CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
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Project Number
S1608

Project Title
Effects of Motility and Contact Inhibition on Tumor Viability: A Discrete Simulation Using the Cellular Potts Model

Abstract

Objectives/Goals
We studied the effect of motility and contact inhibition on tumor growth using mathematical modeling.

Methods/Materials
Based on the Celluar Potts Model, tumor cell properties such as motility, contact inhibition, volume constraints, and adhesion energies are incorporated in my model of tumor growth. The simulation is coded in COMPUCELL3D with Python. Conditions influencing the contact inhibition, motility, and compressibility of cells were changed for different data sets. MATLAB is used to generate growth constants using generalized logistic curves. To streamline this process, I created a macro so that the simulation could be run with minimal human presence. About 100 sets of data (4 GB) were recorded.

Results
The data closely followed a generalized logistic curve, initially growing exponentially and then leveling off at carrying capacity. Plots of volume vs. time graphs revealed that low motility cells had a slower growth rate. In addition, cells that exhibited a high response to contact inhibition showed the same pattern of a slower growth rate and even amplified the effect of motility. Also, less compressible cell lines exhibited faster growth. These observations were quantitatively confirmed by the growth constants of curves fitted to the data.

Conclusions/Discussion
Our results showed that higher migration leads to faster growth rates. Motile cells create space for cells in the center of the tumor to grow and proliferate. We also observed that cells with high response to contact inhibition amplified the effect of motility. By increasing the contact inhibition restraint, clustered cells were less likely to proliferate. Cells in the center of the tumor were completely surrounded by homotypic cells and thus were not able to grow.

These results call into question the effectiveness of chemotherapy. Some treatments administer drugs that kill healthy and cancer cells indiscriminately. When those cells die, both cell lines must compete for the newly created space. Our research shows that cells with high motility and less response to contact inhibition will have increased proliferation rates. Since cancer cells often have these attributes, chemotherapy may in fact speed the growth of tumors in certain cases. The results from the simulation can be used to identify specific attributes that are associated with high growth rates and lead drug production to target those characteristics.

Summary Statement
We developed a mathematical model for tumor growth using the Celluar Potts Model and studied the effect that motility and contact inhibition on tumor viability.

Help Received
Dr. John Lowengrub of the University of California, Irvine is my mentor.