

## **Engineering Immunity: A Gamified Approach to Bioengineering for Middle School Students (Resource Exchange)**

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Stephanie Dietrich holds a master's degree in library and information sciences and is a certified K-12 teacher, with experience teaching computer science and engineering design to K-8 students. She currently serves as the Educational Programs Manager at the Cancer Center at Illinois, where she leads K-12 outreach and community engagement initiatives, inspiring young learners through hands-on STEM activities and cancer education.

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Dr. Marcia ("Marci") Pool is the Assistant Director for Education at the Cancer Center at Illinois and a Teaching Associate Professor in Bioengineering. She holds a Ph.D. in Biomedical Engineering, has served for sixteen years as teaching faculty/staff in biomedical/bioengineering and nine years in departmental/institute educational administration, and is an ABET program evaluator for Bioengineering/Biomedical Engineering. She focuses on identifying and evaluating mechanisms to enhance the educational experience and develop students into engineers and researchers. Her work includes interventions to enhance training for high school students, undergraduate students, and predoctoral (graduate students) and postdoctoral trainees through training programs such as NIH T32s. These programs include curricular, extracurricular, and professional and career development components with required evaluation and tracking of student participants.

# Engineering Immunity: A Gamified Approach to Bioengineering for Middle School Students (Resource Exchange)



Developed by:

Cancer Center at Illinois Cancer Research Training and Education  
Coordination Team in collaboration with students from the Cancer  
Scholars Program

Time

60 Minutes

Grade Level:

6-8 Grade (Middle School)

## OVERVIEW

Gamification offers a powerful way to make abstract biological processes tangible. This resource details a hands-on activity that models targeted immunotherapy. In this “Immune Cell Hunt,” students simulate how the body identifies threats and, more importantly, how bioengineers “train” immune cells to recognize specific cancer markers. This models real-world solutions like CAR T-Cell therapy, demonstrating the transition from non-specific treatments (chemotherapy) to precision engineering.

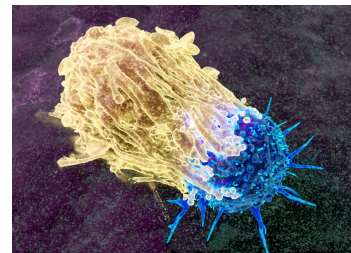


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## Learning Goals

1. **Understand** that the immune system uses “receptors” (molecular flags) to identify healthy vs. harmful cells.
2. **Contrast** non-targeted treatments with engineered, targeted therapies.
3. **Model** the bioengineering process of “priming” or “training” an immune cell to recognize a specific cancer receptor.
4. **Analyze** the limitations of natural immunity vs. the efficiency of engineered immunity.

## Standards Alignment

### Engineering & Scientific Standards (NGSS)

- MS-LS1-2: Cell Structure and Function
- MS-LS1-3: Body Systems and Subsystems
- MS-ETS1-1: Engineering Design: Defining Design Problems

## Materials

Receptor objects (feathers, burlap, pool noodles), blind folds, and open space.

## Student Brief Design

**Design Challenge:** If you were a bioengineer, what specific “flag” or marker would you train an immune cell to recognize? How would your design help the immune cell find harmful cells while avoiding healthy cells?

## Preparations

For a group of 10, assign 1 student as the “Immune Cell,” 2-3 students as “Cancer Cells,” and the rest as “Healthy Cells.” Then, give each “Cell” (both Healthy and Cancer) an object with a distinct texture that can be identified by touch.

## Instructional Procedures

### The “Flag” Analogy

**The Problem:** Cancer cells are sneaky; they look like healthy cells. Chemotherapy (non-targeted) is like a “carpet bomb” that hits everyone.

**The Solution:** Engineering. We can “program” the immune system to hunt for one specific flag.

## Round 1: Natural Immunity (The “Untrained” Search)

- **The Hunt:** The Immune Cell walks around the circle blindfolded, feeling the “receptor” objects held by other students.
- **The Goal:** The Immune Cell must try to guess who the cancer cells are without knowing what texture to look for.
- **Results:** Usually, the Immune Cell makes many mistakes (false positives) or misses cancer cells entirely.

## Round 2: Engineered Immunity (The “CAR T-Cell” Training)

- **The Change:** The teacher “engineers” the Immune Cell by allowing them to feel the specific texture (e.g., burlap) that only the cancer cells are holding.
- **The Hunt:** Repeat the exercise. This time, the Immune Cell knows exactly what “ID card” to hunt for.
- **Observation:** The detection becomes faster and much more accurate.

## Post-Activity Reflection

- **Analysis:** Students compare the number of correct identifications, false positives, and missed cancer cells in Round 1 and Round 2.
- **Discussion:** What roles can bioengineers play in immunotherapy?



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### Contact:

**Project Link:** <https://go.illinois.edu/CCILoutreach>

This outreach is supported by the Cancer Center at Illinois.

### References:

- CAR T-Cell Therapy and Its Side Effects, American Cancer Society. <https://www.cancer.org/cancer/managing-cancer/treatment-types/immunotherapy/car-t-cell.html> (accessed 2022).
- NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press. <https://www.nextgenscience.org/ngss-trademarks-and-copyright/ngss-trademarks-and-copyright>
- What is CAR-T Therapy?. Penn Medicine <https://www.pennmedicine.org/treatments/car-t-cell-therapy> (accessed 2022).