CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

Jonathan F. Li

Project Number

31738

Project Title

Effects of Cell Compressibility, Motility, and Contact Inhibition on the Growth of Tumor Cell Clusters

Abstract

Objectives/Goals

To study how tumor growth are affected by cell compressibility, motility and contact inhibition.

Methods/Materials

I created a mathematical model and computer simulation of tumor cells. I incorporated properties such as compressibility, motility, adhesion energies, and contact inhibition, as well as the 4 major phases of the cell cycle to simulate growth and mitosis. After 30 simulation runs, I input the data to MATLAB for statistical analysis. Lastly, I compared results obtained from in vitro experimentation to the simulation data.

Results

I discovered an inverse relationship between the motility and compressibility parameters. I used this result to calibrate the rest of my simulations. I discovered that tumor cell clusters that are not compressible grow faster than those that are. In addition, compression plots show that cells in the center of the cluster tend to be the most compressed in the cluster. I also test the motility parameter and find that motile cell lines have fast growth rates. Finally, comparisons with in vitro experimentations have shown that my model is accurate.

Conclusions/Discussion

I found that motility is an attribute that can make cells more fit if motile cells do not experience significant compression, compared with their less motile counterparts. Motility plays an especially important role when contact inhibition is a factor. Contact inhibition acts as a penalty for clustered cells since growth is halted when cells are surrounded by other cells. However, I have also found that increasing cell motility can induce changes in cell volume as it is easier for smaller cells to move. My research identified the interplay between cell motility and stiffness via the system energy and provided a means for compensating for this effect. This problem is an artifact of all simulations using the Cellular Potts Model and the procedure we discovered to compensate for the interplay may be used for all models.

These results also call into question the effectiveness of cancer therapies that involve high cell death rates such as chemotherapy. The mass die-off of cells places a selective pressure on more motile cells. Each round of die-off increased the proportion of motile cells. Similarly, high cell death rate therapies could select for cells with a particularly low response to contact inhibition, leading ultimately to more invasive cells.

Summary Statement

I developed a mathematical model and computer simulation to study the effects of cell compressibility, motility and contact inhibition on the growth of tumor cell clusters.

Help Received

I wrote the draft report and my mentor provided valuable comments for me to revise the paper in its final form.