The object of the game is to eliminate an infectious agent from your body by removing all of the pathogen. At the completion of this game, you should be able to

- put the steps of immune system response in the appropriate order;
- distinguish between primary and secondary immune responses; and
- describe why an infected person will feel sick shortly after infection and why this feeling of sickness will dissipate.

In most cases, when a new infectious agent gets into your body, the bacteria or viruses are never able to proliferate because the phagocytic cells of your innate immune system recognize and destroy many common benign pathogens before you can get sick. This innate response is not very specific and cannot protect us from all pathogens, but it can activate the adaptive immune system when a more powerful immune response is needed. When the infectious agent is able to proliferate, the cells (T & B) and proteins (antibodies) of the adaptive immune system efficiently distinguish between self and nonself (the infectious agent) cells and mount an immune attack directed specifically at that particular infectious agent. The adaptive immune response is, however, relatively slow to develop the first time a particular infectious agent is detected (the primary response). After detection of the infectious agent, it takes time to develop a specific response that has mobilized a sufficient number of antibodies and immune cells; during that time, the infectious agent can proliferate and make you sick. Eventually, your specific immune response to that specific infectious agent will trigger the production of antibodies that help your immune system fight off the pathogen. Additionally, in the process of making antibodies, your adaptive immune system will have made memory cells that will allow you to mount a rapid immune response the next time you are exposed to the infectious agent (secondary infection). This response typically happens so fast that the infectious agent cannot proliferate, and usually you do not get sick.

Bacterial Infection

Materials Needed:

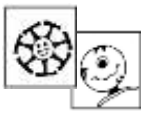
- Bag – The body bag represents your body
- Ziplock bag of Game Pieces – The playing cards are the immune cells and infectious agents that are circulating in your body and doing battle
- A coin – for flipping

Add the bacterial starter kit to your body bag.

- 3 Pathogens
- 1 Macrophage
- 1 B-Cell
- 1 Helper T-Cell

Directions for a Primary Bacterial Infection (How to Play):

1. Draw a card from the body bag.
    a. If you draw a bacterial pathogen, put it on your desk and add another to your body bag (it has replicated).
    b. If you draw a Helper T cell or a B cell, return the card to the body bag; those cells cannot recognize or act against a pathogen without first having the antigens presented to them by a macrophage.



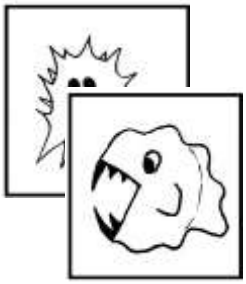
2. After each draw record what you drew, action, and # of items in the bag on the table. (This is for the whole game).
3. Draw again from the body bag.
    a. If you draw a bacterial pathogen, put it on your desk and add another to your body bag (it has replicated).

b. If you draw a macrophage and have a pathogen on your desk, flip a coin.

i. If you get tails, the macrophage can't see your pathogen and returns to the body bag.

1. Continue drawing until you draw a macrophage. Every time you draw a Bacterial Pathogen, place it on your desk and replace it with a new one in your body bag (it replicated).

ii. If you get heads, the macrophage finds and eats a pathogen.

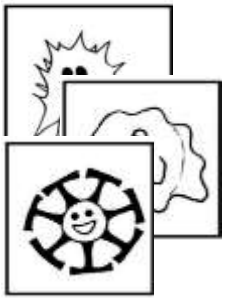


1. Cover the pathogen with the macrophage card, and then add two macrophages to the body bag to represent the movement of that macrophage to the lymph nodes and activation of macrophages there.
2. If the macrophage eats the pathogen, it presents the pathogen's antigens to the immune system. The antigen will also will attract Helper T-cells.

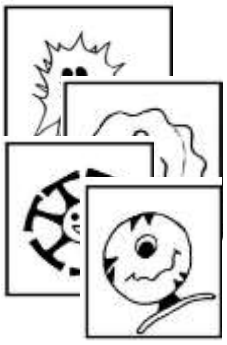
a. Add two Helper T-cell cards to the body bag to represent the increased density of these cells in the vicinity of the infection.

4. Continue drawing until you get a Helper T-cell card and place it on the macrophage–pathogen stack to represent the maturation of the Helper T-cell.

a. As you continue drawing, follow the rules for Bacterial Pathogens and macrophages (with the coin flip) until you draw a Helper T-cell.



b. Helper T-cells will activate B cells (add two B cells to the body bag to simulate the proliferation of cells that occurs during activation).

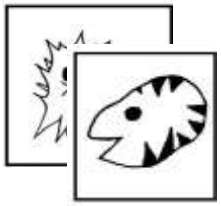


5. Continue drawing until you get a B cell (place it on the Helper T-cell stack to represent the activation of naive B cells by Helper T-cells).

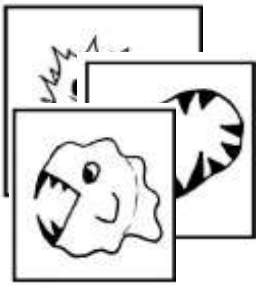
a. Follow the rules for all other cells as you draw.

6. Once the B cells have been activated, your immune system needs 14 days (14 draws from the body bag, during which you continue to follow the rules governing pathogen and macrophage behavior; steps 1 and 3) to produce antibodies and B cells (be sure to clip a B cell – Memory B-Cell – to the body bag for use during the secondary infection).
    a. Highlight the draw that starts the 14 days and the draw that will end the 14 days to keep track of this period.
7. After the 14 days (draws), place an antibody on every exposed pathogen on your desk.

a. Any pathogens that are subsequently drawn from the body bag after the antibodies have been produced will also bind to an antibody and will not be able to reproduce – do not replace them – (antibodies interfere with basic pathogen functions, such as reproduction).



8. Continue drawing from the body bag until you have drawn enough macrophages to kill all of the pathogens.



    a. Remember that once the pathogen binds to an antibody, macrophages will always find the antibody-labeled pathogen (no need for a coin flip).
    b. Follow the rules for all other cells as you draw.
9. Once the pathogens on your desk have been consumed, count and record the ratio of pathogens to white blood cells (WBCs) in the body bag. (Not on the desk). Record this at the bottom of your data table.
10. Return the bacterial started kit cards to your body bag and all other cards to the Ziplock bag.
11. After you have modeled the primary infection, run a secondary infection.

Directions for Secondary Infection:

1. Repeat the set-up and steps for a primary infection. After a Helper T-cell binds to the macrophage (step 4), it will activate the memory B cell you clipped to the body bag during the primary infection. The memory B cells immediately proliferate and produce antibodies. (Skip to step 7 without the 14 day waiting period). And continue with the direction for primary infection.

Data Table – You need one for the primary infection and a second data table for the secondary infection

Draw #	What was drawn?	What action did you take?	# of bacterial in body bag	# of macrophages in body bag	# of Helper T-Cells in body bag	# of B-cells in body bag
Initial Draw	Bacteria					
2						
3						
4						
5						
Etc…						

*To calculate the number of each item in the bag at the end of each draw, simply add what you put in the bag and subtract what you took out and put on your desk from the numbers from the previous draw. There is no need to empty the bag and count each round.

END OF GAME: _____ # of WBCs (Macrophages + Helper T-cells + B-Cells)

_____ # of pathogens (Bacteria)

Analysis Questions

1. How do the pathogen: WBC ratios compare between the primary and secondary infections? Explain why this different occurred.
2. What is the relationship between the innate and adaptive immune systems?