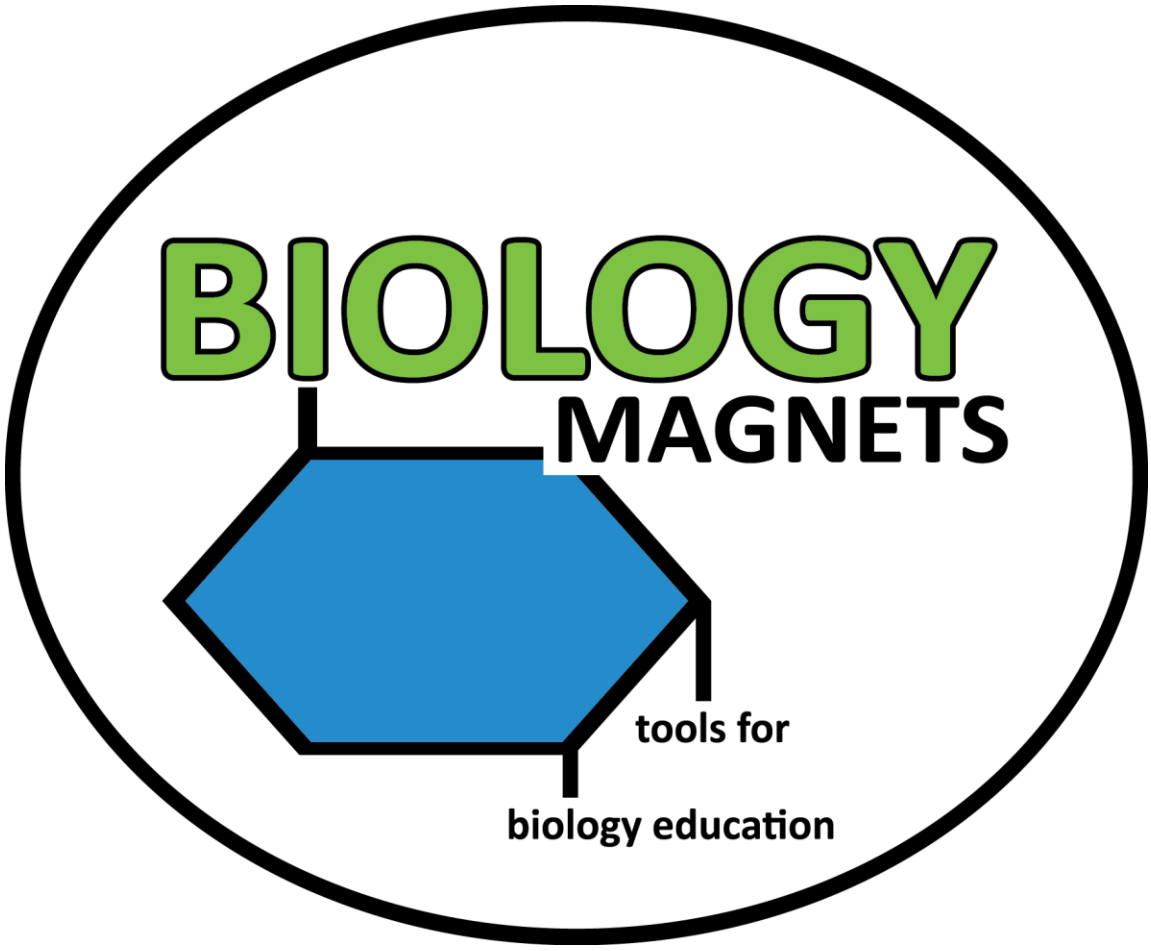
Biology Magnets Module 8: Immune System - Teacher and Student Guides



Teacher Information

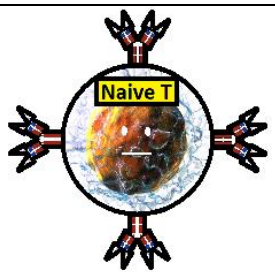
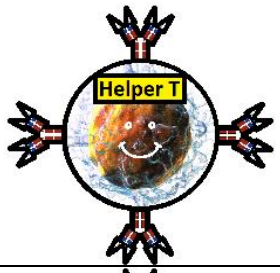
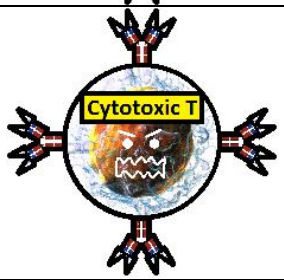
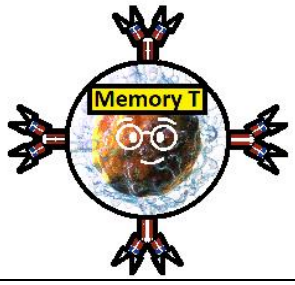
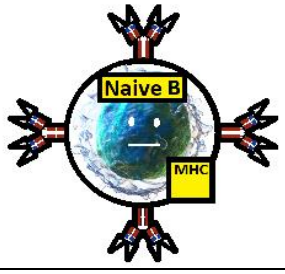
This module uses magnets designed for teacher and student interaction to guide learning the processes involving the immune system. Contained in this guide are lesson ideas that can last from 10 minutes each to an entire class period, depending upon teacher preference. Each lesson has both teacher-centered and student-centered activities. The student-centered activities are most effective if students are in small groups. It may be necessary to have multiple magnet sets for large classes. A student handout is provided which can be printed out and given to each student group to help guide their progress as they work with the Biology Magnets. If budget or white board space is limited, groups can alternate between using a set of Biology Magnets and doing other activities. Teachers can refer to the videos posted at the Biology Magnet web site at BiologyMagnets.com for guided teaching instructions. The guides presented here are written to supplement, not replace, textbooks and lessons and thus do not fully elaborate on all processes and terms.

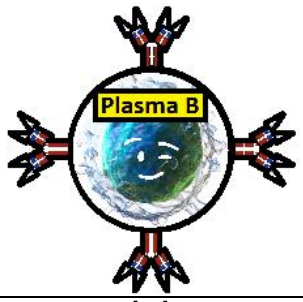
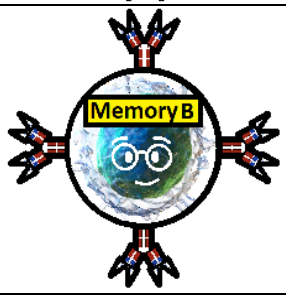
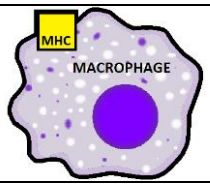
Magnet Care and Maintenance

Biology magnets are made to last for years. Periodically magnets will fall off or are knocked off the plastic. A piece of magnetic tape is included with each module, which should be able to replace around 10-12 magnets if necessary. Simply cut a new magnet and peel off the back to replace. Magnetic tape can be purchased from a hobby store to replace magnets lost over time. Laminate may peel off, especially on small pieces. Transparent tape can be used as a replacement or to re-attach laminate that comes loose by curling the tape over the back of the magnet. The machines used to cut Biology Magnets are not always perfectly accurate. Sometimes a bit of white or black outline on the edges occurs or a cut might be slightly off center. Use scissors to remove extra outline that is unnecessary if desired. Store magnets in the clasp envelopes in which they arrived for easy organization.

Copyright Information – Module 8 – Immune System

Biology Magnets Module 8 Materials List

Magnet Name	Quantity	Picture
Naïve T Cell	4	
Helper T Cell	2	
Cytotoxic “Killer” T Cell	2	
Memory T Cell	2	
Naïve B Cell	4	

Plasma B Cell	2	
Memory B Cell	2	
Antibody	12	
Virus	16	
Macrophage	4	
Antigen	8	
3” Magnetic Tape Strip	1	
Total Quantity	**59**	

Lesson 8A – Immune System – T Cells (20-70 minutes)

Teacher Centered Activity (20-30 minutes): This lesson utilizes the Biology Magnets to model the immune system and basic T cell activity. Start by drawing two large ovals to represent lymph nodes and fill one with the naïve T cells and the other with the naïve B cells. Also draw a number of body cells (throat cells for example) which will become infected with a virus. Move a single virus into one of the cells (**Figure 8.A.1**). Once the cell is invaded by the virus, make it multiply by adding many new virus magnets to the cell. In defense, the cell will display a few of the virus antigens it produces for the virus to alert other cells to the presence of the invader (**Figure 8.A.2**). After the cell dies, the viruses erupt from the cell and fill the spaces and fluids outside of the cell. Move viruses into nearby cells to demonstrate further infection (**Figure 8.A.3**). Move one of the macrophages to engulf a virus and display a viral antigen on its surface MHC protein. Note that the size of the antigens have been magnified in the Biology Magnets for ease of use. The macrophage is now known as an antigen presenting cell (APC) (**Figure 8.A.4**).

