Rational Development of a Therapeutic Peptide Vaccine Targeting Tumor-Specific Antigens in Neuroblastoma

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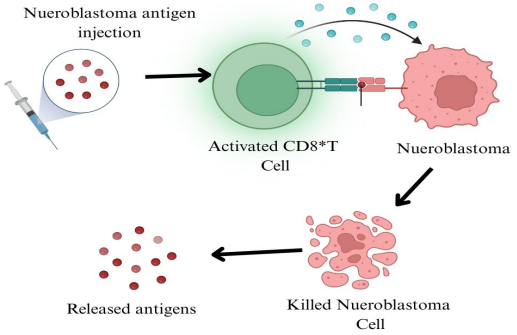
Introduction:

- Neuroblastoma is a type of brain cancer that affects immature nerve cells called neuroblasts
  - Seen in infants and children
- Hides from body, making the cancer deadly
- Current treatment includes high-dose chemotherapy, stem cell transplants, and different surgeries
  - Often times treatment is not enough for survival

Rationale and Hypothesis:

- My research aims to find the specific sites (epitopes) on the Neuroblastoma that become recognized by immune cells (B-Cell), allowing for immune cell response
- **Hypothesis:**
  - I hypothesize epitope (1) will bind the strongest to the B-Cell and can be used to develop the peptide vaccine against Neuroblastoma

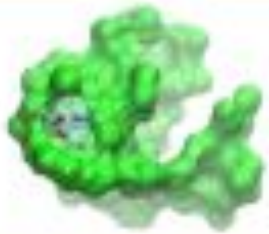


Epitope vaccine be able to activate the immune cells such as killer T cell, which binds to Neuroblastoma and kills the cell releasing antigens.

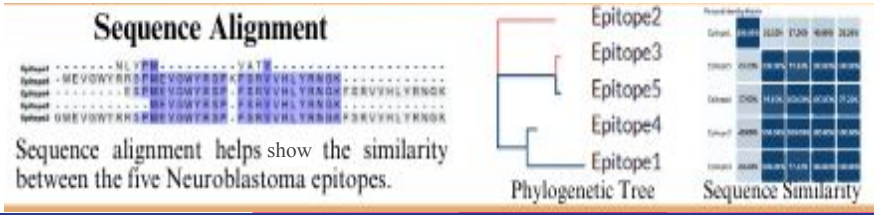
Methodology:

- Immune Epitope Database and Tools gave 5 potential epitopes
- AlphaFold 3 and P2Rank showed 3-D structure of B-Cell receptor and predicted binding site
- Protter and Human Protein Atlas showed how the B-Cell receptor is organized, and the different Neuroblastoma epitopes and sequences

AlphaFold3 will model accurate 3-D shape of protein



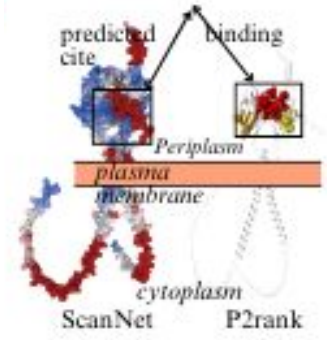
P2Rank will predict B-Cell binding site for epitopes



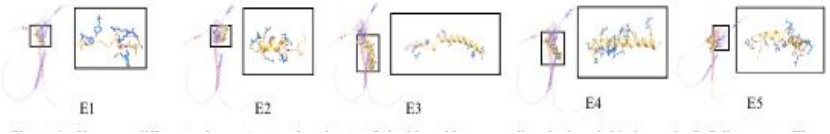
Methodology

- Used GRAMM and CD79-Epitope Interaction with PLIP analysis to see the interaction between the epitopes and B-Cell
- Used ChimeraX to see 3-D representation of the epitope and B-Cell binding
- ScanNet and P2Rank showed accurate 3-D model of the B-Cell and binding cite

Show the B-Cell and ligand (epitope) binding as shown in the picture



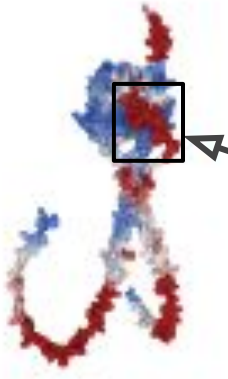
The 3-D visual of B-Cell receptor and predicted binding site



