



CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

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| Name(s) Kevin Huang | Project Number S1204 |
| Project Title The Effect of Cancer Stem Cells and the Tumor Microenvironment on Tumor Growth and Invasion | |
| <p style="text-align: center;">Abstract</p> <p>Objectives/Goals The purpose of this experiment is to investigate how cancer stem cells and the tumor microenvironment can affect tumor growth and alter the effectiveness of different therapies.</p> <p>Methods/Materials I created a mathematical model incorporating a two-species cell lineage model (with cancer stem cells and terminally differentiated cells) into the Cellular Potts Model. Properties like motility, adhesion energies, growth, and the cell cycle are accounted for in each cell. Feedback mechanisms act upon cancer stem cells, influencing self-renewal and differentiation probabilities. The simulation was coded in XML and Python and run with CompuCell3D.</p> <p>Results The model was very accurate, with simulated tumors closely resembling in vitro tumor spheroids. When the cell cycle length of cancer stem cells was made longer, tumor growth slowed down drastically, and the tumor did not grow to be very large. When the responsiveness of cancer stem cells to positive feedback was lowered, no discernible change in tumor growth was recorded. However, when the responsiveness of cancer stem cells to negative feedback was decreased, tumor growth increased dramatically. Increasing the concentration of negative feedback in the tumor did not alter tumor growth.</p> <p>Conclusions/Discussion The results present an opportunity for quiescence therapy - inducing extended quiescence, or longer G0 phases, in cancer stem cells could rapidly halt tumor growth.</p> <p>Some have suggested using positive feedback inhibitors to control tumor growth. This was modeled by decreasing the responsiveness of cancer stem cells to positive feedback, but its effects were negligible.</p> <p>The importance of negative feedback in preventing uncontrolled cell proliferation was also demonstrated. However, when differentiation therapy was applied by increasing the concentration of negative feedback, tumor growth was almost completely unaltered. This suggests that differentiation therapy must be used in combination with other therapies to successfully eradicate the tumor.</p> <p>The cancer stem cell hypothesis explains why cancer has been such a difficult disease to cure. Clearly there will be no #silver bullet# in the war against cancer, but mathematical models can help to elucidate more of cancer#s weaknesses.</p> | |
| Summary Statement I incorporated a two-species cell lineage model into the Cellular Potts Model to study tumor evolution and the effects of different therapies on tumor growth. | |
| Help Received I would like to thank Dr. John S. Lowengrub for mentoring my project and allowing me the opportunity to work with him. The time he spent to answer my questions and give me advice was invaluable. | |