CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Anin Sayana

Project Number
J1724

Project Title
A Novel Configuration of Carbon Nanotubes to Selectively Target Chemotherapy-Resistant Cancer Stem Cells

Abstract

Objectives/Goals
Current chemotherapy methods to treat cancer do not eradicate all of the cancer cells, and a relapse of the tumor often occurs because of a subpopulation of self-renewing and self-differentiating cells called cancer stem cells (CSCs). CSCs express the surface marker CD133 and the membrane transporter protein ABCG2, which induces chemotherapy resistance. I hypothesized that chemotherapy drugs can be made more effective in targeting CSCs by loading the chemotherapy drug and the ABCG2 inhibitor Imatinib into a multi-wall carbon nanotube (CNT) conjugated with the CSC-specific anti-CD133 antibody.

Methods/Materials
L1210 Leukemia Cells were grown in 30 flasks for three weeks in DMEM+FBS+Penicillin/Streptomycin. A FACS flow cytometry test was conducted, in which 1x10^4 cells were conjugated with the FITC anti-CD133 antibody and analyzed to determine the percentage of CD133-expressing cancer stem cells. Additionally, 2.5x10^4 cells were tested for chemotherapy resistance, a property of CSCs, using ethidium bromide. To test for destruction of CSCs, CNTs were conjugated with the anti-CD133 antibody, Imatinib (IM), and ethidium bromide (EB). Cells were treated with this configuration and 10 combinations of EB, IM, CNT+Anti-CD133 Antibody, using 2.5x10^4 CSCs per test. Each test was repeated four times, for a total of 40 tests. Healthy cells with the CNT combination were tested for cell viability. Finally, a SEM analysis and student t-test were conducted.

Results
CSCs identified by flow cytometry expressed chemotherapy-resistance, as < 1% of the cells were nonviable when treated with EB and EB+IM. For CSCs treated with CNT+Anti-CD133+EB+IM, > 99% of the CD133+ expressing CSCs were nonviable, while healthy cells were viable. The nonviability rate of CNT+Anti-CD133+EB was 7.5%, Imatinib alone was 5.5%, and CNT+IM+Anti-CD133 was 5.75%. The SEM images proved the binding of the CNTs to the cells. A p-value of $p < 0.001$ from the student t-test showed an extremely significant statistical difference between the values.

Conclusions/Discussion
The FACS and the chemotherapy resistance tests identified the CD133+ cells and proved them to be chemotherapy resistant, and the novel CNT configuration successfully destroyed the cancer stem cells. The incorporation of the Anti-CD133 antibody, ABCG2 inhibitor imatinib, and chemotherapy drug in carbon nanotubes shows promise for the treatment of conventional-cancer-therapy-resistant CSCs.

Summary Statement
I identified a population of chemotherapy-resistant CD133+ cancer stem cells, created a carbon nanotube configuration to selectively target the CSCs, and tested this combination's effect on cancer stem cell viability.

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