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Photophysics and biological effects of photosensitized of CdSe quantum dots JAY NADEAU, PAUL CHEUNG, McGill University — Certain biomolecules are able to function as electron or hole donors when conjugated to CdSe quantum dots (QDs) in aqueous solutions; this includes very common small molecules such as the DNA purine bases, the amino acid tryptophan, and the neurotransmitter dopamine. The position of the QD bandgap relative to the aqueous redox potential of the biomolecule provides a good (but not exact) method for predicting the likelihood of electron transfer. Such transfer leads to characteristic changes in the spectral properties of the nanocrystals, including quenching of steady-state photoluminescence emission and elimination of the fast component in time-resolved spectra. Such quenched QDs are "photosensitized" and show unique biological properties, including the ability to pass through cell membranes, including those of bacterial cells and mammalian cell nuclei. High-resolution electron microscopy suggests that the QDs cause transient openings in the membrane of 10-20 nm in size, probably due to the generation of oxidative radicals by the photosensitized QDs. Cells containing these QDs show oxidative DNA damage that is not seen when non-photosensitized QDs are injected or taken up by endocytosis. Experiments with bacteria which are able to grow in aerobic and anaerobic conditions indicates that the presence of oxygen is necessary for membrane damage and DNA toxicity. These results provide a general method for the design of photosensitizing drugs for targeted killing of specific pathogens or cell types.

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