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Interactions of Tetracationic Porphyrins with DNA and their Effects on DNA Cleavage

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ABSTRACT

The interaction of tetracationic porphyrins with DNA was studied using UV - Vis absorption, fluorescence spectroscopy and viscometry, and the particle sizes were determined. As cationic porphyrins, two isomer porphyrins, 3,3',3'',3'''-(5,10,15,20-Porphyrinetrayl)tetrakis(1-methylpyridinium) (TMPyP3) and 4,4',4'',4'''-(5,10,15,20-Porphyrinetrayl)tetrakis(1-methylpyridinium) (TMPyP4), were studied. They differ in the position of NCH₃⁺ group in phenyl ring of the porphyrins and hence, in degree of freedom of rotation of the phenyl rings about the central macrocycle. It was found that intercalated complexes are formed at DNA/porphyrin molar ratios (R) of 2.2 and 3.9 for TMPyP3 и TMPyP4, respectively. Decreasing R up to 0.4 and 0.8 for TMPyP3 и TMPyP4, respectively, leads mainly to formation of outside complexes due to π - π stacking between the porphyrin chromophores interacting electrostatically with phosphate framework of DNA. Each type of the obtained complexes was characterized using Scatchard approach. It was ascertained that the affinity of TMPyP4 to DNA is stronger than TMPyP3, meanwhile the wedge effect of the latter is higher. The differences between the porphyrin isomers become more evident at irradiation of their complexes with DNA. It was established that irradiation of the intercalated complexes results in DNA fragmentation. In the case of TMPyP4, DNA fragments of different size are formed. The irradiation of the outside DNA/porphyrin complexes leads to cleavage of DNA (TMPyP3 and TMPyP4) and partial destruction of the complex due to photolysis of the porphyrin (TMPyP3).

Keywords: Porphyrin, DNA, UV-Vis, Fluorescence, tetrakis-(3-N-methylpyridyl)porphine, tetrakis-(4-N-methylpyridyl)porphine

1. Introduction

Studies of photochemical processes involving porphyrins and metalloporphyrins are of great interest both for development of fundamental science and novel photochemical methods in photobiochemistry and

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