Magnetic Nanodelivery of Therapeutic Agents across the Blood Brain Barrier

Novel multifunctional magnetic nanoparticle system

Contact
Pedro "Peter" Hernández
Director, Technology Management and Commercialization
11200 SW 8th St., MARC 440
Miami, FL 33199
Tel: 305-348-0008
Fax: 305-348-0081
E-mail: pedro.hernandez7@fiu.edu

Principal Investigator
Dr. Madhavan P.N. Nair

Field
Pharmaceutical and drug delivery

Technology
Nanotechnology

Key Features
Drug delivery technology crossing the blood brain barrier

Stage of Development
BBB model studies completed
Preparation for preclinical studies underway

Status
Seeking a commercial partner

Patent Status
Patent Pending

Background

The technology relates to the synthesis and targeted delivery of therapeutic agents across the blood brain barrier (BBB) using a multifunctional magnetic nanoparticle system. The delivery system involves reversible binding to two or more therapeutic agents belonging to several classes of antiretroviral, central nervous system based agonist and antagonist, neuropeptides, neuroprotectives, neurotropic agents, or anticancer drugs. The nanoparticle system is encapsulated resulting in the formation of a magnetic liposome and further modified to target the brain and circulating immune cells (monocytes / macrophages).

The BBB is a tight seal of endothelial cells that lines the blood vessels in the brain and acts as a barrier to protect brain cells. The BBB limits transport into the brain through both physical (the tight junction between endothelial cells) and metabolic (enzyme) barriers and prevents most substances including brain-disrupting blood compounds alkaloid toxins from plants, and other toxins, out of the brain. With very few exceptions, only nonionic and low molecular weight molecules soluble in fat clear the BBB. For example, alcohol, caffeine, nicotine and antidepressants meet these criteria. However, large molecules needed to deliver drugs cannot cross the BBB.

Recent work from Dr. Nair has shown that magnetic nanoparticles loaded with AZTTP (the triphosphate, active form of AZT) and encapsulated in liposolmes migrate across an established in vitro BBB model (primary human brain microvascular endothelial cells and astrocytes) when induced by application of an external magnetic field. Furthermore, it has been shown that the magnetic liposomes are phagocytosed by human monocytes, and that application of a magnetic field induces transmigration of the now-magnetic monocytes across the BBB. Additional studies to evaluate the drug release kinetics and stability of the developed nanoformulation are currently underway. The delivery of AZTTP using magnetic liposomes is expected to be increase the effectiveness of treatment for NeuroAIDS and may reduce the risk of developing drug resistant viral strains that seek safe habor in the brain.

More generally, the liposome encapsultated magnetic nanoparticple approach could be useful for delivering other types of therapeutics across the BBB.

Current Neuropharmaceuticals

Although the neuropharmaceutical market is substantial, the development of new drugs for the brain has not kept pace with progress in the molecular neurosciences, because the majority of new drugs discovered do not cross the BBB. However investments in the present market still account for around 23 percent of all research and development in the pharmaceutical industry committed to neurological conditions. The availability of an effective method of delivering pharmaceutical agents across the BBB would likely be of great interest to this market.

Opportunity

FIU is seeking a commercial partner.

Magnetic Nanodelivery of Therapeutic Agents across the Blood Brain Barrier

Novel multifunctional magnetic nanoparticle system

Principal Investigator

Madhavan P.N. Nair, Ph.D.
Professor and Founding Chair, Dept of Immunology,
Director, Institute of Neuro-Immune Pharmacology, FIU College of Medicine
Associate Dean, Bio. Med. Res, Florida International University

Dr. Madhavan Nair received his Ph.D. from Tata Memorial Cancer Center, Bombay University, India in Cancer Immunology and trained at Memorial Sloan Kettering Cancer Center, New York City. He then joined the faculty of the Department of Pediatrics at University of Michigan, Ann Arbor and subsequently worked at the Department of Medicine and Microbiology at SUNY, Buffalo, NY as a Tenured Professor and Director of Research in Allergy and Immunology. He is a certified Clinical Nutrition Specialist (CNS), Fellow of American College of Nutrition (FACN) and Fellow of American Academy of Allergy, Asthma and Immunology (FAAAI).

Dr. Nair and his colleagues discovered the suppressor factor in cancer serum (1978) and first reported that intravenous drug users manifest low natural killer cell activity (1986) and morphine induces apoptosis of normal lymphocytes (1997). In 1988, Dr. Nair reported for the first time (PNAS) that HIV recombinant purified gene products possess significant biological activities. His original discovery that cocaine increases the sensitivity to HIV infection by increasing the HIV co-receptors and methamphetamine exacerbates the HIV replication in dendritic cells had a profound effect on the role of these drugs on HIV disease progression. His recent research mainly involves the role of different drugs of abuses such as alcohol, morphine, cocaine and methamphetamine on neuro-AIDS and therapeutic approach to control Neuro-AIDS by specific drug targeting to brain using nanotechnology.

Dr. Nair is the first FIU researcher to earn a prestigious MERIT Award from the National Institutes of Health recognizing outstanding competence and productivity in research. He has published more than 100 papers as first and/or senior author. He has organized various national and international conferences, chaired a number of scientific sessions and served on various NIH study sections committees as chair/ member since 1980. His research is currently supported by four major NIH grants.