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Low energy electron interactions with complex biological targets

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The low energy (1-25 eV) electron-induced damage of DNA oligomers have been examined both theoretically and experimentally. Specifically, elastic scattering of 5-30 eV electrons within B-DNA 5'-CCGGCGCCGG-3' and A-DNA 5'-CGCGAATTCGCG-3' sequences has been calculated using the separable representation of a free-space electron propagator and a curved wave multiple scattering formalism. The disorder brought about by the surrounding water and helical base stacking leads to featureless amplitude build-up of elastically scattered electrons on the sugars and phosphate groups for all energies between 5-30 eV. However, some constructive interference features arising from diffraction were revealed when examining the structural waters within the major groove. We correlated these scattering features with measured DNA single and double strand breaks. Compound resonance states involving interfacial water and excitation energies > 5 eV seem to be required for lethal double strand breaks. We have recently extended this work to excitation energies below 5 eV by examining the damage using Raman-microscopy and scanning electrostatic force microscopy. Very efficient damage via single strand breaks is observed below 5 eV excitation energies. This involves π^* negative ion resonances that are initially localized on the bases but transferred to the σ^* states of the sugar-phosphate bond. The efficacies of these channels depend upon the base-pair sequences as well as the presence of water.