

AbstractID: 7337 Title: Probabilistic two-stage model of cell inactivation by ionizing radiation: The model, its interpretation, and relation to kinetic radiobiological models

Purpose: To discuss the recently proposed probabilistic model of cell inactivation, possible biophysical interpretation of the involved damage classification, and the relation of the model to kinetic radiobiological models.

Method and Materials: The probabilistic two stage model takes into account two classes of DNA damage of different severity. While even a single unrepaired lethal lesion is assumed to inactivate the cell, less severe lesions have to combine in at least pairwise manner. Repair success probabilities, strongly varying between different cell lines, are represented.

Results: The probabilistic model enables to represent in a systematic manner a large variety of survival curves observed experimentally, including also the low-dose hypersensitivity phenomena. Under some conditions, the probabilistic model can be viewed as a solution to kinetic models of radiation action, such as the lethal-potentially lethal, repair-misrepair, or saturable repair model. E.g. for acute irradiation and fully developed endpoints, assuming non-saturated repair processes, the model predicts survival curves with a linear and a logarithmic term, similarly to the predictions of kinetic models, and can be approximated in terms of the linear-quadratic model, too. To address possible biophysical interpretation of the damage classification used in the probabilistic model, a detailed analysis of published survival data for V79 cells irradiated by low-energy protons was performed. Comparison with the yields of complex DNA lesions, estimated by Monte Carlo methods, indicates that lethal lesions correlate with a specific subset of complex DNA double-strand breaks.

Conclusion: The probabilistic model is a valuable tool for analyzing and interpreting radiobiological data. It enables damage induction and repair be described systematically. Development of a detailed microscopic radiobiological model is desirable to estimate damage probabilities in dependence on radiation quality on a model basis and thus increase the predictive power of the present model scheme.