

Discoveries in nanotechnology have enabled the development of innovative drug delivery systems that can overcome previously impassable barriers. One such barrier is the blood-brain barrier, which is the main obstacle to the effective delivery of active substances between the blood and nerve tissue in the brain. The primary role of the blood-brain barrier is to regulate the transport of substances, providing an optimal environment for neural signalling. Unfortunately, this protective function prevents the passage of the vast majority of currently known drugs from the blood to the brain, making the treatment of neurological disorders associated with the central nervous system an extremely difficult challenge for medicine. The scale of the problem is worth highlighting here - it is estimated that hundreds of millions of people worldwide suffer from neurological disorders.

The research project focuses on coating dextran drug carriers with cell membranes derived from immune cells, such as monocytes and macrophages. The aim of this process is to facilitate the transport of carrier-encapsulated active substances across the blood-brain barrier. Dextran, which is a biopolymer with an easily modifiable structure, has been approved for medical applications. Monocytes and macrophages, having specific proteins on their membranes, can actively target tumour cells and penetrate the blood-brain barrier. Nanoparticles coated with cell membranes form a biomimetic structure that inherits the surface properties and functions of the source cells.

The project's research can be divided into five key parts. Firstly, we will focus on the synthesis of dextran nanoparticles, which we want to use as drug carriers. Next, we will culture monocytes from an immortalized cell line to extract valuable membranes from the cells. The membranes obtained will be used to coat the previously synthesized dextran nanoparticles. The coated particles will then be tested on specially cultured in vitro models of the blood-brain barrier. In the later stages of the project, we will focus on differentiating monocytes into macrophages and obtaining cell membranes from them, which will also be used to coat the dextran nanoparticles and tested on cultured barriers.

The aim of this research is to determine whether dextran nanocarriers coated with monocyte/macrophage cell membranes can cross the blood-brain barrier more effectively and reach disease sites in the brain compared to their uncoated counterparts. We expect that the results from our project will contribute to the development of new, more effective therapeutic strategies for neurological diseases. The findings may provide a foundation for further research into the development of nanocarriers with potential clinical applications, improving treatment efficacy and quality of life for patients.