MATHEMATICS RESEARCH SEMINAR

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MATHEMATICAL MODELING AND ANALYSIS FOR PRE-MALIGNANT MUTATION EQUATIONS

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ABSTRACT: We study the stability or instability of the pre-malignant stage of mutation. The variables (U, V_k, W); where $k = 1, 2, \ldots, n-2$, represent the densities of normal, intermediate mutant, and pre-malignant cells as functions of time t and space variables (x, y, z). For further study of carcinogenesis mutation, we impose condition on the parameter e, the satiation effect which may be chosen arbitrarily. The logistic parameter is α, the birth rate cell is represented by β, and ϵ is the diffusion rate. The rate of diffusion could become large or small.

We consider a one-dimensional nonlinear system of partial differential equations (PDE). The diffusion term D is dependent on intermediate and pre-malignant cells. The interaction factor η between mutant cells may be chosen arbitrarily for first mutation. For second mutation, the interaction factor may become nonlinear if malignant cells increase randomly. Then α will be replaced by η in the set of equations written below.

$$\epsilon U_t = \epsilon^2 U_{xx} + U(1-U) - \alpha \frac{UV}{(1-eU)}$$

$$V_t = DV_{xx} + bV(1-V) + m\frac{UV}{(1+eU)} - n\frac{VW}{(1-cV)}$$

$$W_t = W_{xx} - W + \beta \frac{UV}{(1+cV)}$$

Here, $\frac{D_0}{D_2} = \epsilon$ and $\frac{a_0}{a_2} = \frac{1}{\epsilon}$ is the ratio of selection pressure to the growth rate. The terms b, c, m, n are constant parameters.

Thus the above system may generate a non-deterministic system of PDE. The solution is optimized by initializing a value through initial stage to second and third stages for a probability function $P(p_{ij})$ over the solution space. The i, j represent matrix indices. An average expectation value E for malignant cells mutating for two or three stages is calculated. One can generalize further for several stages of mutations of malignant cells.

The analytical and numerical solutions are being compared. The software(s) used are Mat-Lab, Mathematica and/or Statistical software SPSS, and Minitab.