INVESTIGATING MECHANISMS OF RADIATION-INDUCED DNA DAMAGE USING LOW ENERGY PHOTONS

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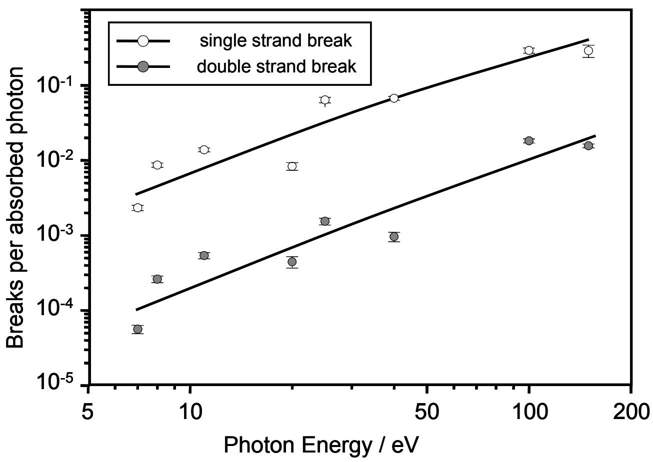
The study of radiation damage to biomolecules underpins our understanding of the mechanisms of radiation damage to cells, tissues and ultimately, living organisms. Developing a mechanistic model of how ionizing radiations interact with living tissues (from the initial energy deposition event at the molecular level, through to the consequences for the whole organism) may yield improved estimates of occupational and environmental radiation risk at low-doses and provide new pathways for improving the efficacy of radiation therapy. Theoretical track structure modelling show us that penetrating radiations (i.e. energetic photons or electrons) produce a significant number of nanometre-sized clusters of ionisations at the low-energy track-ends of secondary electrons (with energies of hundreds of eV, or less). Such clusters can induce 'complex' strand-breaks in DNA, which are less easily repaired than the predominantly 'simple' breaks produced by energetic photons or electrons. The low-energy electrons therefore have an important role in determining overall radiobiological effect of ionizing radiations and the mechanisms by which they damage DNA. Recent studies have indicated that low-energy electrons can induce single and double strand breaks in DNA below the threshold for ionisation, via the formation and decay of molecular resonances involving DNA components. Our own studies have endeavoured to quantify the amount of energy involved in the induction of strand-breaks in DNA. The approach we have used is to expose DNA to low-energy ionizing radiation at a range of energies and look for thresholds, below which single-strand and double-strand breaks are not produced. Our target molecule for these studies is plasmid DNA, which assumes a different topology depending on the damage it receives. We have also developed a novel 'wet cell' that permits the exposure of DNA in solution to vacuum-UV energies below 10eV. Even at these low energies, we find that single- and double-strand breaks are readily induced in DNA, and that indirect damage through the formation of radicals in the water is an important. The results suggest that mechanisms other than direct ionisation or free radical damage may be important in producing observable biological effects.



The formation of strand breaks in DNA as a function of energy