The Basics of Immunology: An Introductory Unit for High School Junior and Senior Students

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Science Background

Technology and increased travel ability have resulted in the increased mobility of diseases that would normally be isolated in one area. Understanding how different diseases affect humans is therefore something that can prove beneficial to students, even at the high school level. My summer laboratory research experience through The American Association of Immunologists High School Teachers Summer Research Program in Immunology provided me with an increased understanding of functioning of specific immune cells. The research focused on the metabolic responses of certain cells when exposed to different types of viruses, and inspired me to create a curriculum for high school students which would introduce them to parts of the immune system and how they will react and interact as a result of exposure to disease.

The unit that I created focused on discussion, lecture, and review to introduce complex topics to high school junior and senior students. I took the opportunity not just to teach the students concepts of immunology, but to also introduce students to different ways to organize and approach difficult material in order to better prepare them for future academic challenges. Students performed WebQuest assignments and completed paper-based labs in order to familiarize themselves with the various parts of the immune response. The unit ended with students learning about screening for HIV using an enzyme-linked immunosorbent assay (ELISA) simulation. The goal of the unit is to not only provide students with basic knowledge of the functioning of the immune system, but to also introduce them to specific immune responses for different types of stimulation of immune response as well as how diseases are tested for in the medical community, as well as prepare them for future science classes.

I used many resources in order to put together the information that was then presented to the students. Please see the concepts listed in the "Student Outcomes" section for a more complete and detailed list of topics. See below for the specific resources used to supplement my knowledge.

Resources/References Used to Prepare Unit:

- Lodish, Harvey., et. al. (2016). Chapter 23: Immunology. In *Molecular Cell Biology* 8th ed. (pp. 1079-1133). New York, NY: W.H. Freeman and Company.
  - **ISBN-13:** 978-1464183393
  - **ISBN-10:** 1464183392
- Murphy, Kenneth. (2012). Chapter 1: Basics Concepts in Immunology. In *Janeway's Immunobiology* 8th ed. (pp. 1-36). London and New York: Garland Science.
  - **ISBN-13:** 978-0815342434
  - **ISBN-10:** 0815342438
- Bauman, Robert W. (2012). Chapters 15-18: Innate Immunity, Adaptive Immunity, Immunization and Immune Testing, AIDS and Other Immune Disorders. In *Microbiology with Diseases By Body System* 3rd ed. (pp.445-554). Boston: Benjamin Cummings.
  - **ISBN-13:** 978-0321712714
  - **ISBN-10:** 0321712714
- Dr. P. Fitzgerald-Bocarsly immunology lecture notes (personal communication), August 1-28 2016.

Student Outcomes

Science Concepts Covered in the Unit

(Note: please see the additional, attached power point presentation for more)

1. (Intro) Parts of the immune system
    - Innate vs. adaptive immunity
    - Organs
    - Cells
    - Other aspects of the immune system
2. Functioning of the innate immune system
    - Elements of the first line of defense
    - Functioning of the second line of defense (outlined in the flow chart seen in the power point)
        1. Cells
        2. Opsonization
        3. Cytokines
        4. Complement
        5. Inflammation
3. Functioning of the adaptive immune system
    - Introduction and overview of adaptive immunity
        1. Characteristics of adaptive immunity
        2. Cell functions (basics of B and T cells)
        3. Formation of B and T cells
        4. The MHC
    - Humoral immunity → How B cells function
    - Cell mediated immunity → T cell types and functioning
    - How the cells work together for an adaptive immune response (another flow chart created by me to summarize the adaptive immunity section)
4. Vaccines, Diseases of the Immune System
    - Vaccines
        1. Types of immunity
        2. Types of vaccines
        3. Vaccine safety and herd immunity
        4. CDC recommendations
    - Disease of the immune system
        1. Hypersensitivities
        2. Graft rejection and graft vs. host disease
        3. Autoimmunity
        4. Primary and secondary immunodeficiency diseases
            - Focus on AIDS, but will also discuss other diseases/disorders

Next Generation Science Standards (NGSS)

HS-LS1 From Molecules to Organisms: Structures and Processes

1. **HS-LS1-2** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
    a. [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [*Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.*]

2. Science and Engineering Practices
    a. *Developing and Using Models:* Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
        i. Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)
3. Disciplinary Core Ideas
    a. *LS1.A: Structure and Function*
        i. Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
        ii. Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)
4. Cross-Cutting Concepts
    a. Systems and System Models
        i. Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2)

Recommended Course Placement

This unit is intended for high school junior and senior students who have already had a biology class. It can be adapted for various levels of student. Due to its length, it is recommended that this unit be placed into a high school elective class where applicable (such as Anatomy and Physiology, Health, or other relevant elective depending upon what is offered in the school). It may be used either in an AP Biology class or as a supplement to material covered in AP Biology.

Student Activities and Skills

Note alignment with previous section: Science Concepts Covered in Unit

1. (Intro) Parts of the immune system
    - Students will fill in note packet during lecture of this section
        - Notes will be taken during class lecture
    - Flow chart (my creation) that will be filled out in class of the overview of the immune system
    - Introduction to immunology using a Khan Academy video and EdPuzzle
        - Students will also have access to Khan Academy videos and my notes/outlines which they will use as an introduction to the immune system and its functioning
    - Review material on:
        - Introduction to the immune system
        - Specific functioning of cells of the immune system
    - Quizzes on topics discussed
        - Quiz 1: Immunology Introduction
            - Format = Fill in the blank, true/false, short answer
        - Quiz 2: Cells and Chemicals of the Immune System
            - Format = Fill in the blank, multiple choice, matching, short answer
2. Functioning of the innate immune system
    - Students will fill in note packet during lecture of this section
        - Notes will be taken after class lecture
    - Review material on:
        - Components of innate immunity
        - Inflammation

- Khan Academy video and question worksheet
  - Question worksheet created by me to go along with the video and to function as review of inflammation
- Quiz on topics discussed
  - Quiz 3: Innate Immunity and Inflammation
    - Short answer, fill in the blank, matching

3. Functioning of the adaptive immune system
   - Students will highlight provided notes during lecture of this section
     - Students choose what to highlight based on discussion
     - Additional notes added in along margins during discussion
   - Review materials:
     - Flow chart: Overview of Adaptive Immunity (created by me)
     - Flow chart: Humoral Immunity (created by me)
     - Flow chart: Cell-mediated Immunity (created by me)
   - ***Antibody Function—Student Activity Kit***
     - From Flinn Scientific (link above)
     - Activity designed to introduce students to idea of antibody specificity. Introduces variable and constant regions and matches specific antibodies with specific antigens for binding
   - Quizzes on topics discussed
     - Quiz 4: Overview of Adaptive immunity
       - Short answer and fill in the blank, based on the review flow chart
     - Quiz 5: Specifics of B and T cells
       - Multiple choice, labeling, and short answer
4. Vaccines, Diseases of the Immune System
   - Students will highlight provided notes during lecture of this section
     - Students provided what to highlight in lecture notes (intention is to confirm how they highlighted things previously)
     - Additional notes added in along margins during discussion
   - ***AIDS Simutest Kit*** → **Includes pipette training**
     - This is an activity that will have students following ELISA procedure to screen various "patients" for HIV infection.
     - Follow up questions about procedure and how it relates to what we have learned will be done by students as assessment of this activity

Relevance

This unit is designed to be relevant to students both in terms of the material covered as well as how it is covered. The material, immunology, is relevant to students so they understand how the body protects them from disease. The unit delves deeply into material to prepare students for further study in the sciences and to expose them to intricate material that they may be experiencing in their future studies (after high school). It is also relevant as brief lesson on how the immune system functions in conjunction with vaccines to develop memory and understanding of vaccine benefit and safety. How the material is presented exposes students to different ways that they will be expected to learn material after high school, helping them to develop skills for success in science lectures in the future.

Learning Objectives

Students will be able to:

- Differentiate between innate and adaptive immunity
- Describe the different organs that are used for various functions as part of the immune response
- List the main functions of each of the cells of the innate and adaptive immune response
- Describe how other elements of immunity (such as cytokines, surface receptors, and complement) relate to the functioning of the immune system and its parts
- Describe the four features of inflammation and how they occur
- Summarize the steps and functioning of cells during an acute inflammatory response
- Differentiate between B and T cell functioning, including the different types of T cells (helper, cytotoxic, and regulatory)
- Describe how B and T cells are formed through clonal deletion and clonal expansion
- Perform a randomized antibody construction activity to illustrate the formation of specific antibody molecules
- Explain the purpose of both MHC class I and MHC class II and how they relate to T cell functioning
- Justify how and why B and T cells need to work together for an effective immune response that does not attack self
- Summarize the effects of helper T cells on other functions of adaptive immunity
- Relate the functioning of cytotoxic T cells to NK cells
- Describe different types of vaccines and their benefits and drawbacks
- Explain the definition and purpose of herd immunity
- Describe hypersensitivities, graft rejection, GvHD, and various autoimmune diseases
- Differentiate between primary and secondary immunodeficiency diseases
- Predict the negative impact of deficiencies of various parts of the immune system seen in primary immunodeficiency disorders
- Perform an ELISA to determine patients who are positive for simulated HIV

Time Requirements

The daily plans are designed around 42 minute periods, but may be adapted as needed. The ELISA simulation requires 60 minutes to perform. I did this after school but have designed the unit plan provided here for 42 minute periods. Time requirements for each lesson are found in the daily plans. This unit is designed to take 40 full class days to complete, but portions are subdivided and may be removed as you see fit.

Advance Preparation

1. Photocopies of each of the following for all students, except where noted *(a * indicates that I made that file available for the students online rather than photocopying it)*:
    a. Student flow chart – blank
    b. Student flow chart – filled in *(this is only a class set intended for use on quizzes)*
    c. Note packet
    d. Immune System Quiz 1 Review
    e. QUIZ 1: Intro to Immunology
    f. Immune Cells ID WS
    g. Immune System Quiz 2 Review
    h. QUIZ 2: Cells and Other Defenses
    i. Innate Immunity Review

j. Inflammation WebQuest*
k. QUIZ 3: Innate Immunity and Inflammation
l. Overview of the Adaptive Immune System Review
m. Adaptive Immunity flow charts
n. QUIZ 4: Adaptive Immunity
o. Create Your Own Antibodies! (Activity)
p. Humoral and Cell-Mediated flow charts
q. QUIZ 5: Humoral and Cell-Mediated Specifics
r. AIDS Simutest (Lab)

2. Khan Academy EdPuzzle
    a. Use provided guide to create an EdPuzzle at www.edpuzzle.com for students to complete
3. Create Your Own Antibodies!
    a. Photocopy an antibody for each student from the kit
    b. Photocopy several pages of the antigens (you do not need one for each student as there are 8 antigens on each sheet)
    c. Set up paper, scissors, and multiple rolls of tape for students to use when cutting out the pieces
4. AIDS Simutest
    a. Organize the samples, chromogen, and conjugate vials so groups have easy access
    b. You may want to label the plates the students will be running the tests in so that you can save time on day of the lab

Materials and Equipment

1. Paper for student copies
2. Computers with Internet access
    a. We had access to Chromebooks for student use, allowing 1:1 use of technology, but students may work in groups on the assignments
    b. Approximate cost = $10,000.00 for a charging cart and 30 Chromebooks
    c. Possible alternatives include:
        i. Use of a computer lab on days that you will need computer access
        ii. Allowing students to use personal devices, such as their own laptops or their cell phones
3. Create Your Own Antibodies!
    a. Antibody Function – Student Laboratory Kit from Flinn Scientific (item #FB1967)
    b. Cost = $18.60 per class set
    c. The kit was used as a base to create the paper activity. You may use the lab directly or make the photocopies as suggested above.
4. AIDS Simutest
    a. AIDS Simutest Kit from Carolina Biological (item #700472)
    b. Cost = $136.95 per class set

Student Prior Knowledge and Skills

Students should be knowledgeable about basic cell structure and function. Students should have a basic knowledge of the systems of the body, but a previous anatomy and physiology course is not required. Finally, students need an understanding of different types of pathogens (bacteria, viruses, fungi, parasitic worms, and protozoans). This understanding should include basic characteristics as well as life cycles and how these organisms can cause disease.

Daily Unit Plans

Below are the daily plans for this unit. Note the length of time. Due to the intense nature of this material, students were instructed to be reviewing daily, so even if there was no assigned homework for the night the expectation was set. For reference materials, please see the list in **Section I: Science Background**. Note that material often pulled from all of the references listed there, and did not directly come from just one of those resources at a time.

DAY 1: Introduction to Immunology	
Materials:	• Computers for student use • Create the EdPuzzle as shown in provided documents
Procedure:	1. Students will complete a created EdPuzzle on an overview of the immune system. 2. EdPuzzle works by adding students into the class and having them answer questions during a video (which can be selected through the EdPuzzle website). EdPuzzle will then grade the student's answers and provide results to you the teacher. a. Students may rewind portions of the video as needed to help them with the assigned questions, but cannot go back to questions once they have answered them. 3. As students watch the video, they should also be recreating the flow chart that is being drawn by the instructor on the video. a. Students are instructed to color code the information similarly to how it is being grouped by different colors in the video
Homework:	None

DAY 2: Introduction to Immunology	
Materials:	• Presentation • Note packet • Student flow chart hand out (color copies, if possible)
Procedure:	1. Begin discussion on the immune system (hand out note packet). Start by discussing what students already know about the immune system. From previous knowledge, they should be able to state that white blood cells are part of the immune response, and that they will respond to pathogens that enter the body (such as bacteria, viruses, etc.). 2. Discuss the four features of immunity, focusing more time on the antibody and its structure and function in relation to specificity in recognizing antigens. 3. Hand out the flow chart to students. The animated flow chart starts with the first line of defense and continues through innate and adaptive immunity. Expand on each of the items as they come up in the power point, discussing the notes that are added on as well as other material that you learn/know about cells while preparing for this unit. Note that cells are in ovals, other processes and portions of the immune response are in cloud shapes. Arrows indicate interaction, and a circular arrow indicates proliferation. 4. Continue discussion, moving to the three lines of defense. a. For the first line of defense, discuss that microbes will enter through openings, parasitic worms can burrow in, and fungi may digest exterior cells to gain entry. b. For innate and adaptive immunity, focus on the differences between the two, comparing and contrasting in relation to speed of action as well as specificity. Use this time to use the flow chart that was filled out in order to expand on material that you will be coming back to throughout the unit. 5. End discussion with how innate and adaptive immunity will work together and inform each other. Do not get into detail yet, just introduce the idea that they help each other out.
Homework:	Review

DAY 3: Game Review Preparation	
Materials:	• Game Review Instruction Sheet
Procedure:	1. Hand out and discuss the Immunology Game Review. Discuss possible topics that students can choose from and assign groups. 2. Have student groups choose topics and use what has been discussed as an overview to begin designing their game
Homework:	Create, as a group, a game proposal

DAY 4: Organs of the Immune System	
Materials:	• Presentation • Immune System Quiz 1 Review
Procedure:	1. Continue introductory discussion by talking about the organs of the immune system, introducing it by explaining the role of the circulatory and lymphatic system. Discuss how these systems will cycle between each other. a. When discussing lymph nodes, this is a good time to talk about how cell division is what causes lymph nodes to enlarge when you are sick 2. Finish the discussion with the critical thinking question a. The cross-sectional area of the afferent lymphatic vessels arriving at a lymph node is greater than the cross-sectional area of the efferent lymphatics exiting the lymph node. The result is that lymph moves slowly through a lymph node. What advantage does this provide the body? b. Ans: Allows for antigen and cells to more effectively meet up if it is slow moving 3. Hand out the quiz review. If there is time, allow students to begin work in class.
Homework:	Finish the quiz review

DAY 5: Cells of the Immune System	
Materials:	• Presentation
Procedure:	1. Discuss answers to the quiz review 2. Begin notes on cells of the immune system. Note that the notes during this section will start referring to other parts of the presentation, this is for students to go back later and make connections. Discussion today will go through mast cells. a. Make sure to discuss hematopoietic stem cells in the bone marrow in relation to T cells: recall that they are generated there but then will mature in the thymus b. The flow chart of hematopoiesis is adapted from an image found online (see link). Students are given this image in their note packet and it will be returned to at a later date for expansion. c. When discussing neutrophils, make sure to stress their important as phagocytes d. When discussing eosinophils, mention that allergies are thought to be because we are cleaner now and do not have parasitic worms that the eosinophils will normally react to. Relate eosinophils to basophils and mast cells (connect with allergies).
Homework:	Study for Quiz 1: Intro to Immunology

DAY 6: Cells of the Immune System	
Materials:	• Presentation • QUIZ 1: Intro to Immunology • Immune Cells ID WS • Flow chart for use on quiz (no extra notes except for students who get modifications)
Procedure:	1. Allow time for students to complete QUIZ 1: Intro to Immunology. Hand out printed flow chart for use on the quiz as a resource. Re-collect with quiz when students are finished. 2. Finish discussion on cells. Relate NK cells to cytotoxic T cell functioning. Discuss the different types of T cells, but students aren't required to know the information yet. When macrophages are discussed, focus on phagocytosis and mention the importance of "tissue resident" macrophages and their difference from circulating monocytes that will become macrophages. Focus on dendritic cells (name from dendrites like nerve cells, but not related to nervous system!) and their importance as antigen-presenting cells to bridge the innate and adaptive response. End the discussion by discussing the importance of phagocytosis and antigen presentation. 3. Hand out the Cells ID WS and allow students to begin if they have time. Note to the students that multiple answers may be applicable for some of the questions. If that is the case, they are expected to list all the cells that are being described.
Homework:	Finish the Cells ID worksheet

DAY 7: Review of Cells	
Materials:	• Markers or colored pencils
Procedure:	1. Discuss answers to the homework sheet 2. Turn back to the hematopoiesis flow chart with the different types of immune cells. Instruct students to get 5 different colors. a. Students should make the following key, using a different color for each one: i. Innate/nonspecific cells ii. Adaptive/specific cells iii. Antigen presenting cell iv. Phagocyte v. "Professional" b. Discuss which cells fall under each of the categories. Students should circle each of the cells with their respective color. Note that macrophages and neutrophils are professional phagocytes (very good at it), and dendritic cells are professional antigen presenting cells, so when that color is used they need to indicate what feature the "professional" is referring to. Also note that many cells will have more than one color associated with it. c. When done with the flow chart in the note packet, instruct students to underline and color code the notes with the respective colors as well in order to get those features to "pop" out to them while they are studying.
Homework:	Review materials discussed (finish color coding if they didn't finish in class)

DAY 8: Game Review Preparation	
Materials:	• Game Review Instruction Sheet
Procedure:	1. Allow students to work on their game, adding in the new information discussed in class.
Homework:	Edit game proposal, adding in more information

DAY 9: Non-cellular immune components	
Materials:	• Presentation • Immune System Quiz 2 Review
Procedure:	1. Continue notes: How cells identify and respond to pathogens and nonspecific chemical defense against pathogens a. Make sure to clarify that there are different types of TLRs and that both TLRs and PRRs are ON the cells of our immune system and will be responding to PAMPs that are ON the cells of invaders. b. When discussing cytokines, note that there are TONS of cytokines and that the information presented is a huge oversimplification. Note the importance of chemokines, as they will be discussed again later on, specifically with inflammation. c. When complement kills pathogens, it creates a membrane attack complex. When it binds to things to alert macrophages to phagocytize, it is opsonization. Both of these terms will be discussed later. 2. Hand out the review for the second quiz and allow students to begin. Note that material from the second quiz will cover cells through nonspecific defenses, but they need an understanding of the introductory material to be able to understand all material moving forward.
Homework:	Finish Quiz 2 Review

DAY 10: Review of Parts of the Immune System	
Materials:	• Flash cards or cell phones
Procedure:	1. Discuss answers to the review. Inform students that many short answer questions on the quiz are drawn directly from the review packet. 2. Remaining time in class should be used to create flash cards to review all the new terms that are discussed in this section. They may use hard copy cards or use Quizlet on their phone.
Homework:	Study for quiz

DAY 11: Introduction to the Innate Immune Response	
Materials:	• Presentation • QUIZ 2: Cells and Other Defense • Flow chart for use on quiz (no extra notes except for students who get modifications)
Procedure:	1. Give time for students to complete Quiz 2 (roughly 25-30 minutes should be enough). Hand out printed flow chart for use on the quiz as a resource. Re-collect with quiz when students are finished. 2. Begin discussion of the innate immune system (specifics which were not discussed in depth previously). Discussion will be through opsonization. a. Begin by showing the flow chart that they have in their possession. Note that portions that will not be discussed in this section have been faded out. b. This section has been broken up into pieces and the different parts have overviews for each portion. This is intended to organize the material for students to help break it down. Discuss basic ideas regarding these topics before getting to the notes. c. When discussing opsonization, recall that this process has already been discussed when complement was introduced. Explain that not only complement, but also antibodies created in the adaptive response are able to act as opsonins. d. The image that you will end with was created based on another image. Note that the bacterium is covered with round shaped opsonins which will match up with numerous

round receptors on the macrophage to encourage phagocytosis.
Homework: Review

DAY 12: Game Review Preparation	
Materials:	• Game Review Instruction Sheet
Procedure:	1. Allow students to work on their game, adding in the new information discussed in class.
Homework:	Edit game proposal, adding in more information

DAY 13: Innate Immune Functioning	
Materials:	• Presentation
Procedure:	1. Continue discussion with cytokines and complement. Discussion will go through an introduction to cell specifics, ending with macrophages. a. When discussing cytokines, note that do not have to know specifically WHAT macrophages are releasing, but they do need to realize that macrophages release a LOT of different cytokines with different functions. b. Mention that type I interferon is present early in an infection while type II is going to be present later on in an infection. Note that dendritic cells and NK cells will both release IFN, and discuss why this would be the case (ans: both are going to be responding to a viral infection, but in different ways). c. When discussing complement, relate back to opsonization and also recall that the killing was discussed previously. How the killing is done (with a membrane attack complex) is now being discussed. Note that students to NOT have to know about the three different pathways associated with complement activation. d. Note that much of the information discussed about cells is reviewing some information which was discussed previously. This is intentional. e. Show the video of the neutrophil performing phagocytosis. This links to other good YouTube resources that can be interesting for students to see. f. Note that nets made by neutrophils are called NETs (neutrophil extracellular traps) and result in trapping pathogens with peptides that will kill the pathogens. g. Discussion will be finished next day.
Homework:	Review

DAY 14: Innate Immune Cells	
Materials:	• Presentation
Procedure:	1. Finish notes on cells and discuss how the innate and adaptive immune systems work together. a. Remind students of similar functioning of NK cells and cytotoxic T cells. Discuss that the inhibitory receptor that will prevent NK cells from functioning will show antigen to cytotoxic T cells, letting them perform the killing of the cell if necessary. b. When discussing ADCC, note the shape of the antibody and explain that NK cells have receptors for the “stem” of the Y shape, allowing ADCC to occur. 2. When notes are done, students should start making study materials in preparation for their test. Options include quizlet/flash cards, outlines, color coding, etc.
Homework:	Review

DAY 15: Inflammation	
Materials:	• Presentation • Chromebooks
Procedure:	1. Notes on inflammation will be done differently than previous notes. Students will listen to the discussion and follow along with the presentation available to them online. During this time they are allowed to ask clarification questions, but should not be taking notes. Once the discussion is finished, students will then go back to the beginning of the inflammation presentation and fill in their note packet. a. When discussing the characteristics of inflammation, note why each characteristic will occur (focused on in the next slide). b. The overview of inflammation is a brief description of the steps that will be further discussed. 2. When finished with their notes, students should go back and write down clarifying statements and ask questions as needed. The rest of the time may be used for review.
Homework:	Review

DAY 16: Inflammation	
Materials:	• Chromebooks • Inflammation WebQuest
Procedure:	1. Students will complete an inflammation question sheet (web quest). You may print this out or you may put the assignment online (I put it online for students to turn in electronically). 2. Students will watch the Khan Academy video on inflammation (link is in the document). They will answer the questions on the sheet VERY BRIEFLY. 3. Students must finish this assignment in class. Credit will be given for attempts. 4. Please note that the video discusses mast cells but macrophages were taught in class as being the first responders for inflammation. Either answer will be acceptable on the quiz.
Homework:	Review

DAY 17: Innate Immunity Review	
Materials:	• Innate Immunity Review
Procedure:	1. Students will work in groups, pairs, or alone to complete the innate immunity review worksheet packet. 2. Answers will be discussed in class and were also posted online for student use.
Homework:	Study for quiz

DAY 18: Game Review Preparation	
Materials:	• Game Review Instruction Sheet
Procedure:	1. Allow students to work on their game, adding in the new information discussed in class.
Homework:	Edit game proposal, adding in more information

DAY 19: Innate Immunity and Introduction to Adaptive	
Materials:	• Presentation • QUIZ 3: Innate Immunity and Inflammation • Flow chart for use on quiz (no extra notes except for students who get modifications) • Highlighters or colored pens/markers
Procedure:	1. Allow students enough time to complete the quiz (roughly 30 minutes). Hand out printed flow chart for use on the quiz as a resource. Re-collect with quiz when students are finished. 2. Introduce adaptive immunity. Notes are now going to be different once again. In the note packet, students have been provided with images of the slides. While notes are being discussed, students are instructed to highlight or underline points that are being stressed and add in extra notes along the margins where applicable. a. <u>Focus topics include:</u> specificity, B and T cells, lymph node structure allowing B and T cell interaction.
Homework:	Stuff

DAY 20: Introduction to Adaptive Immunity	
Materials:	• Presentation • Highlighters or colored pens/markers
Procedure:	1. Adaptive immunity discussion will continue from cell types through the MHC. a. <u>Focus topics include</u>: DCs presenting to T cells, definitions (bolded and underlined), types of T cells, receptors on B and T cells, antigens and epitopes, MHC II vs. MHC I in relation to T cells b. Remind students of the CD4 and CD8 markers on helper and cytotoxic T cells c. When discussing epitopes, discuss how B cells will react to surfaces of the whole pathogen, while T cells will respond to epitopes that are presented to them through another molecule. These pieces may be internal antigens that, once the antigen presenting cell has processed the pathogen, are now able to be "seen" by the cells. d. The MHC should also allow for discussion of transplants and rejection, due to needing to find a "match" based on the composition of MHC molecules that are present. You may introduce this by taking apart the word "histocompatibility." e. Make note that dendritic cells will have both MHC I and MHC II, due to them filling both categories of cell types that have each MHC. f. Finally, bring back the idea of the inhibitory receptor and NK cells. Explain that MHC class I is normally the inhibitory receptor for NK cells, but will show cytotoxic T cells if the cell is infected with a virus and needs to be killed. However, viruses may downregulate this MHC molecule, preventing death through T cells. This then removes the stop signal for NK cells, and they will be able to take over. 2. When the discussion is concluded, students will go back through all the notes that have been discussed about adaptive immunity. On a separate sheet of paper, they should rephrase the notes and write out the key points that were discussed, using this time to ask clarifying questions.
Homework:	Review

DAY 21: Review of Adaptive Immunity	
Materials:	• Presentation • Overview of the Adaptive Immune System Review WS • Highlighters or colored pens/markers

Procedure:

1. Finish the discussion on the introduction to specifics of adaptive immunity by continuing the presentation through the end of formation of B and T cells.
    a. Focus topics include: Generation of receptors through genetic recombination, apoptosis to destroy cells that react with self to avoid autoimmunity, mature vs. naïve, activate/proliferate/differentiate.
2. When the discussion is concluded, students will go back through all the notes that have been discussed about adaptive immunity. On a separate sheet of paper, they should rephrase the notes and write out the key points that were discussed, using this time to ask clarifying questions.
3. Hand out the overview of the adaptive immune system review worksheet and allow students to begin in class.

Homework: Finish the review worksheet

DAY 22: Review of Adaptive Immunity

Materials:

- Adaptive Immunity Flow Charts
- Adaptive Immunity Flow Charts KEY (class set)
- Tape (or staples/staplers)

Procedure:

1. Discuss answers to the review worksheet.
2. Hand out the first page of the adaptive immunity flow chart (it is the fourth sheet that will print out from the resources). Students will finish the first page (which is marked with sections 1 and 2). Once they have completed sections 1 and 2 on the first page, students should check their answers with the key.
3. Once answers are correct, student can take the next sheet that has section 3 on it. Check answers and then take section 4, check answers and then take section 5 for a total of four sheets.
4. Once all sheets are complete, students may tape or staple their sheets together where the sections of the flow charts overlap, creating a large map that relates the topics of this section.
5. Answers to the review were also posted online for students to check once they left class.
6. If students do not finish in class, they were allowed to take any blank sheets they needed and complete the work and check it at home.

Homework: Study for quiz on adaptive immunity

DAY 23: Introduction to Humoral Immunity Specifics

Materials:

- Presentation
- QUIZ 4: Adaptive Immunity Quiz
- Flow chart for use on quiz (no extra notes except for students who get modifications)
- Highlighters or colored pens/markers

Procedure:

1. Allow students enough time to complete the quiz (roughly 25-30 minutes). Hand out printed flow chart for use on the quiz as a resource. Re-collect with quiz when students are finished.
2. Introduce the discussion on humoral immunity. It will go through the function of antibodies.
    a. Focus topics include: Immunoglobulins as term for antibody, activated B cells becoming plasma cells that make lots of antibodies and memory cells that react faster, constant region vs. variable region of the antibody, genetic rearrangements to create variable region.
    b. When the faded flow chart is displayed on the projector, I took the opportunity to introduce membrane-bound vs. free antibodies. Using the white board, I projected the image and added Y's to the "B cell", then showed them being released from the plasma cell. Additionally, I wrote out antibody, immunoglobulin, and BCR and indicated where the terms applied to the Y shapes.

	c. When discussing the constant region, the idea of different subtypes of immunoglobulin can be brought up. IgM is the first types that is created and is a pentamer, IgG is the most common, IgA can be secreted, IgE is associated with allergies, and IgD is relatively unknown. 3. When the discussion is concluded, students will go back through all the notes that have been discussed about adaptive immunity. On a separate sheet of paper, they should rephrase the notes and write out the key points that were discussed, using this time to ask clarifying questions.
Homework:	Review

DAY 24: Humoral Immunity	
Materials:	• Presentation • Highlighters or colored pens/markers • Create Your Own Antibodies! • Antibody and antigen copies • Scissors • Tape • Blank paper • Chromebooks
Procedure:	1. Finish the discussion on humoral immunity. a. Focus topics include: Activation of B cells and what it signals, help that B cells receive from helper T cells, why the interaction between B cells and helper T cells is needed (protection from autoimmunity), plasma cells vs. memory B cells 2. Hand out and describe the activity "Create Your Own Antibodies!" Students should first work on their pre-lab questions (they may do this online as this activity was turned into an online location called turnitin.com). This activity is designed to introduce students to the idea of antibody specificity. It introduces the variable and constant regions and matches specific antibodies with specific antigens for binding. 3. Once they are done with their pre-lab questions, students will be allowed to begin putting together their antibodies according to provided lab directions.
Homework:	Review, work on lab questions

DAY 25: Humoral Immunity	
Materials:	• Antibody and antigen copies • Scissors • Tape • Blank paper • Chromebooks
Procedure:	1. This class period is dedicated to finishing the cut and paste portion of Create Your Own Antibodies! Students will hand this structure in tomorrow, when the lab questions are due.
Homework:	Finish all lab questions for Create Your Own Antibodies!

