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Title : MATHEMATICAL MODELING OF BRAIN TUMOR CELL GROWTH FOR PASSIVE, ACTIVE AND OXYGEN TRANSPORT MECHANISM WITH MICROGRAVITY CONDITION

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The unpredictable conduct of the brain tumor cells present difficulties in creating precise models. The limitation of medical imaging in forecasting the nature of the tumor growth and the costly techniques for diagnostic and treatment posed an obstacle to the effort in understanding and fighting this life-threatening disease. As the tumor itself can only be detected and treated through the biological process, a good mathematical model should represent the important biological aspects with useful solution that contribute to further understanding of the problem. Addressing the current challenges in developing a realistic model by bridging the theoretical with the clinical applications, this research aims to govern mathematical models for brain tumor cell growth by emphasizing the cell migration and proliferation as the key characteristics. The models of passive and active cell mechanisms are representing the tumor cell migration while the model of oxygen transport mechanism configures the cell proliferation. New parameters for oxygen and gravity effects are included as the model novelty. The conditions of microgravity and oxygen deprivation are presented using the microscopic model of the tumor cellular dynamics. The models developed are in the form of parabolic equations which is discretized using the Finite Difference Method (FDM) with weighted average approximation. Numerical iterative methods, namely Jacobi (JAC), Red-Black Gauss-Seidel (RBGS), Red-Black Successive Over Relaxation (RBSOR) and Alternating Group Explicit (AGE) method are used to solve the discretized models. The sequential algorithms for these methods are developed and written in Matlab R2009a code to produce the numerical simulations of the models. Magnetic Resonance Imaging (MRI) images of a specific brain tumor patient are obtained from the local hospital for validation purposes. The image processing technique known as Enhanced Distance Active Contour (EDAC) are utilized in edge detection of the MRI images to get the parameter estimations for comparison with the model simulations. Simulations for one and two-dimensional space for all models are performed and discussed. Numerical results presented include the computational complexity of the iterative methods. The research found that the passive cell mechanism model is appropriate to describe the early stage of the tumor growth while the active cell migration model is good to describe the invasive tumor stage. It is also noted that oxygen and gravity condition play a big role on the tumor cell growth which could also controlled their internal cellular dynamics. The research proposed that the models can be used for brain tumor growth prediction, visualization, observation and monitoring purposes. The two-dimensional model provided a better visualization of the tumor since it provides information on diffusion and velocities in multiple directions at each grid point at each computational interval. The computation of velocity profiles in two dimensions allows the accurate representation of tumor cell growth and better prediction of the effects of oxygen deprivation and microgravity conditions.