CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

33699

Project Title

Modeling the Effects of Vascularization and Tumor Location on the Rate of Tumor Growth

Abstract

Objectives/Goals

The project aims to create an accurate iterative computer model of the growth and vascularization of a tumor that projects the radius, volume, number of cells, and volume of vascularized tissue of the tumor over time based on rate of vascularization and location.

Methods/Materials

Scilab, a mathematical programming language similar to Matlab was used to program the model. A model of oxygen diffusion throughout the tumor was created. The variations in oxygen concentration throughout the tumor then dictated cell division and blood vessel growth, which in turn changed the pattern of oxygen content. Many simpler models, such as a model of cell division rates and a model of oxygen diffusion from a capillary, were created and combined to form a comprehensive picture of tumor growth based on the processes within the tumor. Parameters were in place for rate of vascularization and tumor size at the start of vascularization, a value influenced by the location of a tumor. Values for these parameters were determined from publicly available data and the model was run with these various values in place.

Results

The model created fit the data used well. Changes in the #rate of vascularization# parameter had a more significant impact on the tumor growth dynamics than did changes in the #initial size# parameter.

Conclusions/Discussion

The model appears to be accurate despite the assumptions made in the creation of the model. These include the assumption that the tumor had a perfectly smooth surface, disregarding small projections, and the assumption that interstitial fluid pressure compressed the tumor into a sphere. Other assumptions include the assumption that no branching took place in the vasculature of the tumor. It can therefore be concluded that the factors disregarded by the model have minimal impact on the growth of the tumor. The model created has many practical applications, including treatment projections and use in epidemiology studies.

Summary Statement

An iterative mathematical model of tumor growth and vascularization dictated by oxygen distribution in tissue, that predicted effects of varying tumor location and vascularization rate, was created, and then simulated in Scilab.

Help Received