Figure 8.A.1 – Initial viral infection of a cell

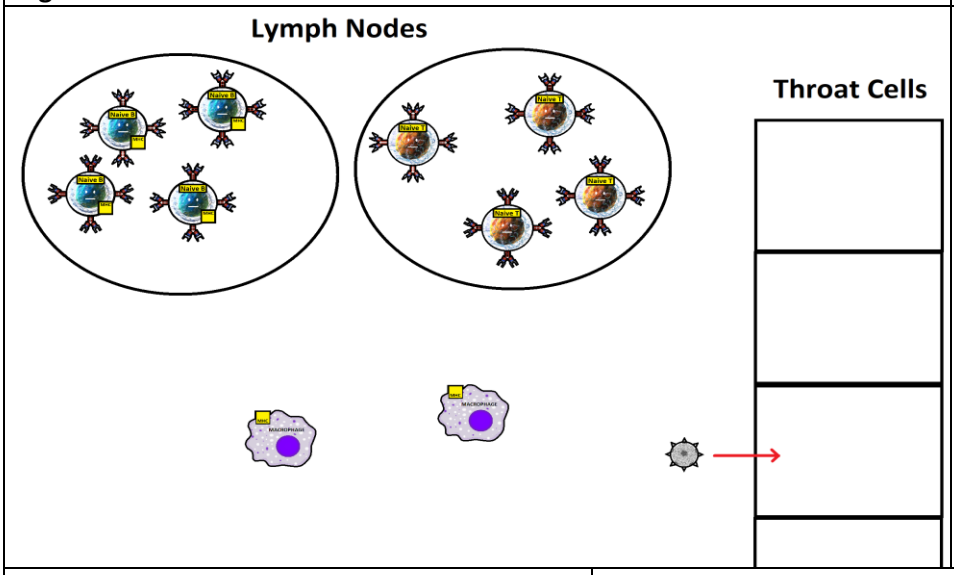


Figure 8.A.2 – Virus reproduces in cell

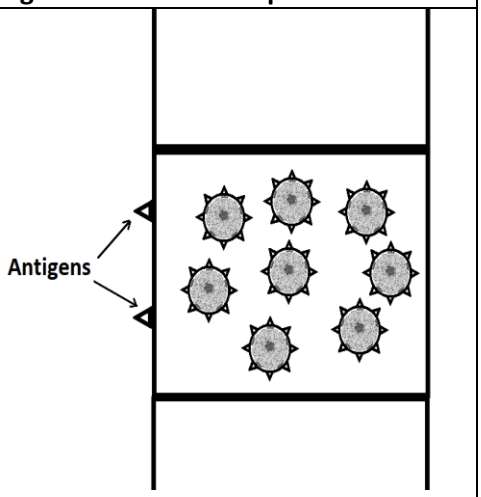


Figure 8.A.3 – Virus erupts and infects cells

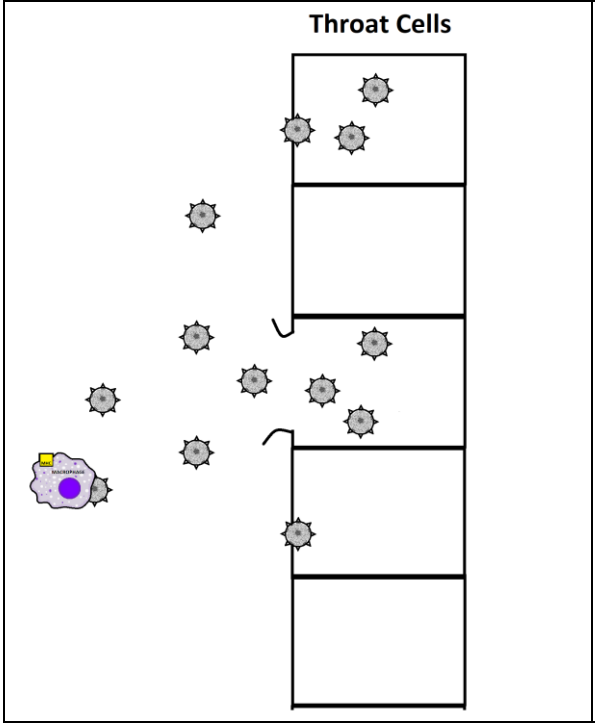
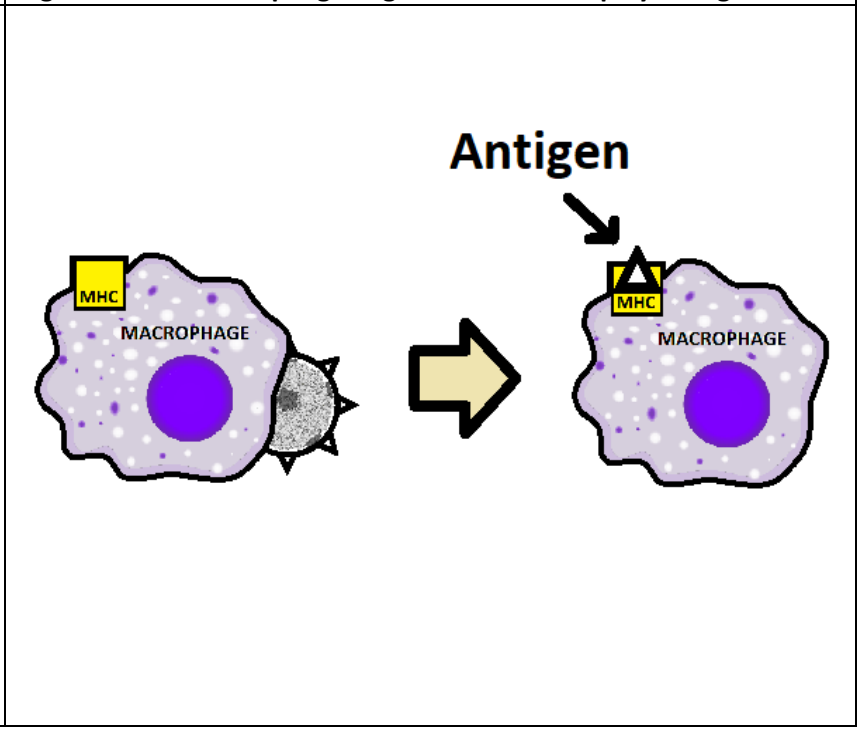


Figure 8.A.4 – Macrophage engulfs virus and displays antigen



Clonal response: Move the macrophage into the lymph node that contains the naïve T cells. The macrophage will present its antigen to all of the naïve cells until it finds the T cell with the matching receptor (**Figure 8.A.5**). Once activated, the naïve T-cell has a clonal response, multiplying to form helper T cells, cytotoxic T cells, and memory T cells. Place those magnets into the lymph node (**Figure 8.A.6**). The cytotoxic T cells will leave the lymph nodes and move through the body, encountering cells until they encounter an antigen on the cell surface. When they do so, they release perforins, chemicals that destroy the cell and the viruses under construction within the cell. Demonstrate this activity with the magnets and draw perforins with a marker (**Figure 8.A.7**). Next, move the helper T cells out of the lymph node. Helper T cells have many functions, including release of cytokines (interleukins) to stimulate and recruit other immune cells. Draw the cytokine release from a helper T cell onto a macrophage with a marker. Add more macrophage magnets to illustrate the recruitment (**Figure 8.A.8**). Explain that memory T cells provide lasting immunity and are ever present to help fight infection quickly if the virus is encountered in the future.

