Techniques for genetic evaluations of individual responses to radiation are rapidly evolving, with the prospect of incorporating such concepts into routine treatment planning. Such applications will require data concerning the response of normal tissues as a dose-limiting factor, the cytogenetics, and the genetics of the normal-tissue changes, and mathematical models to describe changes and to assess biological factors. We have begun *in-vivo* studies using the Sprague-Dawley rat to evaluate biological consequences of irradiations with photons, protons, and energetic heavy ions without and with pharmaceuticals that alter effects in normal tissues. This animal model is hypersensitive to the production of mammary tumors, although all consequences are being evaluated and archived. The use of different particle types is relevant because of their use as therapeutic modalities, and because their different distributions of energy deposition afford a unique opportunity to examine differences in cytogenetics and gene activation and inactivation as a function of particle types. Planning treatments will require accurate, efficient modeling of the biology for optimization. Preliminary results of a nonlinear, genetic model for the animal system being developed will be presented, which takes into account, for example, the cellular structure of the mammary tissues and the genetics. The work is part of program projects evaluating the consequences of radiations and methods to mitigate risks.

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