Pyrrole-based polymer layers as a drug delivery system with neurological activity

In the elderly age, the incidence of neurodegenerative diseases, which damage neurons in the nervous system, has increased. Neurodegenerative diseases include Alzheimer's disease (AD) and Parkinson's disease (PD). These are diseases that weaken the body and lead to the destruction or death of nerve cells. They result in problems with movement or reduced mental efficiency (dementia). When neurons, which are the building blocks of the nervous system, are damaged or completely destroyed, they cannot be replaced. They have limited regenerative capacity, so reconstruction is not possible if the damage is too great. There is an urgent need to introduce targeted therapies to alleviate the symptoms of neurodegenerative diseases. Statistics reveal a significant increase in the incidence of neurodegenerative diseases, which is associated with the low effectiveness of pharmacological agents.

From the point of view of neurodegenerative diseases, it is important that the following proteins exist in the brain: beta-amyloid and tau. Beta-amyloid forms plaques in the brain that accumulate between neurons, disrupting cell functions. Tau forms neurofibrillary tangles inside neurons, blocking their transport system. Currently, there are two types of drugs aimed at symptomatic treatment (elimination of memory impairment, language difficulties, performing movements). One group is cholinesterase inhibitors responsible for breaking down acetylcholine, which helps transmit impulses between nerve cells and maintain memory. Another type of drug is the NMDA receptor, which blocks the effect of glutamate, a chemical whose release in excessive amounts causes damage to nerve cells. The name of this drug is memantine. These drugs can be effectively used in controlled drug release systems (DDS). DDS systems use intelligent polymers as scaffolds with built-in molecules of medical substances released under the influence of an external factor (potential).

Physiologically, at the cellular level, information transfer in the nervous system is enabled by the jump of an electrical impulse between synapses. Therefore, conducting polymers are used in the designed applications. It is possible to use polypyrrole as an electrically conductive scaffold, creating nerve guidance channels. Neurodegenerative scaffolds introduced into nerves damaged by diseases are intended to stimulate them and regenerate the neural network. The presented work includes the use of electrochemical polymerization (using two synthetic protocols) to obtain active layers of polypyrrole with built-in molecules of medical substances with neurological activity: chlorpromazine (a phenothiazine derivative), memantine hydrochloride and amantadine hydrochloride. The obtained layers will be characterized in terms of their use as drug delivery systems.