Figure 8.A.5 – Activation of Naïve T Cell by APC

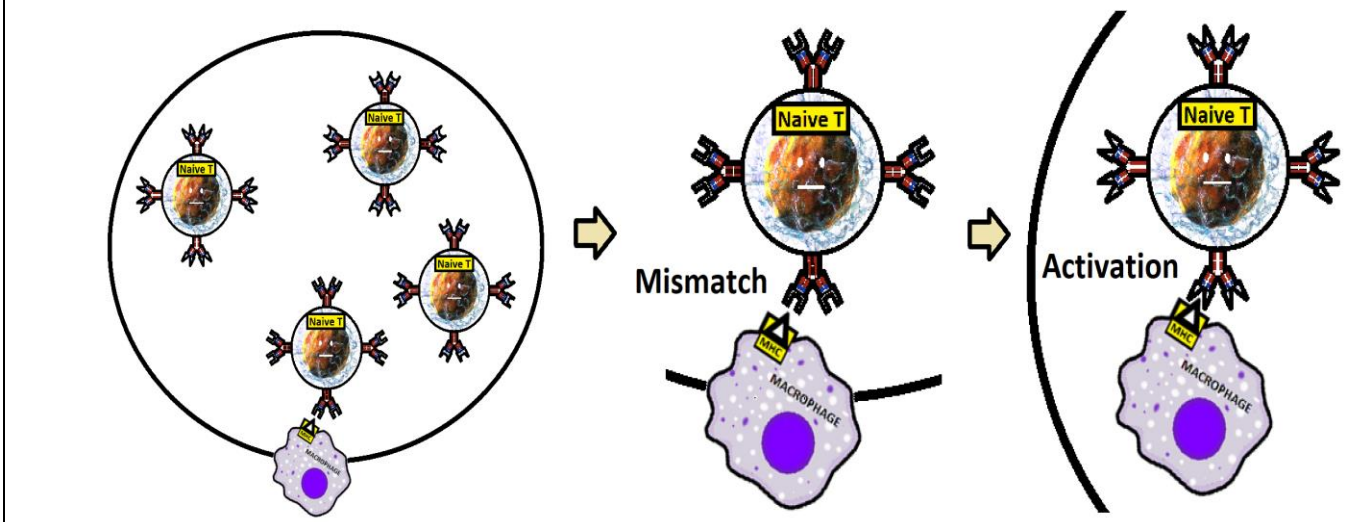


Figure 8.A.6 – Clonal expansion of T cells

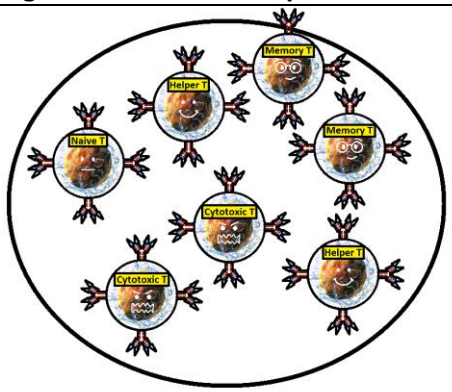


Figure 8.A.7 – Destruction of an infected cell by a cytotoxic T cell

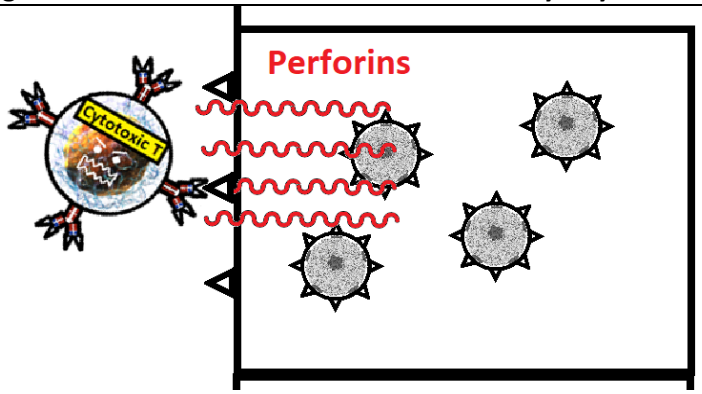
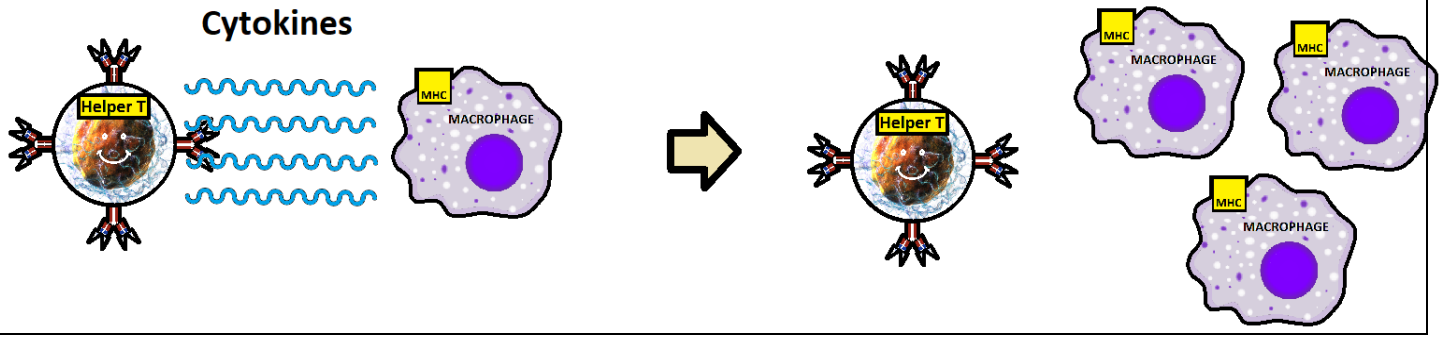


Figure 8.A.8 – Helper T cell using cytokines to stimulate and recruit macrophages



Student centered activity (20-40 minutes): After teaching T cells, put students into small groups. A copy of the student guide for the lesson may be given to each group if necessary. Have the students take turns moving the Biology Magnets to accurately model T cell activity. Allow the students to correct and help one another. Continue to practice until each student can model T cell activity without looking at the guide.

Extra exercises:

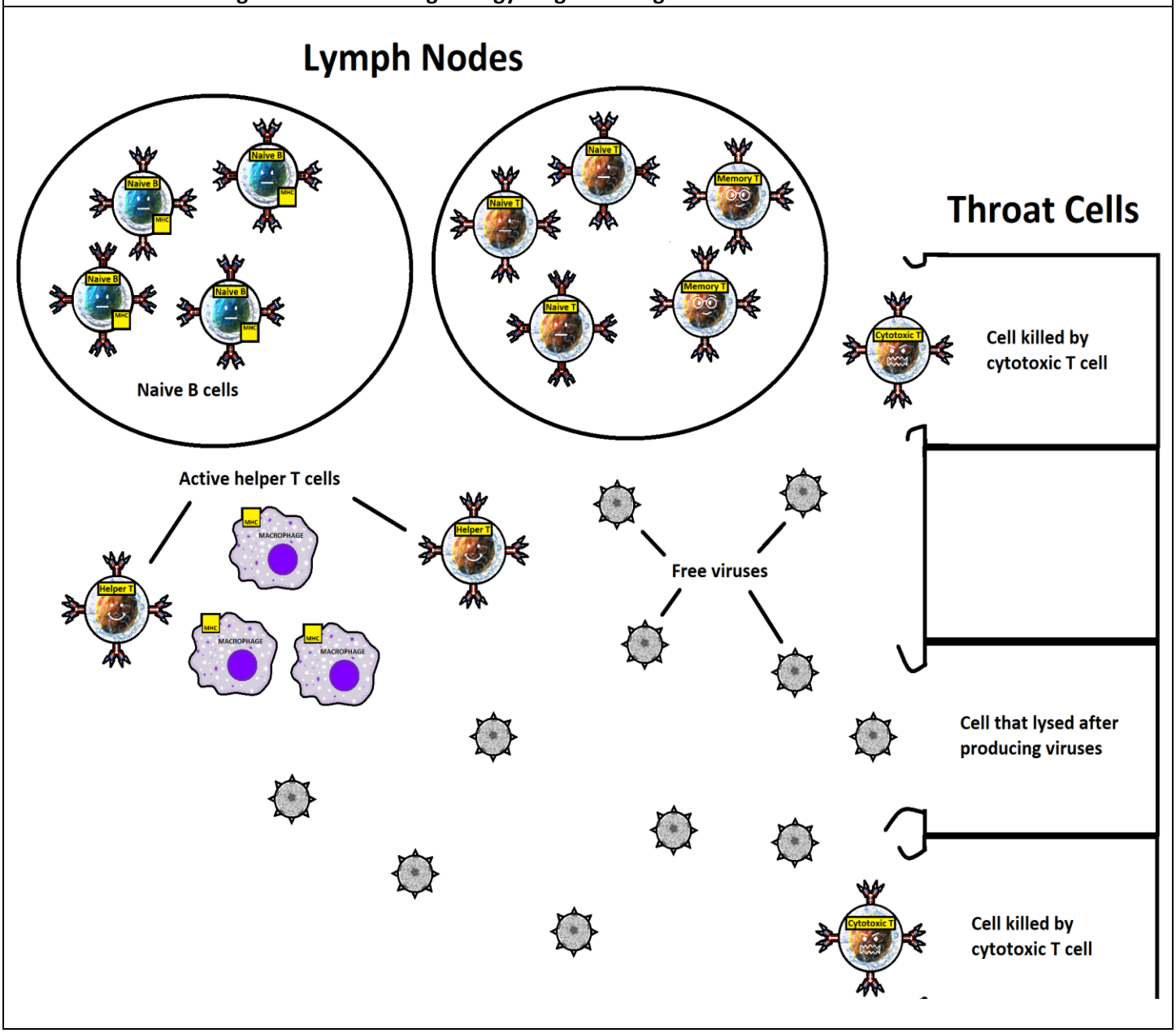
Research other T cell types: Have students go online and research other types of T cells. These include regulatory T cells, natural killer T cells, and gamma delta T cells. If extra magnetic tape is available, have students use notecards to make their own magnets to help demonstrate the activities of the other T cells. Have the students show their findings to the teacher or other groups.