DAY 26: Game Review Preparation	
Materials:	• Game Review Instruction Sheet

Procedure:	1. Allow students to work on their game, adding in the new information discussed in class.
Homework:	Edit game proposal, adding in more information

DAY 27: Cell-Mediated Immunity	
Materials:	• Presentation • Highlighters or colored pens/markers
Procedure:	1. Discussion of cell-mediated immunity will begin once again with a flow chart that has most of it faded out, highlighting the portion that is being focused on in this discussion. All cell-mediated notes will be discussed, and the discussion will end with an overview of humoral and cell-mediated responses working together. a. This discussion once again differs from previous ones because at this point I edited the presentation to indicate to the students what they should be highlighting. This allowed students to be able to focus more on the discussion and ask questions. b. Note during the discussion of helper and regulatory T cells that there are lots of types of helper T cells (or CD4+ T cells). Th1, Th2, Th17, etc. and that even sources I used to create this unit differ in the number of helper T cell types only because some were more recent publications than others and this is a currently developing area. c. The discussion will end with a flow chart of T and B cells. This animates in the presentation that was created. Different styles of numbers are used for B, helper T, and cytotoxic T cells. Students were told to color code the different sections and note the overlap of the different parts of the adaptive immune response in addition to filling in the information. 2. When the discussion is concluded, students will go back through all the notes that have been discussed about adaptive immunity. On a separate sheet of paper, they should rephrase the notes and write out the key points that were discussed, using this time to ask clarifying questions.
Homework:	Finish going back through the notes.

DAY 28: Adaptive Immunity Specifics Review	
Materials:	• Colored pencils or markers
Procedure:	1. Class will be dedicated to students creating their own flow charts from the details of humoral and cell-mediated immunity (one for humoral and one for cell-mediated), like my previous one. They may work in groups to do this task.
Homework:	Finish the flow charts

DAY 29: Game Review Preparation	
Materials:	• Game Review Instruction Sheet
Procedure:	1. Allow students to work on their game, adding in the new information discussed in class.
Homework:	Edit game proposal, adding in more information

DAY 30: Vaccines and Review	
Materials:	• Presentation • Highlighters or colored pens/markers • Humoral and Cell-Mediated Flow Charts
Procedure:	1. Discussion on vaccines will take place. Note that this material, called Part 4 in the note packet, will not be quizzed on and is merely for discussion purposes. a. Focus topics include: Benefits of vaccines, types of vaccines (specifically discuss attenuated vs. inactivated vaccines), boosters, herd immunity and benefits for those who cannot get vaccinated, CDC recommendations, risks associated with vaccines, lack of link to autism, components of vaccines. 2. Hand out and begin the humoral and cell-mediated flow charts. They will be due in class tomorrow, but students do not have to finish them at home (they will have time in class).
Homework:	Work on the flow charts

DAY 31: Diseases and Review	
Materials:	• Presentation • Highlighters or colored pens/markers • Humoral and Cell-Mediated Flow Chart KEYS
Procedure:	1. Discussion on disease related to the immune system. All notes will be finished today. a. Focus topics include: Allergies because of second exposure and IgE, graft rejection and GvHD relationship to MHC, SCID and "Bubble Boy," HIV infection leading to antibody production used for ELISA test b. When discussing SCID, the "Bubble Boy" case study can be discussed. The child was the second one in the family born with SCID, but the first died in infancy. To try and cure the disease, his sister donated her bone marrow so he could create B and T cells, but it was infected with EBV and he died. Resource = http://www.cbsnews.com/pictures/bubble-boy-40-years-later-look-back-at-heartbreaking-case/ c. When discussing HIV/AIDS diagnosis, discuss the steps that are used in an ELISA test using an appropriate image as a guide in order to introduce students to the ideas that will be addressed in the final activity of the unit. 2. Flow charts created by me will be handed out. Students will work on them for the remainder of the class period and check their answers as they complete pages. Answers are also available online for students who do not finish in class.
Homework:	Study for Quiz

DAY 32: ELISA Test for HIV	
Materials:	• QUIZ 5: Humoral and Cell-Mediated Specifics • Flow chart for use on quiz (no extra notes except for students who get modifications) • AIDS Simutest
Procedure:	1. Allow students enough time to complete the quiz (roughly 25-30 minutes). Hand out printed flow chart for use on the quiz as a resource. Re-collect with quiz when students are finished. 2. Hand out and discuss the AIDS Simutest activity, relating it to the ELISA discussed the previous day. Students may use technology available to begin answering the pre-lab questions.
Homework:	Finish the AIDS Simutest pre-lab questions

DAY 33: ELISA Test for HIV	
Materials:	• AIDS Simutest Kit and noted supplies (see previous section)
Procedure:	1. Discuss the lab once again. This is an activity that will have students following ELISA procedure to screen various "patients" for HIV infection. There are questions about the procedure and how it relates to what has been learned in this unit. The procedure will be addressed/mentioned again during another unit in my elective. An additional bonus is that this lab provides delicate pipette training to students. 2. Students will use the time to set up the lab. This class period will not be sufficient to complete the lab, but students need to set up in a way that they are ready to start the minute they arrive in class the next day. 3. If there is time, students may start to get results going one patient at a time, but will have to rinse their materials before they leave class.
Homework:	Review

DAY 34: ELISA Test for HIV	
Materials:	• AIDS Simutest Kit and noted supplies (see previous section) • Chromebooks
Procedure:	1. Students will complete the ELISA lab according to provided instructions. 2. Once clean-up is completed, students will be required to begin their post-lab questions (due tomorrow online).
Homework:	Finish the post-lab questions and submit the whole lab to turnitin.com

DAY 35: Game Review Preparation	
Materials:	• Game Review Instruction Sheet
Procedure:	1. Allow students to work on their game, adding in the new information discussed in class.
Homework:	Edit game proposal, adding in more information

DAY 36: Game Review Preparation	
Materials:	• Game Review Instruction Sheet • Game supplies
Procedure:	1. Allow students to work on their game, adding in the new information discussed in class. 2. Practice the game, making changes and additions as needed
Homework:	Work on finalizing game

DAY 37: Game Review Preparation	
Materials:	• Game Review Instruction Sheet • Game supplies
Procedure:	1. Allow students to work on their game, adding in the new information discussed in class. 2. Practice the game, making changes and additions as needed
Homework:	Work on finalizing game

DAY 38: Game Review Preparation and Practice	
Materials:	• Game Review Instruction Sheet • Game supplies
Procedure:	1. Allow students to work on their game, adding in the new information discussed in class. 2. Practice the game, making changes and additions as needed
Homework:	Finish the game!!!

DAY 39: Game Tournament	
Materials:	• Game Review Instruction Sheet • Game supplies
Procedure:	1. Groups will play each other's games!! Must complete three games today.
Homework:	None

DAY 40: Game Review Preparation and Practice	
Materials:	• Game Review Instruction Sheet • Game supplies
Procedure:	1. Groups will finish playing each other's games! Must finish the games today. 2. Once done, each individual will vote on which game was the "best." Definition of best can be most fun or most educational. Students cannot vote on their own game.
Homework:	None

Summative Assessment

Due to the length of this unit, rather than having one summative assessment there were several that were given throughout the course of the unit. There were 5 quizzes that separated the different sections of the unit. Additionally, the antibody activity and simulated ELISA functioned as further assessment of the students.

Below, you will find the quizzes that were used in this unit. The quizzes are listed below with their respective formats. These quizzes are followed by the keys and rubrics/point values that were used in this unit.

- QUIZ 1: Introduction to Immunology
  - Format = Fill in the blank, true/false, short answer
- QUIZ 2: Cells and Other Defense
  - Format = Fill in the blank, multiple choice, matching, short answer
- QUIZ 3: Innate Immunity and Inflammation
  - Short answer, fill in the blank, matching
- QUIZ 4: Overview of Adaptive immunity
  - Short answer and fill in the blank, based on the review flow chart
- QUIZ 5: Humoral and Cell-Mediated Specifics
  - Multiple choice, labeling, and short answer

Name: _____ Date: _____ Pd:_____
Allied Health Potts

Intro to Immunology Quiz

Part 1: Fill in the blanks for the following questions.

1. When a pathogen invades the body, it will trigger an immune response due to unique molecules called _____. These will lead to the formation of very specific, matching _____ in response to these molecules.

2. Three cells that perform phagocytosis are _____, _____, and _____.

3. Three parts/members of the immune system that will contribute to inflammation include _____, _____, and _____.

4. The spleen is similar in structure to _____, but will filter _____ instead of lymph.

Part 2: State whether each of the following is true (T) or false (F). If it is false, explain why or rewrite it so that it is a true statement. You must provide content-specific details and cannot just rewrite the sentence with the word "not" added (for example)!

5. _____Lymph comes from fluid leaded out of blood vessels.

6. _____Cells are the only features that make up our internal immune system.

7. _____An APC (antigen presenting cell) will directly interact with mast cells.

8. _____When lymph nodes enlarge, it is because cells in the node are dividing in response to an antigenic stimulus.

9. _____Dendritic cells link innate and adaptive immunity.

10. _____Autoimmunity is when your immune system recognizes your tissues and does not react.

11. _____Secondary lymphoid organs allow interactions that will trigger the start of an innate immune response.

12. _____The covering of the eyes is the most frequent portal of entry for pathogens.

13. _____Another word for antigen is immunoglobulin.

Part 3: State which of the three lines of defense (1st, 2nd, or 3rd) each of the following is a part of.

14. _____Skin
15. _____Plasma/B cell
16. _____Neutrophil
17. _____Lysozyme
18. _____Inflammation
19. _____Antibodies
20. _____T helper cells
21. _____Normal microbiota

Part 4: Choose THREE of the four and answer in the space provided.
Extra credit option: Answer all four. Circle the number of the one that you want counted for extra credit!!!

22. What are the four features of the vertebrate immune system? Describe 2.

23. Compare and contrast the innate and adaptive immune response in terms of specificity and reaction time.

24. Describe how the circulatory system and lymphatic system work together to allow the immune system to function properly.

25. What are the two primary lymphoid organs? What role do each play for generation and maturation of both B and T cells?

Name: _____ | 45 points *(49 possible)* | Date: _____ Pd:_____

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Intro to Immunology Quiz

Part 1: Fill in the blanks for the following questions.

1. When a pathogen invades the body, it will trigger an immune response due to unique molecules called _____antigens___[1 pt]_____. These will lead to the formation of very specific, matching _____antibodies__[1 pt]_____ in response to these molecules.

2. Three cells that perform phagocytosis are ___macrophages__[1 pt]____, _____dendritic cells__[1 pt]_, and _____neutrophils__[1 pt]__. (eosinophils, B cells also acceptable, although still being debated)

3. Three parts/members of the immune system that will contribute to inflammation include _____basophils__[1 pt]___, _____mast cells___[1 pt]__, and _____macrophages__[1 pt]___. (neutrophils, complement activation also acceptable)

4. The spleen is similar in structure to _____lymph nodes__[1 pt]__, but will filter _____blood__[1 pt]___ instead of lymph.

Part 2: State whether each of the following is true (T) or false (F). If it is false, explain why or rewrite it so that it is a true statement. You must provide content-specific details and cannot just rewrite the sentence with the word "not" added (for example)!

5. ___T_[1 pt]__Lymph comes from fluid leaded out of blood vessels.

6. ___F_[1 pt]__Cells are the only features that make up our internal immune system.
   Organs and molecules also make up the internal immune system [1 pt]

7. ___F_[1 pt]__An APC (antigen presenting cell) will directly interact with mast cells.
   APCs interact with T cells [1 pt]

8. ___T_[1 pt]__When lymph nodes enlarge, it is because cells in the node are dividing in response to an antigenic stimulus.

9. ___T_[1 pt]__Dendritic cells link innate and adaptive immunity.

10. ___F_[1 pt]__Autoimmunity is when your immune system recognizes your tissues and does not react.
    Immune system will recognize your tissues and attack them [1 pt]

11. ___F_[1 pt]__Secondary lymphoid organs allow interactions that will trigger the start of an innate immune response.

    Start of the adaptive immune response [1 pt]

12. ___F_[1 pt]__The covering of the eyes is the most frequent portal of entry for pathogens.

    Respiratory mucous membranes are the most frequent portal [1 pt]

13. ___F_[1 pt]__Another word for antigen is immunoglobulin.

    Antibody, not antigen [1 pt]

Part 3: State which of the three lines of defense (1st, 2nd, or 3rd) each of the following is a part of.

14. ___1_[1 pt]__Skin
15. ___3_[1 pt]__Plasma/B cell
16. ___2_[1 pt]__Neutrophil
17. ___1_[1 pt]__Lysozyme
18. ___2_[1 pt]__Inflammation
19. ___3_[1 pt]__Antibodies
20. ___3_[1 pt]__T helper cells
21. ___1_[1 pt]__Normal microbiota

Part 4: Choose THREE of the four and answer in the space provided.
Extra credit option: Answer all four. Circle the number of the one that you want counted for extra credit!!!

22. What are the four features of the vertebrate immune system? Describe 2.

[1 pt]	**Specificity** **Diversity**	-tell the difference between very similar things [1 pt] -can recognize lots of different things [1 pt]	**may define any 2 of the 4**
[1 pt]	**Memory** **Tolerance**	– can remember specific invaders and protect against them faster/better – do not react to self	

23. Compare and contrast the innate and adaptive immune response in terms of specificity and reaction time.

    Innate = fast [1 pt] but nonspecific [1 pt]
    Adaptive = slow/takes longer [1 pt] but specific [1 pt]

24. Describe how the circulatory system and lymphatic system work together to allow the immune system to function properly.

    Circulatory exerts pressure that causes fluid to leak from vessels to cells. [1 pt] This fluid collects pathogens/antigens from the environment and is collected into the lymphatic vessels [1 pt]. The lymph travels to the lymph nodes where an immune response is developed [1 pt], then eventually back into the blood vessels of the circulatory system. [1 pt]

25. What are the two primary lymphoid organs? What role do each play for generation and maturation of both B and T cells?

    [1 pt]Bone marrow = B and T cell generation, B cell development [1 pt]
    [1 pt]Thymus = T cell development [1 pt]

Name: _____ Date: _____ Pd:_____
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Quiz 2: Cells and Other Defense

Part 1: Multiple Choice *(1.5pt ea)*
Please choose the correct response from the options given. There will only be ONE answer for each question. *Please write your answer choice on the line provided.*

1. Which of the following is FALSE about histamine?
   a. It is released from granules of cells
_____ b. It causes itching and pain by stimulating nerve endings
   c. It is released as part of the adaptive immune response
   d. It may be released as part of the allergic response

2. Which of the following cells can be found as tissue residents, meaning they do not have to exit the blood in order to be a part of the immune response?
_____ a. Monocytes
   b. Macrophages
   c. Neutrophils
   d. T cells

3. Hematopoietic stem cells will start differentiating by first becoming one of two progenitor cells. Common myeloid progenitors and common lymphoid progenitors are the two cell types that will result in all the blood
_____ cells, including those found as part of our immune system. Cells that come from the same progenitor will be more similar to each other than cells that come from a different progenitor. Based on this, as well as what you know about cells of the immune system, which of the following statements must be true regarding our immune cells?

   a. Since NK cells are similar to B and T cells, they will come from the same progenitor cell (even though they are part of the innate immune response and B and T cells are part of the adaptive).

   b. Common myeloid progenitors and common lymphoid progenitors can each become more cells than the hematopoietic stem cell.

   c. Basophils, eosinophils, and mast cells must all come from different progenitor cells.

   d. Since erythrocytes are not part of the immune response, they do not come from either of the progenitor cells discussed.

4. When are eosinophils able to act as a phagocyte?
   a. When the pathogen is a bacterium
_____ b. When the pathogen is a parasitic worm
   c. When the pathogen has been processed by another cell
   d. When the pathogen is coated in antibodies

5. Which of the following is NOT a nonspecific defense against a pathogen?
   a. Complement
_____ b. Antibodies
   c. Defensins
   d. Lysozyme

Part 2: Fill In: Terms *(1.5pt ea)*
For each of the following, indicate the correct term to complete the sentence.

6. Cells that make up the blood are created from _____, in a process called hematopoiesis.

7. The liquid portion of blood is called _____.

8. Most the cells that make up our blood are _____.

9. Proteins released by cells that will act as messengers are called _____.

10. Antimicrobial peptides, also known as _____, are a nonspecific defense against pathogens.

Part 3: Fill In: Cell Identification *(1pt ea)*
Write the cell (or cells) that each statement is referring to. Note that you do NOT have to give ALL cells, but for some questions you may have to provide more than one response. The number of cells you need to answer are shown by the number of lines available.

Question	Answer space
11. Adaptive immunity cell that matures in the bone marrow	11a) _____
12. Triggers inflammation upon phagocytosis of a pathogen	12a) _____
13. Is a "professional" at its job	13a) _____ 13b) _____
14. When you have a bacterial infection, there will be a large increase in these	14a) _____
15. Phagocyte that will have TLRs	15a) _____ 15b) _____
16. Bridge the innate and adaptive immune system	16a) _____
17. Part of the allergic response OR fighting parasitic worms	17a) _____ 17b) _____
18. Antigen-presenting cell	18a) _____
19. Respond to specific antigens	19a) _____
20. Recognize and kill virally infected cells	20a) _____
21. Job is to constantly sample their environment and show what they have found to other cells	21a) _____
22. Mature into macrophages once they leave the blood	22a) _____

23. Granules contain histamine	23a) _____
24. Will respond to PAMPs	24a) _____ 24b) _____ 24c) _____

Part 4: Long Answer *(5pts ea)*
Choose TWO of the three and answer in the space provided.
Extra credit option: Answer all three. ***Circle the number of the one that you want counted for extra credit!!!***

25. What is complement? What are the three results of complement activation?

_____

_____

_____

_____

_____

_____

_____

26. List three types of cytokines. Describe one.

_____

_____

_____

_____

_____

_____

_____

27. Describe PRRs, PAMPs, and TLRs by explaining how they will relate to a macrophage or neutrophil responding to an infection. Do not just define the terms!

_____

_____

_____

_____

_____

_____

_____

Name: _____ 50 points *(49 possible)* Date: _____ Pd:_____

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Quiz 2: Cells and Other Defense

Part 1: Multiple Choice ***(1.5pt ea)***

Please choose the correct response from the options given. There will only be ONE answer for each question. *Please write your answer choice on the line provided.*

1. Which of the following is FALSE about histamine?
   a. It is released from granules of cells
   b. It causes itching and pain by stimulating nerve endings
   c. It is released as part of the adaptive immune response
   d. It may be released as part of the allergic response

2. Which of the following cells can be found as tissue residents, meaning they do not have to exit the blood in order to be a part of the immune response?
   a. Monocytes
   b. Macrophages
   c. Neutrophils
   d. T cells

3. Hematopoietic stem cells will start differentiating by first becoming one of two progenitor cells. Common myeloid progenitors and common lymphoid progenitors are the two cell types that will result in all the blood cells, including those found as part of our immune system. Cells that come from the same progenitor will be more similar to each other than cells that come from a different progenitor. Based on this, as well as what you know about cells of the immune system, which of the following statements must be true regarding our immune cells?

   a. Since NK cells are similar to B and T cells, they will come from the same progenitor cell (even though they are part of the innate immune response and B and T cells are part of the adaptive).

   b. Common myeloid progenitors and common lymphoid progenitors can each become more cells than the hematopoietic stem cell.

   c. Basophils, eosinophils, and mast cells must all come from different progenitor cells.

   d. Since erythrocytes are not part of the immune response, they do not come from either of the progenitor cells discussed.

4. When are eosinophils able to act as a phagocyte?
   a. When the pathogen is a bacterium
   b. When the pathogen is a parasitic worm
   c. When the pathogen has been processed by another cell
   d. When the pathogen is coated in antibodies

5. Which of the following is NOT a nonspecific defense against a pathogen?
   a. Complement
   b. Antibodies
   c. Defensins
   d. Lysozyme

Part 2: Fill In: Terms ***(1.5pt ea)***

For each of the following, indicate the correct term to complete the sentence.

6. Cells that make up the blood are created from _____hematopoietic stem cells_____, in a process called hematopoiesis.

7. The liquid portion of blood is called _____plasma_____.

8. Most the cells that make up our blood are _____red blood cells/erythrocytes_____.

9. Proteins released by cells that will act as messengers are called _____cytokines_____.

10. Antimicrobial peptides, also known as _____defensins_____, are a nonspecific defense against pathogens.

Part 3: Fill In: Cell Identification ***(1pt ea)***

Write the cell (or cells) that each statement is referring to. Note that you do NOT have to give ALL cells, but for some questions you may have to provide more than one response. The number of cells you need to answer are shown by the number of lines available.

Question	Answer space
11. Adaptive immunity cell that matures in the bone marrow	11a) ___B cell_____
12. Triggers inflammation upon phagocytosis of a pathogen	12a) ___macrophage_____
13. Is a "professional" at its job	13a) ___DC, Macrophage, neutrophil__ 13b) ___See 13a for options_____
14. When you have a bacterial infection, there will be a large increase in these	14a) ___Neutrophil_____
15. Phagocyte that will have TLRs	15a) ___DC, macro, neutro, eosino___ 15b) ___See 15a for options_____
16. Bridge the innate and adaptive immune system	16a) ___Dendritic cell (DC)_____
17. Part of the allergic response OR fighting parasitic worms	17a) ___Mast cell, basophil, eosinophil_ 17b) ___See 17a for options_____
18. Antigen-presenting cell	18a) ___DC, macrophage, B cell_____
19. Respond to specific antigens	19a) ___B, T_____
20. Recognize and kill virally infected cells	20a) ___NK cell (T is ok)_____
21. Job is to constantly sample their environment and show what they have found to other cells	21a) ___Dendritic cell_____
22. Mature into macrophages once they leave the blood	22a) ___Monocyte_____
23. Granules contain histamine	23a) ___Mast cell_____

24. Will respond to PAMPs	24a) ___Macro, neutro, mast, baso,___ 24b) ___eosino, NK, DC_____ 24c) ___See 24a/b for options_____

Part 4: Long Answer ***(5pts ea)***

Choose TWO of the three and answer in the space provided.

Extra credit option: Answer all three. ***Circle the number of the one that you want counted for extra credit!!!***

25. What is complement? What are the three results of complement activation?

___Proteins found in plasma activated as part of the innate/nonspecific response___[2 pts]_____

_____Results = kill cells (punch holes in membrane) [1 pt]_____

_____Coat pathogens for macrophages [1 pt]_____

_____Chemokine signals (or signal inflammation) [1 pt]_____

26. List three types of cytokines. Describe one.

[1 pt] Chemokines → attract cells to an area [1 pt] Interleukins → Signals between WBCs [2 pts] [1 pt] Interferons → Nonspecific antiviral proteins

_____Growth factors_____

_____Tumor necrosis factor_____

27. Describe PRRs, PAMPs, and TLRs by explaining how they will relate to a macrophage or neutrophil responding to an infection. Do not just define the terms!

[1 pt] Pattern recognition receptor → on cell [1 pt] Toll-like receptor → type of PRR on phagocytes [1 pt] Pathogen-associated molecular pattern → general structures on pathogens [1 pt] These will bind to PRR/TLR [1 pt] Student must relate to cell type correctly!

Name: _____ Date: _____ Pd:_____
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Innate Immunity and Inflammation Quiz

PART I: FILL IN

Directions – Fill in the blanks with appropriate terms in order to accurately describe the inflammatory response.

Oh no! You were running late to your Allied Health class and fell outside on the way to the classroom. Unfortunately, you cut your elbow open pretty badly, and even though you cleaned the cut, you weren't able to get rid of all the bacteria that were on the ground. Since you are learning about immunology in your class, you know exactly what's going to happen in your arm as a result of the fall.

First of all, the bacteria that enter into your body are going to be recognized by tissue-resident cells called (1)_____. These are the first defenders to "raise the alarm!" Both the damage and the cells will cause a release of cytokines that will (2)_____ blood vessels (which slows the blood down and results in two signs of inflammation: (3)_____ and (4) _____). It will also change the blood vessels to make them more permeable, which lets two general things leave the blood stream: (5)_____ and (6)_____ (which is responsible for the swelling).

The cells that respond to the infection will be called to the area by (7)_____. These cells will release more cytokines that will affect nerves and result in the fourth sign of inflammation, (8)_____. Most of the cells called to the area are going to be (9)_____, which will usually kill pathogens through the process of (10)_____.

The fluid that is released to the site of infection will contain (11)_____, such as complement, which will also act on the pathogens. Together, all of these will work to eliminate the infection. If it's not enough, then over time the (12)_____ will present antigen and activate the adaptive immune response.

PART II: SHORT ANSWER

Directions – Answer each of the following in the space provided.

13) What are two benefits of having a fever?

_____

_____

_____

14) List two ways that the innate and adaptive immune systems work together to rid the body of a pathogen.

_____

_____

_____

15) What are the two ways neutrophils kill cells OTHER than through phagocytosis?

_____

_____

_____

16) Describe how NK cells relate to inhibitory and activating receptors.

_____

_____

_____

PART III: MATCHING

Directions – Match the descriptions in the first column the options in the second column. If used, an option will only be used once. Not all options will be used. *Please put your answers on the line provided.*

Description	Options
_____ 17) Proteins, such as complement or antibodies, that coat microbes	A. Acute inflammation
_____ 18) From NK cell granules and creates a hole in the membrane of a self-cell	B. ADCC (antibody-dependent cellular cytotoxicity)
_____ 19) Lyse virally infected cells and tumors	C. Basophils
_____ 20) Cytokine that activates NK cells, but is also created by NK cells	D. Chronic inflammation
_____ 21) Pore formed in the membrane of a pathogen by complement	E. Complement
_____ 22) When NK cells connect to antibodies to be signaled to kill a self-cell	F. Dendritic cells
_____ 23) Major signal for the inflammatory response (created by mast cells)	G. Eosinophils
_____ 24) Beneficial inflammation	H. Granzyme
_____ 25) Long lasting and may be due to improper control of the inflammatory response	I. Histamine
_____ 26) Released by NK cells and digests/causes self-cell to die	J. Interferon
_____ 27) Results in increasing the number of binding sites on the surface of a microbe to make it easier to phagocytize	K. Macrophages
_____ 28) Proteins activated in a variety of ways by cleaving them into smaller and smaller pieces, leading to several different results for the immune response	L. Membrane attack complex
_____ 29) Samples environment and produces interferon	M. Neutrophils
_____ 30) Releases inflammatory chemicals as a result of infection (more than one possible response: choose only one!)	N. NK cells
	O. Opsonins
	P. Opsonization
	Q. Perforin

Name: _____ | 40 points *(40possible)* | Date: _____ Pd:_____

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Innate Immunity and Inflammation Quiz

PART I: FILL IN

Directions – Fill in the blanks with appropriate terms in order to accurately describe the inflammatory response.

Oh no! You were running late to your Allied Health class and fell outside on the way to the classroom. Unfortunately, you cut your elbow open pretty badly, and even though you cleaned the cut, you weren't able to get rid of all the bacteria that were on the ground. Since you are learning about immunology in your class, you know exactly what's going to happen in your arm as a result of the fall.

First of all, the bacteria that enter into your body are going to be recognized by tissue-resident cells called (1)___macrophages (mast cells is ok)____. These are the first defenders to "raise the alarm!" Both the damage and the cells will cause a release of cytokines that will (2)____dilate/widen_____ blood vessels (which slows the blood down and results in two signs of inflammation: (3)____heat_____ and (4) _____redness_____). It will also change the blood vessels to make them more permeable, which lets two general things leave the blood stream: (5)_____cells_____ and (6)_____fluid_____ (which is responsible for the swelling).

The cells that respond to the infection will be called to the area by (7)__chemokines (cytokines not ok)__. These cells will release more cytokines that will affect nerves and result in the fourth sign of inflammation, (8)___pain_____. Most of the cells called to the area are going to be (9)_____neutrophils_____, which will usually kill pathogens through the process of (10)_____phagocytosis_____.

The fluid that is released to the site of infection will contain (11)___proteins (opsonins is ok)___, such as complement, which will also act on the pathogens. Together, all of these will work to eliminate the infection. If it's not enough, then over time the (12)___dendritic cells (macrophages is ok)___ will present antigen and activate the adaptive immune response.

[above portion is 1 pt each for a total of 12 points]

PART II: SHORT ANSWER

Directions – Answer each of the following in the space provided.

13) What are two benefits of having a fever?

__[2 pts] Increase neutrophil production from bone marrow_____

__[2 pts] Make environment inhospitable for pathogen survival_____

_____Catalyze reactions of the immune response (another option)_____

14) List two ways that the innate and adaptive immune systems work together to rid the body of a pathogen.

