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INTERACTION OF DNA WITH Cu IONS

M.Belli, M.Matzeu, A.Scafati
Istituto Superiore Sanità, and INFN, Sezione Sanità, Roma, Italy

A.Balerna, E.Bernieri, S.Mobilio
INFN, Laboratori Nazionali di Frascati, Frascati, Italy

G.Onori
Università di Perugia, Perugia, Italy

A.Reale
Istituto di Fisica, Università dell'Aquila, L'Aquila, Italy

A.Bianconi
Dip. di Fisica, Università "La Sapienza" di Roma, Roma, Italy

High resolution X-ray spectroscopy with synchrotron radiation has been used at the Frascati synchrotron radiation facility as a tool for studying the interaction of metal ions with nucleotides and nucleic acids.

The biological relevance of this interaction is well established[1,2]; as a matter of fact a wide variety of metal ions are bound in living cells to nucleic acids, some of them in considerable amounts, and others as trace elements.

These cations have a fundamental effect on the structure and activity of polynucleotides, being implicated in their folding into compact secondary and tertiary structures, in the formation of anomalous links between the bases, and possibly in the opening mechanism of the two strands.

Correspondingly, alterations in the amount or in the nature of metal ions bound to nucleic acids may have toxic, mutagenic and carcinogenic effects in connection with interferences in the fidelity of the DNA duplication and protein synthesis.

High resolution X-ray spectroscopy presents unique features as an investigation method in this field, and particularly when samples in aqueous solution are studied, where the usual X-ray diffraction technique cannot be employed. If the metal ions are dispersed at low concentration in a matrix of light atoms, the fluorescence spectrum of the samples is preferred to the transmission one.

Most of the experiments performed up to now on biological molecules have been addressed to metalloproteins, and only a few have been devoted

to metal-nucleotide or metal-nucleic acid complexes, although these complexes are subjected to intensive investigation with other techniques.

The few studies on nucleic acids or nucleotides performed by X-ray spectroscopy which appeared in the literature, as far as we know, are reported in references (5-10).

The present study is devoted to a deeper investigation of the bonding of Cu atoms to DNA. We have shown in a previous work on this subject that the X-ray spectroscopy evidentiates the in situ reduction of Cu(II) in DNA complexes to Cu(I), caused by reductants or UV radiation and that several classes of Cu binding sites should be present in DNA.

To characterize these different sites, measures have been made both in the EXAFS and in the XANES region of the spectrum, on Cu-DNA complexes at two extreme values of the ionic strength, to make a selection between phosphate groups and the donor groups of the nucleosides.

This investigation is accompanied with a study of the Cu complexes with AMP, with ATP, and with its ribose moiety, in two extreme protonation states of the possible Cu ligands of the nucleotides.

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