HIV and AIDS: Have the students research how helper T cells are involved in the reproduction of the HIV virus and the eventual onset of AIDS. Have them report their findings to the teacher or other groups.

Lesson 8B – Immune System – B Cells (10-70 minutes)

Teacher Centered Activity (10-30 minutes): This lesson utilizes the Biology Magnets to model the immune system and basic B cell activity. Pick up the lesson where lesson 8A (T cells) left off. Cytotoxic T cells have destroyed the cells affected with the virus, and free viruses exist in the body fluids outside the cells. Helper T cells are active and present. Naïve B cells await activation within lymph nodes (**Figure 8.B.1**).

Figure 8.B.1 – Starting Biology Magnet configuration for lesson 8B – B cells



Activating B cells: To activate B cells, two separate processes must occur. First, viruses encounter various naïve B cells until finding one with receptors that match the surface antigens on the virus. Demonstrate this with the magnets. The naïve B cell will engulf the virus and display one of its antigens on a surface MHC protein (**Figure 8.B.2**). Second, a helper T cell must match its receptor to the surface antigen on the MHC complex of the naïve B cell. Move the magnets so the displayed antigen matches with the helper T receptor. When this match is made, the helper T cell stimulates the naïve B cell with cytokines. Draw the cytokine release with a marker (**Figure 8.B.3**).

Figure 8.B.2 – Activation of Naïve B Cell Part 1

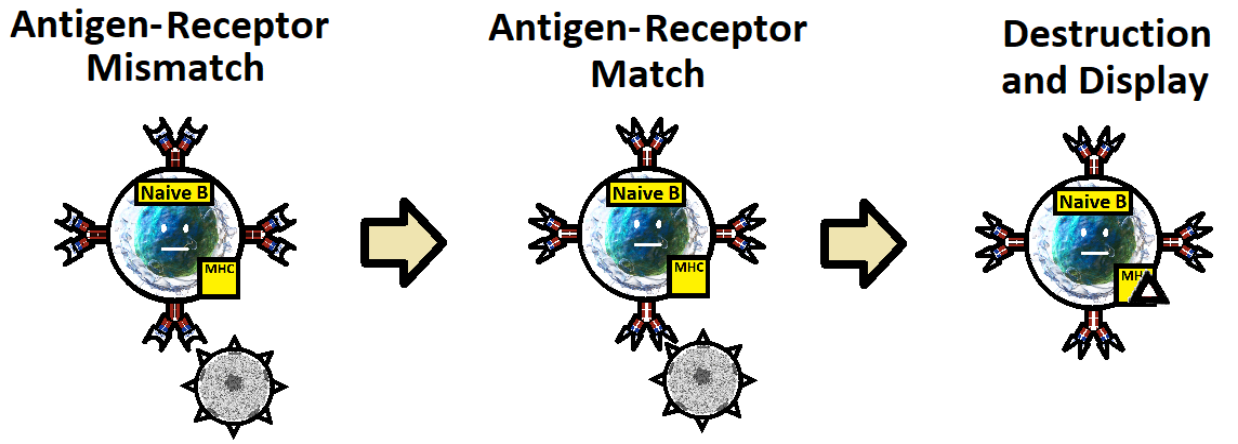
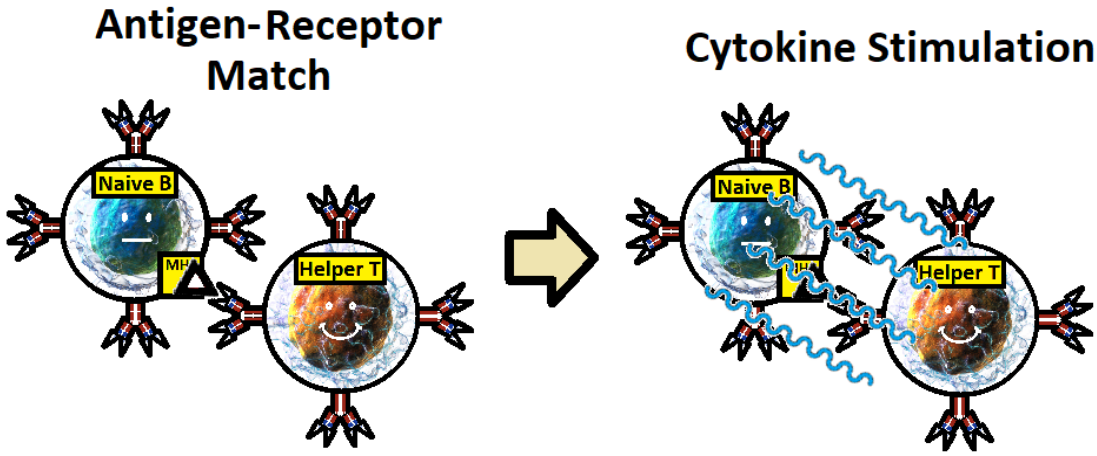


Figure 8.B.3 – Activation of Naïve B Cell Part 1



Clonal Expansion: The activated, naïve B cell undergoes clonal expansion, multiplying to form plasma and memory B cells (**Figure 8.B.4**). The plasma B cells can make antibodies (immunoglobulins), Y shaped receptors that leave the lymph node and enter the body fluids. Place antibody Biology Magnets on the board exiting the lymph node (**Figure 8.B.5**).

