

I. First Line of Defense (Non-specific – treats all invaders the same)

The goals:

1. *Invaders* must get past skin (2 square meters) and mucous membranes (400 square meters) and into the body.
2. The *Body* must keep *all* invaders out. (Barrier, microbes on skin, cilia in mucous membranes, exocrine glands secrete lysosomes, urine pH, phagocytic sentinel cells).

How it works:

1. The *Timekeeper* will start the stopwatch and call “Go”. At the end of five minutes, the *Timekeeper* will say “Stop” or blow a whistle.
2. *Invaders* in the group take turns - they call a number and roll the dice. If the number they call matches the number they roll, that invader gets inside the body. The invader has breached the first line of defense!
3. The *Scorekeeper* will tally the number of times an invader **DOES NOT** get past the first line of defense and will quit keeping the tally when one invader gets inside the body or the timekeeper calls “Stop”. The *Body* will receive points for each time it successfully kept an *Invader* out. If no *Invader* gets inside in five minutes, the body has succeeded in keeping the invader out and the *Body* wins! In this case, start over, keeping all points won by the *Body*.
4. If an *Invader* gets inside, he or she will draw an *Invader Card* and the teacher will read it to the group. All *Invaders* enter the *Gamma Master’s Body* as described.
5. All *Invaders* must make an antigen by bending a pipe cleaner into the antigen shape shown on the *Antigen Template Cards*. Attach to *Invader* badges with paperclips.



II. Sentinel Challenge (Non-specific)

The goals:

1. *Invaders* - must make copies of themselves faster than the *Macrophages* can destroy them.
2. *The Body - Macrophages* are cells that
 - Are activated when they recognize “non-self” – they will “reach out” and grab onto invading bacteria, engulf them and destroy them with powerful enzymes.
 - Patrol in body tissues looking for harmful invaders such as bacteria and viruses.
 - Send chemical signals to attract other macrophages and immune system cells to help with the battle.
 - Must divide to increase their number.

How it works:

1. *Invaders* enter the *Gamma Master’s Body*, the *timekeeper* starts the stopwatch and calls “Go”. After all *Macrophages* are activated and wearing the antigen or after 5 minutes, the *timekeeper* calls “Stop” or blows the whistle.
2. When *Invaders* breach the *First Line of Defense*, a chemical signal is sent to draw *macrophages* to the area. (*Invaders* simulate the chemical signal by chanting, repeatedly, “Macrophage”).
3. All *Macrophages* race toward the *Invaders*. These chemical signals must be sent out QUICKLY, because the bacterial invaders can duplicate themselves every second (actually, in real life, they divide every 30 minutes).
4. When a *Macrophage* reaches an *Invader*, it touches the *Invader antigen*, and by recognizing “Non-self”, the *Macrophage* becomes “activated”. (Turn the *Character Badge* over to simulate an activated *Macrophage*. Notice the macrophage is now a super-charged cell).
5. *Activated Macrophages* aggressively “reach out” to attack *Invaders* then surround and digest them. (Use “sticky hands” to grab Invaders).
6. *Macrophages* “wear” pieces of *Invader* antigen on their cell membranes. (After grabbing an *Invader* with the “sticky hands”, make a pipe cleaner antigen just like the one on the *Invader Card*, and attach to the *Macrophage Character Card* with paperclips).
7. *Macrophages* undergo cell division to increase their numbers. (This is accounted for on the Score Card).

IMMUNE-CHECK: If *Invaders* won this round, injection time – remove 100 *Invader Points*

II

III. Helper T Cell Activation (Specific)

The goals:

1. Invaders:

- a. Duplicate
- b. Avoid destruction
- c. Cause illness in the body

2. The Body

- a. *Invaders* travel in lymph fluid to lymph nodes around the body - Uh-oh! These lymph nodes are loaded with immune cells!
- b. *Macrophages* call *Helper T cells* and activate them with a “double lock and key” system.
- c. *Helper T cells* are now activated so they make many clones – all of which are “trained” to release chemical signals that direct the other immune cells.

How it works:

1. Invaders move to a lymph node, *Timekeeper* starts stopwatch and calls “go”. The *Timekeeper* stops the stopwatch and calls “stop” or blows a whistle when all *Helper T cells* are activated or 5 minutes passes.
2. *Invaders* move to a lymph node in the *Gamma Master’s Body*. Now they can’t avoid the immune cells as easily!
3. *Macrophages* create chemical signals that call *Helper T cells* into the battle. (All *Macrophages* simulate this by chanting “*Helper T cells*” until all arrive at *the scene*).
4. *Helper T Cells* arrive, but must be instructed about the *Invader*. (*Macrophages* must present an *antigen* and *a protein key* to make doubly sure correct information is transferred to the *Helper T cells*. *Macrophages* use the *Antigen Template Card* to make an antigen out of pipe cleaner. Attach the pipe cleaner antigen to the *Helper T Character Badge*. But that’s not all – there must also be a second key that activates the *Helper T cell*. The *Macrophage* presents the key to the *Helper T cell*. Turn over the *Character Badge* and attach the second key - the *Helper T cell* is now activated! This must be completed as quickly as possible.)
5. Hurry, *Invader* cells are doubling every second (this actually takes 30 minutes). The activated *Helper T cells* begin dividing.

