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Editorial

Thinking big with neuronanosicence-A plethora of opportunities

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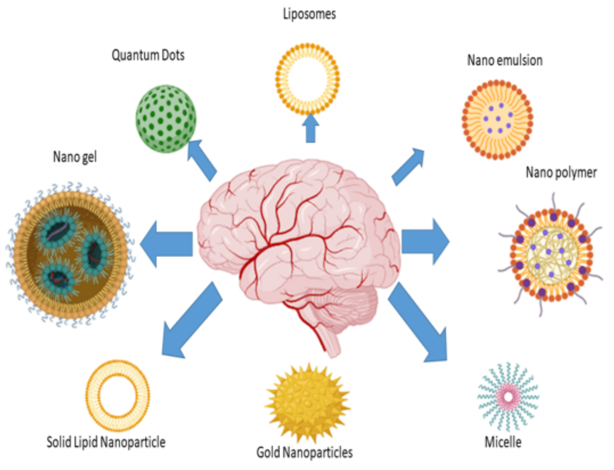

Figure 1: Potential applications of nanotechnology in neuronal nano drug delivery

Nanoneuroscience is an area of focus that integrates the foremost objectives of nanotechnologies with neuroscience.[1] Integrating nanotechnology with neuroscience and bioengineering can revolutionize basic research by creating advanced technologies and tools for diagnosing, treating, and monitoring the pathophysiological conditions linked to neurological disorders.[2] NeuroNanoTechnology is an emerging diagnostic approach in neuroscience that is focused on enticing elements at an incredibly small scale to develop novel nanostructures with atomic, cellular, or molecular capabilities. These small structures are utilized to regulate and repair neurons that are currently disrupted.[3]

Kogen et al. revealed an intriguing neuroprotective approach using gold nanoparticles (AuNPs) that has the potential to help prevent and slow down Alzheimer's disease advancement. Gold nanoparticles (AuNPs) were produced and conjugated with the peptide H-Cys-Leu-Pro-Phe-Phe-AspNH2 (Cys-PEP) to enable specific attachment of the nanoparticles to the Aβ aggregates. Following conjugation, the AuNP system was exposed to weak microwave fields, resulting in the absorption of radiation and subsequent energy release. This led to the amyloid clumps undergoing disaggregation. Considering the significant correlation that exists due to Aβ aggregates with respect to the Alzheimer's disease, the current approach, in conjunction with more comprehensive animal(models) investigations, has the potential to serve as a very promising neuroprotective treatment against this debilitating neurological disorder.[4]

Dahan et al. showcased the potential of quantum dots (QDs) to monitor individual particles for varying durations, from seconds to minutes. This enabled the real-time investigation of the diffusion of spinal glycine receptors.[5] A newly developed NEMS that shows promise is the 'Nano

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Knife', which is employed in irreversible electroporation (IRE), a revolutionary approach for non-thermal ablation. While the Nano Knife had been studied for its effectiveness in treating solid tumors in various locations, its use in the brain had not been explored until a group of researchers utilized the Nano Knife to treat intracranial glioma in dogs.[6] The system comprises a generator that utilizes low-energy direct current, operating outside the sterile surgical area, and a single-use disposable electrode probe, which serves as the primary cutting tool. The pulse delivery is continuously checked and will be halted if it over 50A at any given moment. The Nano Knife successfully excised the tumour.

Similarly Superparamagnetic iron oxide (SPIO) nanoparticles and ultra small superparamagnetic iron oxide (USPIO), both categorized as magnetic nanoparticles (MNPs), have already been utilized as agents to enhance contrast. Current research in neuroscience is specifically examining the potential of stem cells/progenitors labelled with iron oxide to deepen our understanding of neurological diseases.[7]

Advancements in nanoscale sensors and electrodes have enabled researchers to track the movement of ions in the brain's neural circuit. This is possible because to the exceptional sensitivity, broad potential range, and compatibility with living organisms of these technologies.[8] A research shown that wireless instantaneous neurotransmitter concentration systems (WINCS) based on carbon nanofibers have superior selectivity and sensitivity in detecting neurotransmitters compared to macroelectrodes. The techniques were able to detect the specific amounts of neurotransmitters by combination of dopamine (DA), serotonin (5-HT), and ascorbic acid at very low concentrations. The detection limit was 50 nM for DA and 100 nM for 5-HT, using a technique called differential pulse voltammetry.[9]

Furthermore, there have been advancements in the development of sensors for neurotransmitters. As an example, a certain team created a wireless sensor that measures the concentration of neurotransmitters using carbon nanofibers. This sensor uses a technique called rapid scan voltammetry (FSCV) to detect both dissolved oxygen and dopamine at the same time, but only in a laboratory setting.[10] The findings demonstrate the potential of using carbon nanofiber electrodes and using time-independent decoupled waveforms to detect various neurotransmitters. Hence, CNF electrodes have the capacity to assist in uncovering the process of deep brain stimulation, hence enhancing our comprehension of the pathophysiology of nervous system illnesses.

Nevertheless, nano neuroscience encounters several obstacles, including neurotoxicity, the incapacity to traverse the blood-brain barrier for enhanced specificity, bioavailability, and shorter half-lives, as well as the monitoring of illness therapy. The presence of nano neurotoxicity is a significant obstacle that has to be addressed in order to successfully use these nanoparticles in medical applications. Although the obstacles related to nano neuroscience may seem limitless, they really provide prospects for future research. The use of nanoscience in the field of nano neuroscience has led to substantial advancements in our comprehension of biological systems, the functionality of various brain regions, and the pathophysiology of nervous system disorders.

Conflict of Interest

None.

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