Figure 8.B.4 – Clonal expansion produces memory and plasma B cells

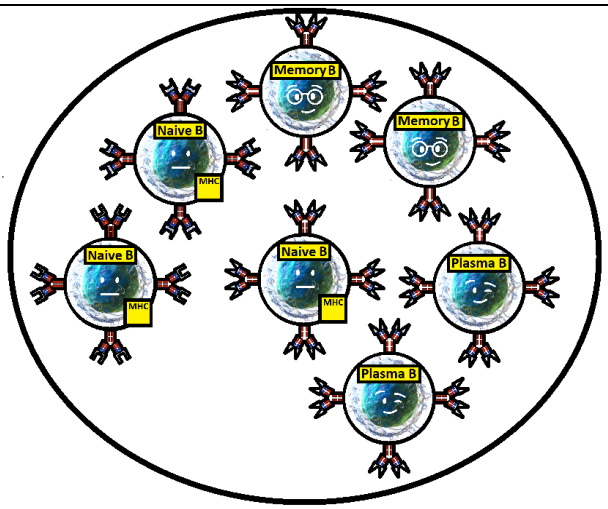
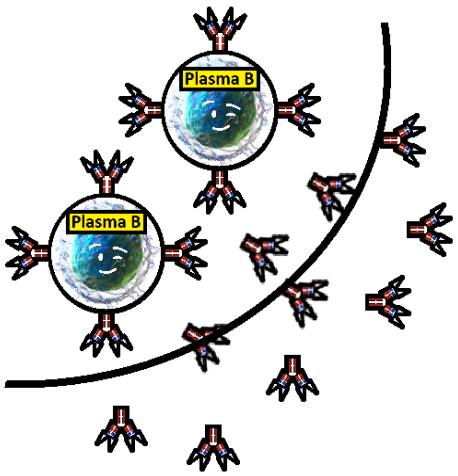
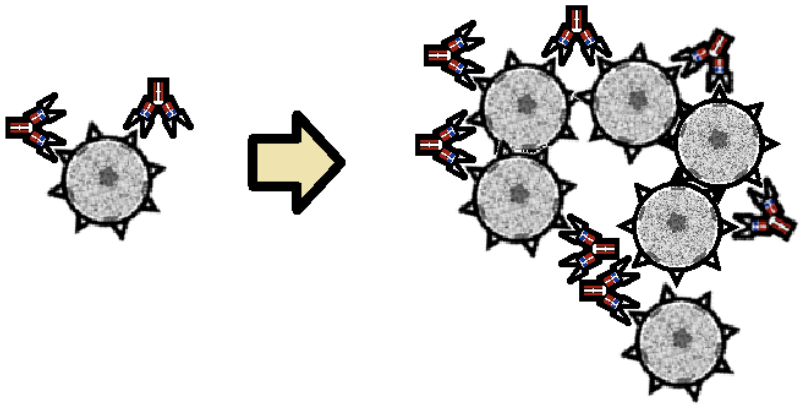
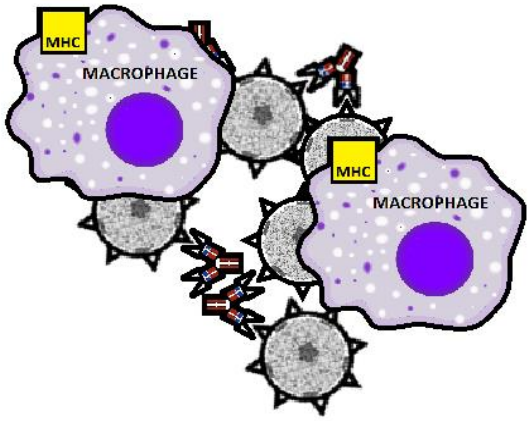


Figure 8.B.5 – Plasma B cells produce antibodies



Antibody action: Antibodies (immunoglobulins) will stick to the surface antigens of the virus, disabling the virus and making it agglutinate (clump) (**Figure 8.B.6**). Macrophages and other immune cells then phagocytize the viral clumps (**Figure 8.B.7**). Explain that memory B cells provide lasting immunity and will produce some level of antibodies for up to a lifetime after infection.

Figure 8.B.6 – Antibody action causing agglutination of viruses	**Figure 8.B.7 – Macrophages phagocytize viral clumps**
	

Student centered activity (20-40 minutes): After teaching B cells, put students into small groups. A copy of the student guide for the lesson may be given to each group if necessary. Have the students take turns moving the Biology Magnets to accurately model B cell activity. Allow the students to correct and help one another. Continue to practice until each student can model B cell activity without looking at the guide.

Extra exercises:

Research other B cell types: Have students go online and research other types of B cells. These include plasmablasts, lymphoplasmacytoid cells, B-2 cells, B-1 cells, and regulatory B cells. If extra magnetic tape is available, have students use notecards to make magnets to help demonstrate the activities of the other B cells. Have the students show their findings to the teacher or other groups.

Research antibody types: Have the students research different types of antibodies. These include IgA, IgD, IgE, IgG, and IgM. If extra magnetic tape is available, have students use notecards to make magnets to help demonstrate the antibody types. Have the students show their findings to the teacher or other groups.

Lesson 8A – Immune System – T Cells – Student Guide

Student Centered Activity: After learning about T cells, start by drawing two large ovals to represent lymph nodes and fill one with the naïve T cells and the other with the naïve B cells. Also draw a number of body cells (throat cells for example) which will become infected with a virus. Move a single virus into one of the cells (**Figure 8.A.1**). Once the cell is invaded by the virus, make it multiply by adding many new virus magnets to the cell. In defense, make the cell display a few of the virus antigens it produces for the virus to alert other cells to the presence of the invader (**Figure 8.A.2**). After the cell dies, the viruses erupt from the cell and fill the spaces and fluids outside of the cell. Move viruses into nearby cells to demonstrate further infection (**Figure 8.A.3**). Move one of the macrophages to engulf a virus and display a viral antigen on its surface MHC protein. Note that the size of the antigens have been magnified in the Biology Magnets for ease of use. The macrophage is now known as an antigen presenting cell (APC) (**Figure 8.A.4**).

