Immune Attack: A Video Game in the Molecular World
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Immune Attack teaches students core concepts of Cellular and Molecular Biology.

Immune Attack increases students' confidence regarding cellular and molecular biology.

**ABSTRACT:** Jerome Bruner proposed the "Spiral Curriculum" as a method for teaching deep understanding of scientific concepts. Bruner writes that five year olds intuitively create grammar correctly sentenced sentences and are therefore prepared to understand sentence structure more deeply when it is formally introduced in school. The "Spiral Curriculum" provides an iterative understanding of cellular biology and molecular science. Proteins, molecules, and cells behave in Immune Attack as they do in nature. Objects in the game, such as white blood cells, are drawn to look like the schematics that scientists use in their own models. Game actions, such as the capture of white blood cells by proteins on blood vessel walls, mimic actions that occur in nature, and are described using vocabulary similar to that of scientific literature. Our Scientific Advisory Group of 20 active scientists reviews our game outline and contributes to the faithful and exciting presentation of molecular science. We have successfully developed a method of communication, a guided wiki-like document, that allows these scientists to contribute meaningful information in a time-efficient manner. We collaborate directly with teachers to conduct controlled evaluations, using the Medical Mysteries System (MEDYST), which covers non-molecular topics of infectious disease as a negative control. We tested students' knowledge, comprehension of game dynamics and communication, a guided wiki-like document, that allows these scientists to understand sentence structure more deeply when it is formally introduced in school.

**CORE CONCEPTS**

1. Cells don't respond to their environment simply, adhere to a stimulus, and then stop responding to it when no stimulus is present.
2. Some stimuli do not have the same effect on all of the other cells present within a certain area.
3. The ability of several cell types to respond to and emit specific signals (molecules) produces a cellular network, that can be altered by other cells, activities of the cell, or the activity level of the cell.
4. Cell activity can affect other cell activity, which in turn affects the activity level of the cell.
5. Cells generally move in random ways, and their behavior is guided by the molecules in their environment.
6. The binding of molecules to specific receptors can be differentially expressed in the other type of molecules present within a cell.
7. The ability of several cell types to respond to and emit specific signals (molecules) produces a cellular network, that can be altered by other cells, activities of the cell, or the activity level of the cell.
8. Some cellular responses alter the complement of genes within the cell, while others may affect the cell's metabolism.
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**Figure 1.** This is a view of how Micro and Nano scale objects and action are presented in Immune Attack 2.0. The player is manipulating the Nanobot on the surface of the vein endothelial cell, while the change in behavior of cells can be observed in the Microscope's camera.

**Figure 2.** Some results of our current evaluation. Each class is randomly divided into two groups. One group plays Immune Attack for two 40-minute computer games. The other group plays the control game. One or 2 days after the second session, all students take an online survey. The questions are designed to determine whether players comprehend the core concepts, see below.

**Figure 3.** To determine whether Immune Attack provides students with deeper understanding, we designed a test for feelings rather than actual knowledge. The TOP figure demonstrates an increase in confidence due to playing Immune Attack. This figure, despite its complexity, contains many in-depth aspects. The BOTTOM figure is preliminary data that indicates that the confidence gain may not be limited to topics in the game, but may also be transferred to any three-dimensional depiction of molecular structures. We will follow up on these results.

**Immune Attack** is a video game that teaches basic facts and vocabulary about Cellular and Molecular Biology.

**Conclusions**

A video game may be used to create an understanding of the Core Concepts of Cellular and Molecular systems.

1. To further validate the results of the study, we plan a large scale evaluation in 2013-2014 and 2014 and 2015.

2. To demonstrate that Immune Attack provides a deep understanding of cellular biology and molecular biology, we will continue to develop our methodology, uncovering whether Immune Attack conveys a deeper understanding of the core content.

8. What is the name of the protein that will make a slowed...? (Concepts 1 and 6)

9. What changes happen to the cells of the vein when there is an infection? (Concepts 1 and 6)

10. How do Macrophages summon other cells to fight an infection? (Concepts 1 and 6)

References

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