2. Streszczenie w języku angielskim

Nucleobase derivatives are a large group of compounds with a broad spectrum of biological activites. The chemistry of these compounds enjoys unflagging interest from both academic and industrial laboratories, especially from the pharmaceutical industry.

At the Department of Organic Chemistry of the Faculty of Chemistry of the University of Lodz for several years has been conducted research on the preparation, chemical transformations, structure and electrochemical properties of organometallic (i.e. containing at least one carbon-metal bond) derivatives of nucleobases. This is a little-known group of compounds with interesting chemistry and biological properties. Initially, work was focused on obtaining metallocenyl (ferrocenyl and ruthenocenyl) derivatives of thymine and adenine. The obtained compounds were tested for their biological properties, i.e. anticancer and antibacterial activity. Studies have allowed to identity of compounds with significant antibacterial and anti-cancer activity. Current work is focused on synthesis of organometallic nucleotides and their use for the synthesis of xeno nucleic acids (XNA).

The subject of this doctoral dissertation falls under the above mentioned, briefly described, research context and its extention and development. It focused on the synthesis and chemical transformation of organometallic (cyrhetrenyl, cymantrenyl) and organic (pyrenyl, anthracenyl) derivatives of selected nucleobases (adenine, N,N-dimethyladenine, thymine, uracil, 5-fluorouracil, 4-thiothymine). Undertaking research on the above the compounds were justified by the desire to learn about their biological activity (antitumor, antibacterial and antiparasitic), and for pyrene and anthracenyl derivatives, luminescent properties and their use for cell bioimaging by confocal microscopy.

The key stage in obtaining the aforementioned compounds was the Michael addition reaction in which the generated *in situ* α, *β*-unsaturated carbonyl compound (Michael acceptor) reacted with the nucleophile (anion of the appropriate nucleobase as Michael donor). In the fallowing the Michael adducts were subjected, as needed, to further chemical transformations (reduction, methylation, substitution of carbonyl ligands by phosphine, thionation, dehydration or substitution).

An interesting observation was that depending on the conditions used (presence of $Yb(OTf)_3$ or lack thereof, temperature), the reaction of anthracenyl nucleoside

with ethylene glycol leads to olefin (dehydration product) or hydroxy ether (substitution product) as the main product.

In respect to the photophysical studies, it has been found that all the obtained pyrenyl and anthracenyl Michael adducts are weak emitters (low quantum yields Φ_{PL}, short emission lifetime τ). This phenomenon was also observed for the olefin derivative of thiothymine. Other organic derivatives were characterized by much better emission properties. In addition, they did not show significant cytotoxicity, and were characterized by significant photo stability, which enabled their use as luminescent probes for imaging in the live cervical cancer HeLa cells using confocal microscopy. Based on the literature survey, it can be stated that these compounds are the first compounds of this class used as luminescent probes for bioimaging. The tested luminophores effectively accumulated mainly in the lipid-rich structures and organelles of the cells studied. One of the pyrenyl derivatives of adenine also accumulated in the nuclear structures of HeLa cells. This nuclear staining pattern correlated with the observation that the same compound binds *in vitro* to the single-stranded and double-stranded T10 oligonucleotide. What was found thanks to the collaboration with the group of prof. H.-A. Wagenknechta (Karlsruhe Institute of Technology, Germany).

In respect to other biological studies, it is noteworthy that one of the cymantrenyl 5-fluorouracil derivatives showed significant anticancer activity (IC50 = 7.24 μM) against A549 lung cancer cells. In addition, some of the obtained cymantrenyl and cyrhetrenyl derivatives have shown promising antitrypanosomal activity against (*Trypanosoma brucei*), which is the pathogen causing African coma. One of the cymantrenyl derivatives also showed antibacterial activity against clinical gram-positive strains including methicillin-resistant *Staphylococcus aureus*. Antimicrobial activity studies were augmented by bacterial cell morphology visualisation using a scanning electron microscope (thanks to cooperation with Prof. M. Arruebo (Department of Chemical Engineering, University of Zaragoza, Spain).

In conclusion, this doctoral thesis theme is set in a wider stream of "biologically oriented" (metalo) organic chemistry. The research carried out during the doctoral studies included in this work have significantly expanded knowledge of chemistry and biology of nucleobase derivatives.