Multifunctional Nanoparticles for Selective Drug Delivery to Cerebral Artery-Tissue Regions

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Abstract

The development of new therapeutic techniques for brain tumor diseases is an ongoing field of active research for effective treatment of brain diseases. Presence of Blood Brain Barrier (BBB) and the complexities of the blood flow low and drug flow dynamics through complex artistry- capillary flow network in brain region is some of the main challenges in development of drugs particles and delivery systems. Nanotechnology is a promising approach where different types of multifunctional nanoparticles as drug carrier with different characteristics such as use of coating and appropriate sizes, enabling efficient delivery of drugs to target region. Structural design of nano-particle drug carriers also plays a critical role in the effective delivery of drugs to targeted tumor sites by diffusion through the blood vascular tissues and through the tumor cells. Several physiochemical and blood low dynamics conditions plays critical role in the effective deliver of the dugs to the targeted site. Development of multifunctional nano carriers for diagnostics, drug delivery and targeted treatment across blood-brain barrier focuses both on the structural composition of drug as well their transmission through brain artery-tissue and BBB layer. This review study includes discussion of the strategy in using multifunctional nano-drug carrier particles and their transport through blood flow dynamic in the brain tissue region for selective and target delivery. This study reviews the issues associated with the structural design and functionalization of nano carriers, delivery to targeted region, and visual imaging of nano-scaled drug delivery system. Further, the preparation of multifunctional polymeric drug carrier for tumor-specific uptake and enhanced intracellular delivery using amphiphilic polymer linker is presented. A new generation of methodology based on three-dimensional computational simulation model of the artery capillary network based on reconstructing multiple CT and MRI scan images of a tumor-affected patient is used for analyzing multifunctional drug distribution through the cerebral artery and adjacent tissue-tumor region. Potential future integration of advanced visualization tools such as augmented reality will play a significant role in the effective utilization of such simulation methodology for evaluating effectiveness of such multi-functional and selective drug particle delivery to a targeted brain tissue-tumor region.

BIOGRAPHY:

Dr. Pradip Majumdar is the Founder & CEO at DSinnovtech, USA. Dr. Majumdar earned his M.S. and Ph.D. in mechanical engineering from Illinois Institute of Technology. He is an adjunct professor at Illinois Institute of Technology, USA. He was a professor and the chair of the Department of Mechanical Engineering at Northern Illinois University (NIU). He is a recipient of the Faculty of the Year Award for Excellence in Undergraduate Education. Dr Majumdar's expertise and research includes AI-Machine Learning (ML) /Data Analytics; Advanced Simulation and Modeling; IoT/ML Application Developments. Fuel Cell Energy Systems; Li-Ion Battery Storage Design and Analysis; Engine combustion, Thermal Heat Management; Renewable Energy and Power generations; Thermo-Fluid Sciences; Computational Fluid Dynamics (CFD) and Heat Transfer; Finite Element Methods; Nano-structured Materials; Thermal Interface Materials (TIM); Electronics Cooling; Experimental Methods and Analysis; High energy Laser Material processing; and Transport Phenomena in Biological Systems.



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