CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

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Project Number

35755

Project Title

Novel Design and Optimization of an EGFRvIII-based Cancer Peptide Vaccine

Abstract

Objectives/Goals

Cancer vaccines are a revolutionary field of cancer therapeutics that aim to utilize the body's natural defenses to treat cancer. Traditional chemotherapy strategies focus on targeting malignant cells directly, either by damaging DNA or otherwise inducing apoptosis. However, an alternative approach to this methodology is a peptide vaccine that stimulates an immune response. Through my research, I was able to design and optimize an effective anti-cancer vaccine based on the existing EGFRvIII vaccine by computationally and experimentally evaluating optimal proteasome processing, MHC reception, and ultimately malignant cell death.

Methods/Materials

Mass Spectrometry (MS) was conducted on five separate variations of the LEEKKGNYVVTDHC (LEEK) peptide that were fed to the human proteasome. Normalization offset was calculated, and I used a (Screen Pixel)/Dalton ratio to normalize the data. Effective and ineffective peptides were compared with other effective and ineffective variations, respectively. Finally, I designed a Java-based algorithm to evaluate the MS data in order to validate graphical analysis.

Results

Based on mouse survival data obtained from previous research, variations A and B consistently performed poorly, with survival rates averaging less than 40%. Several trials of MS analysis I conducted with A and B revealed that beyond the parental peptide, the proteasome did not process the parental peptide significantly further. As demonstrated, around 2600 Daltons, the presence of a synthesis peptide greater than the original molecular weight for both variation A and variation B is almost non-existent. Variations C, D, and E performed significantly better than A and B, with survival rates in mice generally averaging above 50%. Several repetitions of MS demonstrated large amounts of the breakdown of the effective peptides above their original molecular weight, around 2600 Daltons.

Conclusions/Discussion

This vaccine complex, as validated computationally, biologically, and graphically, was prevalent in effective peptides, but not present in ineffective peptides. The cancer vaccine variations show improved survival data, which correlate with the production of the larger processed peptide. In summary, my research discovered the optimal EGFRvIII-based cancer vaccine for glioblastoma through characterizing its processing in the proteasome using the experiments and analysis methods I developed.

Summary Statement

Overall, I was able to successfully design and optimize an EGFRvIII-based cancer peptide vaccine using the methods I developed, which can potentially be used to improve the efficiency of any peptide vaccine.

Help Received

Worked under Dr. Albert Wong at Stanford University.

Preliminary