Applying Viral Nanoparticles in a Treatment Vector for Alzheimer's Disease Using Molecular Dynamics Simulations

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A progressively neurodegenerative disease, Alzheimer’s disease presents a serious emotional and physical cost to patients and their families today. It is thus imperative that a cure is developed soon. However, new treatments are often too large in size to cross the blood-brain barrier (BBB) and thus do not localize to regions of the brain well. Nanoparticles offer one potential solution to this problem. The extremely small size and high targeting accuracy of nanoparticle vectors allow them to deliver therapeutic molecules to a treatment site without compromising surrounding tissue. In this project, solvated models of the cowpea mosaic virus (CPMV) capsid were developed to identify its possible therapeutic values in Alzheimer’s disease. Using molecular dynamics simulations, the CPMV capsid proteins were shown to interact with a combination of tight-junction protein ZO-2 (a BBB protein) and vimentin (a protein found in Alzheimer’s plaques); a combination of tight-junction protein ZO-2, vimentin, occludin, and vinculin (two other BBB proteins); and vimentin alone, as well as projected to interact with a combination of vimentin and beta-amyloid (another protein in Alzheimer’s plaques), without overheating the systems. Ramachandran plots and contact maps were used respectively to verify the secondary structure of the CPMV capsid proteins and location of interactions within the molecular systems. The CPMV capsid, based on simulation data, presents a promising drug vector in treating Alzheimer's disease because it could increase the efficacy of established treatment regimens and deliver new, promising drugs to treatment sites. Therefore, it should be explored further through experimental studies in animal models for incorporation into a treatment for Alzheimer’s disease.

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