A significant obstacle to organic photovoltaics is radiation damage, either directly by photochemical reactions or indirectly via hot electrons. Such effects are investigated for biomimetic dye molecules for solar cells (phthalocyanines) and for a biological analog (the charge transfer protein cytochrome c). Both feature a central transition metal atom (or H$_2$) surrounded by nitrogen atoms. Soft X-ray absorption spectroscopy and photoelectron spectroscopy are used to identify three types of radiation-induced changes in the electronic structure of these molecules: 1) The peptide bonds along the backbone of the protein are readily broken, while the nitrogen cage remains rather stable in phthlacyanines. This finding suggests minimizing peptide attachments to biologically-inspired molecules for photovoltaic applications. 2) The metal atom in the protein changes its 3d electron configuration under irradiation. 3) The Fermi level $E_F$ shifts relative to the HOMO-LUMO gap in phthalocyanine films due to radiation-induced gap states. This effect has little influence on the optical absorption, but it changes the lineup between the energy levels of the absorbing dye and the acceptor/donor electrodes that collect the charge carriers. This affects the efficiency of a solar cell.