__[2 pts] Macrophages present antigen to T cells_____ADCC w/ NK cells (another option)_____

__[2 pts] Antibodies act as opsonins to increase phagocytosis by neutrohpils and macrophages_____

_____Cytokines activate cells of both the adaptive and innate immune responses (another option)_____

15) What are the two ways neutrophils kill cells OTHER than through phagocytosis? [3 pts – lose 1 if only 1 way]

Release chemicals similar to bleach to directly kill

Release antimicrobial peptide nets to trap pathogens for killing by other cells

16) Describe how NK cells relate to inhibitory and activating receptors. [3 pts – 1 for attempt, 1 for each receptor]

Bind to activating receptors on cells to get signal to kill cell

Healthy cells will have inhibitory receptors that will signal NK cells NOT to kill them

Infected cells won't have these inhibitory receptors

PART III: MATCHING [below portion is 1 pt each for a total of 14 points]

Directions – Match the descriptions in the first column the options in the second column. If used, an option will only be used once. Not all options will be used. *Please put your answers on the line provided.*

Description	Options
O 17) Proteins, such as complement or antibodies, that coat microbes	A. Acute inflammation
Q 18) From NK cell granules and creates a hole in the membrane of a self-cell	B. ADCC (antibody-dependent cellular cytotoxicity)
N 19) Lyse virally infected cells and tumors	C. Basophils
J 20) Cytokine that activates NK cells, but is also created by NK cells	D. Chronic inflammation
L 21) Pore formed in the membrane of a pathogen by complement	E. Complement
B 22) When NK cells connect to antibodies to be signaled to kill a self-cell	F. Dendritic cells
I 23) Major signal for the inflammatory response (created by mast cells)	G. Eosinophils
A 24) Beneficial inflammation	H. Granzyme
D 25) Long lasting and may be due to improper control of the inflammatory response	I. Histamine
H 26) Released by NK cells and digests/causes self-cell to die	J. Interferon
P 27) Results in increasing the number of binding sites on the surface of a microbe to make it easier to phagocytize	K. Macrophages
E 28) Proteins activated in a variety of ways by cleaving them into smaller and smaller pieces, leading to several different results for the immune response	L. Membrane attack complex
F 29) Samples environment and produces interferon	M. Neutrophils
G/C/E/K/M (any) 30) Releases inflammatory chemicals as a result of infection (more than one possible response: choose only one!)	N. NK cells
	O. Opsonins
	P. Opsonization
	Q. Perforin

Name: _____ Date:_____ Pd: _____
Allied Health Potts

Adaptive Immunity Quiz

1. Adaptive immune cells will interact mainly at the _____ in the body.
    a. What about this organ makes it a good place for the cells to interact? _____
    _____

2. The adaptive immune system is divided into two responses: The _____ response, which uses B cells, and the _____ response, which uses T cells.

3. What is one difference between antigen that B cells respond to vs. antigen that T cells respond to? _____
_____
_____

4. Fill in the following information about the different types of T cells. You may choose which two to expand on, but you must list all three.
    a. First type: _____
        i. Abbreviated: _____
        ii. Surface marker: _____
        iii. Function: _____
        _____
    b. Second type: _____
        i. Abbreviated: _____
        ii. Surface marker: _____
        iii. Function: _____
        _____
    c. Third type: _____

5. What is the purpose of the MHC? _____
_____
_____

Continued on back…

6. Fill in information for one of the classes of MHC below. Circle your choice: MHC I or MHC II
    a. What type of cell is it found on? _____
    b. What does it show antigen to? _____
    c. What is the purpose of this MHC (what does it allow to happen)? _____
    _____

7. T and B cells originate from a cell called a _____. As they are formed, they will generate unique TCR and BCR surface receptors through _____.

8. The first part of the formation of B and T cells is called _____. The purpose is to kill cells that _____. They are killed through a process called _____.
    a. It's more complex in T cells due to the _____, and only the only cells that survive are those that _____.
    b. The resulting cells are _____ (because they have specific a specific BCR or TCR) but also _____ (because they haven't seen their matching antigen yet).

9. Once antigen binds to the B or T cell, the second phase of B and T cell formation will occur. This is called _____.
    a. When antigens bind, it is called _____. This leads to cells dividing, called _____. When they divide they will become functionally more specific, which is called _____.

EXTRA CREDIT:

10. Why will NK cells be able to "pick up the slack" for some T cells? What is it that they are able to do that is similar to T cell functioning, and when/why will it occur? _____
_____
_____
_____

Name: _____ Date:_____ Pd: _____

Allied Health Potts

35 points
(35 possible)

Adaptive Immunity Quiz

1. Adaptive immune cells will interact mainly at the _____lymph nodes_____ in the body. [1 pt]
   a. What about this organ makes it a good place for the cells to interact? _____
   _____keeps everything close together_____[1 pt]_____

2. The adaptive immune system is divided into two responses: The ____humoral___[1 pt]____ response, which uses B cells, and the _____cell-mediated_[1 pt]___ response, which uses T cells.

3. What is one difference between antigen that B cells respond to vs. antigen that T cells respond to? _____
   _____B = whole, or directly interact___[1 pt]_____
   _____T = piece, or in an MHC_____[1 pt]_____

4. Fill in the following information about the different types of T cells. You may choose which two to expand on, but you must list all three.
   a. First type: _____Helper T cell_____ [1 pt]
      i. Abbreviated: ___Th____ (or Treg) [1 pt]
      ii. Surface marker: ___CD4_____ [1 pt]
      iii. Function: _____Activate other parts of adaptive immunity_____[1 pt]_____
      _____(Treg = turn off immune cells)_____
   b. Second type: _____Cytotoxic T cell_____ [1 pt]
      i. Abbreviated: ___Tc____ [1 pt]
      ii. Surface marker: ___CD8_____ [1 pt]
      iii. Function: _____Kill virally infected cells and tumors_____[1 pt]_____
      _____
   c. Third type: ____Regulatory T cell_____ [1 pt]

5. What is the purpose of the MHC? _____
   _____Holds antigen to show to T cells_____[2 pts]_____
   _____

Continued on back…

6. Fill in information for one of the classes of MHC below. Circle your choice: MHC I or MHC II [1 pt]
    a. What type of cell is it found on? ___1: all nucleated_____2: APCs_____ [1 pt]
    b. What does it show antigen to? ___1: cytotoxic T cells_____2: helper T cells_____ [1 pt]
    c. What is the purpose of this MHC (what does it allow to happen)? _____
    _____1: give the "ok" or show infection/tumor inside cells [2 pts] 2: activate helper T cells_____

7. T and B cells originate from a cell called a _____common lymphoid progenitor [1 pt]__. As they are formed, they will generate unique TCR and BCR surface receptors through _____genetic recombination_____. [1 pt]

8. The first part of the formation of B and T cells is called _____clonal deletion_____[1 pt]____. The purpose is to kill cells that _____react with self__[1 pt]__. They are killed through a process called _____apoptosis_[1 pt]___.
    a. It's more complex in T cells due to the _MHC_[1 pt]__, and only the only cells that survive are those that _____react slightly_____[1 pt]__.
    b. The resulting cells are _____mature_[1 pt]_ (because they have specific a specific BCR or TCR) but also _____naive__[1 pt]_ (because they haven't seen their matching antigen yet).

9. Once antigen binds to the B or T cell, the second phase of B and T cell formation will occur. This is called _____clonal expansion_____[1 pt]____.
    a. When antigens bind, it is called _____activation__[1 pt]___. This leads to cells dividing, called _____proliferation__[1 pt]__. When they divide they will become functionally more specific, which is called _____differentiation_____[1 pt]___.

EXTRA CREDIT:

10. Why will NK cells be able to "pick up the slack" for some T cells? What is it that they are able to do that is similar to T cell functioning, and when/why will it occur? _____
    __[+1 pt]__Tc kills virally infected cell, but viruses get rid of MHC I. This stops Tc from working, but signals_____
    __NK cells that something is wrong [1 pt] and they will kill the cell (MHC I is usually the inhibitory signal)__ [1 pt]
    _____

Name: _____ Date:_____ Pd: _____
Allied Health Potts

Quiz: Humoral and Cell-Mediated Specifics

MULTIPLE CHOICE:

Answer the following by putting your answer in the box provided.

1. Which of the following is NOT a direct function of antibodies produced during the immune response?

Ans:

a. Toxin neutralization
b. Opsonization
c. Activation of inflammation
d. ADCC
e. Agglutination

2. Choose the INCORRECT pairing from the options below:

Ans:

a. MHC II → dendritic cell
b. Cytotoxic T cell → CD4
c. Helper T cells → cytokine release
d. MHC I → dendritic cell
e. CD8 → MHC I

3. Which of the following is NOT a type of T cell?

Ans:

a. Regulatory
b. Helper
c. Cytotoxic
d. Plasma
e. Effector

4. Features of memory cells include:

Ans:

a. Faster reaction when infected with the same thing again
b. Constantly create antibodies to ward off infection
c. Survive longer than effector B and T cells
d. A and B are correct
e. A and C are correct

5. Which of the following statements is TRUE?

Ans:

a. B and T cells react to the same epitopes on antigens in order to react to the same invader, and therefore have the same variable regions
b. BCR and TCR are both very specific, but the BCR is never released from the cell
c. B cells cannot ever become activated without helper T cells
d. NK cells recognize and kill specific virally infected cells, just like Tc
e. Antigens of the same pathogens will be recognized by B and T cells that work together, but the antigens will be structurally different

6. What is the purpose of regulatory T cells?

Ans:

a. Reverse the functioning of helper and cytotoxic T cells
b. Prevent B cells from acting on “self” antigen
c. Keep helper T cells functioning, but regulate this functioning so they are only minimally active
d. Decrease inflammation
e. Soak up extra antibodies to regulate the humoral response

7. Why do B cells usually require signaling from helper T cells?

Ans:

a. In order to tell them which pathogen to react to
b. So they don't produce too many antibodies
c. To protect you so B cells don't react against self
d. So that the B cells can then activate the cytotoxic T cells
e. To be able to react to and kill cancer cells

8. Which of the following is FALSE about cytotoxic T cells?

Ans:

a. By forcing helper T cells to undergo apoptosis, they activate the cell-mediated immune response
b. They kill cells the same way that NK cells do
c. A cytotoxic T cell will be very specific for virally infected or cancer cells
d. Cytotoxic T cells release perforin and granzymes in order to kill cells
e. Tc will have CD8 on their surface

9. Which of the following is the **BEST** at presenting antigen to T helper cells?

Ans:

a. Dendritic cell with MHC I
b. Macrophage with MHC I
c. Dendritic cell with MHC II
d. Macrophage with MHC II
e. B cell with MHC II

10. Which of the following statements is FALSE?

Ans:

a. The humoral and cell-mediated response will use B and T cells to attack specific pathogens that are infecting you
b. T cells will directly react to things that are floating around, while B cells only react to things inside cells by binding with MHC I or II
c. Antibodies (or immunoglobulins) are B cell receptors (BCRs) which are released from plasma cells after B cells have been activated
d. The cell-mediated immune response can function to boost other parts of adaptive immunity
e. Regulatory T cells also have CD4 on their surface, but we aren't considering them as helper T cells

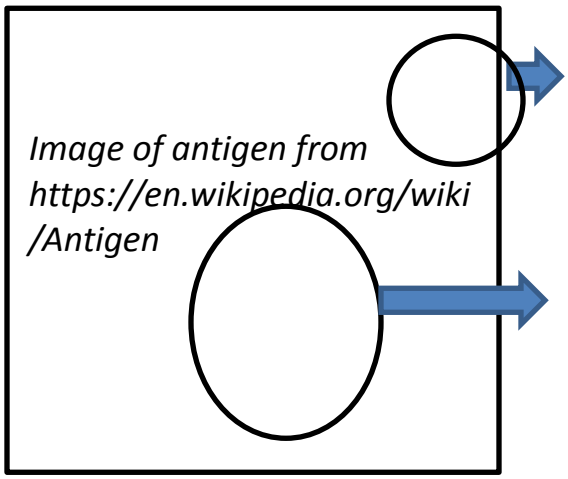
LABELING:

11. Label the portions of the image below, and then briefly describe each.

a. There are three names for what this structure could be. What are two of these three possible names?

i. _____

ii. _____



Called the:_____

Description: _____

_____

Called the:_____

Description: _____

_____

LONG ANSWER:

12. HIV specifically infects CD4 helper T cells. These cells will then be destroyed as a result of the viral infection. Explain, using what you know about CD4 helper T cell functioning, how this will negatively impact the immune functioning of a patient infected with HIV. I am expecting a good amount of detail in your response, and you must indicate all ways discussed in class that Th functioning will be impacted. Note that you do NOT need to discuss HIV in particular; this is just the lens through which you're describing what T helper cells do.
Use the image to help.

_____

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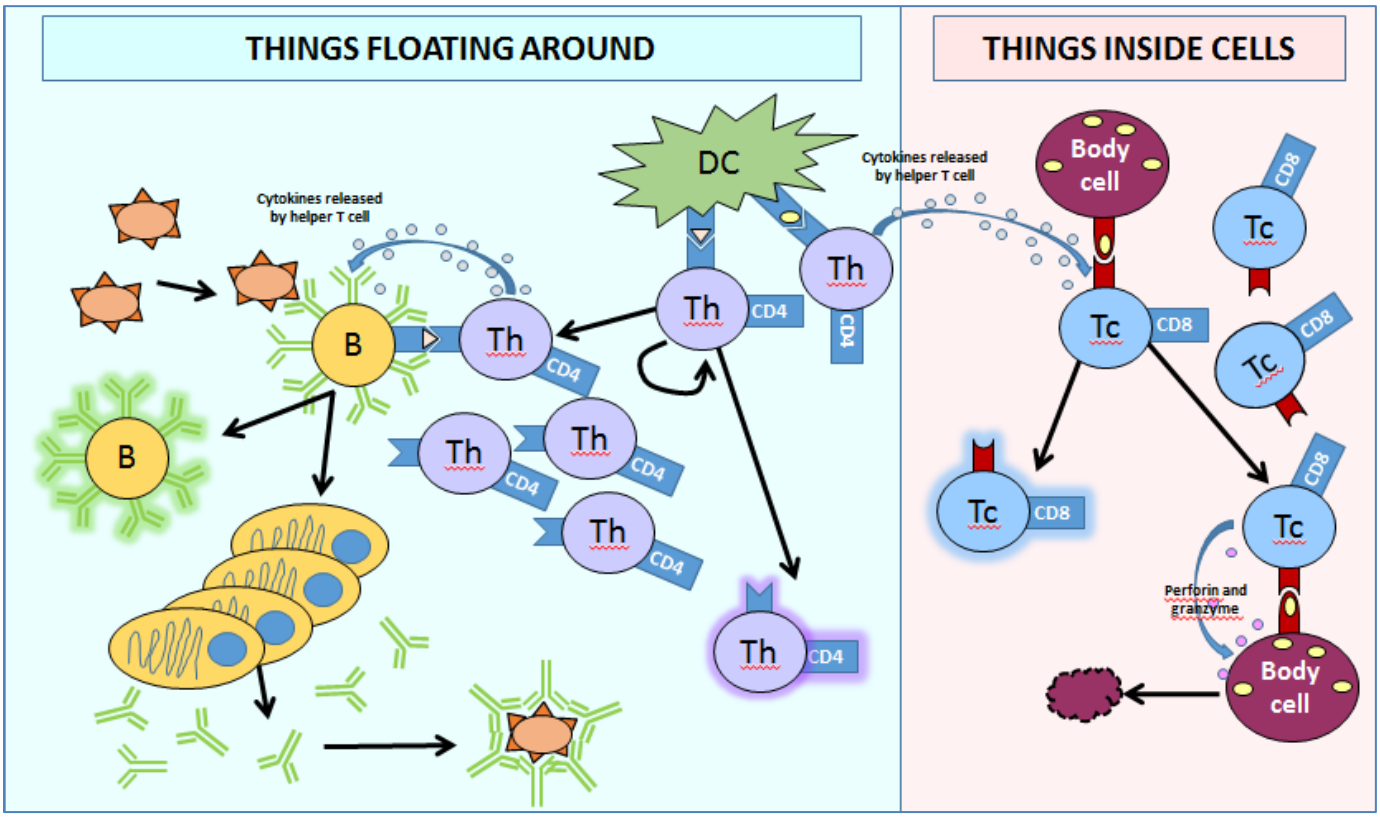


EXTRA CREDIT:

You may do both of the extra credit questions.

13. What is "herd immunity"? Why is it important?_____

    _____

    _____

    _____

14. Describe ***UP TO*** three of the following (in terms of the effect on the immune system or the immune system's effect on the body):

    a. Graft-versus-host disease (GvHD) – _____

       _____

    b. Autoimmune hemolytic anemia – _____

       _____

    c. Multiple sclerosis – _____

       _____

    d. Chronic granulomatous disease – _____

       _____

    e. DiGeorge syndrome – _____

       _____

    f. Severe combined immunodeficiency disease (SCID) – _____

       _____

Name: _____ Date:_____ Pd: _____

Allied Health

35 points
(35 possible)

Potts

Quiz: Humoral and Cell-Mediated Specifics

MULTIPLE CHOICE:

Answer the following by putting your answer in the box provided. [2 pts for each question, 20 points total]

1. Which of the following is NOT a direct function of antibodies produced during the immune response?

Ans: C

a. Toxin neutralization
b. Opsonization
c. Activation of inflammation
d. ADCC
e. Agglutination

2. Choose the INCORRECT pairing from the options below:

Ans: B

a. MHC II → dendritic cell
b. Cytotoxic T cell → CD4
c. Helper T cells → cytokine release
d. MHC I → dendritic cell
e. CD8 → MHC I

3. Which of the following is NOT a type of T cell?

Ans: D

a. Regulatory
b. Helper
c. Cytotoxic
d. Plasma
e. Effector

4. Features of memory cells include:

Ans: E

a. Faster reaction when infected with the same thing again
b. Constantly create antibodies to ward off infection
c. Survive longer than effector B and T cells
d. A and B are correct
e. A and C are correct

5. Which of the following statements is TRUE?

Ans: E

a. B and T cells react to the same epitopes on antigens in order to react to the same invader, and therefore have the same variable regions
b. BCR and TCR are both very specific, but the BCR is never released from the cell
c. B cells cannot ever become activated without helper T cells
d. NK cells recognize and kill specific virally infected cells, just like Tc
e. Antigens of the same pathogens will be recognized by B and T cells that work together, but the antigens will be structurally different

6. What is the purpose of regulatory T cells?

Ans: A

a. Reverse the functioning of helper and cytotoxic T cells
b. Prevent B cells from acting on "self" antigen
c. Keep helper T cells functioning, but regulate this functioning so they are only minimally active
d. Decrease inflammation
e. Soak up extra antibodies to regulate the humoral response

7. Why do B cells usually require signaling from helper T cells?

Ans: C

a. In order to tell them which pathogen to react to
b. So they don't produce too many antibodies
c. To protect you so B cells don't react against self
d. So that the B cells can then activate the cytotoxic T cells
e. To be able to react to and kill cancer cells

8. Which of the following is FALSE about cytotoxic T cells?

Ans: A

a. By forcing helper T cells to undergo apoptosis, they activate the cell-mediated immune response
b. They kill cells the same way that NK cells do
c. A cytotoxic T cell will be very specific for virally infected or cancer cells
d. Cytotoxic T cells release perforin and granzymes in order to kill cells
e. Tc will have CD8 on their surface

9. Which of the following is the **BEST** at presenting antigen to T helper cells?

Ans: C

a. Dendritic cell with MHC I
b. Macrophage with MHC I
c. Dendritic cell with MHC II
d. Macrophage with MHC II
e. B cell with MHC II

10. Which of the following statements is FALSE?

Ans: B

a. The humoral and cell-mediated response will use B and T cells to attack specific pathogens that are infecting you
b. T cells will directly react to things that are floating around, while B cells only react to things inside cells by binding with MHC I or II
c. Antibodies (or immunoglobulins) are B cell receptors (BCRs) which are released from plasma cells after B cells have been activated
d. The cell-mediated immune response can function to boost other parts of adaptive immunity
e. Regulatory T cells also have CD4 on their surface, but we aren't considering them as helper T cells

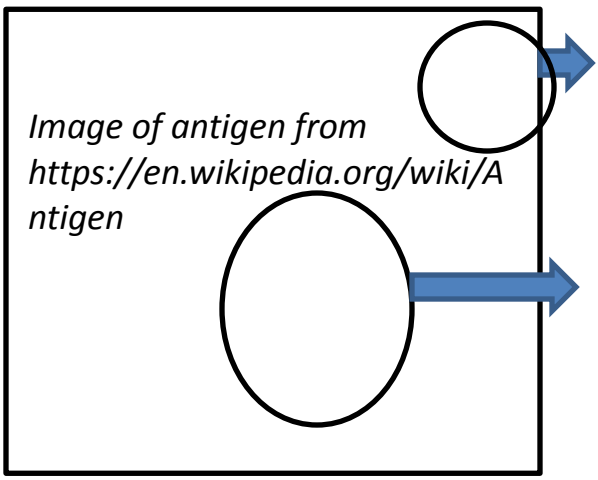
LABELING:

11. Label the portions of the image below, and then briefly describe each.

a. There are three names for what this structure could be. What are two of these three possible names?

i. Antibody (BCR is ok) [1 pt]

ii. Immunoglobulin [1 pt]



Called the: Variable region [1 pt]

Description: Specific and different [1 pt]

Billions of variants!

Called the: Constant region [1 pt]

Description: Only a few types/no genetic recombination

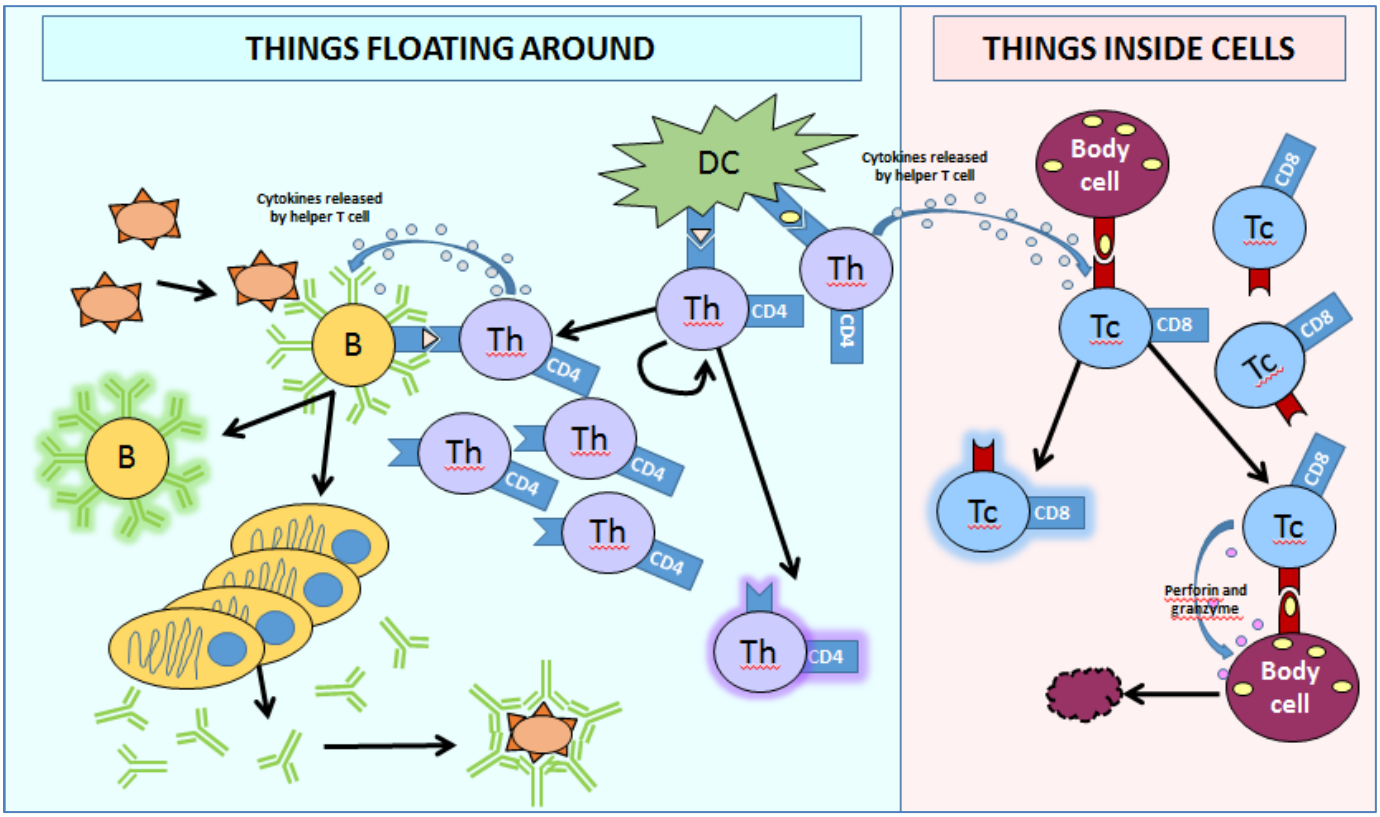
[1 pt]

LONG ANSWER:

12. HIV specifically infects CD4 helper T cells. These cells will then be destroyed as a result of the viral infection. Explain, using what you know about CD4 helper T cell functioning, how this will negatively impact the immune functioning of a patient infected with HIV. I am expecting a good amount of detail in your response, and you must indicate all ways discussed in class that Th functioning will be impacted. Note that you do NOT need to discuss HIV in particular; this is just the lens through which you're describing what T helper cells do.
Use the image to help.

What T helper cells do:		***Loss will lead to:***
Activate B cells [2 pts]	[1 pt]	No plasma cells making antibodies against infective agent
Activate Tc cells [2 pts]	[1 pt]	No reaction to viral infection
Create more Th [2 pts]	[1 pt]	No memory Th or further effects on B cells and Tc cells

Overall: Loss of Th leads to immunosuppression



EXTRA CREDIT:

You may do both of the extra credit questions.

13. What is "herd immunity"? Why is it important?_____

    _____When most people (75-80%) are vaccinated, protecting those that are not____ [+1 pt]_____

    _____Important for people who CAN'T get vaccinated____ [+1 pt]_____

    _____

14. Describe ***UP TO*** three of the following (in terms of the effect on the immune system or the immune system's effect on the body): [+1 pt each]

    a. Graft-versus-host disease (GvHD) – ___Donated bone marrow creates T cells that attack the body_____

    _____

    b. Autoimmune hemolytic anemia – ____Recognize antigens on RBCs, leading to premature destruction__

    _____

    c. Multiple sclerosis – ____Tc attacks myelin sheaths of nerve cells, decreasing ability to send signals_____

    _____

    d. Chronic granulomatous disease – ____Phagocytes cannot destroy ingested bacteria_____

    _____

    e. DiGeorge syndrome – _____No thymus develops, so people lack mature T cells_____

    _____

    f. Severe combined immunodeficiency disease (SCID) – _____

    _____No B or T cells are produced, so no adaptive immune response is made_____

Teacher Answer Keys

Answer keys for various materials used throughout this unit can be found here. The following answer keys are available:

a. Khan Academy Ed Puzzle
b. Immunology Game Review Grade Sheet
c. Immune System Quiz 1 Review
d. Immune Cells ID WS
e. Immune System Quiz 2 Review
f. Innate Immunity Review
g. Inflammation WebQuest
h. Overview of the Adaptive Immune System Review
i. Adaptive Immunity Flow Charts
j. Create Your Own Antibodies!
k. Humoral and Cell-Mediated Flow Charts
l. AIDS Simutest

Please see the Student Section for the original, blank versions of these documents.

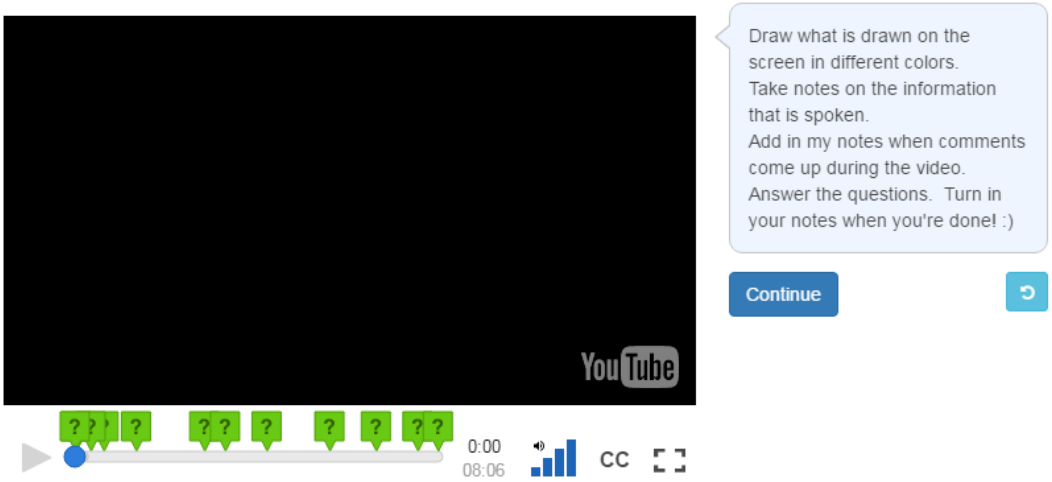
Khan Academy EdPuzzle

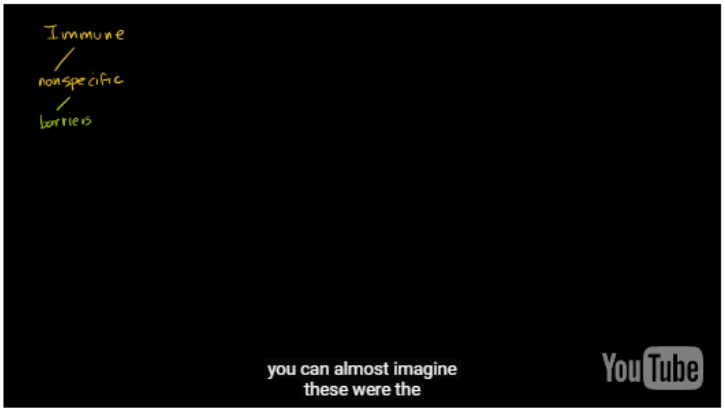
The screenshots below show:

- When questions were asked
- Questions and answer choices
- Correct responses
- Any notes that I added into the video for the students

In addition to answering the questions, students were instructed to draw the chart that was being drawn in the video.

**The video used is “Types of immune responses: Innate and adaptive, humoral vs. cell-mediated” by Khan Academy.





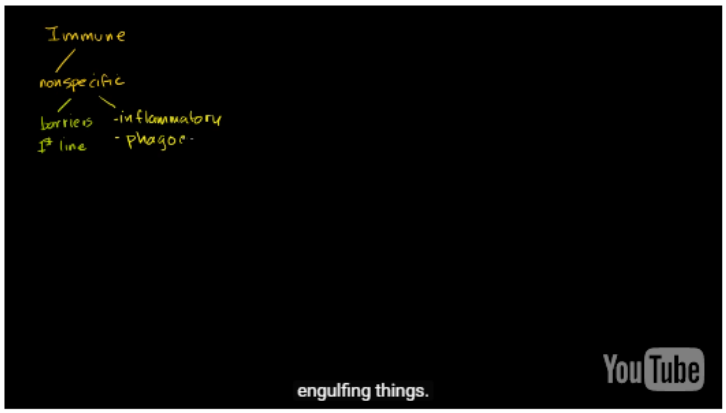
0:38
08:06
EN

Which of the following is NOT a natural barrier to prevent things from getting inside your body?