Figure 8.A.1 – Initial viral infection of a cell

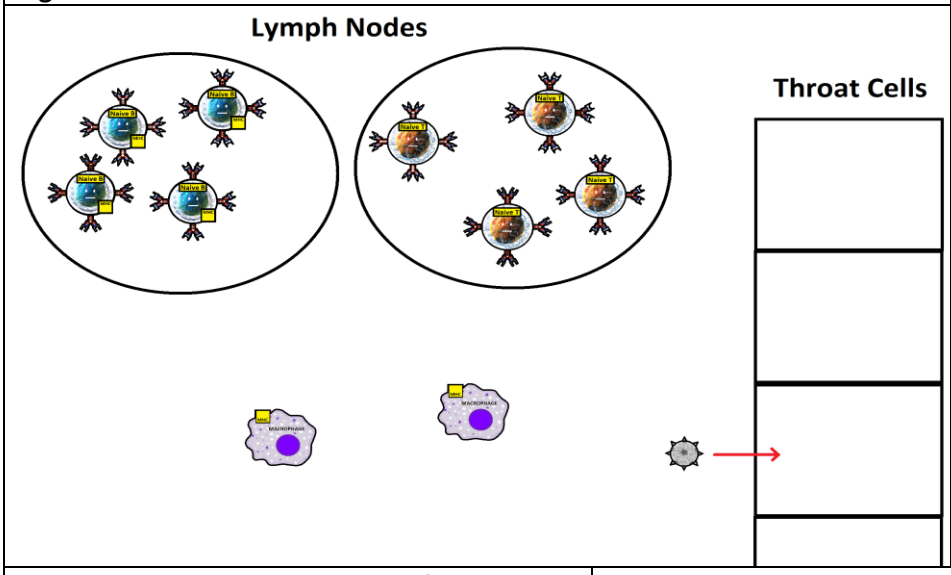


Figure 8.A.2 – Virus reproduces in cell

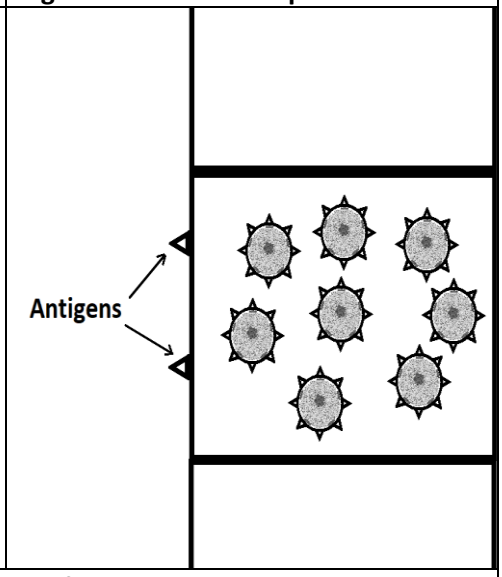


Figure 8.A.3 – Virus erupts and infects cells

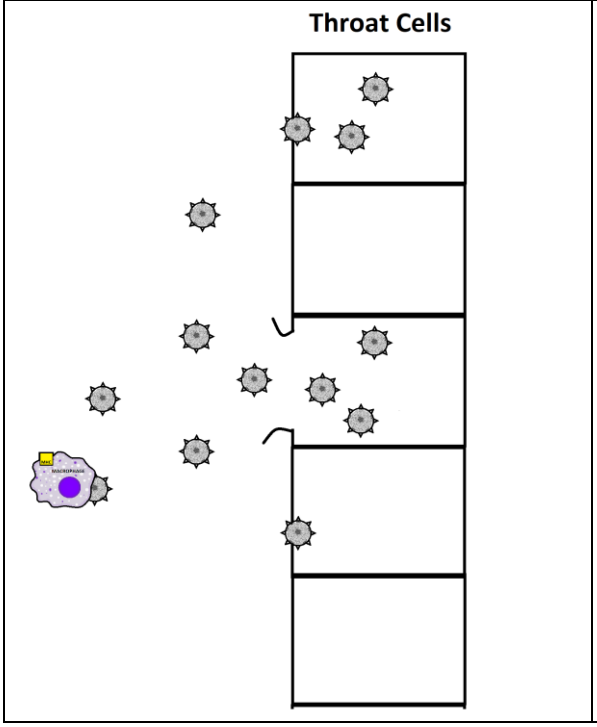
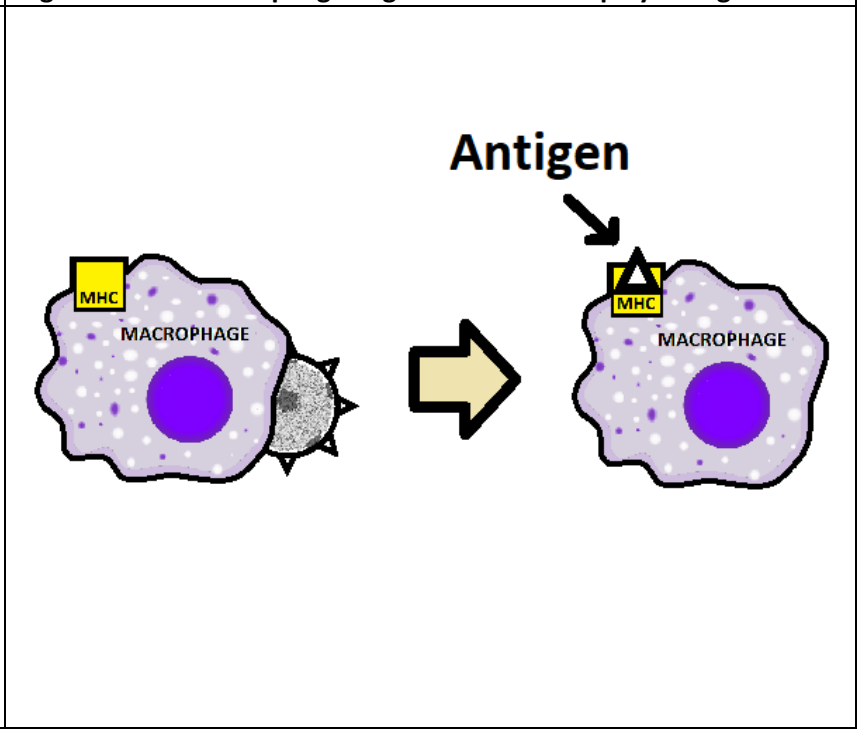


Figure 8.A.4 – Macrophage engulfs virus and displays antigen



Clonal response: Move the macrophage into the lymph node that contains the naïve T cells. The macrophage will present its antigen to all of the naïve cells until it finds the T cell with the matching receptor (**Figure 8.A.5**). Once activated, the naïve T-cell has a clonal response, multiplying to form helper T cells, cytotoxic T cells, and memory T cells. Place those magnets into the lymph node (**Figure 8.A.6**). The cytotoxic T cells will leave the lymph nodes and move through the body, encountering cells until they encounter an antigen on the cell surface. When they do so, they release perforins, chemicals that destroy the cell and the viruses under construction within the cell. Demonstrate this activity with the magnets and draw perforins with a marker (**Figure 8.A.7**). Next, move the helper T cells out of the lymph node. Helper T cells have many functions, including release of cytokines (interleukins) to stimulate and recruit other immune cells. Draw the cytokine release from a helper T cell onto a macrophage with a marker. Add more macrophage magnets to illustrate the activation and recruitment (**Figure 8.A.8**). Explain that memory T cells provide lasting immunity and are ever present to help fight infection quickly if the virus is encountered in the future.