IMMUNE-CHECK: If *Invaders* won this round, injection time – remove 10 *Invader Points*

III

IV. B Cell Activation (Specific)

The goals:

1. *Invaders:*
 - a. Duplicate
 - b. Avoid destruction
 - c. Cause illness in the body
2. *Body*
 - a. *B cells* are activated by chemical signals and direct contact with activated *Helper T cells*.
 - b. *Activated B cells* double in size and split into 2 (takes 12 hours).
 - c. Duplicate for 1 week – 20,000 *clones* (identical B cells), each with thousands of identical antigen receptors just waiting to find the “right” invader.
 - d. *B cells* use some antigen receptors as antibodies.

How it works:

1. *Timekeeper* starts the stopwatch and calls “Go”. At the end of 5 minutes or when all B cells are activated, stop the stopwatch and call “stop”.
2. *Activated Helper T cells* train *B cells* about the *Invader* through direct contact. The *Activated Helper T cell* makes a pipe cleaner antigen and presents it to the *B cells*. *B cells* must also receive the correct chemical signal before they can be activated. Make the *Antigen* out of pipe cleaners and attach it to the *B cell Character Badge*, say the chemical signal (the name of the *Invader*), and turn the *Character Badge* over to become an *Activated B cell*.
3. Once *B cells* are activated, they begin dividing rapidly (20,000 *clones* in 1 week)!

IMMUNE-CHECK: If *Invaders* won this round, injection time – remove 100 *Invader Points*

IV

V. Opsonize (Specific for most pathogens, but not cancer or virus-infected cells)

Note: The antibodies produced in this step are not used for cancer or virus-infected cells – For these, go to Card VI. Killer T Cells

The goals:

1. *Invaders*
 - a. Duplicate
 - b. Avoid destruction
 - c. Cause sickness, which means it is thriving
2. *Body*
 - a. Antibodies identify invaders carrying antigens that fit antibody sites and let other immune cells to the dirty work.
 - b. Opsonize (prepare for eating; mark for destruction; decorate) the invader.
 - c. Macrophages bind to antibodies and become “supercharged phagocytes”.
 - d. Sometimes antibodies can bind to viruses to keep them from going into the cell.

How it works:

1. *Timekeeper* starts the stopwatch and calls “go”. After 5 minutes or when all *Invaders* are destroyed, the *Timekeeper* stops the stopwatch and calls “Stop” or blows a whistle.
2. *B cells*, make huge numbers of *Antibodies* (B cells must make as many pipe cleaner antibodies with the reverse shape of the Invader antigen as possible. Attach the antibodies to the end of the IgM template with paperclips).
3. Remember, *Antibodies* are specific, they only attach to *Antigens* that are a perfect match. *Antibodies* lock together with the *Invader Antigen* and thus “tag” the *Invader* for destruction by supercharged *Macrophages*. *Invaders* walk to the large *Antibody* and stand on it). A cluster of *Invaders* are marked for destruction.

IMMUNE-CHECK: If *Invaders* won this round, injection time – remove 100 *Invader Points*



VI. Killer T Cells (Specific for Cancer cells and virus-infected cells)

The goals:

1. Invaders–

- Virus must get into a body cell where it is hidden from the immune system. Once inside, it will make copies of itself until the cell ruptures, releasing new viruses to infect new body cells.
- Cancer cells form and begin dividing rapidly, creating a cancerous lesion in the body that may spread to other parts of the body.
- Immune system must recognize that the body's own cells have a problem. The immune system must fight off these cells without harming the healthy body cells.
- When the antibody defense system fails, *Killer T cells* to the rescue!

2. Body

- a. *Killer T cells* trigger infected or cancerous cells to commit cell suicide (apoptosis).
- b. Mystery exists as to how the *Killer T cells* are activated – it appears that *Helper T cells* come in contact with special *Dendritic cells* and give them a license to activate *Killer T cells*.
- c. *Killer T cells* then give a packet of *granzymes* to the virus-infected or cancerous cell. This causes cell suicide (apoptosis).

How it works:

1. *Timekeeper* starts the stopwatch and calls “Go”. After 5 minutes or when all *Killer T Cells* give their packets to the *Viral Invader* or *Cancer Cell*, the *Timekeeper* will stop the stopwatch and call “Stop”.
2. *Activated Helper T cells* train *Dendritic cells* and give them a license to activate *Killer T cells* against virus-infected body cells or abnormal cancer cells. (*Activated Helper T Cells* make antigen and attached to the Character Badge of the *Dendritic cells*, who make antigens for each of the *Killer T Cells* – attach the antigen to the *Killer T Cell Character Badge*, turn the badge over and *Killer T Cells* are *Activated Killer T Cells*).
3. *Activated Killer T cells* recognize abnormal body cells (in this case the *Invader* is a cancer cell or virus-infected cell) and move very close to them. [*Killer T cells move to the Invaders* and hand over a packet of *granzymes*. The packet of *granzymes* signals to abnormal cell to undergo cell suicide (apoptosis). The abnormal cells DIE!].

IMMUNE-CHECK: If *Invaders* won this round, injection time – remove 100 *Invader Points*

VI