100/100

- ☐ Skin
- ☐ Stomach acid
- ☐ Acidity of oils you produce
- → ☑ White blood cells

Continue



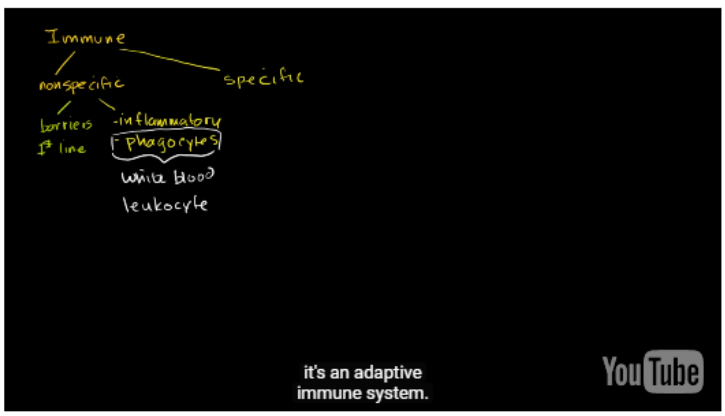
01:21
08:06
EN

What is the purpose of an inflammatory response?

100/100

- → ☑ Get things to where they need to be in order to get rid of an invader
- ☐ Prevent the microbe from infecting you in the first place
- ☐ Kill the microbial invader by ingesting it and breaking it down

Continue



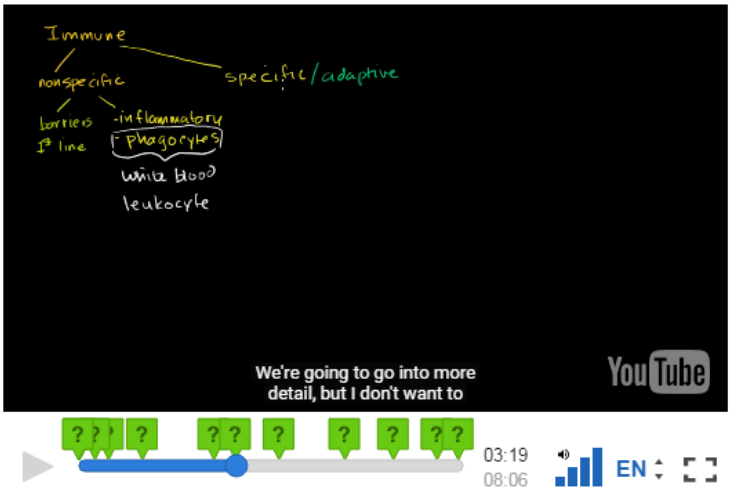
02:51
08:06
EN

What kinds of microorganisms might the innate, or nonspecific, immune system react to?

100/100

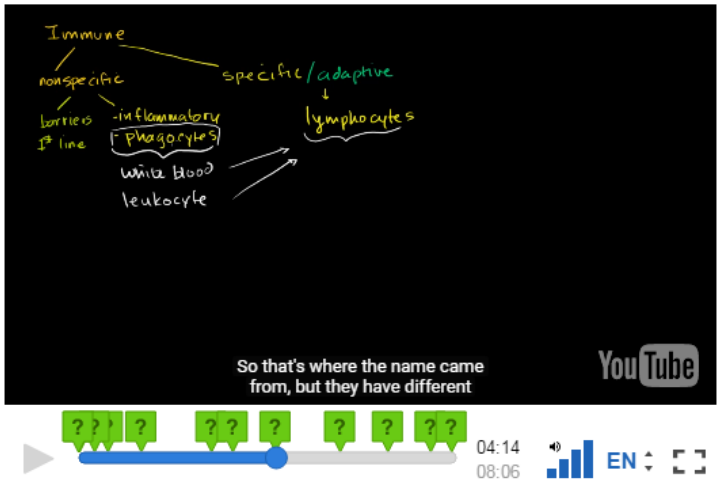
- ☐ Viruses
- → ☑ All of the above, because it's only looking for something that could be causing harm!
- ☐ Parasitic worms
- ☐ Bacteria

Continue



Antigen presenting cells are specific phagocytes that will "show" the adaptive immune system the pieces of invaders so that they can create cells specific to that invader.

Continue

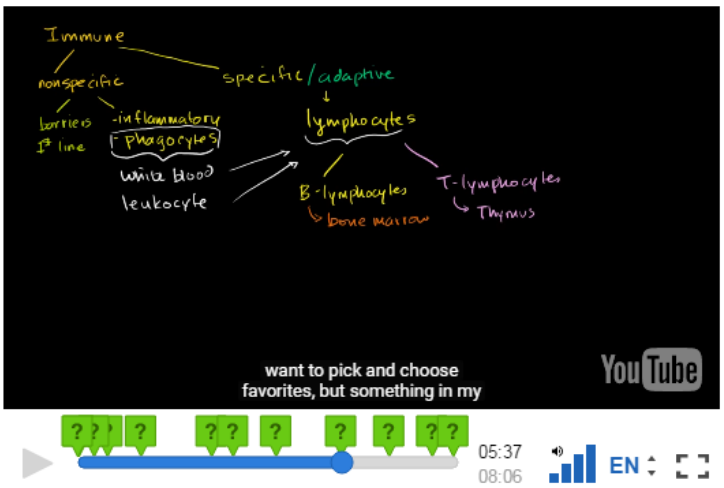


Which of the following are white blood cells associated with?

100/100

- ☐ Neither innate nor adaptive immunity
- ☐ The specific immune response (adaptive immunity)
- → ☑ Both innate and adaptive immunity
- ☐ The nonspecific immune response (innate immunity)

Continue

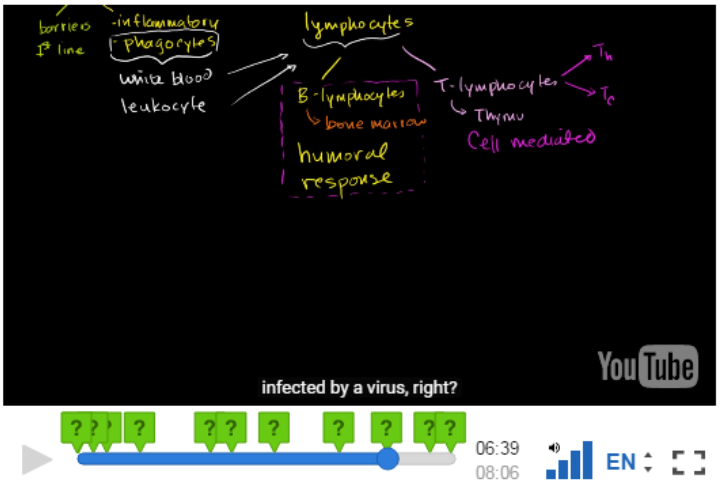


Where are T lymphocytes first created?

100/100

- ☐ Thymus
- ☐ Neither
- → ☑ Bone marrow

Continue



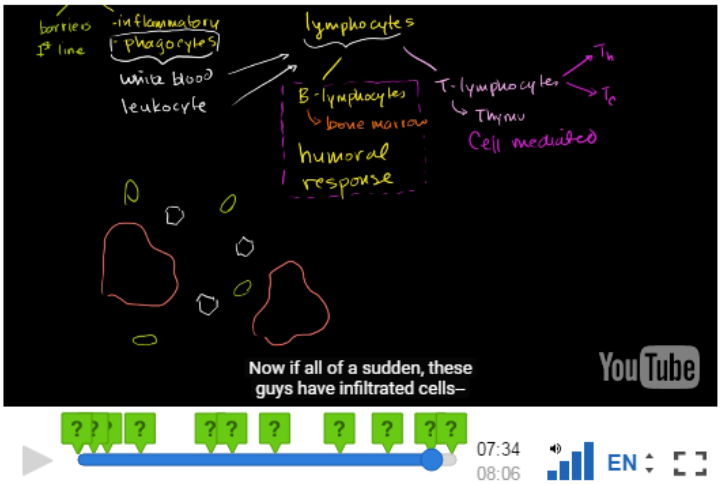
How ar the cell mediated and humoral responses related?

100/100

- ☐ Cell mediated will stop the humoral response once you're no longer infected
- ➔ ☑ Cell mediated will help to increase the humoral response
- ☐ Cell mediated happens after humoral, always
- ☐ Cell mediated happens before humoral, always

Continue

Types of immune responses: Innate and adaptive, humoral vs. cell-mediated | NCLEX-RN | Khan Academy

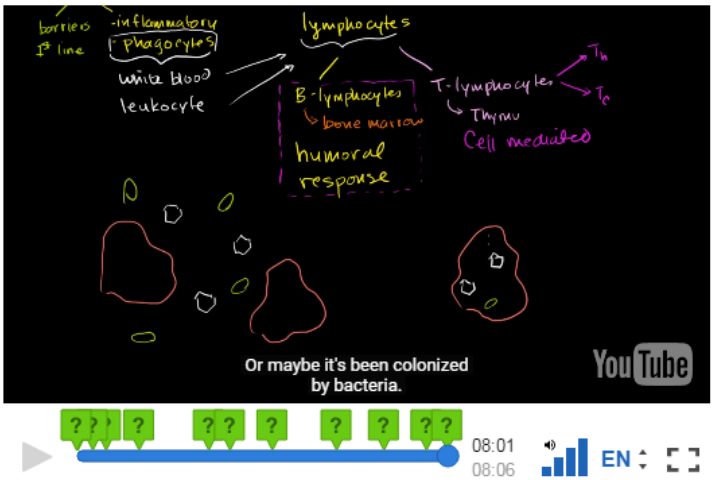


True or false:
The viruses and bacteria in the video may also be acted upon by the nonspecific immune system, as well as being acted on by the humoral response

100/100

- ➔ ☑ True
- ☐ False

Continue



T cells in the cell mediated response and certain cells that are nonspecific will be able to kill the cells that have been infected by viruses or bacteria.

Continue

Student: _____
Game:_____

Immunology Game Review Grade Sheet

Directions					
5 Directions are clear and to the point. Handouts provided for all participants in the game. Sections of directions are well organized and labeled.	**4** Directions should be edited slightly for clarity. Other parts (see 5) present.	**3** Directions provided but require more organization and/or edits for clarity.	**2** Directions provided, but they are not very clear or are not organized in a way that makes them easy to follow.	**1** Directions provided, but they are unclear and unable to be used to play the created game.	**0** NOT DONE
Pieces					
5 Pieces required to play the game are well-made (sturdy, clear, etc) and clearly different from other portions of the game.	**4** Pieces may need to be more clearly different from other pieces or may need to be edited a little.	**3** Pieces are given, but they are made rather flimsy or are messy.	**2** Pieces provided, but are not made in a way that makes the game able to be easily played multiple times	**1** Pieces provided but are messy, not reusable, and hard to differentiate from each other	**0** NOT DONE
Addresses each of the following topics: (*= must have 2/4)					
*Overview of parts of the immune system that are involved**					
5 Various pieces of the immune system are used, covering all aspects discussed in class.		**3** Not all aspects discussed in class are addressed properly, others are addressed in depth.	**1** General topics are mentioned, but fail to be expanded upon sufficiently.		**0** NOT DONE
*Innate immune reaction**					
5 Innate immunity addressed as part of the game in depth (ex: cells, inflammation, etc.)		**3** Parts of innate immunity addressed in depth, others only briefly.	**1** General topics are mentioned, but fail to be expanded upon sufficiently.		**0** NOT DONE
*Adaptive: Cell-mediated response**					
5 Cell-mediated response addressed in depth as part of the game (different T cell responses and functions, etc).		**3** Parts of cell-mediated response addressed in depth, others only briefly.	**1** General topics are mentioned, but fail to be expanded upon sufficiently.		**0** NOT DONE
*Adaptive: Humoral response**					
5 Humoral response addressed in depth as part of the game (B cell types, antibody functions, etc.).		**3** Parts of humoral response addressed in depth, others only briefly.	**1** General topics are mentioned, but fail to be expanded upon sufficiently.		**0** NOT DONE
Progression of a particular disease or situation from initial stage to late stages					
5 Progression of chosen situation from early to late are both expanded on in depth in game.		**3** Initial or late stage reaction addressed in depth, other only briefly.	**1** General topics are mentioned, but fail to be expanded upon sufficiently.		**0** NOT DONE
Creativity/class work/effort apparent					
5 Students worked well during class and effort is apparent in their final product		**3** Final product is well made, but students did not put work in during class time when instructed.	**1** Students did not focus during class time and final product is not well made.		**0** NOT DONE
+3 **Won the "Game Day" votes**					
TOTAL POSSIBLE POINTS:	**30**				

Name: _____ Date: _____ Pd: _____
Allied Health Potts

Immune System Quiz 1 Review

1. Fill in the blank with which term is being described by each sentence below.
    a. Molecules made in response to antigens that are specific to that particular pathogen and signal other functions of the immune response: _____antibodies_____
    b. Colorless, water liquid from fluid leaked out of blood vessels: _____lymph_____
    c. Any material that can evoke an immune response: _____antigen_____
    d. The system in the body that will protect us from foreign invaders by mounting an immune response: _____immune system_____
    e. When the immune system attacks "self" tissues; the immune system thinks your tissues are dangerous: _____autoimmunity_____
    f. A product of the adaptive immune response and another word for "antibody": _____immunoglobulin_____
    g. Areas around the body where specific immune interactions are developed: _____lymph nodes_____
    h. State of protection against harmful effects of exposure to pathogens: _____immunity_____
2. Describe the four features of the vertebrate immune system. Give a generalized description as well as examples of how the features are achieved in humans.

    Specificity – tell the difference between very similar things (by making lots of cells)
    Diversity – can recognize lots of different things (by making lots of cells)
    Memory – can remember specific invaders and protect against them faster/better (make specific things)
    Tolerance – do not react to self (kill things during development)

3. Flow chart practice:
    a. List the CELLS of the innate immune response.

        Monocytes, macrophages, eosinophils, neutrophils, mast cells, basophils, NK cells

    b. List the CELLS of the adaptive immune response.

        B cells (memory cells and plasma cells), T cells (helper T cell, memory Th cells, Cytotoxic T cells, memory Tc cells, Regulatory T cells)

c. Explain why dendritic cells are important in connecting the innate and adaptive immune response.

Dendritic cells are the main antigen presenting cells

d. What types of cells are phagocytes?

Macrophages, neutrophils, dendritic cells, eosinophils (limited), B cells (limited)

e. What two things might phagocytes do?

Kill the invader or present to T cells

f. How are basophils, eosinophils, and mast cells related?

All function for the allergic response

g. How are NK cells and cytotoxic T cells related?

They both kill virally infected cells and tumors

h. What parts of the immune system contribute to inflammation?

Neutrophils, macrophages, basophils, mast cells, complement activation

i. Where do plasma cells come from? What do they do?

B cells and they secrete antibodies

j. What are the two kinds of T cells? How do you tell the difference?

Helper and cytotoxic (regulatory is another). Tell difference because of either CD4 or CD8 on the cell surface.

k. What is the relationship between B cells and helper T cells?

Helper T cells bind and release cytokines to activate B cells and turn them into plasma or memory cells.

4. Summarize the three main lines of defense.

First = external/physical barriers (such as skin)
Second = innate immunity (nonspecific)
Third = adaptive immunity (specific)

5. Describe how skin and mucous membranes are similar and different when defending against pathogens.

   Both are physical barriers, but while skin is tightly packed, dry, and thick, mucous membranes are thin, moist, and easier for pathogens to gain entry through

6. List the two chemical defenses discussed in class. Describe or give an example of one.

   Low pH – gastric secretions that kill pathogens
   Enzymes – things like lysozyme that will attack microbes

7. Compare and contrast the innate and adaptive immune response in terms of specificity and reaction time.

   Innate = fast but nonspecific
   Adaptive = slow/takes longer but specific

8. Why are both the innate and adaptive immune response important to our defense?

   Innate protects while the adaptive develops. They will both react with each other back and forth for an effective immune response to kill a pathogen.

9. Describe how the circulatory and lymphatic system work together to allow the organs of the immune system to function properly.

   Circulatory exerts pressure that causes fluid to leak from vessels to cells. This fluid collects pathogens/antigens from the environment and is collected into the lymphatic vessels. The lymph travels to the lymph nodes where an immune response is developed, then eventually back into the blood vessels of the circulatory system.

10. Summarize the role of bone marrow and the thymus in B and T cell generation and development.

    Bone marrow = B and T cell generation, B cell development
    Thymus = T cell development

11. What are the secondary lymphoid organs? Why are they important?

    Lymph nodes and spleen, and they are the locations that allow for adaptive immune responses to start

Name: _____ Date: _____ Pd: _____
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Immune Cells ID WS

**When a piece of information can apply to more than one cell, please list all applicable answers.

1. Found in the bone marrow and will not leave until fully developed. ___Hematopoietic stem cells,_____
_____B cells, basophils, mast cells, dendritic cells, eosinophils, neutrophils, monocytes, NK cells_____

2. After these phagocytize a pathogen, it will release chemicals that will trigger inflammation. _____
_____Macrophage_____

3. Sometimes these innate immune cells will travel to tissues from the blood, but sometimes there are residents in the tissues that will constantly survey the area for pathogens. _____
_____Macrophage_____

4. This is the PROFESSIONAL antigen-presenting cell… Most important one!!! ____Dendritic cell_____

5. Increase in amount of these is used to diagnose a non-specific bacterial infection. _____
_____Neutrophil_____

6. Help other responses or will directly kill cells, depending on the surface markers found on the mature version.
_____T cell_____

7. Major/main white blood cell of the immune response. _____Neutrophil_____

8. These will exit the blood to directly attack invading microbes in the tissues, but will not change when they do so. They are directed to the tissues because of chemical signals. _____
_____Neutrophil_____

9. Adaptive immune cell created and matured in the bone marrow. _____B cell_____

10. Acts as a phagocyte. _____Neutrophil, macrophage, dendritic cell, B cell, eosinophil_____
_____

11. Function in allergic response. _____Mast cell, basophil, eosinophil_____
_____

12. Link the innate and adaptive immune responses. _____Dendritic cell_____

13. Antigen-specific. _____B cell, T cell_____

14. These cells will release granules that contain chemicals to signal degranulation of other cells. ___Mast___

15. Helps defend against parasitic worms. _____Mast cell, basophil, eosinophil_____
_____

16. Recognize antigen from dendritic cells. _____T cell_____

17. Cell that travels and matures in the thymus. _____ T cell _____

18. Look like lymphocytes (because also from a common lymphoid progenitor), but are part of the innate immune response. ____NK cell_____

19. Function in antigen presentation (as an APC: antigen-presenting cell). _____ _____Dendritic cell, macrophage, B cell_____

20. Respond to signals from mast cells. _____Eosinophil, basophil_____ _____

21. Recognize and kill virally infected cells. _____ T cell, NK cell_____

22. May kill cells covered in antibodies, but NOT via phagocytosis. _____NK cell_____

23. Job is to always sample their environment and show what they have found to other cells in case the immune system needs to respond. _____Dendritic cell_____

24. Mature forms are called plasma cells. _____B cell_____

25. Acts as a phagocyte only when the target pathogen is coated in antibodies. _____Eosinophil_____

26. Cells of adaptive immunity. _____B cell, T cell_____

27. Will mature into macrophages once they leave the blood. _____Monocytes_____

28. Cells that will give rise to the many different types of cells. _____ _____Hematopoietic stem cells_____

29. Releases granules when stimulated. _____Mast cells, eosinophil, basophils (NK cells ok)_____ _____

30. When there is an infection, the number of this will increase significantly, beyond the roughly 50% it is normally found at. _____Neutrophil_____

31. Nonspecific in their immune response. _____Basophil, mast cell, eosinophil, neutrophil, macrophage,___ _____NK cell_____

32. Secretes antibodies _____B cell (plasma cell)_____

33. NOT white blood cells, but still part of the immune system! _____Dendritic cell_____

34. Granules will contain histamine. _____Mast cell_____

35. Develop memory. _____ B cell, T cell _____

Name: _____ Date: _____ Pd:_____

Allied Health Potts

Immune System Quiz 2 Review

Cells and Nonspecific Components of the Immune System

Directions:

Answer each of the questions in the space below

1. Describe each of the following:
   a. PRR - ____Pattern recognition receptor. Receptor on cells that binds to pathogen molecules____ _____(PAMPs)_____
   b. PAMP - ___Pathogen-associated molecular patterns. Parts of pathogens that are recognized____ _____by PRRs_____
   c. TLR - _____Toll-like receptors. Special PRRs found on phagocytes._____ _____
   d. IL - _____Interleukin. Cytokine that allows WBCs to communicate with each other_____ _____
   e. IFN - ____Interferon. Cytokine produced against viruses._____ _____ _____

2. Use three of the terms above to describe how a neutrophil OR macrophage will react to an infection.

_____Various responses._____
_____Ex: Macrophages have TLRs, a special type of PRR on their cell surface to recognize PAMPs and_____
_____phagocytize pathogens._____
_____

3. What is complement?

_____Proteins that directly affect pathogens._____
_____

4. What are defensins/antimicrobial peptides?

_____Antimicrobial, nonspecific proteins against pathogens._____
_____

5. What are the three results of complement activation? Compare these to the effects of defensins.

_____Complement = punch holes in membrane _____
_____bind/coat pathogens _____
_____chemotactic signal/signal inflammation _____
_____
_____Defensins = kill/punch holes in pathogen_____
_____Act as enzymes_____
_____Call leukocytes to the area_____

6. Explain why PRRs are important for the innate immune response but not the adaptive.

They are nonspecific, but adaptive is specific.

7. Discuss the relationship between eosinophils, mast cells, and basophils. Make sure to discuss their common function as well as how they will interact with each other!

Mast signals eosinophil and basophil

All are for allergies/parasitic worms.

8. What is the unique function of NK cells?

Kill virally infected cells and tumors

9. Differentiate between B and T lymphocytes. How are they different? How are they similar?

B = secrete antibodies Both = specific memory

generated and developed in bone marrow

T = helper and cytotoxic functions

generated in bone marrow, developed in thymus

10. How does inflammation relate to monocytes and cytokines? Be specific about what happens and about the type of cytokine!

Monocytes called to the area by cytokines (chemokines)

Turn into macrophages that release cytokines that turn on inflammation

11. Relate complement activation to macrophages.

One function is to coat pathogens and increase uptake by macrophages and neutrophils

12. Will dendritic cells respond to PAMPs? Why or why not?

Yes! (TLRs bind to PAMPs)

Need to phagocytize in order to break down the general thing and show it to the specific response (present antigen)

13. List the five types of cytokines discussed in class. Describe two of them.

Chemokines → attract cells to an area
Interleukins → Signals between WBCs
Interferons → Nonspecific antiviral proteins
Growth factors (no description given/needed)
Tumor necrosis factor (no description given/needed)

14. Fill out the following table about the cells of the immune response. Put a check where appropriate.

	Neutrophil	Macrophage (monocyte)	Eosinophil	Basophil	Mast cell	NK cell	B cell	T cell	Dendritic cell
Innate	X	X	X	X	X	X			X
Adaptive							X	X	
Related to innate AND adaptive									X
Phagocyte	X	X	X				X		X
Can create memory							X	X	
Professional	X	X							X
Antigen presenting cell		X					X		X
Allergic response			X	X	X		X	X	X
Has PRRs	X	X	X	X	X	X			X
Will respond to PAMPs	X	X	X	X	X	X			X
Probably has TLRs	X	X	X						
Produces IL	X	X	X	X	X	X	X	X	X
Responds to chemokines	X	X	X	X	X	X	X	X	X
Related to complement activation		X					X		
Creates antimicrobial peptides	X								

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Innate Immunity Review

1. What is the purpose of opsonization? What are opsonins (generally) and what can act as an opsonin?

Purpose = Increases the ability of phagocytes to bind to and therefore ingest microorganism. This is because opsonization increases the number of places on the microbe the phagocytic cell can bind to.

Opsonins = Proteins that coat the microbes.

Complement and antibodies can act as opsonins.

2. Why is fever not always bad (what beneficial effects does it have on the body)?

Increases neutrophils from bone marrow

Environment is too hot for microbes to survive

Increased temperature acts as a catalyst for immune reactions

3. List the major cytokine functions discussed in class (5).

Activate immune cells

Increase macrophage and neutrophil phagocytosis

Activate complement

Set up antiviral defenses (interferons)

Signal to adaptive immune cells to start differentiating

4. How are interferons beneficial to infections by more than one type of virus? How are interferons harmful to us?

Beneficial: act generally/nonspecifically, so one virus can activate and it will act against others

Harmful: causes the negative feelings/symptoms associated with infection (fever, headaches, chills, aches, etc.).

5. Relate interferons to innate immune cells. Be specific about where they come from and what they do (if it was discussed in class).

IFN is made by dendritic cells → activate NK cells → NK cells make more IFN → activate more NK cells and also activate macrophages to be better at killing things they've ingested

6. Describe how complement will proceed once activated (what happens to the proteins).

Cascade of reactions that cleaves proteins over and over into smaller pieces until they are what they need to be to have the results of activation

7. What are the three results of complement activation? Use terms and define them!

MAC: membrane attack complex → Make pores in the pathogen's membrane

Opsonization (see question 1)

Chemotactic cues (call other cells over) and trigger inflammation

8. Describe the three ways that neutrophils can kill microbes.

Phagocytosis: Eat and break down pathogen

Release chemicals to directly kill pathogens (similar to bleach)

Release proteins that will create nets around pathogens so they cannot move away from other cells

9. Explain how macrophages will "raise the alarm" when you have an infection.

Once they phagocytize an invader, the macrophages will release chemicals that will start the inflammatory response. These include chemokines to call other cells over as well as cytokines that dilate and increase permeability of blood vessels, which makes it easier to get everything needed to fight the pathogens in one place.

10. How do macrophages relate (specifically!) to what happens during inflammation? Discuss cytokines and their effects, when applicable.

Chemokines will call other cells to the area

Cytokines will dilate blood vessels (slowing down blood flow to allow cells to respond easier) and increase permeability of blood vessels (which will make it easier for cells to squeeze through to get to where they need to be)

11. How are NK cells signaled to kill a cell? There is more than one way, so make sure you list both!

Bind to cells with inhibitory and activating receptors. When the cell is "okay" it will show the inhibitory receptor, but if the cell is infected with a virus it will not show that receptor and only the activating receptor will be available to signal the NK cell. This results in the NK cell killing the cell that isn't saying "I'm okay!"

ADCC: NK cells will connect to antibodies on the surfaces of cells that activates them to kill that cell.

12. What are perforin and grazes? Where do they come from and what do they do?

Enzymes released in the granules from NK cells

Perforin: poke holes in the membrane

Granzyme: digest the cell and trigger it to kill itself so that it limits damage and inflammation

13. How are mast cells related to the overall inflammatory response? Explain both the effects they have on parts of the body and also how they will communicate with other cells (which ones?) and what this does for you.

Mast cells release histamine.

Histamine increases permeability of blood vessels (like macrophages) to let cells squeeze through more easily.

Call to basophils and eosinophils, which contribute to inflammation or directly kill certain types of pathogens

14. Contrast acute and chronic inflammation.

Acute is fast and generally beneficial

Chronic is long-lasting and results in disease/damage to tissues. It's generally a result of loss of control of the inflammatory response (could be because of autoimmune disease due to improper functioning of the adaptive immune response)

15. What are the four "classic" characteristics of inflammation? Explain on a cellular level how they occur.

Redness – due to vasodilation

Swelling (edema) – due to loss of fluid from increased permeability of blood vessels

Heat – due to vasodilation

Pain – due to chemicals made by immune cells called to the area that stimulates nerves

16. How and why do cells in blood vessels move out into infected tissue?

Cells move there as a result of chemokines calling them to the area in order to fight the pathogens that have infected the tissue. They get here because they squeeze through blood vessels (following the gradient of chemokines created by other cells). They can squeeze through because chemicals increase permeability of the vessels, causing the cells of the blood vessel walls to "loosen" and let the immune cells through.

17. Summarize inflammation. Be pretty general, but do not just copy the flow chart (more info than that)!

Macrophages (or mast cells) encounter a pathogen and release chemokines and cytokines as a result (macrophages due to phagocytosis, mast cells due to release of histamine).

Chemicals cause vasodilation (bring more blood cells to the area) and increased permeability of blood vessels (loosen the cells of the blood vessel walls), allowing cells to get to the area and then squeeze through into the tissue where the infection is. These are mostly neutrophils.

Phagocytosis clears infection, adaptive immune response is signaled, and blood clotting and healing occurs to "fix" the initial problem that caused the inflammatory response to begin.

18. How do the innate and the adaptive immune response work together to defend you? Be as specific as possible, using terms discussed in class!

Macrophages may present antigen to T cells

ADCC as a result of antibodies that are made by B cells (signaling to NK cells)

Antibodies made by B cells can act as opsonins to increase phagocytosis

Cytokines may activate both innate and adaptive cells

Name: FILL THIS IN

15 points
(16 possible)

Inflammation Video Question Worksheet

Directions:

- Fill in your name at the top and then save this document in a place on your Drive that you can find it again easily.
- Go to https://www.khanacademy.org/science/health-and-medicine/human-anatomy-and-physiology/introduction-to-immunology/v/inflammatory-response
- Using headphones, watch the video and type in your answers to each question below (I put bullets in for you to for organization, but you can remove them and answer it in any format you feel is most organized).
- Submit the file to Classroom by the due date.