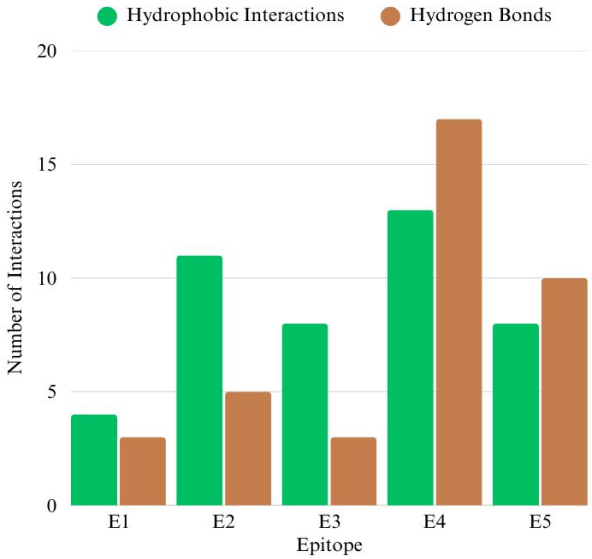
ChimeraX visual of the B-Cell and epitopes binding on the predicted binding site

Results

- CD79a and CD79b identified as tumor specific areas on B-Cell
- Epitope 4 was identified as the strongest epitope that binds to the B-Cell
  - Had the most hydrogen and hydrophobic bondings
- Epitope 4 can be used to advance the peptide vaccine for Neuroblastoma and hypothesis denied (E1 was strongest)



The deep red is the predicted binding site (CD79a and b) for the epitope interaction.



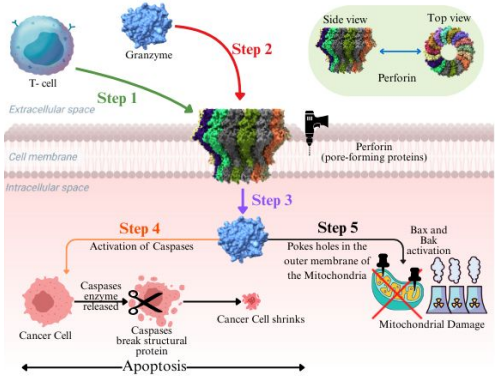
Graph (came from PLIP analysis) shows E4 having the most interactions with the B-Cell proving its the strongest epitope

Discussion and Future Work

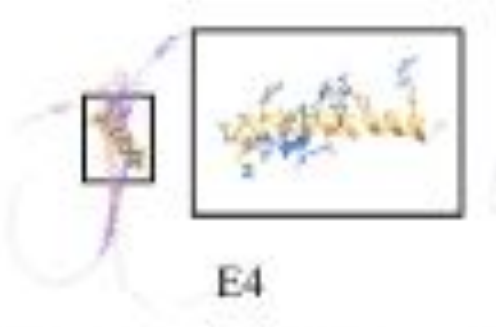
- Epitope 4 will bind to B-Cell, activating the cell, leading to the killer T cell being activated, signaling Apoptosis (programmed cell death), which will kill the Neuroblastoma

Future work

- testing epitope 4 with immune cells
- analyze more Neuroblastoma epitopes and simulate more T-Cell responses



Shows process of how other immune cells (killer T) can cause Neuroblastoma to undergo programmed cell death (apoptosis).



Application

- Using this research, we can screen for other vaccine targets for other pediatric cancers
- With further testing and modification, this research can lead to the peptide vaccine for Neuroblastoma and other similar cancers
- If I repeated this project, I would try expanding on more Neuroblastoma epitopes to maximize efficiency in Epitope and B-Cell binding leading to strongest vaccine

References

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IEDB.org: Free **Epitope Database** and Prediction Resource. www.iedb.org.

Pharmai. “GitHub - Pharmai/Plip: **Protein-Ligand Interaction Profiler** - Analyze and Visualize Non-covalent Protein-ligand Interactions in PDB Files According to 📝 Schake, Bolz, Et Al. (2025), https://doi.org/10.1093/nar/gkaf361.” GitHub, github.com/pharmai/plip.