Figure 8.A.5 – Activation of Naïve T Cell by APC

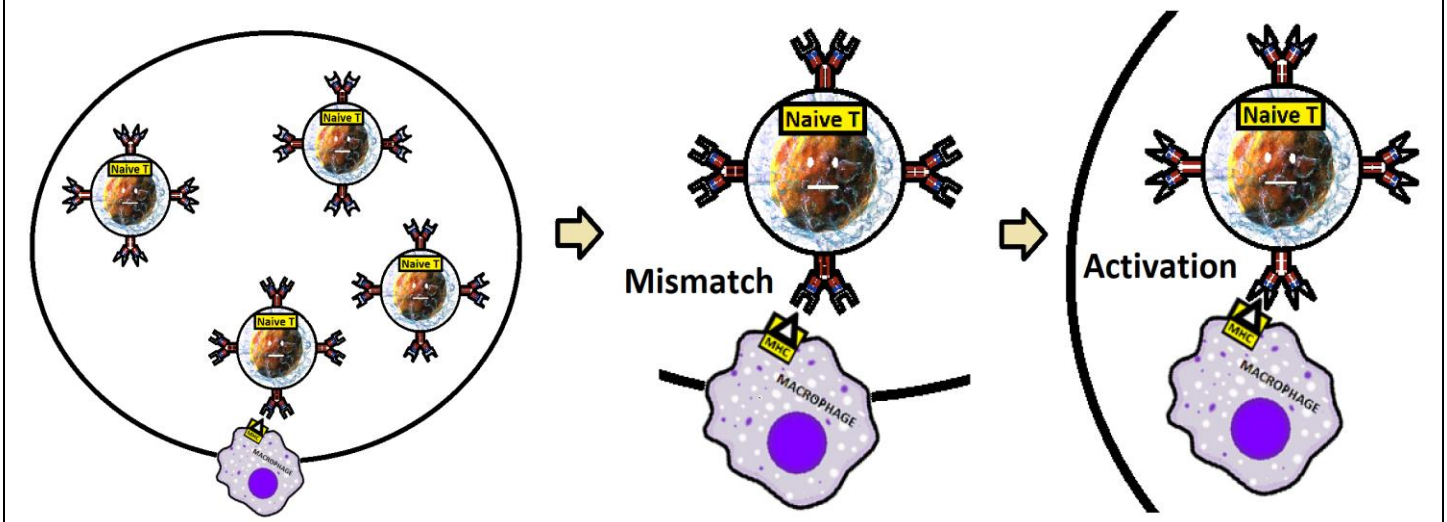


Figure 8.A.6 – Clonal expansion of T cells

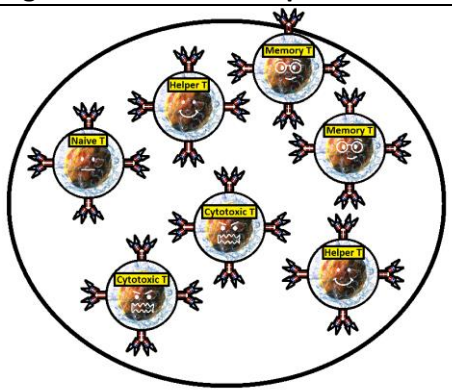


Figure 8.A.7 – Destruction of an infected cell by a cytotoxic T cell

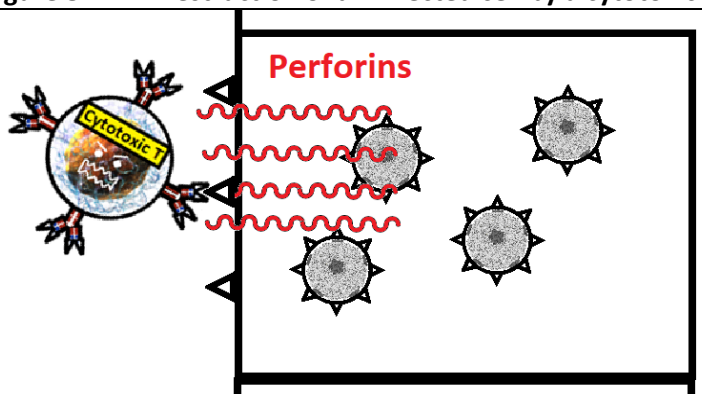
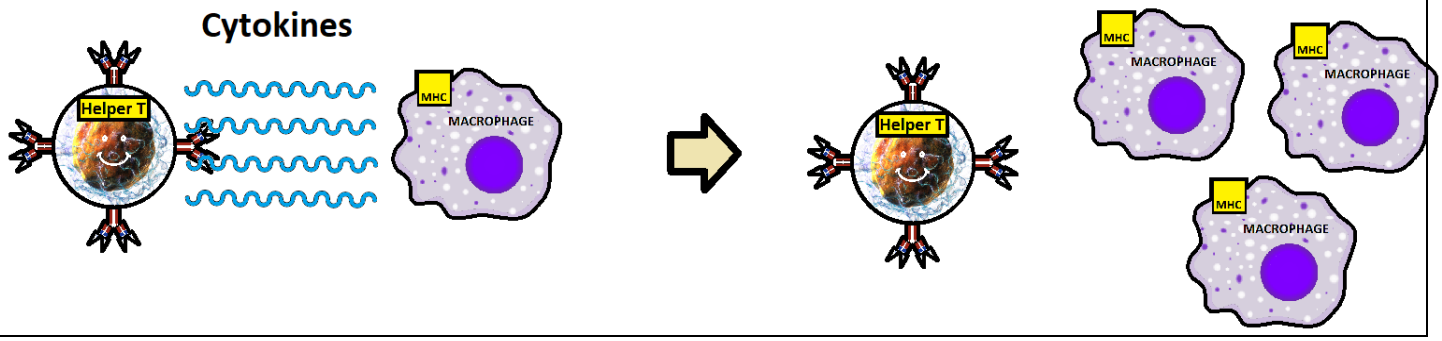


Figure 8.A.8 – Helper T cell using cytokines to stimulate and recruit macrophages



Extra exercises:

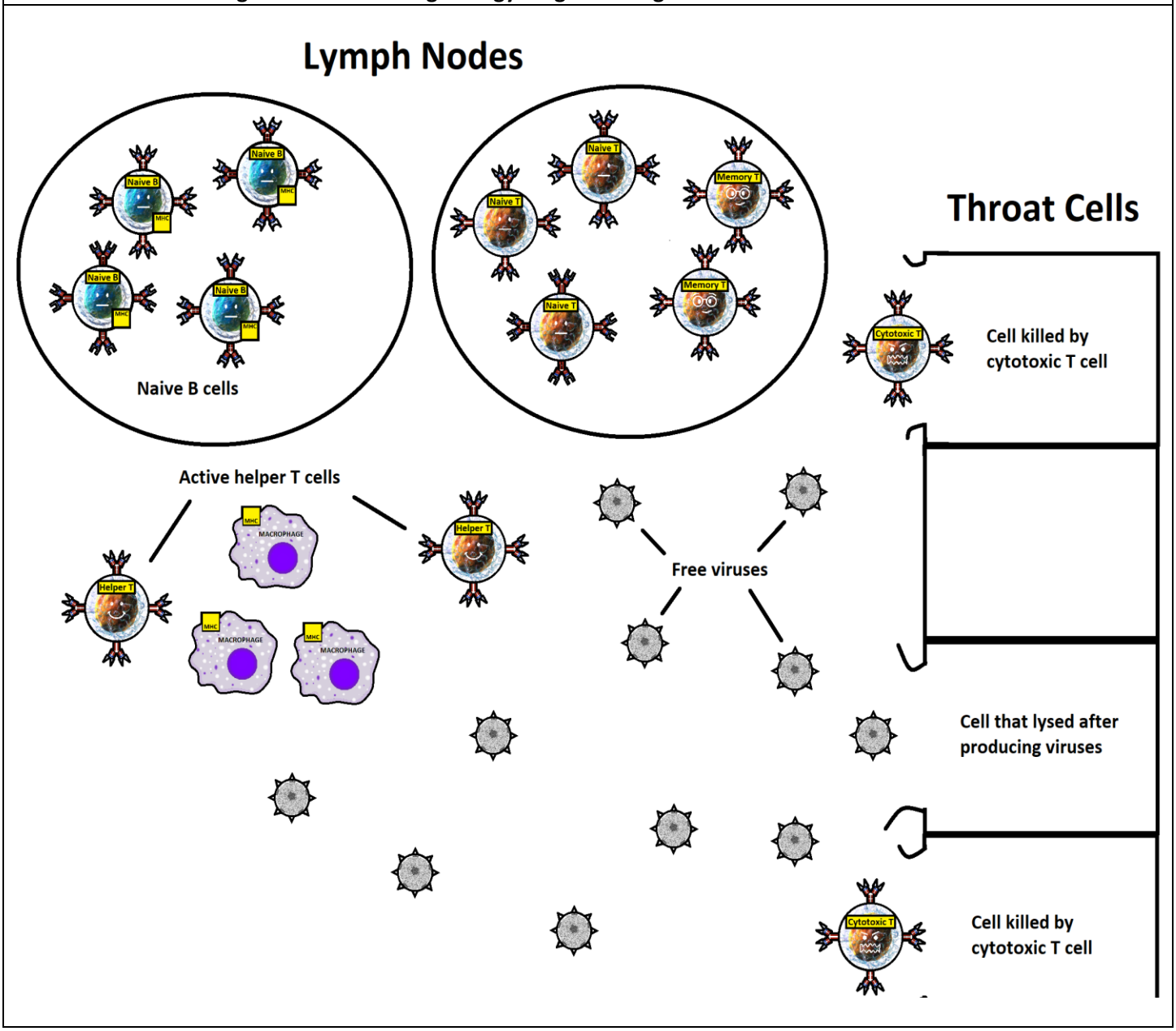
Research other T cell types: Go online and research other types of T cells. These include regulatory T cells, natural killer T cells, and gamma delta T cells. If extra magnetic tape is available, use notecards to make magnets to help demonstrate the activities of the other T cells. Show the research findings to the teacher or other groups.

HIV and AIDS: Research how helper T cells are involved in the reproduction of the HIV virus and the eventual onset of AIDS. Report the research findings to the teacher or other groups.

Lesson 8B – Immune System – B Cells - Student Guide

Student Centered Activity: After learning about B cells, pick up the lesson where lesson 8A (T cells) left off. Cytotoxic T cells have destroyed the cells affected with the virus, and free viruses exist in the body fluids outside the cells. Helper T cells are active and present. Naïve B cells await activation within lymph nodes (**Figure 8.B.1**).

Figure 8.B.1 – Starting Biology Magnet configuration for lesson 8B – B cells



Activating B cells: To activate B cells, two separate processes must occur. First, viruses encounter various naïve B cells until finding one with receptors that match the surface antigens on the virus. Demonstrate this with the magnets. The naïve B cell will engulf the virus and display one of its antigens on a surface MHC protein (**Figure 8.B.2**). Second, a helper T cell must match its receptor to the surface antigen on the MHC complex of the naïve B cell. Move the magnets so the displayed antigen matches with the helper T receptor. When making a match, the helper T cell stimulates the naïve B cell with cytokines. Draw the cytokine release with a marker (**Figure 8.B.3**).