Questions:

1. What are the four main characteristics of the inflammatory response (inflammation)?
    - FILL

2. What is meant by calling the inflammatory response the “field of battle”?
    - FILL

3. Where do dendritic cells “hang out”? Why might they be in this location?
    - FILL

4. What is interstitial fluid? How does this relate to capillaries/the circulatory system?
    - FILL

5. What are endothelial cells?
    - FILL

6. In the example in the video, where do the chemokines come from? Note this answer should be different from what was discussed in class.
    - FILL

7. What does the word “chemokine” mean?
    - FILL

8. What are the three ways mentioned that mast cells could be activated?
    - FILL

9. How does histamine relate to the inflammatory response? What general effects does it have related to how you feel during cold season?
    - FILL

10. Discuss the effect histamine has on endothelial cells. Why is this effect important to the inflammatory response?
    - FILL

11. Describe the changes in the nearby blood vessels and which of the four characteristics of inflammation that this leads to.
    - FILL

12. What role do neutrophils play? How do they know where to go?
    - FILL

13. Describe the following:
    a. Marginization - FILL
    b. Diapedesis - FILL
    c. Extravasation - FILL

14. What other kinds of cells (other than neutrophils) will be called to the area to fight the infection?
    - FILL

15. What fights an infection other than cells? Describe this.
    - FILL

16. What is exudate? What do you see as a result of it (look at the four characteristics of inflammation!)?
    - FILL

Grading:
1 point for each question
15 points
Any 1 question left blank is okay (free question)

Name: _____ Date:_____ Pd:_____
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Overview of the Adaptive Immune System Review

1. Describe the movement of cells of the adaptive immune throughout the body (where are they circulating?).

   Circulate between the blood stream and lymphoid organs

2. How is the lymph node structured to encourage a successful adaptive immune response?

   T and B cells will closely meet with each other and be able to interact

3. What is the purpose (or result) of dendritic cells processing self-antigen (parts of our own cells)?

   Nothing occurs (doesn't activate T cells)

4. What does a humoral response react to in the body? What kinds of cells are associated with humoral immunity?

   Things floating around rather than things in cells
   Cells = B cells

5. What does a cell-mediated response do for the body? What cells are associated with cell-mediated immunity?

   Aids the humoral response/adaptive response or deals with pathogens that have invaded cells
   Cells = Tcells

6. Describe the different types of T cells.

   Helper T cells = Th = activate and amplify the humoral response
   Cytotoxic T cells = Tc = kill virally infected cells and tumors
   Regulatory T cells = Treg = reverses action of adaptive cells

7. What are epitopes?

   Specific part of the antigen that the B or T cell is responding to

8. How will B and T cells respond to antigen differently?

   B cells respond to the whole antigen (whole pathogen) while T cells respond to pieces bound to MHC

9. Where are the two types of MHC found? What are they each recognized by?

   Class I – Found on all nucleated cells, recognized by cytotoxic T cells
   Class II – Found on antigen presenting cells, recognized by helper T cells

10. How does the MHC relate to how T cells respond to antigen? Why are they necessary?

    MHC is an antigen presenting protein that will take a piece of the original pathogen and move it to the surface of an antigen presenting cell (in the case of MHC II) or any nucleated cell (in the case of MHC I)

11. What process allows there to be such a large amount of diversity in the TCR and BCR that will be created in our immune system?

    Genetic recombination

12. What is the purpose of clonal deletion?

    Get rid of any immune cells that will react to the host antigen

13. How does the MHC affect clonal deletion of T cells?

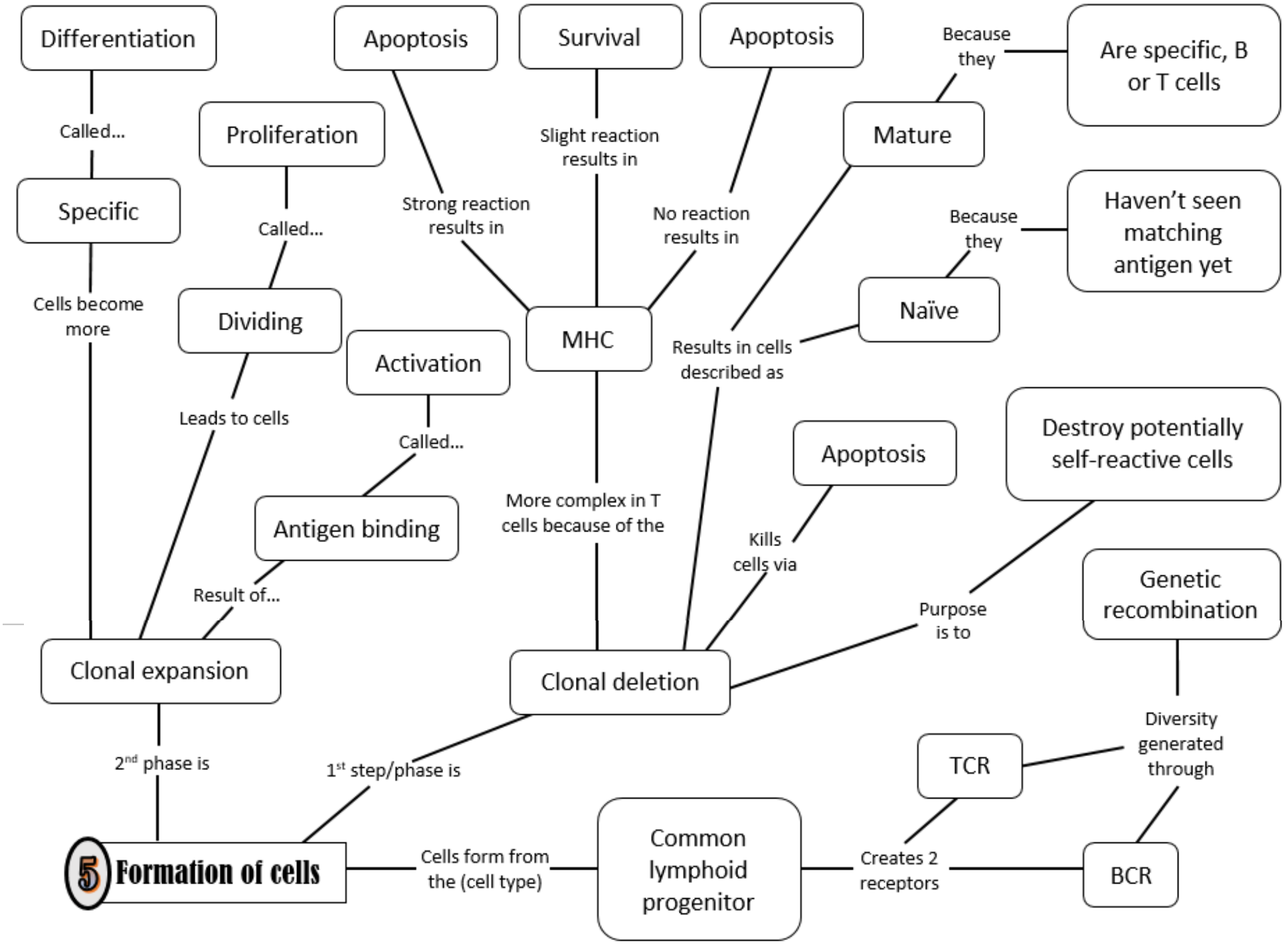
    Requires more processing because the body has to react to the MHC appropriately, too. No reaction is not good, and too strong a reaction is not good.

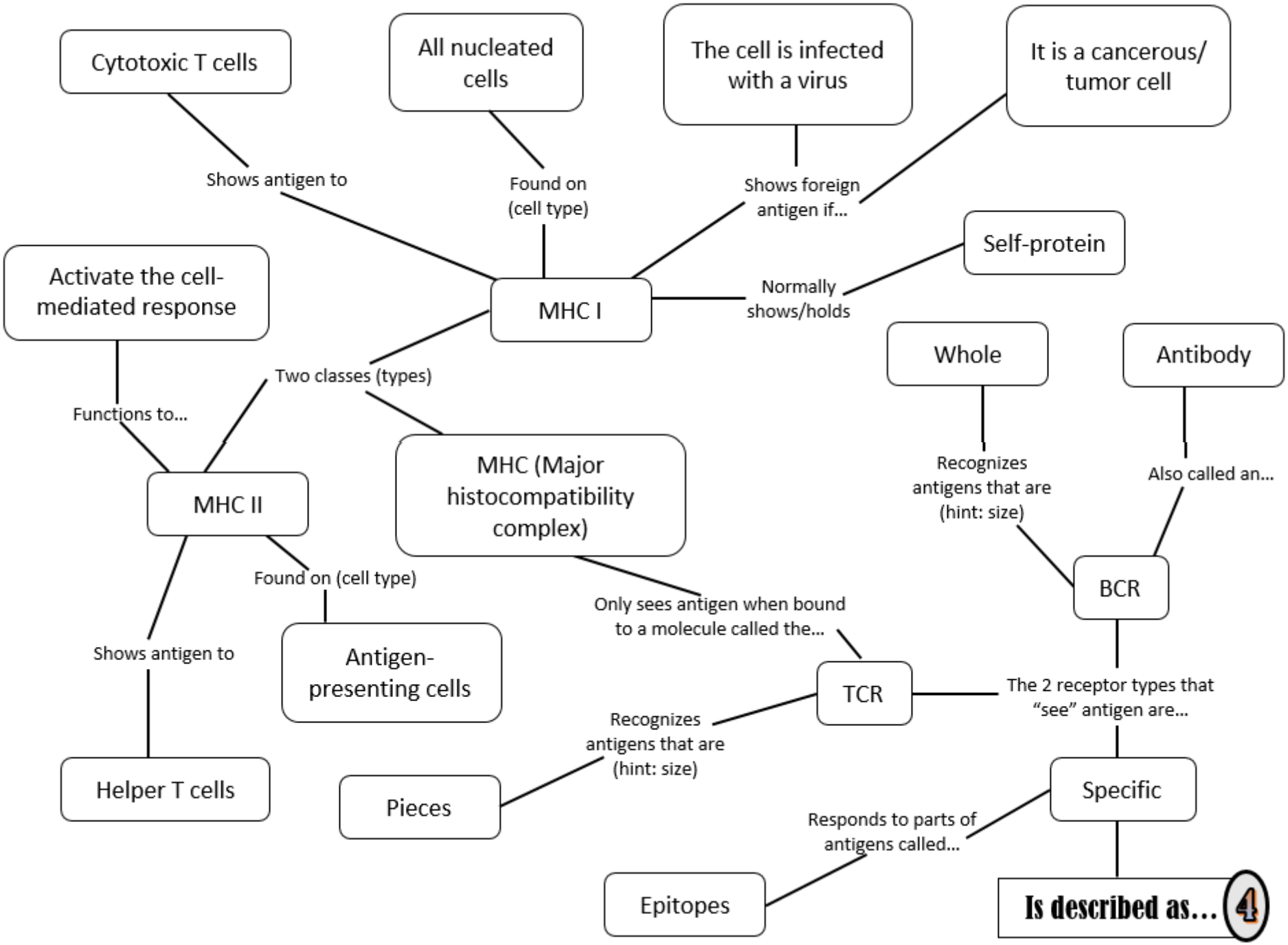
14. What is meant by a mature, naïve lymphocyte?

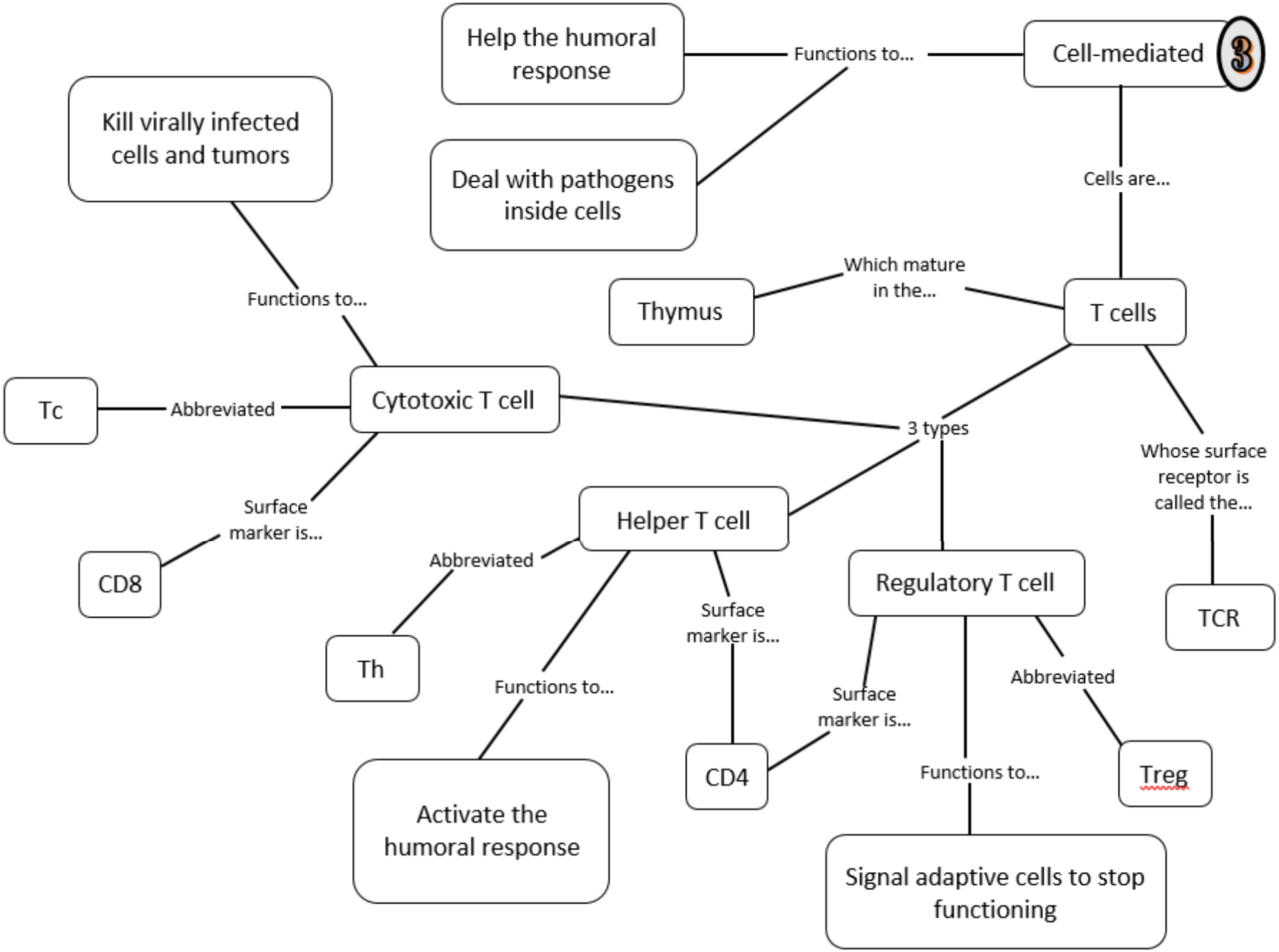
    Mature = they are specific for an antigen and won't react with self
    Naïve = they haven't encountered their antigen yet (they are not activated)

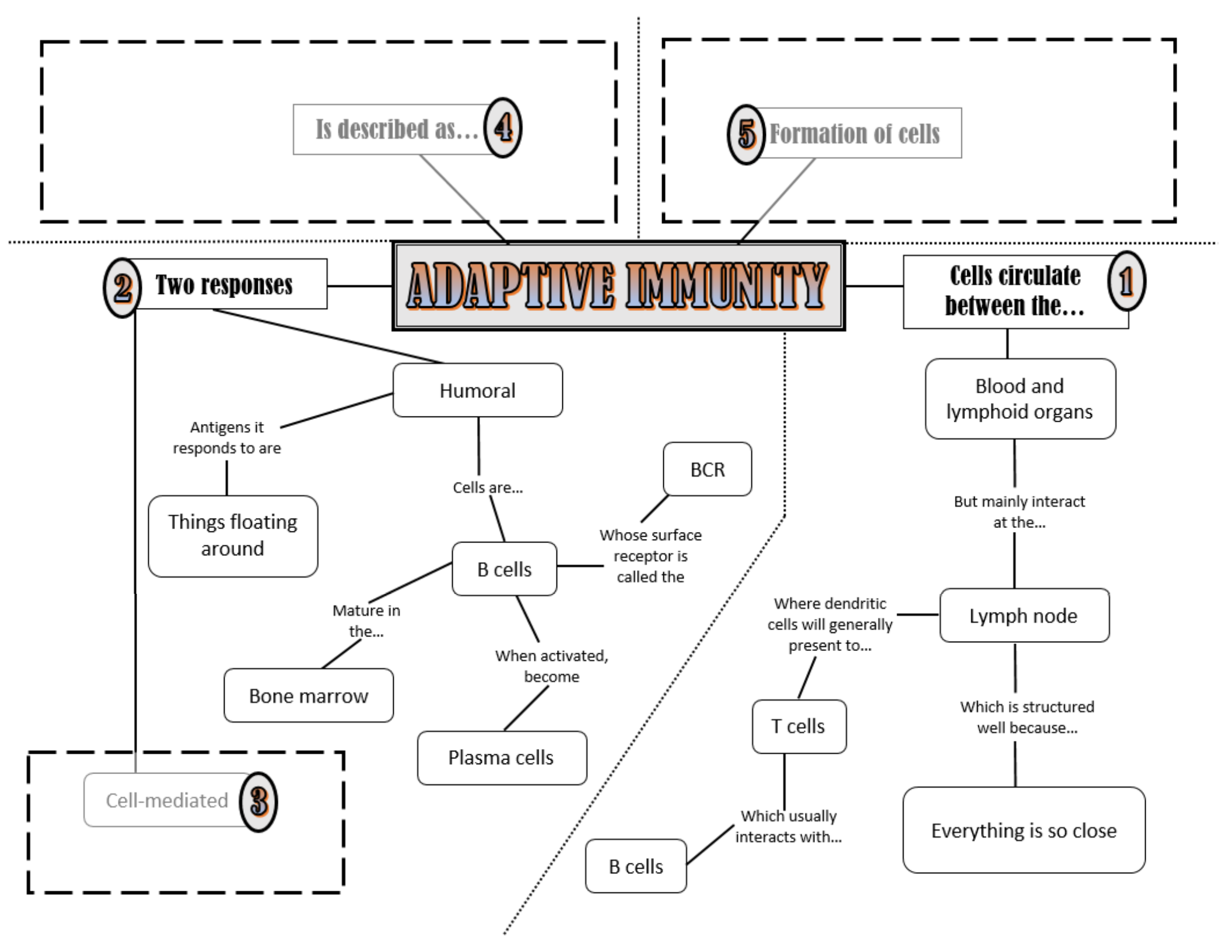
15. What occurs during clonal expansion? Why will this occur? Use the three terms discussed in class!

    Encounter antigen (*activate*) and cells will start dividing (*proliferate*) and their functions will become more specific (*differentiate*)


5 Formation of cells
Cells form from the (cell type)
Common lymphoid progenitor
Creates 2 receptors
TCR
BCR
Diversity generated through
Genetic recombination
1st step/phase is
2nd phase is
Clonal deletion
Clonal expansion
Purpose is to
Destroy potentially self-reactive cells
Kills cells via
Apoptosis
More complex in T cells because of the
Result of...
Antigen binding
Called...
Activation
Leads to cells
Dividing
Called...
Proliferation
Cells become more
Specific
Called...
Differentiation
MHC
Strong reaction results in
Slight reaction results in
No reaction results in
Apoptosis
Survival
Apoptosis
Results in cells described as
Naïve
Because they
Haven't seen matching antigen yet
Mature
Because they
Are specific, B or T cells


Cytotoxic T cells
All nucleated cells
The cell is infected with a virus
It is a cancerous/ tumor cell
Shows antigen to
Found on (cell type)
Shows foreign antigen if…
Self-protein
Activate the cell-mediated response
MHC I
Normally shows/holds
Whole
Antibody
Two classes (types)
Functions to…
MHC II
MHC (Major histocompatibility complex)
Recognizes antigens that are (hint: size)
Also called an…
BCR
Found on (cell type)
Only sees antigen when bound to a molecule called the…
Shows antigen to
Antigen-presenting cells
TCR
The 2 receptor types that "see" antigen are…
Recognizes antigens that are (hint: size)
Helper T cells
Pieces
Specific
Responds to parts of antigens called…
Epitopes
Is described as… 4


Cell-mediated
3
Functions to...
Help the humoral response
Deal with pathogens inside cells
Cells are...
T cells
Which mature in the...
Thymus
3 types
Cytotoxic T cell
Functions to...
Kill virally infected cells and tumors
Tc
Abbreviated
Surface marker is...
CD8
Helper T cell
Abbreviated
Th
Functions to...
Activate the humoral response
Surface marker is...
CD4
Regulatory T cell
Surface marker is...
Functions to...
Signal adaptive cells to stop functioning
Abbreviated
Treg
Whose surface receptor is called the...
TCR


ADAPTIVE IMMUNITY
1
Cells circulate between the…
Blood and lymphoid organs
But mainly interact at the…
Lymph node
Which is structured well because…
Everything is so close
Where dendritic cells will generally present to…
T cells
Which usually interacts with…
B cells
2
Two responses
Humoral
Antigens it responds to are
Things floating around
Cells are…
B cells
BCR
Whose surface receptor is called the
Mature in the…
Bone marrow
When activated, become
Plasma cells
Cell-mediated
3
4
Is described as…
5
Formation of cells

Create Your Own Antibodies!

30 points
(30 possible)

Pre-Lab Questions:

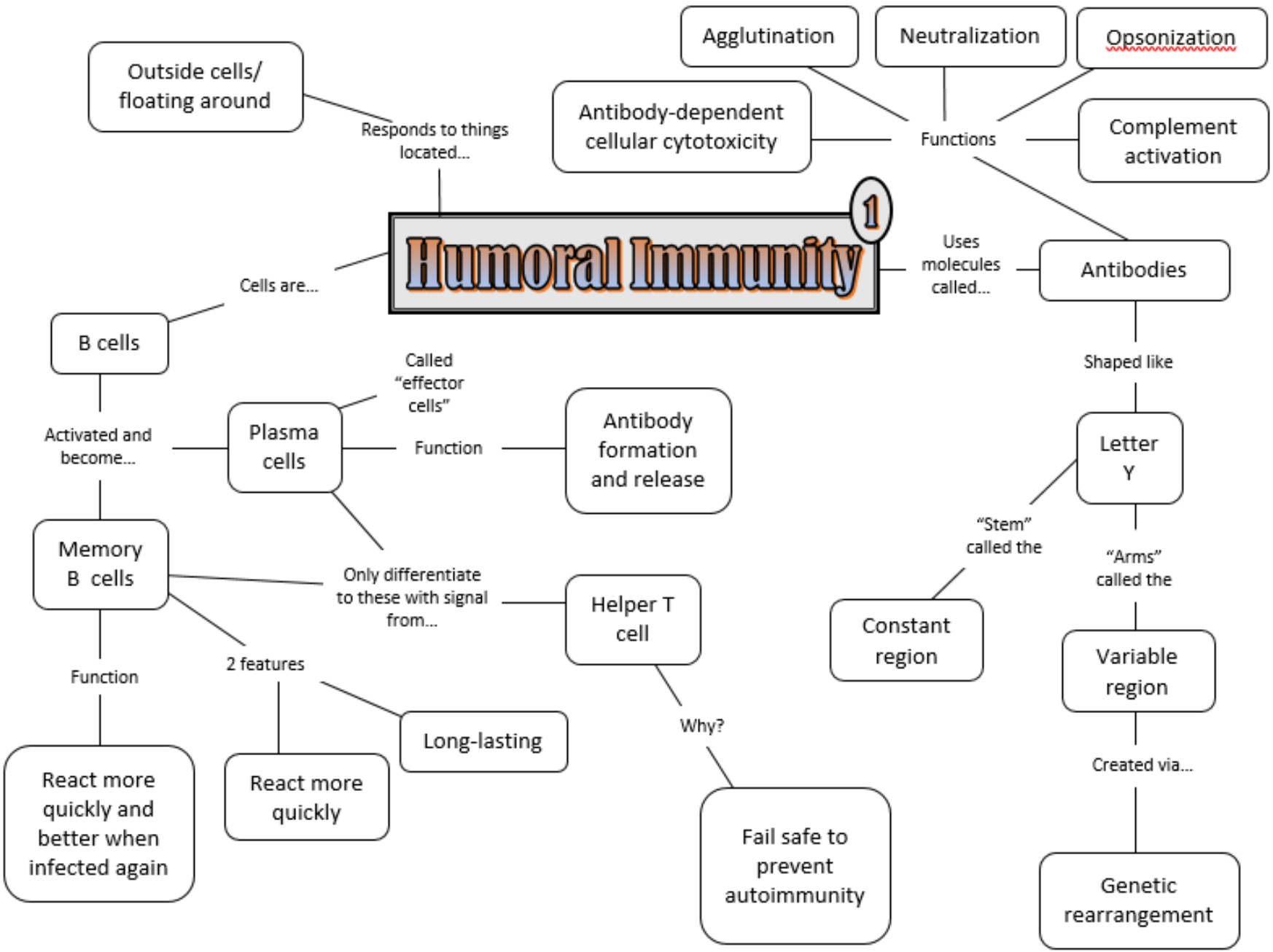
These answers will be uploaded to turnitin.com.

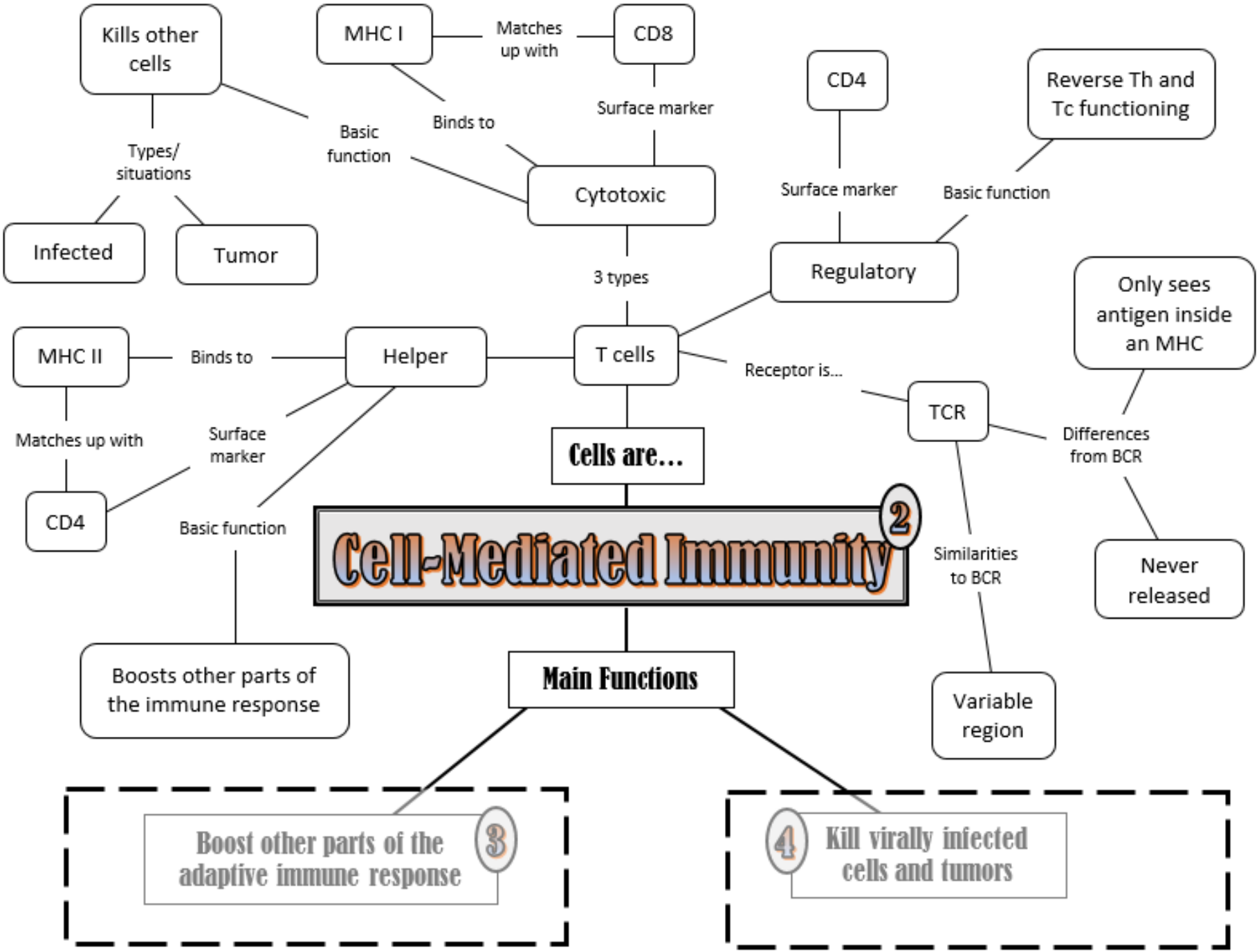
1. Define the following terms in your own words:
    a. Antibody – specific proteins produced in response to a specific antigen (various accepted) [1 pt]
    b. Antigen – any substance that can induce an immune response [1 pt]
    c. Activation – when a B cell meets up with its matching antigen [1 pt]
2. Describe the structure of an antibody. Make sure to reference the different types of chains as well as the shape and variable region.
    a. Y shape [1 pt]
    b. Changes between different antibody isotypes (constant region doesn't) [2 pts]
    c. Each antibody has 2 heavy and 2 light chains [2 pts]
3. Refer to Figures 1 and 2. Each arm shown in Figure 1 is able to bind one antigen. How many antigens can each antibody in Figure 2 bind?
    a. IGM = 10; IgG = 2; IgA = 4; IgD = 2; IgE 2 [3 pts]

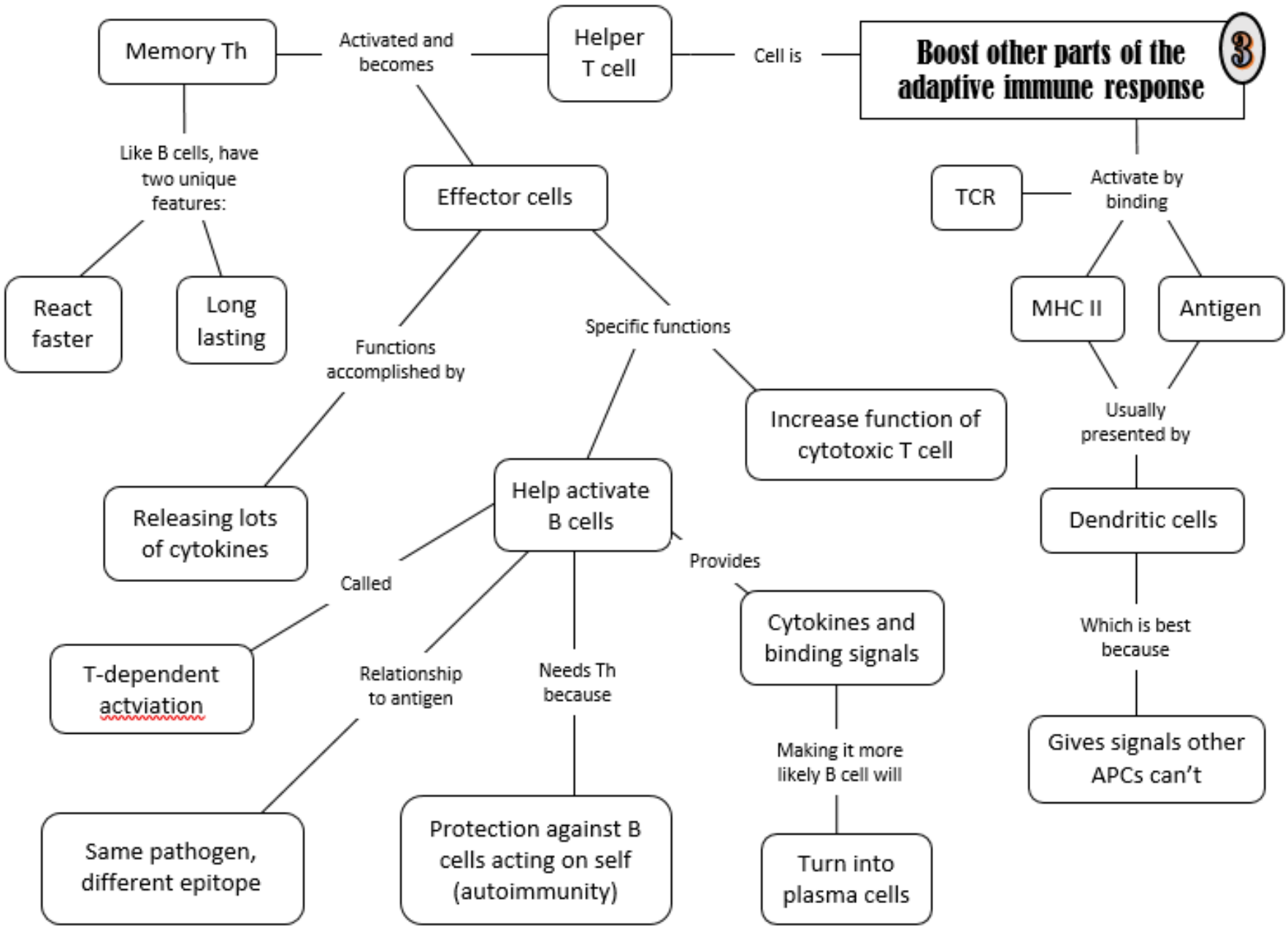
Post-Lab Questions:

