NONTHRESHOLD MODELS OF THE SURVIVAL OF BACTERIA AFTER IRRADIATION

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1. Introduction

The purpose of this paper is to investigate a certain class of nonthreshold models for the survival of the bacteria *E. coli* following exposure to X-ray and ultraviolet radiation. The threshold or multihit model contains two assumptions —that the effect of radiation is a process of accumulation of hits or irreversible structural defects in the cell and that death occurs when exactly n hits have accumulated. Woodbury [17] suggested a general method of modifying the model to include the possibility of repair during the irradiation period. Although the purport of the method is clear, some of the generality has to be abandoned to resolve the conflict between the first two sets of equations on p. 77 of [17]. The second assumption in the threshold model is retained, changing its form slightly so that the cell will die if more than n unrepaired hits have been accumulated at the end of the dose.

A fruitful approach to threshold problems in general has been suggested by L. LeCam and developed by Puri [13] in connection with a situation in which a host is infected with a parasite which multiplies and eventually kills the host. If we call the underlying process, be it the accumulation of hits in a cell or parasites in a host, $\{X(s): 0 \leqq s \leqq t\}$, where t is the time interval considered, then the LeCam-Puri approach is that the probability of dying in a time period $(s, s + \tau)$ is proportional to $\tau g(X(s)) + o(\tau)$, where g may be, for example, the identity function. It follows that the probability $S(t)$ of surviving a time t is of the form $f(X(s): 0 \leqq s \leqq t)$, for example, $\exp\left\{-\int_0^t X(s)\,ds\right\}$. In a seminar given at the University of California in 1967, the author applied this approach to radiation problems and showed that repair could be incorporated quite naturally in this context.

For the present purposes this approach is too general. In most cases the

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