Figure 8.B.2 – Activation of Naïve B Cell Part 1

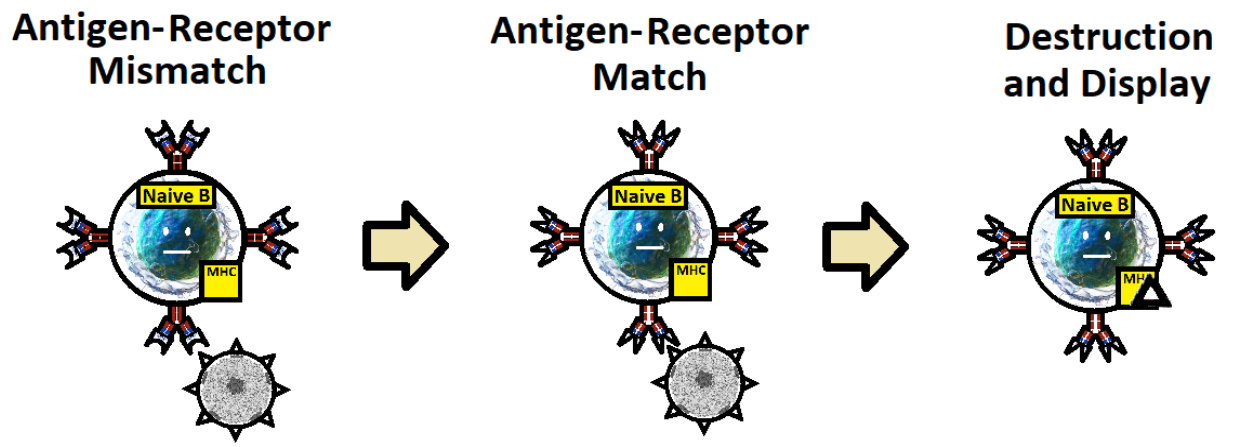
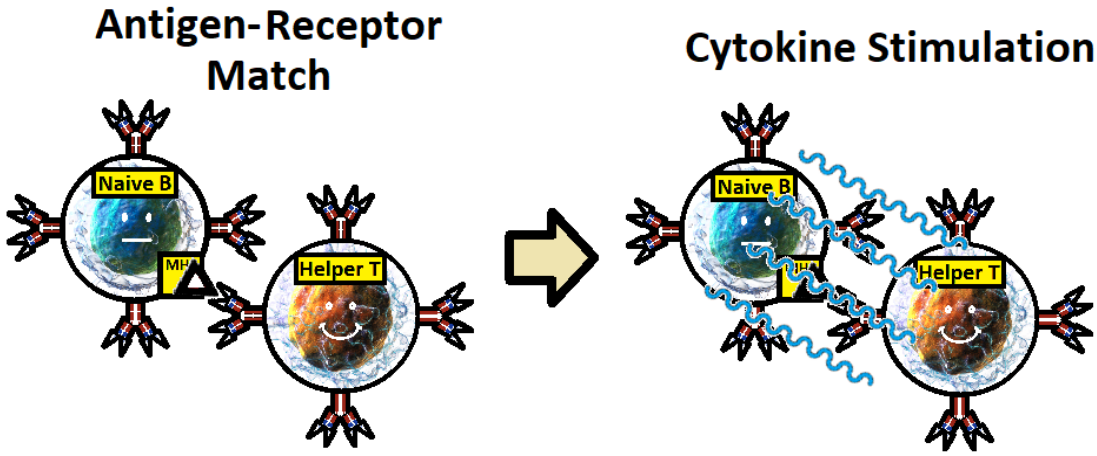


Figure 8.B.3 – Activation of Naïve B Cell Part 1



Clonal Expansion: The naïve B cell undergoes clonal expansion, multiplying to form plasma and memory B cells (**Figure 8.B.4**). The plasma B cells can make antibodies (immunoglobulins), Y shaped receptors that leave the lymph node and enter the body fluids. Place multiple antibody Biology Magnets on the board exiting the lymph node (**Figure 8.B.5**).

Figure 8.B.4 – Clonal expansion produces memory and plasma B cells

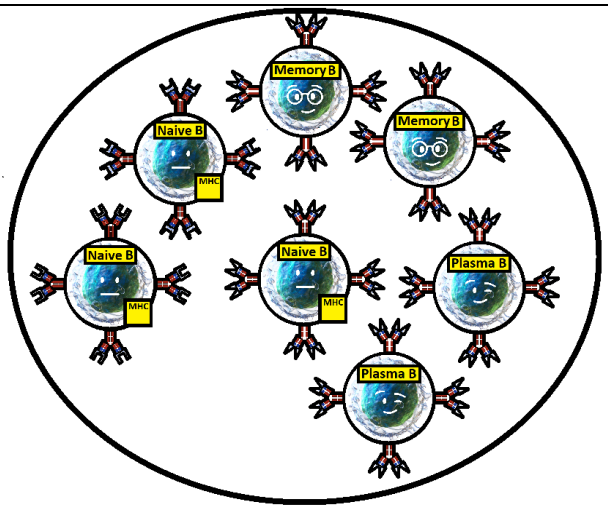
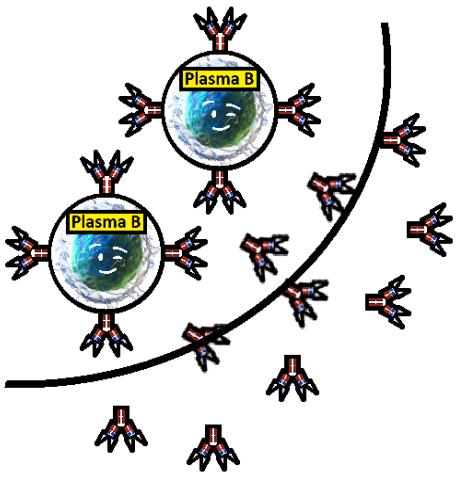
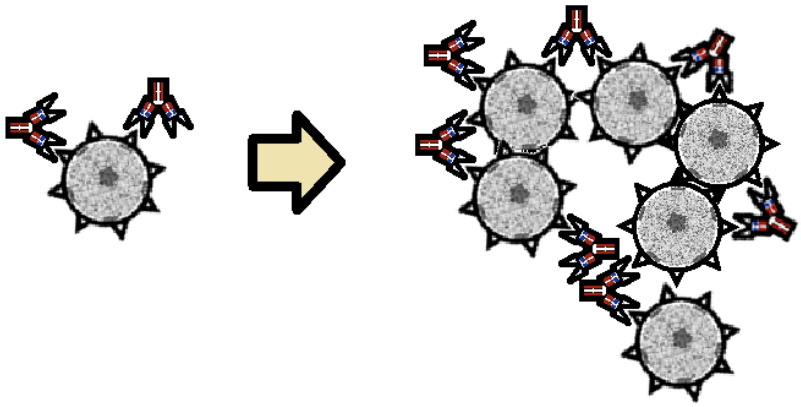
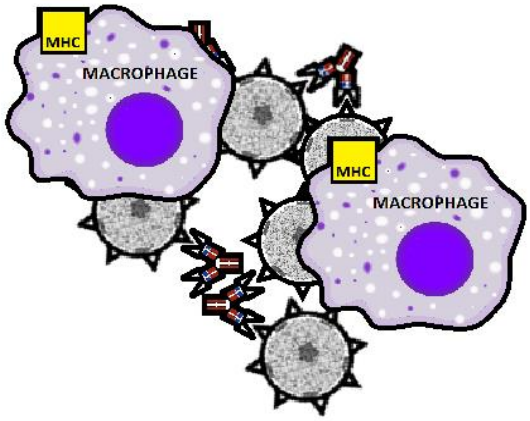


Figure 8.B.5 – Plasma B cells produce antibodies



Antibody action: Antibodies (immunoglobulins) will stick to the surface antigens of the virus, disabling the virus and making it agglutinate (clump) (**Figure 8.B.6**). Macrophages and other immune cells then phagocytize the viral clumps. Show this with the magnets (**Figure 8.B.7**). Explain that memory B cells provide lasting immunity and will produce some level of antibodies for up to a lifetime after infection.

Figure 8.B.6 – Antibody action causing agglutination of viruses	**Figure 8.B.7 – Macrophages phagocytize viral clumps**
	

Extra exercises:

Research other B cell types: Go online and research other types of B cells. These include plasmablasts, lymphoplasmacytoid cells, B-2 cells, B-1 cells, and regulatory B cells. If extra magnetic tape is available, use notecards to make magnets to help demonstrate the activities of the other B cells. Show the findings to the teacher or other groups.

Research antibody types: Go online and research different types of antibodies. These include IgA, IgD, IgE, IgG, and IgM. If extra magnetic tape is available, use notecards to make magnets to help demonstrate the actions of these antibodies. Show the findings to the teacher or other groups.