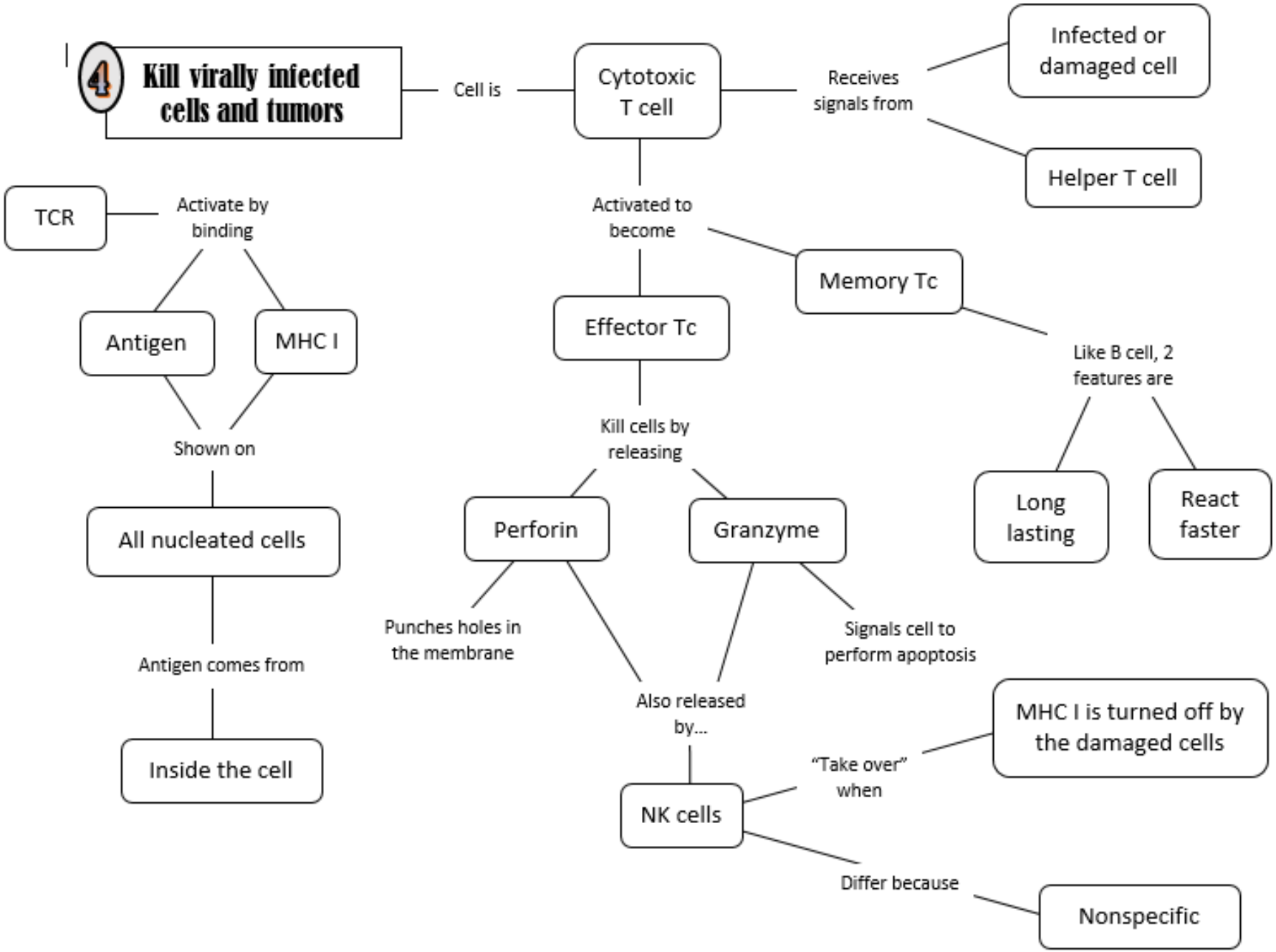
These answers will need to be uploaded to turnitin.com. Where applicable, create table and insert images.

1. List your chosen heavy and light chain variable regions.
    a. HC # [1 pt]
    b. LC # [1 pt]
2. Paste the (completed) model antibody that you constructed onto a blank sheet of paper. Label your heavy and light chain numbers.
    a. Separate sheet of paper with antibody put together and labeled appropriately. [3 pts]
3. Did the antibody "fit" or bind with any of the suspect antigens? If so, paste the bound antibody-antigen complex to show the "fit" and describe the shape of the fit. If your antibody did NOT fit, please paste any antigen that does not "fit", showing why the "fit" did not work and writing in a brief explanation.
    a. If it fit, what did it fit with (if not, what is it not fitting with) [2 pts]
    b. Description of fit [1 pts]
4. Describe the life cycle of a B cell for the following situations:
    a. The B cell has an antibody that matched/was able to bind with an antigen
        i. Mention activate, proliferate, differentiate [3 pts]
        ii. Turns into plasma or memory cell [1 pts]
    b. The B cell has an antibody that did NOT match/couldn't bind with an antigen
        i. Nothing happens [1 pt]
5. Sarah had chicken pox at age 8. Five years later, her brother Ryan also contracted chicken pox. Why is Sarah not at risk of getting chicken pox again?
    a. Memory cells were created [2 pts]
    b. Describe memory cells as reacting to same pathogen faster and more effectively [1 pt]
6. Why do some vaccinations require boosters after a certain amount of time to maintain immunity whereas others require only one initial dose of the vaccine? Look this up and indicate your source in your response.
    a. Type of vaccine (attenuated vs. dead) →describe [2 pts]
    b. Source indicated [1 pt]


Humoral Immunity
1
Outside cells/ floating around
Responds to things located...
Cells are...
B cells
Activated and become...
Plasma cells
Called "effector cells"
Function
Antibody formation and release
Memory B cells
Only differentiate to these with signal from...
Helper T cell
Why?
Fail safe to prevent autoimmunity
Function
React more quickly and better when infected again
2 features
React more quickly
Long-lasting
Agglutination
Neutralization
Opsonization
Antibody-dependent cellular cytotoxicity
Functions
Complement activation
Uses molecules called...
Antibodies
Shaped like
Letter Y
"Stem" called the
Constant region
"Arms" called the
Variable region
Created via...
Genetic rearrangement


Kills other cells
MHC I
Matches up with
CD8
Types/ situations
Basic function
Binds to
Surface marker
Infected
Tumor
Cytotoxic
CD4
Reverse Th and Tc functioning
Surface marker
Basic function
3 types
Regulatory
Only sees antigen inside an MHC
MHC II
Binds to
Helper
T cells
Receptor is...
TCR
Differences from BCR
Matches up with
Surface marker
Cells are...
CD4
Basic function
Cell-Mediated Immunity 2
Similarities to BCR
Never released
Boosts other parts of the immune response
Main Functions
Variable region
Boost other parts of the adaptive immune response 3
4 Kill virally infected cells and tumors


Memory Th
Activated and becomes
Helper T cell
Cell is
Boost other parts of the adaptive immune response
3
Like B cells, have two unique features:
React faster
Long lasting
Effector cells
TCR
Activate by binding
MHC II
Antigen
Functions accomplished by
Releasing lots of cytokines
Specific functions
Increase function of cytotoxic T cell
Usually presented by
Dendritic cells
Help activate B cells
Called
T-dependent actviation
Relationship to antigen
Same pathogen, different epitope
Needs Th because
Protection against B cells acting on self (autoimmunity)
Provides
Cytokines and binding signals
Making it more likely B cell will
Turn into plasma cells
Which is best because
Gives signals other APCs can't


4
Kill virally infected cells and tumors
Cell is
Cytotoxic T cell
Receives signals from
Infected or damaged cell
Helper T cell
Activated to become
Memory Tc
Like B cell, 2 features are
Long lasting
React faster
Effector Tc
Kill cells by releasing
Perforin
Granzyme
Punches holes in the membrane
Signals cell to perform apoptosis
Also released by...
NK cells
"Take over" when
MHC I is turned off by the damaged cells
Differ because
Nonspecific
TCR
Activate by binding
Antigen
MHC I
Shown on
All nucleated cells
Antigen comes from
Inside the cell

AIDS Simutest

40 points
(39 possible)

Pre-Lab Questions:

Use the reading as well as other sources to answer the questions below. These answers will be uploaded to turnitin.com.

1. Describe/define the following terms:
    a. AIDS – Acquired Immunodeficiency Syndrome; the stage of the disease when characteristic symptoms appear, and CD4+ T cell counts drop. [1 pt]
    b. HIV – Human Immunodeficiency Virus, a retrovirus (lentivirus) that causes AIDS. [1 pt]
    c. ELISA – Enzyme-Linked Immunosorbant Assay, an assay which is used to test for the presence of HIV. [1 pt]
    d. Opportunistic infection – An infection by a pathogen (virus, bacteria, fungus, etc.) to which a healthy body would normally be resistant, but a person with AIDS would be susceptible. [1 pt]

2. Name one opportunistic infection that is associated with AIDS and explain what it is.
    a. Various answers accepted. Examples include Kaposi's sarcoma or Pneumocystis carinii pneumonia. [1 pt]
    b. Brief description required (1-2 sentences describing the infection). [2 pts]

3. In the early 1980's, who started to develop AIDS while the transmission of the disease was being investigated?
    a. Hemophiliacs, recipients of blood transfusions, intravenous drug users, heterosexuals, babies born to mothers with the syndrome. [2 pts]

4. How many people died of AIDS in the United States by 1985? How many people in the US are estimated to be living with AIDS (as of 2013)?
    a. 6,000 [1 pt]
    b. 1.1 million [1 pt]

5. Describe the incubation/latency period that occurs before HIV leads to AIDS.
    a. On average, the incubation period is 10 years. [1 pt]
    b. No visible symptoms are during this time. [1 pt]

6. Why can HIV enter immune cells? Which cells is it targeting?
    a. A glycoprotein on its surface mimics an antigen the host identifies as "self." [1 pt]
    b. Targets CD4+ T cells [1 pt]

7. What trait is used to follow the progress of the disease? What marks the final phase of the illness?
    a. Amount of CD4+ T cells. [1 pt]
    b. Final phase marked by sharp drop in number. [1 pt]

8. What does the body's immune system produce in response to viral infections? How is this product used in the AIDS test? Briefly describe the ELISA test in order to adequately answer this question.
    a. Antibodies [1 pt]
    b. The antibody will bind to the viral antigen in the ELISA [1 pt]
    c. Second antibody with conjugate will bind [1 pt]
    d. Chromogen will have a color change indicating a positive test [1 pt]

9. Based on the biological sketches of the individuals that are being tested in the lab or HIV, which individuals do you think will test positive? Why? You may list and summarize your answers for this response.
    a. Answers will vary. Must have at least one person with reasoning. [2 pts]

Results:

This table will need to be recreated and uploaded to turnitin.com.

Table 1: ELISA Results

Use (+) to represent a result that is a shade of red.

++++ would be a deep red and + would be light red.

(pts for filling out each row)	1	2	3	4	5	6	7	8
[1 pt]**A**	-	-	-	-	-	-	-	-
[1 pt]**B**	-	-	-	-	-	-	-	-
[1 pt]**C**	-	-	-	-	-	-	-	-
[1 pt]**D**	++++	++++	+++	+++	++	++	++	++
[1 pt]**E**	-	-	-	-	-	-	-	-
[1 pt]**F**	++++	++++	+++	++	++	+	+	+
[1 pt]**G**	-	-	-	-	-	-	-	-
[1 pt]**H**	-	-	-	-	-	-	-	-

Post-Lab Questions:

These answers will need to be uploaded to turnitin.com. Where applicable, create table and insert images.

1. Based on your data from the lab experiment, who tested positive for HIV?
    a. Patient D (Ron K) [1 pt] and F (Jim C) [1 pt] are HIV positive.

2. Refer back to the biological sketches for the individuals who tested positive; what part of the patient's lifestyle most likely caused the person to contract the virus?
    a. Patient D (Ron K) – Most likely got the virus by having a one night stand with a girl he met at a party. Students may infer from the given information that Ron did not know the girl or her lifestyle. [1 pt]
    b. Patient F (Jim C) – Most likely got the virus because he is a homosexual who has had numerous relationships. Students may infer that this increases his risk of contracting the virus. [1 pt]

3. What kind of treatment options are available for patients who are diagnosed as HIV+? How effective are they? Make sure you indicate your source for this response.
    a. Combo of meds called antiretroviral therapy (ART). [2 pts]
    b. HIV cannot be eradicated from the body and ART regimes may be changed throughout a patient's life as a result of loss of effectiveness or side effects on the body. (Various answers acceptable). [2 pts]

Student Section

Rationale

This unit is designed to be relevant to students both in terms of the material covered as well as how it is covered. The purpose of covering this material is to introduce you, as students, to how the body protects itself from disease. This unit delves deeply into material to prepare you for further study in the sciences and to give you exposure to intricate material that you may experience in your future studies (after high school). It is also relevant as brief lesson on how the immune system functions in conjunction with vaccines to develop memory and understanding of vaccine benefit and safety. Material will be presented in a variety of ways in order to expose you to different learning material after high school and develop skills for success in science lectures in the future. This includes note outlines, online notes, and lectures where the notes are given and you will have to determine what is most relevant. The last portion of the unit will utilize the given notes, and is intended to most closely mimic the type of presentation that you will be exposed to when you begin to take science classes in college.

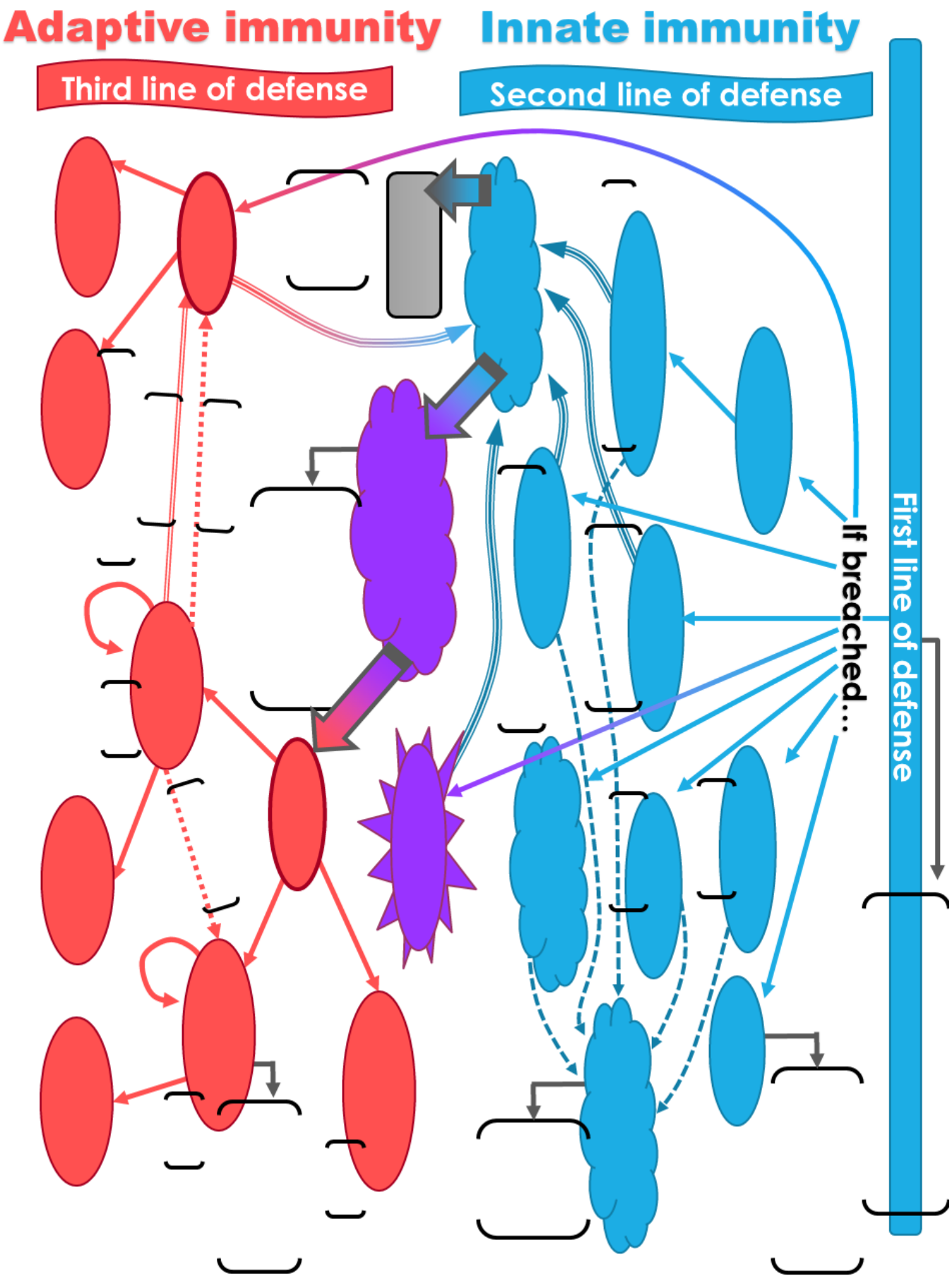
To succeed in this unit, you must have an underlying background of basic cell biology. You probably learned most of this in your biology class, such as the basic structure and function of eukaryotic cells (membrane, surface proteins, etc.). You will also have to be familiar with the basic functions of the different systems of the human body, but a previous course in anatomy and physiology is not required for success in this unit.

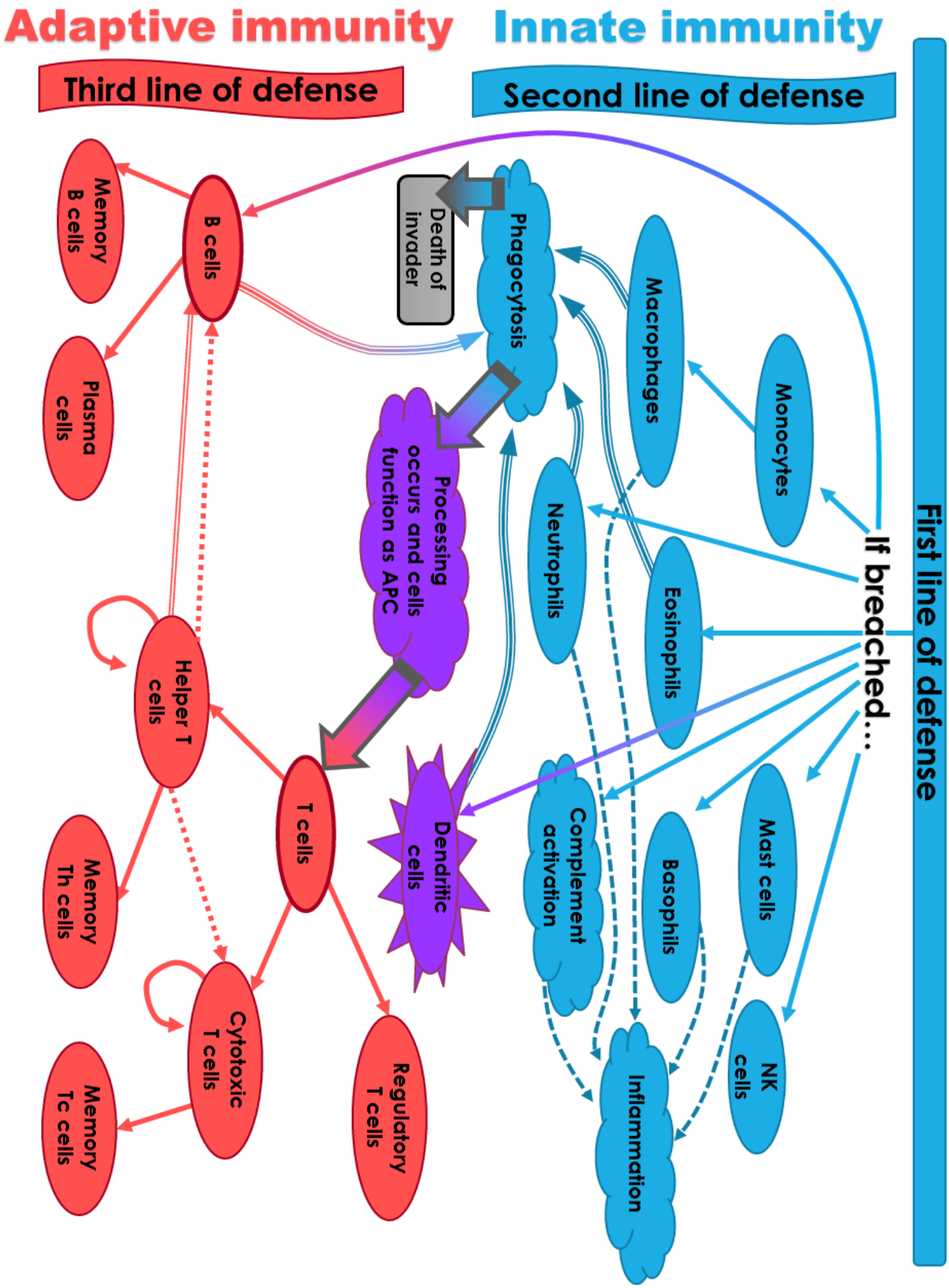
The two main activities you will be doing in this unit will be creating your own antibody to mimic antibody formation and variation, and a simulated enzyme-linked immunosorbent assay (ELISA). The procedures for both of these activities can be found in the handouts available in the materials section (below). Safety precautions are also discussed as needed in those handouts.

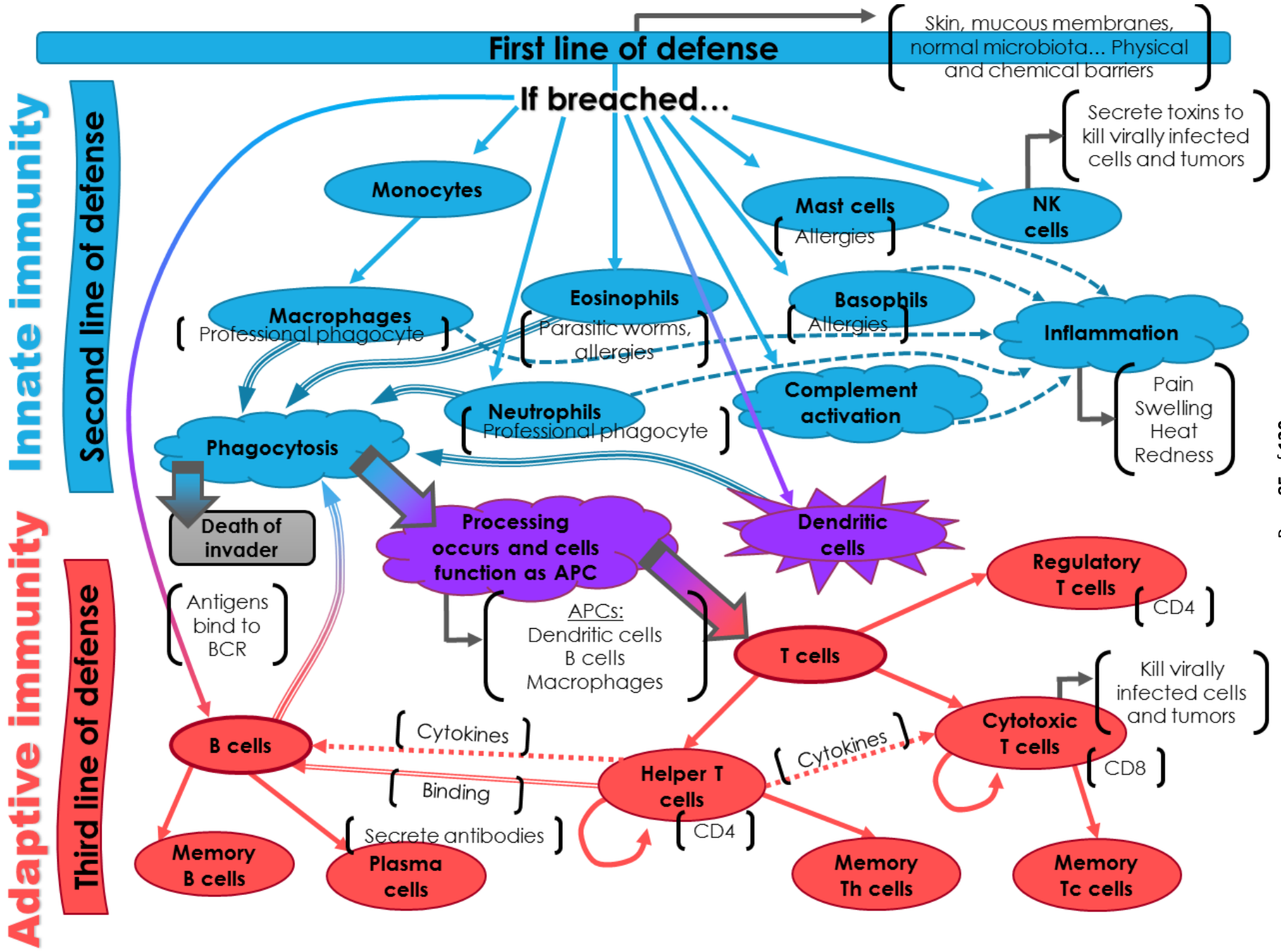
Materials

The handouts for this unit are listed below. Please note that although the note packet is listed, it is available as a separate file (hence the *).

a. Flow charts: Student handout, test resource, and modified test resource
b. Note packet*
c. Immunology Game Review information sheet
d. Immune System Quiz 1 Review
e. Immune Cells ID WS
f. Immune System Quiz 2 Review
g. Innate Immunity Review
h. Inflammation WebQuest
i. Overview of the Adaptive Immune System Review
j. Adaptive Immunity Flow Charts
k. Create Your Own Antibodies!
l. Humoral and Cell-Mediated Flow ChartsAIDS Simutest


Adaptive immunity
Innate immunity
Third line of defense
Second line of defense
First line of defense
If breached...


Adaptive immunity
Innate immunity
Third line of defense
Second line of defense
First line of defense
If breached...
Memory B cells
B cells
Plasma cells
Death of invader
Phagocytosis
Macrophages
Monocytes
Processing occurs and cells function as APC
Neutrophils
Eosinophils
Helper T cells
T cells
Dendritic cells
Complement activation
Basophils
Mast cells
Memory Th cells
Cytotoxic T cells
Regulatory T cells
NK cells
Inflammation
Memory Tc cells


Innate immunity
Adaptive immunity
First line of defense
Skin, mucous membranes, normal microbiota... Physical and chemical barriers
Second line of defense
If breached...
Monocytes
Mast cells
Allergies
NK cells
Secrete toxins to kill virally infected cells and tumors
Macrophages
Professional phagocyte
Eosinophils
Parasitic worms, allergies
Basophils
Allergies
Inflammation
Pain
Swelling
Heat
Redness
Complement activation
Neutrophils
Professional phagocyte
Phagocytosis
Death of invader
Third line of defense
Processing occurs and cells function as APC
Dendritic cells
Antigens bind to BCR
APCs:
Dendritic cells
B cells
Macrophages
Regulatory T cells
CD4
T cells
Kill virally infected cells and tumors
Cytotoxic T cells
CD8
Cytokines
Cytokines
B cells
Binding
Helper T cells
CD4
Secrete antibodies
Memory B cells
Plasma cells
Memory Th cells
Memory Tc cells

Name: _____ Date:_____ Pd: _____
Allied Health Potts

Immunology Game Review

Directions:
The class will be divided into six groups. Each group will be tasked with creating a game to review material learned in the immunology unit through the lens of some sort of disease, vaccine, or other situation which will cause the immune response to begin working. You will need to create a game that can be played by 2-4 people. This can be a board game or something that requires more movement throughout the classroom, it's up to you!

The game can be based on other games that you have played in the past, or you can create something brand new. Games that have been used as bases for review games in the past have been Monopoly, Taboo, Pictionary, or other board games. Be creative! They don't have to be exactly like games played previously, and you are free to make up something brand new.

After each major section, you will be given time in class to rework your game and add more detail. Please use the outline that has been provided to determine where you need to leave a more open structure for your game.

Once the details of your game are created, we will also have a little time in class in order to put together the materials that you will need for your game. These may be cardboard, cloth, wooden, etc., but you will have to bring things in from home in order to complete this section.

We will be having a "Game Day" in class where each group will play the other games in order to review the material. At the end of it, the games will be voted on and the "Best Game" will be awarded with extra credit points!

Topic/Group Options:
1. GvHD response
2. Vaccination and exposure to flu
3. SCID and bone marrow transplant
4. HIV (early and late)
5. Allergens and pollen allergy
6. Tetanus exposure through a rusty nail
7. Tuberculosis exposure
8. Cancer detection
9. MRSA infection
10. Complement activation

**Please note that if you are having trouble with a particular topic you may change it, but you will still have to go through each of the "phases" of setting up the game as we continue in class.

