Shedding light on the interaction between DNA and UVA radiation

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Ultraviolet A (UVA) radiation is now known to cause skin cancers. The first information on the way in which UVA radiation acts directly on DNA has been revealed by a CNRS team from the Laboratoire Francis Perrin in collaboration with a CEA-Inac laboratory in Grenoble. The interaction between UVA and DNA results from the collective behavior of the bases of the DNA double helix, which causes chemical lesions that can induce carcinogenic mutations. This work is published on-line on 18 March 2011 in the *Journal of the American Chemical Society*.

Ultraviolet A (UVA) radiation represents over 95% of the solar UV radiation that reaches the Earth's surface. This UVA radiation is now known to cause skin cancers due to carcinogenic mutations brought about by chemical alterations of the four bases of DNA (adenine, cytosine, guanine and thymine). The most important chemical modification is thymine dimerization: two thymines next to each other in the DNA combine to form a new entity, known as “cyclobutane dimer”.

A CNRS team from the Laboratoire Francis Perrin (CNRS/CEA), in collaboration with researchers from the CEA Laboratoire Lésions des Acides Nucléiques, has examined the very first steps of the formation of such chemical lesions. They are publishing the first study describing the physical and chemical effects, prior to any biological effects, of UVA radiation on model DNA. The team of physical chemists examined the behavior of a synthetic DNA double helix (formed solely of adenine-thymine pairs) with regard to UVA photons. They then compared its behavior with that of two complementary single strands (containing only thymines or only adenines).

They found that DNA's capacity to absorb UVA photons results from the collective behavior of its bases. Studied individually, DNA bases (including thymine) are “transparent” to UVA. However, in this study, the scientists have shown that the absorption of UVA radiation substantially increases following the pairing of two single strands to form a double helix. In addition, the probability that a UVA photon absorbed leads to the formation of cyclobutanes is at least ten times higher in the case of a double strand than it is in the case of a single strand. These differences could be explained by changes induced by the UVA photons to the electronic structure of the bases. Following the absorption of a photon, the new electronic configuration adopted by the DNA, known as excited state, persists longer for a double strand than for complementary single strands. The thymines then have more time to undergo permanent alterations.

These experimental studies now need to be extended to more complex DNA sequences, similar to natural DNA. The stakes in terms of public health are high, especially since the quantity of UVA that reaches us is very high compared to UVB radiation (which represents less than 5% of the ultraviolet radiation that reaches the Earth's surface) and also because UVA radiation is still widely used in tanning centers.

More information: Base Pairing Enhances Fluorescence and Favors Cyclobutane Dimer Formation Induced upon Absorption of UVA Radiation by DNA, Akos Banyasz, et al. – *Journal of the American Chemical Society*, 18 March 2011.

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