheimer's disease and doxorubicin into the human glioma cells, results in the cytotoxic effect on cancer cells damaging the cancer cells. The use of nanoparticles in the field of healthcare has proved to be very effective, especially in the field of drug delivery.

I. BACKGROUND

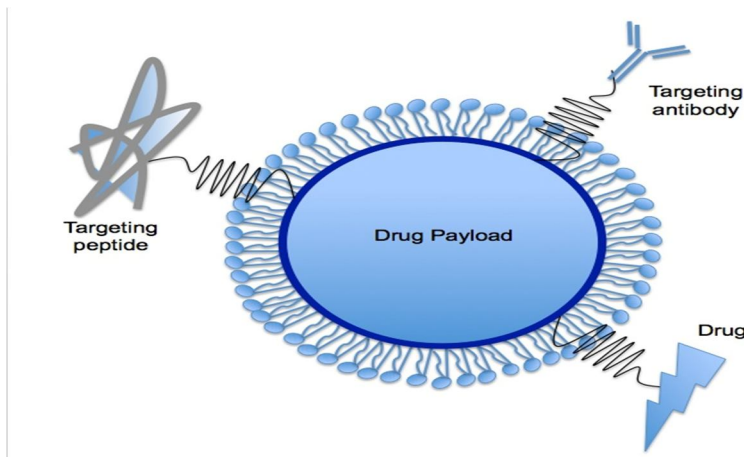
Nanotechnology has proved to be a boon in the field of healthcare. Previously humans used to use plant derived products for the treatment against diseases. Even in modern times nearly 25% of the major pharmaceutical's compounds and their derivatives are obtained from natural sources. Plant derived products have many advantages like their less toxicity, side effects, macromolecular. But pharmaceutical companies are hesitant to invest in natural products more because the question comes down to its biocompatibility, toxicity of some natural substances. Since plant-based derivatives are macromolecular there remains a problem with their poor solubility, poor absorption. However, with the invention of nanotechnology these problems are all solved since nanoparticles with their high absorption rate and high biocompatibility rate are present to deliver drugs across the whole body and since they range from 1-100nm in size. Polymeric nanoparticles are used to transfer therapeutic agents to the brain which could not be done due to the size of plant-based derivatives.



II. NANOPARTICLE BASED DRUG DELIVERY

Nanomedicines, which are a part of nanotechnology, are utilized in healthcare, and it is used in the treatment or solving of problems like low solubility, problems in drug delivery, etc. Nanomedicines increase the bioavailability of drugs because of the reason that, they remain in the intestinal tract for a comparatively longer time than most of the drugs. They can release drug in a controlled fashion which minimizes the side effects. Nanoparticles are also known to avoid phagocytosis by the reticuloendothelial system which increases the concentration of drugs and since the nanoparticles have a size range of 1-100nm they can travel anywhere in the body acting as drug delivery carriers and the polymeric nanoparticles can even deliver drugs across the blood brain barrier (BBB). There exists two ways through which nanoparticles deliver drugs in the body:

- 1) *Passive*: In this method drugs are incorporated in the inner cavity of the nanoparticle through hydrophobic effect and when it reaches the particular site for drug delivery, the drug gets released due to the hydrophobic environment.
- 2) *Self-delivery*: In this method the drug intended for release is attached to the nanoparticle intended for drug delivery. When the nanoparticle reaches the site, the attached drug detaches itself from the nanoparticle, in this method of drug delivery the timing of the separation is crucial.



III. MECHANISMS FOR NANOPARTICLE BASED DRUG DELIVERY

A. Liposomes

Lipid transport across BBB is possible through lipid mediated free diffusion. There exist many lipoprotein receptors in the body which bind the lipoprotein and form complexes which in turn enables the liposome bind nanoparticle to travel across BBB.

B. Polymeric Nanoparticles

Polymer-based nanoparticles travel across the BBB by receptor-mediated endocytosis by the brain capillary endothelial cells. Transcytosis then occurs to transport the nanoparticles across the tight junction of endothelial cells and into the brain. Polymeric nanoparticles provide enhanced drug delivery to the brain, with reduced oxidative stress, inflammation and plaque load through improved delivery.

C. Magnetic and Magnetoelectric Nanoparticles

In this mechanism of drug delivery, the nanoparticles are literally pulled across the BBB by the application of a magnetic field gradient. The nanoparticles can be moved as well as they can be removed from the brain via the application of magnetic field gradient.

IV. CONCLUSION

Nanoparticles have opened new pathways in the advancement of medical science. If nanoparticles are properly studied and researched upon, it will be sure to prove itself useful in the future by becoming the solution to the questions in the current day. By embracing nanotechnology, we will be surely be able to reach a new height in the field of science.

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