Requirements/Rubric:

Directions				
5 Directions are clear and to the point. Handouts provided for all participants in the game. Sections of directions are well organized and labeled.	**4** Directions should be edited slightly for clarity. Other parts (see 5) present.	**3** Directions provided but require more organization and/or edits for clarity.	**2** Directions provided, but they are not very clear or are not organized in a way that makes them easy to follow.	**1** Directions provided, but they are unclear and unable to be used to play the created game.
Pieces				
5 Pieces required to play the game are well-made (sturdy, clear, etc) and clearly different from other portions of the game.	**4** Pieces may need to be more clearly different from other pieces or may need to be edited a little.	**3** Pieces are given, but they are made rather flimsy or are messy.	**2** Pieces provided, but are not made in a way that makes the game able to be easily played multiple times	**1** Pieces provided but are messy, not reusable, and hard to differentiate from each other
Addresses each of the following topics: (*= must have 2/4)				
*Overview of parts of the immune system that are involved**				
5 Various pieces of the immune system are used, covering all aspects discussed in class.		**3** Not all aspects discussed in class are addressed properly, others are addressed in depth.		**1** General topics are mentioned, but fail to be expanded upon sufficiently.
*Innate immune reaction**				
5 Innate immunity addressed as part of the game in depth (ex: cells, inflammation, etc.)		**3** Parts of innate immunity addressed in depth, others only briefly.		**1** General topics are mentioned, but fail to be expanded upon sufficiently.
*Adaptive: Cell-mediated response**				
5 Cell-mediated response addressed in depth as part of the game (different T cell responses and functions, etc).		**3** Parts of cell-mediated response addressed in depth, others only briefly.		**1** General topics are mentioned, but fail to be expanded upon sufficiently.
*Adaptive: Humoral response**				
5 Humoral response addressed in depth as part of the game (B cell types, antibody functions, etc.).		**3** Parts of humoral response addressed in depth, others only briefly.		**1** General topics are mentioned, but fail to be expanded upon sufficiently.
Progression of a particular disease or situation from initial stage to late stages				
5 Progression of chosen situation from early to late are both expanded on in depth in game.		**3** Initial or late stage reaction addressed in depth, other only briefly.		**1** General topics are mentioned, but fail to be expanded upon sufficiently.
Creativity/class work/effort apparent				
5 Students worked well during class and effort is apparent in their final product		**3** Final product is well made, but students did not put work in during class time when instructed.		**1** Students did not focus during class time and final product is not well made.
+3 **Won the "Game Day" votes**				
TOTAL POSSIBLE POINTS:		**30**		

**Although not addressed in this rubric, missing portions will be noted to receive 0 points.

Name: _____ Date: _____ Pd: _____
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Immune System Quiz 1 Review

1. Fill in the blank with which term is being described by each sentence below.
    a. Molecules made in response to antigens that are specific to that particular pathogen and signal other functions of the immune response: _____
    b. Colorless, water liquid from fluid leaked out of blood vessels: _____
    c. Any material that can evoke an immune response: _____
    d. The system in the body that will protect us from foreign invaders by mounting an immune response: _____
    e. When the immune system attacks "self" tissues; the immune system thinks your tissues are dangerous: _____
    f. A product of the adaptive immune response and another word for "antibody": _____
    g. Areas around the body where specific immune interactions are developed: _____
    h. State of protection against harmful effects of exposure to pathogens: _____
2. Describe the four features of the vertebrate immune system. Give a generalized description as well as examples of how the features are achieved in humans.

3. Flow chart practice:
    a. List the CELLS of the innate immune response.

    b. List the CELLS of the adaptive immune response.

c. Explain why dendritic cells are important in connecting the innate and adaptive immune response.

d. What types of cells are phagocytes?

e. What two things might phagocytes do?

f. How are basophils, eosinophils, and mast cells related?

g. How are NK cells and cytotoxic T cells related?

h. What parts of the immune system contribute to inflammation?

i. Where do plasma cells come from? What do they do?

j. What are the two kinds of T cells? How do you tell the difference?

k. What is the relationship between B cells and helper T cells?

4. Summarize the three main lines of defense.

5. Describe how skin and mucous membranes are similar and different when defending against pathogens.

6. List the two chemical defenses discussed in class. Describe or give an example of one.

7. Compare and contrast the innate and adaptive immune response in terms of specificity and reaction time.

8. Why are both the innate and adaptive immune response important to our defense?

9. Describe how the circulatory and lymphatic system work together to allow the organs of the immune system to function properly.

10. Summarize the role of bone marrow and the thymus in B and T cell generation and development.

11. What are the secondary lymphoid organs? Why are they important?

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Immune Cells ID WS

**When a piece of information can apply to more than one cell, please list all applicable answers.

1. Found in the bone marrow and will not leave until fully developed. _____
   _____
2. After these phagocytize a pathogen, it will release chemicals that will trigger inflammation. _____
   _____
3. Sometimes these innate immune cells will travel to tissues from the blood, but sometimes there are residents in the tissues that will constantly survey the area for pathogens. _____
   _____
4. This is the PROFESSIONAL antigen-presenting cell… Most important one!!! _____
5. Increase in amount of these is used to diagnose a non-specific bacterial infection. _____
   _____
6. Help other responses or will directly kill cells, depending on the surface markers found on the mature version. _____
7. Major/main white blood cell of the immune response. _____
8. These will exit the blood to directly attack invading microbes in the tissues, but will not change when they do so. They are directed to the tissues because of chemical signals. _____
   _____
9. Adaptive immune cell created and matured in the bone marrow. _____
10. Acts as a phagocyte. _____
    _____
11. Function in allergic response. _____
    _____
12. Link the innate and adaptive immune responses. _____
13. Antigen-specific. _____
14. These cells will release granules that contain chemicals to signal degranulation of other cells. _____
15. Helps defend against parasitic worms. _____
    _____

16. Recognize antigen from dendritic cells. _____

17. Cell that travels and matures in the thymus. _____

18. Look like lymphocytes (because also from a common lymphoid progenitor), but are part of the innate immune response. _____

19. Function in antigen presentation (as an APC: antigen-presenting cell). _____
    _____

20. Respond to signals from mast cells. _____
    _____

21. Recognize and kill virally infected cells. _____

22. May kill cells covered in antibodies, but NOT via phagocytosis. _____

23. Job is to always sample their environment and show what they have found to other cells in case the immune system needs to respond. _____

24. Mature forms are called plasma cells. _____

25. Acts as a phagocyte only when the target pathogen is coated in antibodies. _____

26. Cells of adaptive immunity. _____

27. Will mature into macrophages once they leave the blood. _____

28. Cells that will give rise to the many different types of cells. _____
    _____

29. Releases granules when stimulated. _____
    _____

30. When there is an infection, the number of this will increase significantly, beyond the roughly 50% it is normally found at. _____

31. Nonspecific in their immune response. _____
    _____

32. Secretes antibodies _____

33. NOT white blood cells, but still part of the immune system! _____

34. Granules will contain histamine. _____

35. Develop memory. _____

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Immune System Quiz 2 Review

Cells and Nonspecific Components of the Immune System

Directions:

Answer each of the questions in the space below

1. Describe each of the following:
   a. PRR - _____
   _____
   b. PAMP - _____
   _____
   c. TLR - _____
   _____
   d. IL - _____
   _____
   e. IFN - _____
   _____

2. Use three of the terms above to describe how a neutrophil OR macrophage will react to an infection.

_____
_____
_____
_____

3. What is complement?

_____
_____

4. What are defensins/antimicrobial peptides?

_____
_____

5. What are the three results of complement activation? Compare these to the effects of defensins.

_____
_____
_____
_____
_____
_____

6. Explain why PRRs are important for the innate immune response but not the adaptive.

7. Discuss the relationship between eosinophils, mast cells, and basophils. Make sure to discuss their common function as well as how they will interact with each other!

8. What is the unique function of NK cells?

9. Differentiate between B and T lymphocytes. How are they different? How are they similar?

10. How does inflammation relate to monocytes and cytokines? Be specific about what happens and about the type of cytokine!

11. Relate complement activation to macrophages.

12. Will dendritic cells respond to PAMPs? Why or why not?

13. List the five types of cytokines discussed in class. Describe two of them.

_____
_____
_____
_____
_____
_____
_____
_____

14. Fill out the following table about the cells of the immune response. Put a check where appropriate.

	Neutrophil	**Macrophage (monocyte)**	**Eosinophil**	**Basophil**	**Mast cell**	**NK cell**	**B cell**	**T cell**	**Dendritic cell**
Innate									
Adaptive									
Related to innate AND adaptive									
Phagocyte									
Can create memory									
Professional									
Antigen presenting cell									
Allergic response									
Has PRRs									
Will respond to PAMPs									
Probably has TLRs									
Produces IL									
Responds to chemokines									
Related to complement activation									
Creates antimicrobial peptides									

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Innate Immunity Review

1. What is the purpose of opsonization? What are opsonins (generally) and what can act as an opsonin?

2. Why is fever not always bad (what beneficial effects does it have on the body)?

3. List the major cytokine functions discussed in class (5).

4. How are interferons beneficial to infections by more than one type of virus? How are interferons harmful to us?

5. Relate interferons to innate immune cells. Be specific about where they come from and what they do (if it was discussed in class).

6. Describe how complement will proceed once activated (what happens to the proteins).

7. What are the three results of complement activation? Use terms and define them!

8. Describe the three ways that neutrophils can kill microbes.

9. Explain how macrophages will "raise the alarm" when you have an infection.

10. How do macrophages relate (specifically!) to what happens during inflammation? Discuss cytokines and their effects, when applicable.

11. How are NK cells signaled to kill a cell? There is more than one way, so make sure you list both!

12. What are perforin and granzymes? Where do they come from and what do they do?

13. How are mast cells related to the overall inflammatory response? Explain both the effects they have on parts of the body and also how they will communicate with other cells (which ones?) and what this does for you.

14. Contrast acute and chronic inflammation.

15. What are the four "classic" characteristics of inflammation? Explain on a cellular level how they occur.

16. How and why do cells in blood vessels move out into infected tissue?

17. Summarize inflammation. Be pretty general, but do not just copy the flow chart (more info than that)!

_____

_____

_____

_____

_____

_____

_____

18. How do the innate and the adaptive immune response work together to defend you? Be as specific as possible, using terms discussed in class!

_____

_____

_____

_____

_____

_____

_____

_____

Name: FILL THIS IN

Inflammation Video Question Worksheet

Directions:

- Fill in your name at the top and then save this document in a place on your Drive that you can find it again easily.
- Go to https://www.khanacademy.org/science/health-and-medicine/human-anatomy-and-physiology/introduction-to-immunology/v/inflammatory-response
- Using headphones, watch the video and type in your answers to each question below (I put bullets in for you to for organization, but you can remove them and answer it in any format you feel is most organized).
- Submit the file to Classroom by the due date.

Questions:

1. What are the four main characteristics of the inflammatory response (inflammation)?
    -
2. What is meant by calling the inflammatory response the “field of battle”?
    -
3. Where do dendritic cells “hang out”? Why might they be in this location?
    -
4. What is interstitial fluid? How does this relate to capillaries/the circulatory system?
    -
5. What are endothelial cells?
    -
6. In the example in the video, where do the chemokines come from? Note this answer should be different from what was discussed in class.
    -
7. What does the word “chemokine” mean?
    -
8. What are the three ways mentioned that mast cells could be activated?
    -

9. How does histamine relate to the inflammatory response? What general effects does it have related to how you feel during cold season?
    -

10. Discuss the effect histamine has on endothelial cells. Why is this effect important to the inflammatory response?
    -

11. Describe the changes in the nearby blood vessels and which of the four characteristics of inflammation that this leads to.
    -

12. What role do neutrophils play? How do they know where to go?
    -

13. Describe the following:
    a. Marginization -
    b. Diapedesis -
    c. Extravasation -

14. What other kinds of cells (other than neutrophils) will be called to the area to fight the infection?
    -

15. What fights an infection other than cells? Describe this.
    -

16. What is exudate? What do you see as a result of it (look at the four characteristics of inflammation!)?
    -

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Overview of the Adaptive Immune System Review

1. Describe the movement of cells of the adaptive immune throughout the body (where are they circulating?).

2. How is the lymph node structured to encourage a successful adaptive immune response?

3. What is the purpose (or result) of dendritic cells processing self-antigen (parts of our own cells)?

4. What does a humoral response react to in the body? What kinds of cells are associated with humoral immunity?

5. What does a cell-mediated response do for the body? What cells are associated with cell-mediated immunity?

6. Describe the different types of T cells.

7. What are epitopes?

8. How will B and T cells respond to antigen differently?

9. Where are the two types of MHC found? What are they each recognized by?

10. How does the MHC relate to how T cells respond to antigen? Why are they necessary?

11. What process allows there to be such a large amount of diversity in the TCR and BCR that will be created in our immune system?

12. What is the purpose of clonal deletion?

13. How does the MHC affect clonal deletion of T cells?

14. What is meant by a mature, naïve lymphocyte?

15. What occurs during clonal expansion? Why will this occur? Use the three terms discussed in class!

ADAPTIVE IMMUNITY

1 Cells circulate between the…

2 Two responses

3 Cell-mediated

4 Is described as…

5 Formation of cells

Antigens it responds to are

Cells are…

Whose surface receptor is called the

Mature in the…

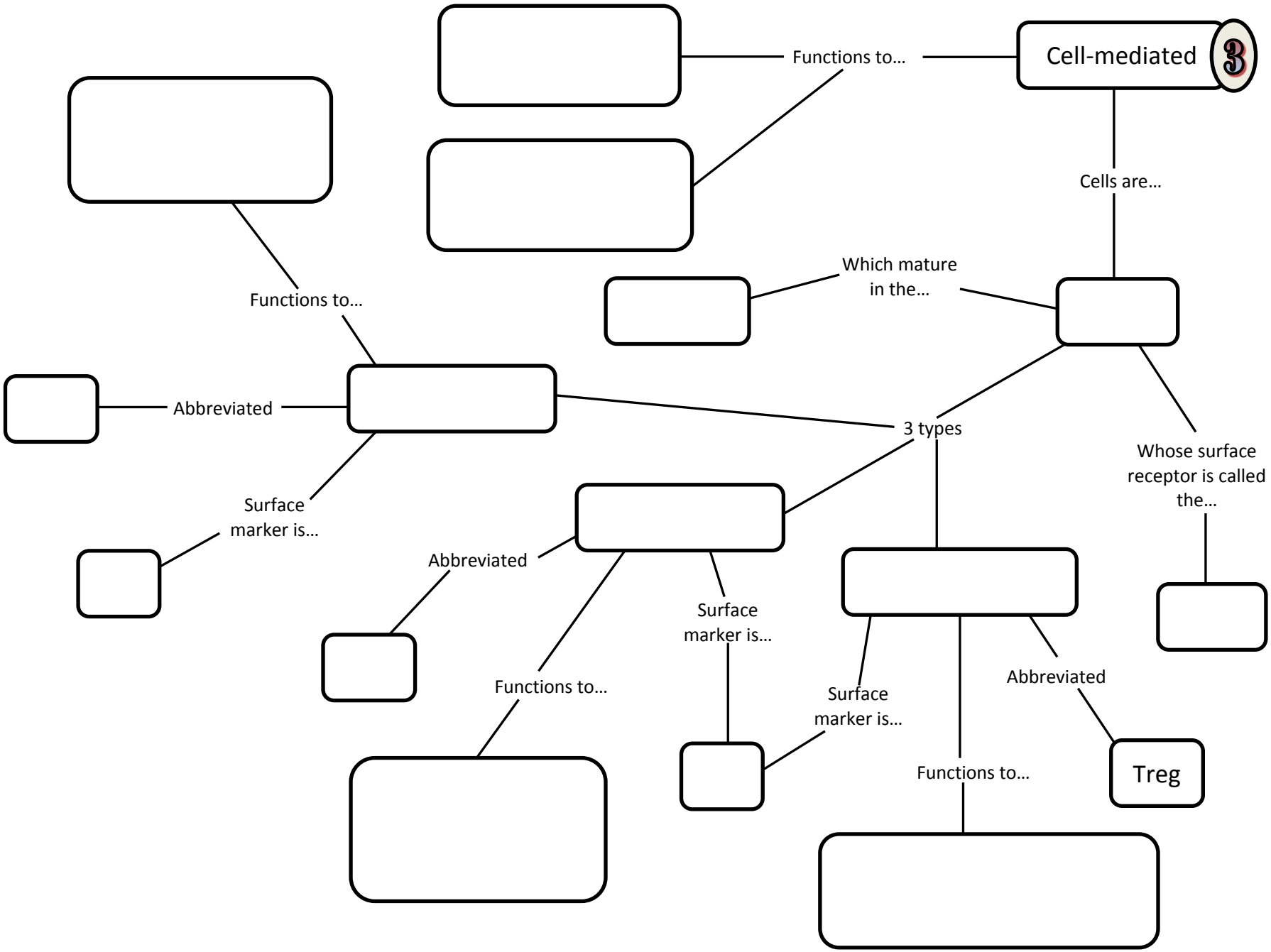
When activated, become

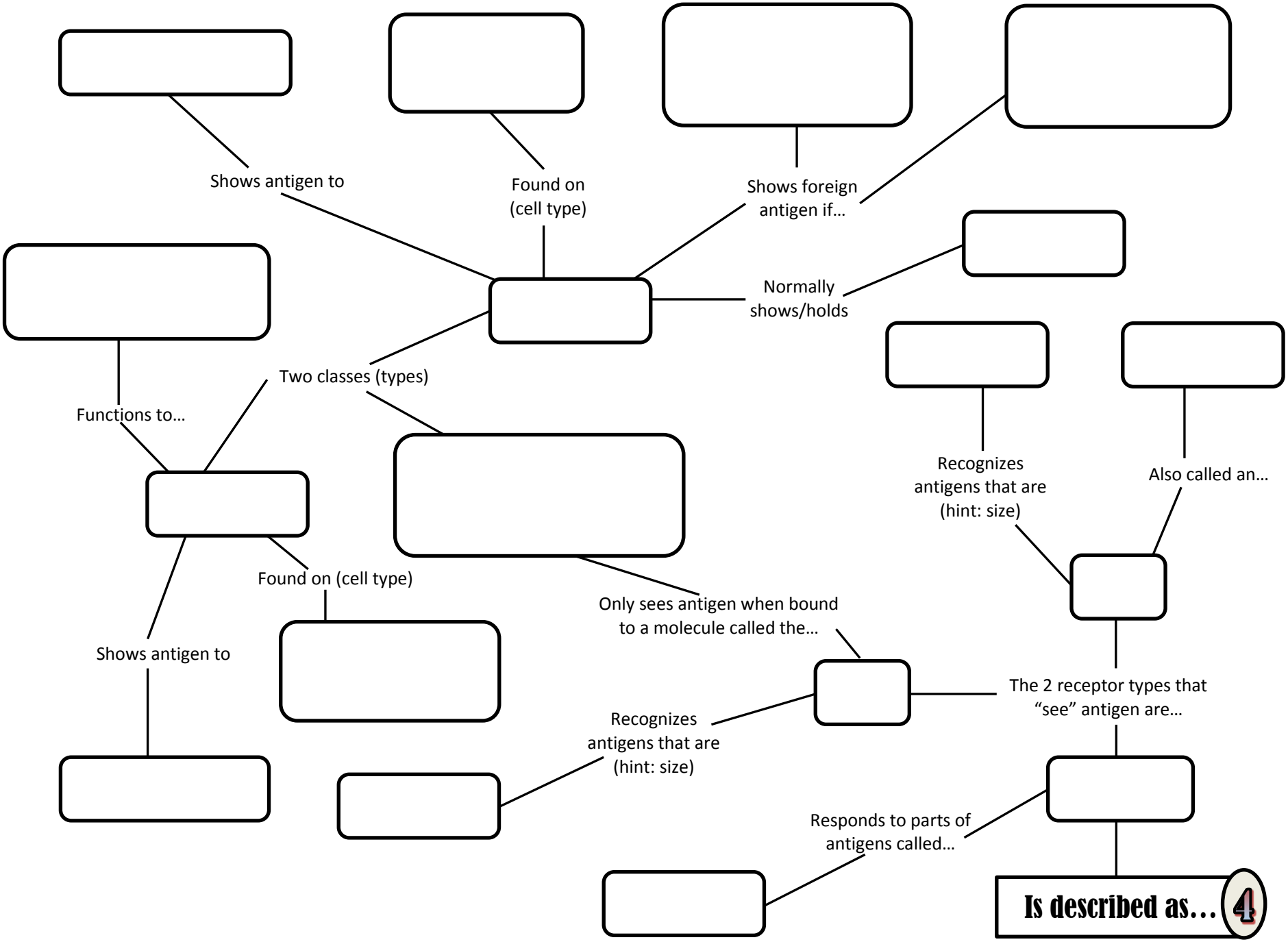
But mainly interact at the…

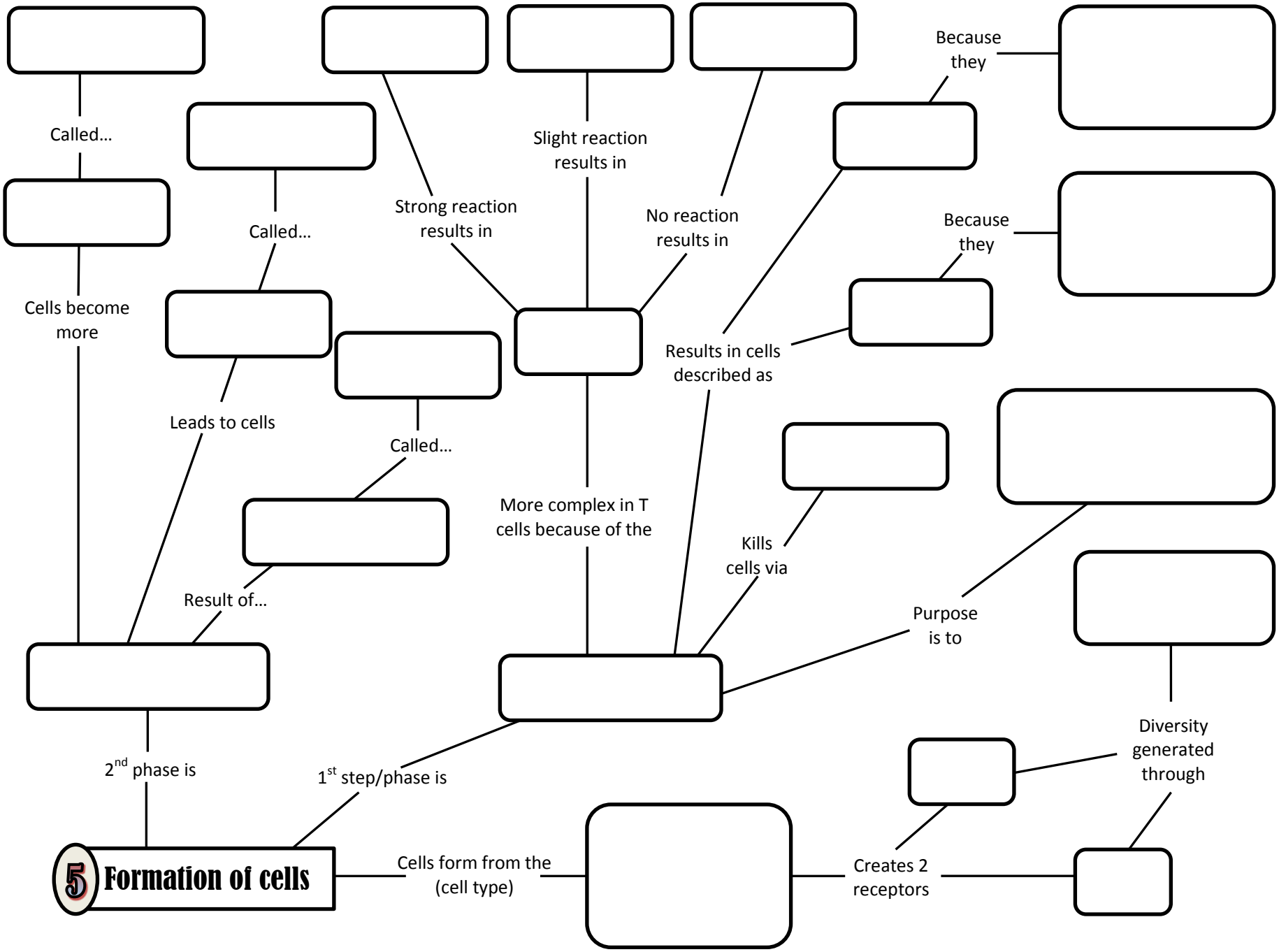
Where dendritic cells will generally present to…

Which is structured well because…

Which usually interacts with…


Functions to…
Cell-mediated
3
Cells are…
Which mature in the…
Functions to…
Abbreviated
3 types
Surface marker is…
Whose surface receptor is called the…
Abbreviated
Surface marker is…
Functions to…
Surface marker is…
Abbreviated
Functions to…
Treg


Shows antigen to
Found on (cell type)
Shows foreign antigen if…
Normally shows/holds
Two classes (types)
Functions to…
Recognizes antigens that are (hint: size)
Also called an…
Found on (cell type)
Shows antigen to
Only sees antigen when bound to a molecule called the…
The 2 receptor types that "see" antigen are…
Recognizes antigens that are (hint: size)
Responds to parts of antigens called…
Is described as… 4


Called…
Called…
Cells become more
Leads to cells
Called…
Result of…
Strong reaction results in
Slight reaction results in
No reaction results in
More complex in T cells because of the
Because they
Because they
Results in cells described as
Kills cells via
Purpose is to
Diversity generated through
2nd phase is
1st step/phase is
5 Formation of cells
Cells form from the (cell type)
Creates 2 receptors

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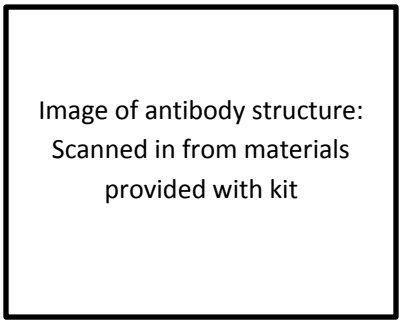
Objectives:

- Describe the basic structure of an antibody
- Understand how antibodies are created by combining various heavy and light chains
- Visualize how antibodies will be specific for specific antigens to function inn an immune response

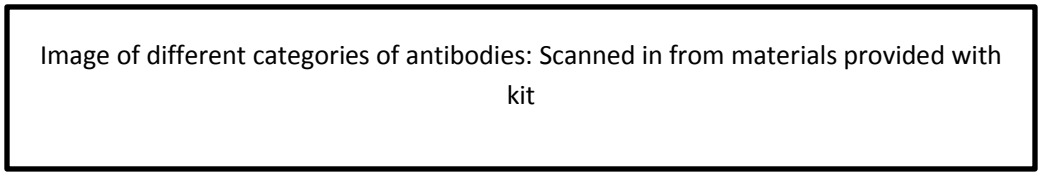
Introduction:

The body is constantly exposed to microbes, toxins, dust, and pollen. These substances are potentially harmful and may even cause disease if they are not eliminated from the body. One of the most important strategies the body uses to fight these hazards is the production of antibodies. In this activity, you will construct your own antibody and witness how it works to destroy specific pathogens by recognizing specific antigens.

Antibodies are glycoproteins found in the blood and other body fluids of vertebrates. A vital part of the immune system, antibodies are produced by B-cells and belong to a class of proteins called *immunoglobulins (Ig)*. The main function of antibodies is to recognize and initiate the removal of foreign objects such as bacteria or viruses. Each antibody molecule consists of four polypeptide chains – two identical *heavy chains* and two identical *light chains*. The heavy and light chains are joined together by specific bonds that will create a Y-shaped protein molecule (see Figure 1).



Antibodies are grouped into five categories based on their heavy chain structure and their location and function in the body (see Figure 2). We will not be constructing IgM or IgA antibodies in this activity, but understanding that different shapes exist for different categories can help when trying to understand the variety of functions that antibodies can have.



Within each category of antibody the two heavy chains and the two light chains are the same. The region at the tip of the antibody is called the *variable region*, and it is this area that allows millions of different antibodies to be created within each category. Both the heavy and light chains will have a variable region, creating immense diversity that allows the immune system to recognize a multitude of antigens.

Antigens are foreign substances or materials, such as bacteria or viruses that do not belong to the host organism. Antibodies recognize and bind to a specific region of the antigen called the *epitope*. Once the antibody binds to the antigen, the antigen is tagged to be destroyed by the immune system. The fit between the antigen-binding site of the antibody and the epitope of the antigen is highly specific. This specificity allows antibodies to bind only with their matching antigen so other substances are not tagged for destruction.

In order for an antibody to survive, it must combine with antigen and undergo *activation*. Activation causes rapid proliferation of antibody-secreting cells, resulting in the production and subsequent release of copies of the antibody which will tag the remaining matching antigens for destruction. The body constantly produces millions of antibodies. Those antibodies that do not match antigens will not undergo activation.

Pre-Lab Questions:

These answers will be uploaded to turnitin.com.

1. Define the following terms in your own words:
    a. Antibody
    b. Antigen
    c. Activation
2. Describe the structure of an antibody. Make sure to reference the different types of chains as well as the shape and variable region.
3. Refer to Figures 1 and 2. Each arm shown in Figure 1 is able to bind one antigen. How many antigens can each antibody in Figure 2 bind?

Materials:

- Antigen Template
- Antibody Regions Model Sheet
- Scissors
- Tape

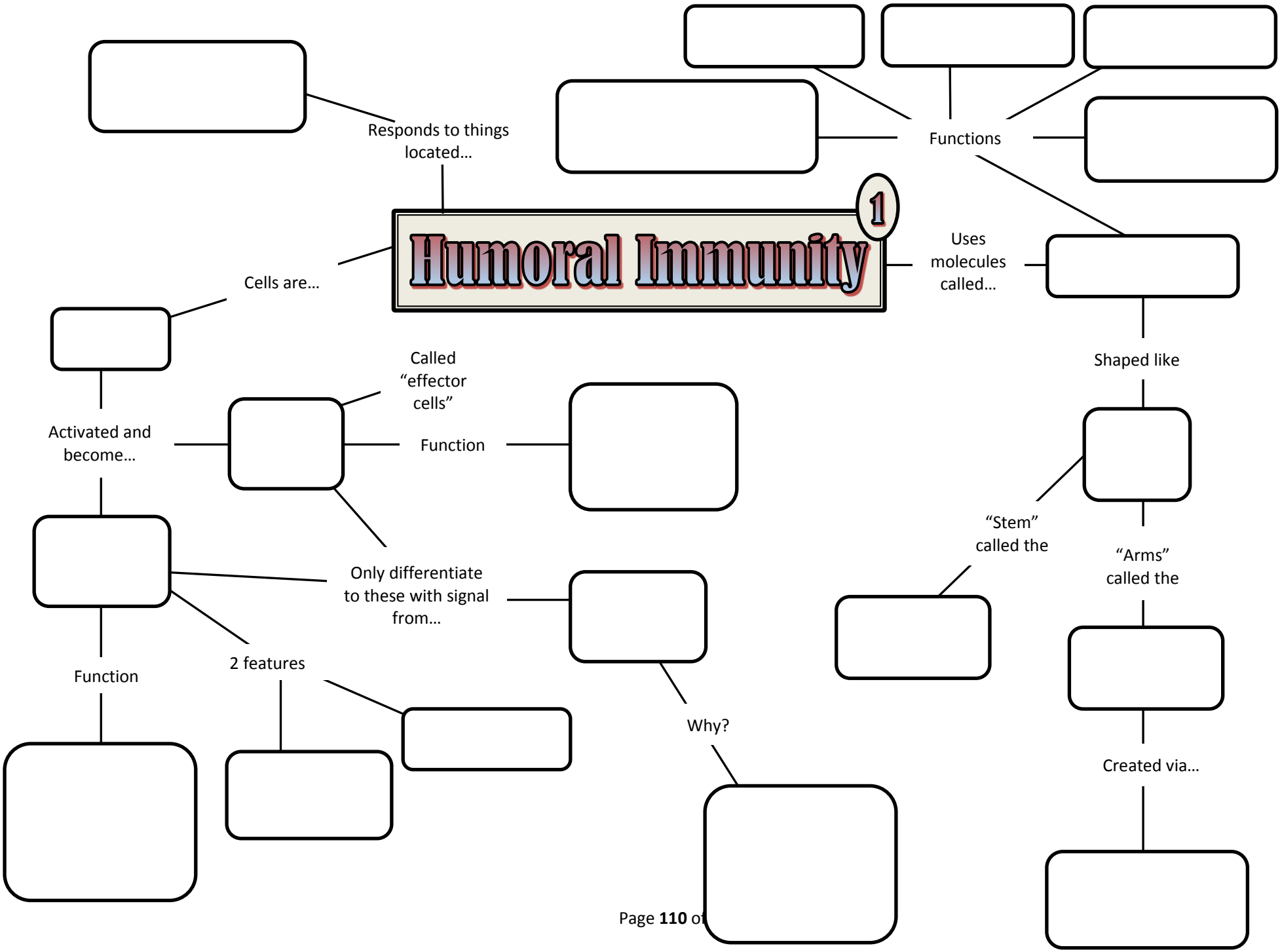
Procedure:

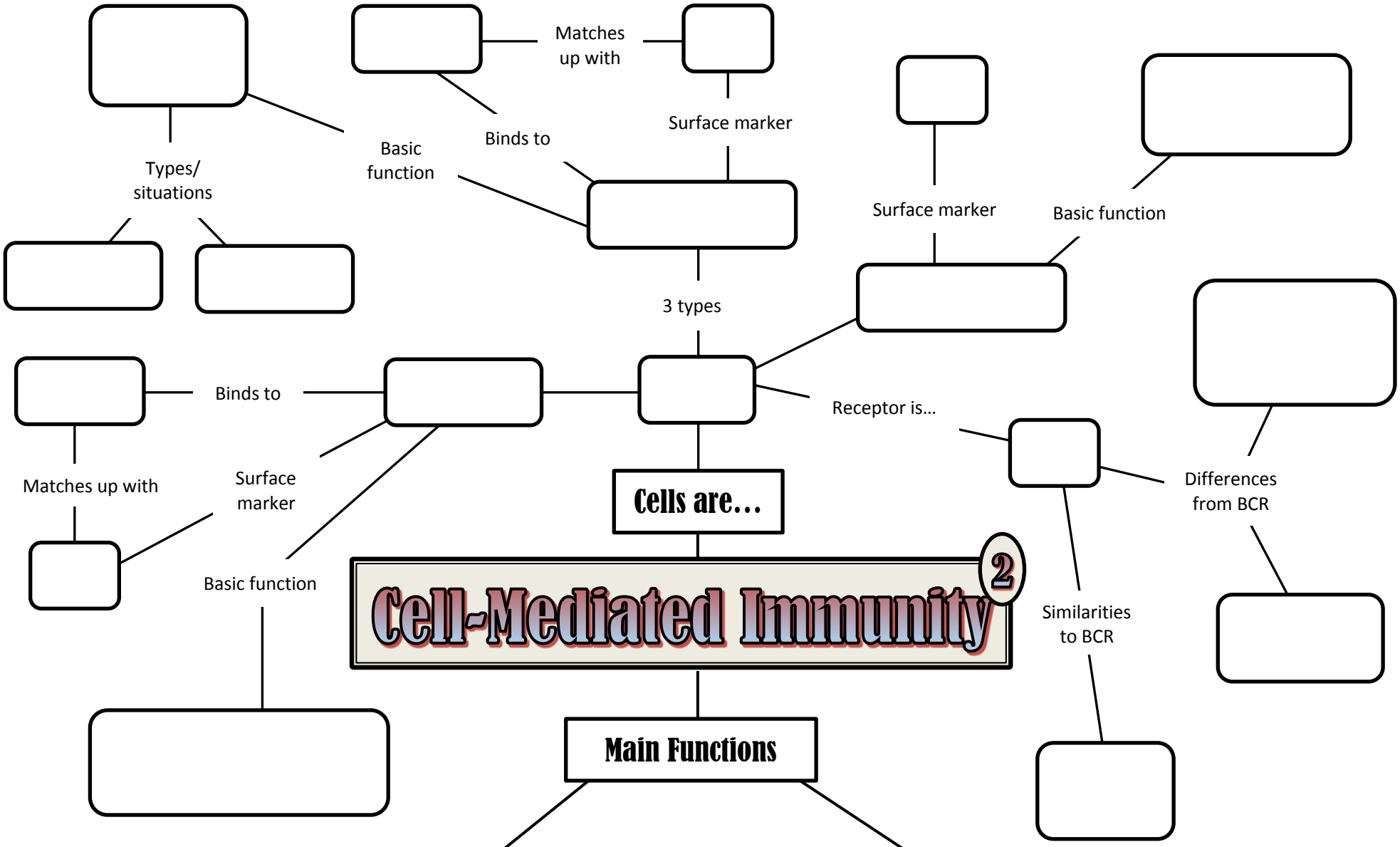
1. Obtain regions model sheet.
2. Cut out the IgG Constant Regions Model, taking care not to cut the dashed lines at the end.
3. Select a heavy chain variable region (HV) and light chain variable region (LV) for the antibody.
4. Choose one of the three matching HV pairs and cut it with scissors, taking care not to cut the dashed lines or tabs. Make a note of which one for Post-Lab Question 1.
5. Choose one of the two matching LV pairs and cut it with scissors, taking care not to cut the dashed lines or tabs. Make a note of which one for Post-Lab Question 1.
6. Match dashed lines to dashed lines on HV to HC and tape them together. Do the same with LV and LC.
7. Examine the sample antigens on the Antigen Templates Sheet and determine if your antibody molecule will "fit" (bind) with one of the antigens.

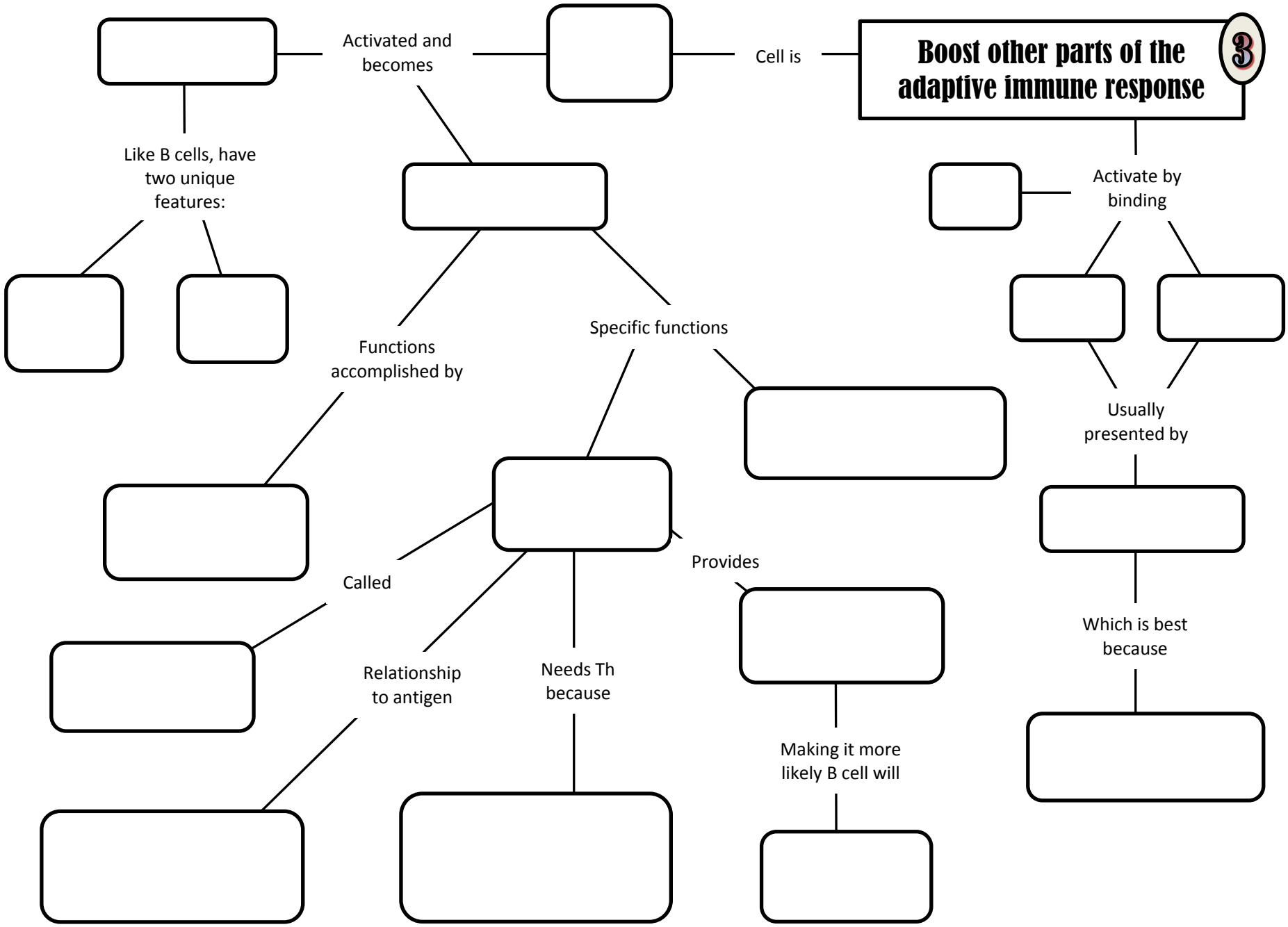
Post-Lab Questions:

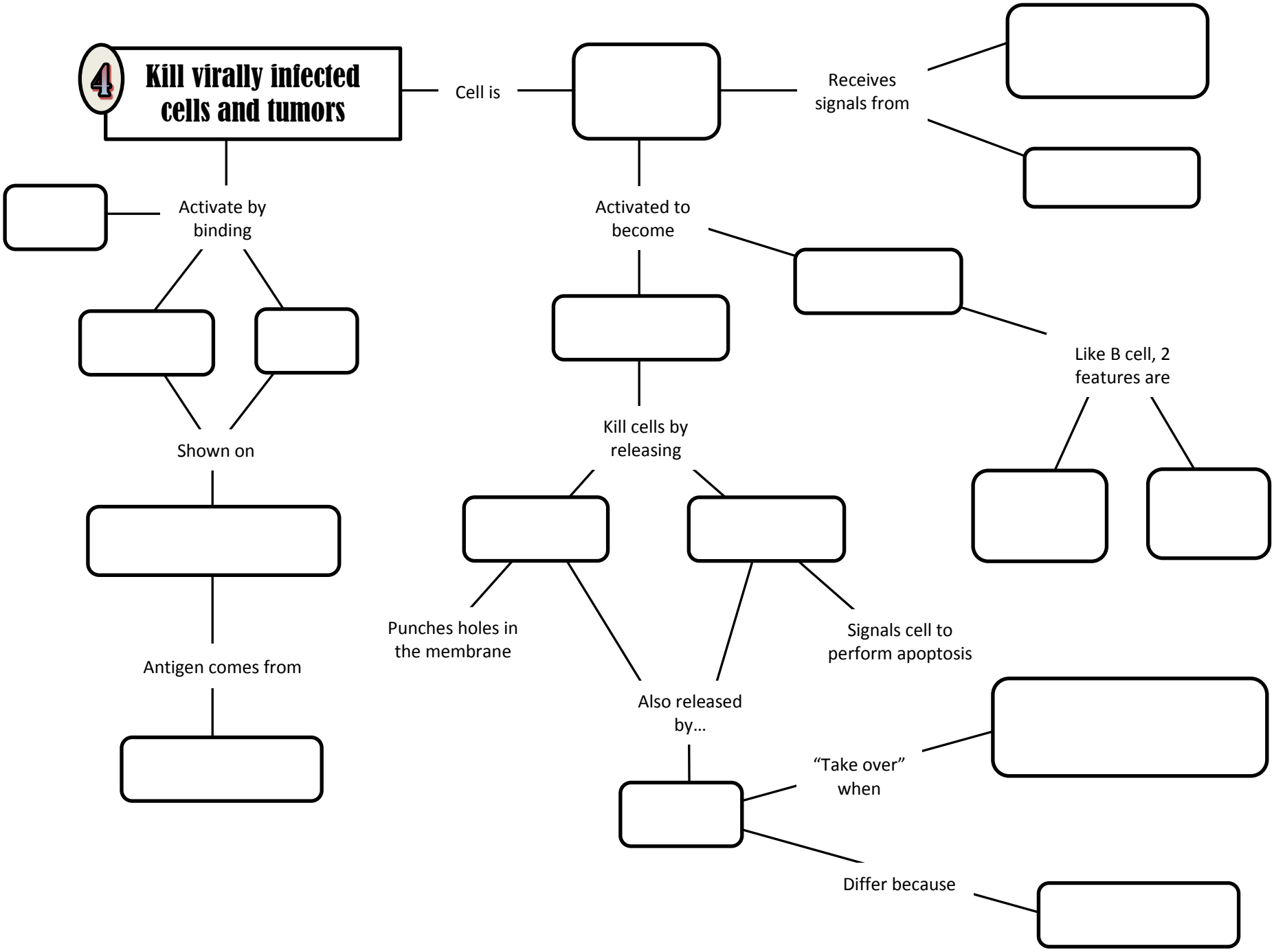
These answers will need to be uploaded to turnitin.com. Where applicable, create table and insert images.

1. List your chosen heavy and light chain variable regions.
2. Paste the (completed) model antibody that you constructed onto a blank sheet of paper. Label your heavy and light chain numbers.
3. Did the antibody "fit" or bind with any of the suspect antigens? If so, paste the bound antibody-antigen complex to show the "fit" and describe the shape of the fit. If your antibody did NOT fit, please paste any antigen that does not "fit", showing why the "fit" did not work and writing in a brief explanation.
4. Describe the life cycle of a B cell for the following situations:
    a. The B cell has an antibody that matched/was able to bind with an antigen
    b. The B cell has an antibody that did NOT match/couldn't bind with an antigen
5. Sarah had chicken pox at age 8. Five years later, her brother Ryan also contracted chicken pox. Why is Sarah not at risk of getting chicken pox again?
6. Why do some vaccinations require boosters after a certain amount of time to maintain immunity whereas others require only one initial dose of the vaccine? Look this up and indicate your source in your response.


Humoral Immunity
1
Responds to things located…
Functions
Cells are…
Uses molecules called…
Shaped like
Called "effector cells"
Activated and become…
Function
"Stem" called the
"Arms" called the
Only differentiate to these with signal from…
Function
2 features
Why?
Created via…


Matches up with
Binds to
Surface marker
Basic function
Types/ situations
Surface marker
Basic function
3 types
Binds to
Receptor is…
Matches up with
Surface marker
Differences from BCR
Cells are…
Basic function
Cell-Mediated Immunity
2
Similarities to BCR
Main Functions
Boost other parts of the adaptive immune response
3
4
Kill virally infected cells and tumors


Activated and becomes
Cell is
Boost other parts of the adaptive immune response
3
Like B cells, have two unique features:
Activate by binding
Functions accomplished by
Specific functions
Usually presented by
Called
Provides
Relationship to antigen
Needs Th because
Which is best because
Making it more likely B cell will


4
Kill virally infected cells and tumors
Cell is
Receives signals from
Activate by binding
Activated to become
Like B cell, 2 features are
Shown on
Kill cells by releasing
Antigen comes from
Punches holes in the membrane
Signals cell to perform apoptosis
Also released by…
"Take over" when
Differ because

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AIDS Simutest

Modified from AIDS Simutest Kemtec Kit #3-403 (from Carolina Biological)

Objectives:

Students will be able to…

- Differentiate between HIV and AIDS.
- Learn how HIV is contracted.
- Learn how a person can avoid contracting HIV.
- Experience using an ELISA to detect HIV antigens and determine if a patient is HIV positive.

Introduction:

History

Early in 1981, doctors and medical researchers in the U.S. began to see a significant number of homosexual men with rare forms of infectious diseases and cancers, such Pneumocystis carinii pneumonia and Kaposi's sarcoma, to which the body is normally resistant. Scientists and physicians realized these men would succumb to these diseases because they had damaged immune system. As scientists began searching for the origin of the problem, hemophiliacs and other recipients of blood transfusions from infected individuals began to show similar symptoms. As the epidemic spread further, intravenous drug users, heterosexuals, and babies born to mothers who had the syndrome also developed the same immunodeficiency.

By the middle of 1985, 12,000 cases of the disease had been reported in the U.S., and half of these cases had resulted in death. The disease became known as Acquired Immunodeficiency Syndrome, or AIDS; a primarily sexually transmitted disease, which inactivates the body's defense system. At the same time that AIDS was detected in the U.S., it was rapidly spreading throughout the rest of the world as well.

By 2011, there were more than 34 million people living with HIV/AIDS worldwide, with 3.3 million under the age of 15. That very year, 1.7 million people succumbed to the disease and/or complications from it and of those 230,000 were under the age of 15. Sadly, most people living with HIV or at risk for HIV do not have access to prevent, care, or treatment for the disease and there is still no cure.

Table of number of AIDS cases by geographic region: Scanned in from materials provided with kit

As of 2013, in the United States there are nearly 56,000 new HIV cases and 18,000 related deaths annually. It is estimated that approximately 1.1 million Americans are living with the disease. More than half (54.5%) of all the new HIV infections in the United States are occurring in people under the age of 25. Surprisingly, it is estimated that one in five of the 1.1 million individuals in the United States who have AIDS are not aware that they are infected with the virus.

What causes AIDS?

AIDS is caused by a virus called the Human Immunodeficiency Virus (HIV). This virus was transmitted to humans from chimpanzees in an area of equatorial Africa encompassing the countries of Gabon, Cameroon, and Equatorial Guinea. The transmission most like occurred when humans hunted the chimpanzees and ate infected animals. Some recent studies indicate that this transmission may have occurred as far back as the late 1800's.

Image of caption for below: Scanned in from materials provided with kit (Figure 4)

HIV is a member of a family of viruses called lentiviruses, which is a subgroup of the retroviruses. The word lentivirus means slow virus because the virus, having a long incubation period, takes a long time to cause disease. After infecting their hosts, lentiviruses enter a period of their life cycle called a 'latency period' during which no visible symptoms are apparent. In HIV infection, this latency period often lasts for 10 years. The lentivirus, like other retroviruses, integrates its DNA into the host cell's genome, becoming part of the host DNA.

Image of how HIV integrates DNA into host cell DNA: Scanned in from materials provided with kit (Figure 3), but originally from http://upload.wikimedia.org/wikipedia/commons/3/35/HIV_gross_cycle_only.png and http://aids.gov/hiv-aids-basics/hiv-aids-101/what-is-hiv-aids/index.html

In order for the virus to survive, it must get past the body's immune system. HIV is able to enter immune cells because of a glycoprotein on its surface, which mimics an antigen in the host which identifies "self." It is able to hide and multiply inside the very cells that are supposed to be patrolling for disease-causing invaders. One of the virus's main targets is the subgroup of white blood cells called $CD4^+$ T cells. When the virus multiples inside of a cell, it eventually ruptures the cell, releasing many virus particles, which can then infect many more cells. Although the latent phase seems quiet, there is actually a fierce battle raging between the immune cells and the virus. The virus is multiplying rapidly, but the immune cells are quickly destroying them. However, due to its ability to hide, in the form of a provirus in the memory CD4 and T4 lymphocytes, the virus slowly gains an advantage. A sharp drop in $CD4^+$ T cells marks the final phase of the illness. This trait is used to follow the progress of the disease.

How Do You Test for AIDS?

To test for HIV, a small amount of blood is drawn for an Enzyme-Linked Immunosorbant Assay (ELISA). If the test returns a positive result, it is repeated. If there are positive results again, it is confirmed by using another type of test. The results of both tests are 99.5% accurate.

These tests depend upon the infected person's B cells forming antibodies to HIV. For the ELISA, a rectangular plate called a microplate will be used. This contains rows of small wells that can hold a small volume of chemicals. HIV coat protein is bound in the bottom of each well of the plate. Dilute serum from a patient's blood sample will be applied to the well. If anti-HIV antibodies are present, they will bind to the HIV protein coat on the bottom of the well. Only individuals that have been infected with HIV will have antibodies that recognize the HIV antigens in the protein coat at the bottom of the well. The wells are rinsed to remove unbound antibodies or other protein. In order to detect if anti-HIV antibodies are bound, a second antibody that recognize the human antibody is added. If the anti-HIV antibodies are present, the anti-human antibody will bind to them. This second antibody also has an enzyme attached and is referred to as a "conjugate." The enzyme that is part of the conjugate will cause a color change when a chemical called a "chromogen" is added. Even if there is only a small amount of HIV-antibody, this color change reaction can be detected.

Image of AIDS ELISA Test: Scanned in from materials provided with kit (Figure 4), but originally from http://en.wikipedia.org/wiki/file:ELISA-sandwich.svg

The AIDS Simutest

In this kit you will perform a simulation of an HIV ELISA. This kit contains no actual blood or blood products, so it is free of contamination by HIV or other infectious agents. As with any chemical kit, care should be taken when handling all reagents. In this lab you will examine eight patient samples and determine if any of them are positive for HIV.

Biographical Sketches:

Sample A
Name: Joe "Cap" S. *Age*: 45 *Sex*: M
Occupation: Transient, lives on the streets
Time after possible exposure: unknown
Reason to suspect AIDS infection: Appears to be a habitual drug user. Has 'needle tracks' on both arms. He denies that he has used intravenous drugs. He is attempting to donate blood to a blood bank in the inner city.

Sample B
Name: Jeanette B. *Age*: 11 *Sex*: F
Occupation: Elementary student
Time after possible exposure: 6 months to 8 years
Reason to suspect AIDS infection: A hemophiliac who has required frequent blood transfusions. She wants to be tested for "peace of mind.

Sample C
Name: Tim R. *Age*: 14 *Sex*: M
Occupation: High school student
Time after possible exposure: 3 years to present
Reason to suspect AIDS infection: He just learned that his gay older brother has AIDS. He fears that he may have been infected due to frequent contact from sharing the same bedroom, bathroom, and eating utensils. He insists on being tested for HIV.

Sample D
Name: Ron K. *Age*: 17 *Sex*: M
Occupation: High school student
Time after possible exposure: 6 months
Reason to suspect AIDS infection: He has recently taken a health class and is concerned that he may have been exposed to HIV. He had a "one night stand" with a girl he met at a party 6 months ago.

Sample E
Name: June L. *Age*: 33 *Sex*: F
Occupation: Homemaker
Time after possible exposure: 7 years to present
Reason to suspect AIDS infection: Her husband tested positive for AIDS before their marriage. They have taken all recommended precautions to protect her from contracting the disease. However, she has recently heard of a CDC report stating that the virus can be transmitted by kissing, if the person with AIDS has bleeding gums. Her husband has the early stages of gum disease.

Sample F
Name: Jim C. *Age*: 25 *Sex*: M
Occupation: Computer programmer
Time after possible exposure: 10 years
Reason to suspect AIDS infection: He has had persistent infections and has been in generally poor health over the last few months. He has had a few homosexual relationships in the past, but is currently in a monogamous homosexual relationship.

Sample G
Name: Donna R. *Age*: 27 *Sex*: F
Occupation: Nurse
Time after possible exposure: 3 months
Reason to suspect AIDS infection: While working with an AIDS patient, a hypodermic needle punctured her latex examination gloves while she was drawing blood.

Sample H
Name: Russ T. *Age*: 34 *Sex*: M
Occupation: Policeman
Time after possible exposure: 3 months
Reason to suspect AIDS infection: While making an arrest, he was scratched, bitten, and spit upon by a person claiming to be HIV positive.

Pre-Lab Questions:

Use the reading as well as other sources to answer the questions below. These answers will be uploaded to turnitin.com.

1. Describe/define the following terms:
    a. AIDS
    b. HIV
    c. ELISA
    d. Opportunistic infection
2. Name one opportunistic infection that is associated with AIDS and explain what it is.
3. In the early 1980's, who started to develop AIDS while the transmission of the disease was being investigated?
4. How many people died of AIDS in the United States by 1985? How many people in the US are estimated to be living with AIDS (as of 2013)?
5. Describe the incubation/latency period that occurs before HIV leads to AIDS.
6. Why can HIV enter immune cells? Which cells is it targeting?
7. What trait is used to follow the progress of the disease? What marks the final phase of the illness?
8. What does the body's immune system produce in response to viral infections? How is this product used in the AIDS test? Briefly describe the ELISA test in order to adequately answer this question.
9. Based on the biological sketches of the individuals that are being tested in the lab or HIV, which individuals do you think will test positive? Why? You may list and summarize your answers for this response.

Materials:

Note that the following is for each PAIR of students.

- ELISA microtiter plate
- Antibody conjugate
- Chromogen
- Serum samples A-H
- Distilled water
- 50 mL beaker filled halfway with the distilled water
- Paper towels
- Plastic pipettes (11)
- Labeling tape
- Permanent marker

Procedure:

Test positive

1. Gather your materials listed above, making sure to get 11 pipets. Label the pipets A-H, Chro, Conj, and Water. You may use tape for this if you need to.

2. Use the permanent marker to label the microtiter plate. Put A-H along the side and 1-8 along the top. You will see small letters or numbers that are already in the plastic (by doing this step we are making them more visible).

3. Carefully place 8 drops of serum A in well 1 and well 2 of row A of the microplate using the pipet labeled A. Do this VERY CAREFULLY, making sure you are gentle when using the pipet and counting the drops carefully.

4. Place 8 drops of serum B in wells 1 and 2 or row B like you did with serum A. Continue in this way for all the serum samples C-H.

5. Add 8 drops of distilled water to wells 2-7 in rows A-H. Note that you are skipping the first well!! Use the pipet labeled "Water" for this step.

6. Using the pipette labeled A, mix the sample in the second well of row A. Do this by very gently sucking up the solution in that well into the stem of the pipet and releasing it back into the well. Do not blow bubbles in the solution with the pipet.

7. Again, use the pipets to suck up the contents of the second well and carefully transfer 8 drops into the next well; well 3 of row A. Return the remaining solution in the pipet to the well you took it from; the second well of row A.

8. Mix the contents of well 3 and transfer 8 drops to well 4. Return the remaining solution to well 3.

9. Continue making dilutions this way across row A. After you have diluted serum from well 6 to well 7, mix as before, then discard 8 drops into well 8. Return the remaining solution to well 7.

10. Repeat steps 5-8 to make dilutions for rows B-H, using the appropriately labeled pipet that you used before when placing the serum into the wells.

11. Wait 10 minutes for the antibodies to bind to the HIV antigen. While you are waiting, work on questions for this activity.

12. Using the pipet labeled "Conj" (for conjugate), add 2 drops of conjugate to each of the wells 1-7 in rows A-H. (In the actual test, the wells would be rinsed with buffer before adding conjugate, but this step is not required for this simulation.)

13. Wait 5 minutes for the antibody-enzyme conjugate to bind to the serum antibodies. While you are waiting, read the biographical sketches for each of the serum don donors and predict who you think is most likely to test positive for HIV. Indicate why you believe they will be most likely to test positive. Note that anywhere from 0-3 serum donors may test positive.

14. Use the pipette labeled "Chro" (for chromogen) and add 3 drops of chromogen to each well 1-7 in rows A-H. (In the actual test, the wells would once again be rinsed with buffer before adding chromogen, but this isn't required for this simulation).

15. **ANALYZE RESULTS:** A light yellow or colorless result is a negative result. A reddish color (from very dark to light red) indicates a positive test for HIV.

Clean Up:

1. When the tests are complete, dispose of the chemicals in the wells by pouring them down the drain followed by a large volume of water. We can use these plates again if they are cleaned properly!

2. Rinse the microplates under a GENTLE stream of tap water to flood the wells.

3. Invert the plate and shake gently to empty the wells of water

4. Repeat two more times and allow the plate to air dry over a paper towel.

5. ***DO NOT wipe anything inside the plate. DO NOT use any cleaner/soap. Either of these things will remove the special antigen bound in the wells!***

Results:

This table will need to be recreated and uploaded to turnitin.com.

Table 1: ELISA Results

Use (+) to represent a result that is a shade of red.

++++ would be a deep red and + would be light red.

	1	2	3	4	5	6	7	8
A								
B								
C								
D								
E								
F								
G								
H								

Post-Lab Questions:

These answers will need to be uploaded to turnitin.com. Where applicable, create table and insert images.

1. Based on your data from the lab experiment, who tested positive for HIV?
2. Refer back to the biological sketches for the individuals who tested positive; what part of the patient's lifestyle most likely caused the person to contract the virus?
3. What kind of treatment options are available for patients who are diagnosed as HIV+? How effective are they? Make sure you indicate your source for this response.

Procedure

Please see provided Create Your Own Antibodies! and AIDS Simutest activities (page 103 and 109 respectively).

Data Collection

Please see provided Create Your Own Antibodies! and AIDS Simutest activities (page 103 and 109 respectively).

Discussion/Analysis

Please see provided Create Your Own Antibodies! and AIDS Simutest activities (page 103 and 109 respectively).