MICB 202 – Midterm Review Package

UBC Microbiology and Immunology Student Association (MISA)

*Materials from **Immunology Section***
Including review notes and 90 review questions with solutions

Price: $10.00 for MISA member
$14.00 for non-MISA member

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Subject title must be in this format: MICB202M - #XXX
(eg. question #1 would be written as #001) One question per e-mail please.
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Overview of the Immune System

Three Lines of Defense

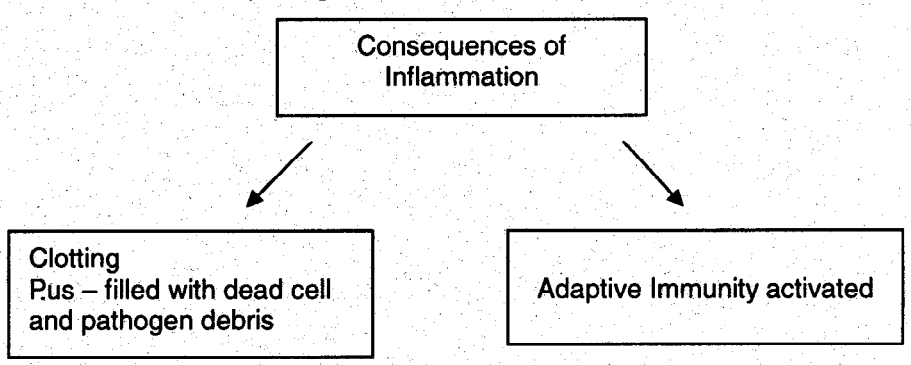
- Anatomical Barrier
- Innate Immune System
  - Neutrophils (aka PMN)
  - Macrophages (or Monocytes)
  - Mast Cells
  - Basophils
  - Nature Killer Cells
  - Eosinophils
  - Immature Dendritic Cells
- Adaptive Immune System
  - Macrophages
  - Dendritic Cells (also known as mature Langerhan Cells)
  - B cells
  - T cells CD8: Cytotoxic T Lymphocyte (kills infected cells)
    CD4: T_{H1} (activates macrophages) & T_{H2} (activates B cells)

Innate vs Adaptive Immune System

Innate Immune System	Adaptive Immune System
Always there	Takes time to prime (inducibility)
No clonal expansion	Has clonal expansion (diversity)
No clonal selection	Has clonal selection (specificity)
No clonal deletion	Has clonal deletion (self-tolerance)
No memory	Has memory (memory T cells & B cells)

Inflammation

1. Breach in anatomical barrier
2. Foreign pathogens enter the wound
3. Phagocytes such as neutrophils and macrophages immediately phagocytose the pathogens and degrade them in phagosomes
4. Cells release hormones such as cytokines and interleukins that increase blood flow and make the site of inflammation red, increase adhesion of nearby blood vessels, increase temperature to dilate vessels, which then attracts more cells of the immune system
5. The site of inflammation becomes swollen
6. Macrophages can release defensins or cytotoxic chemicals such as oxygen radicals and nitric oxide to kill pathogens, but will inevitably kill the surrounding host cells as well

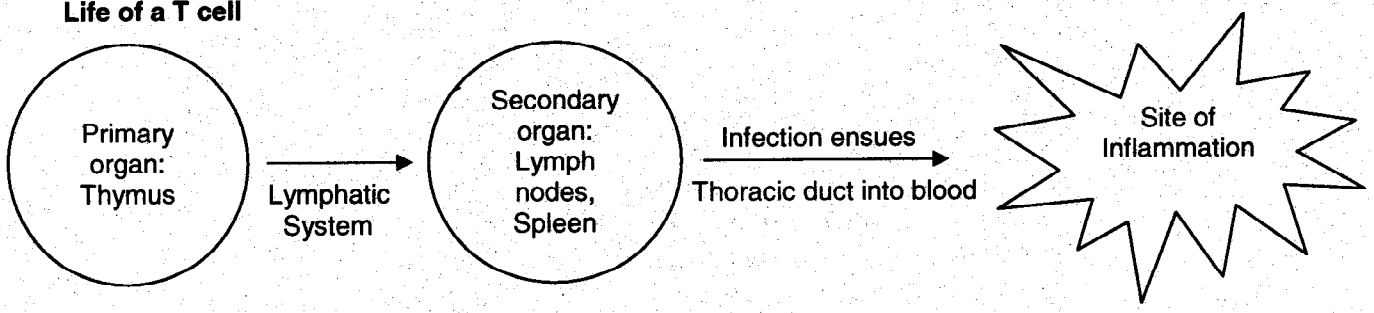


Location of Immune System

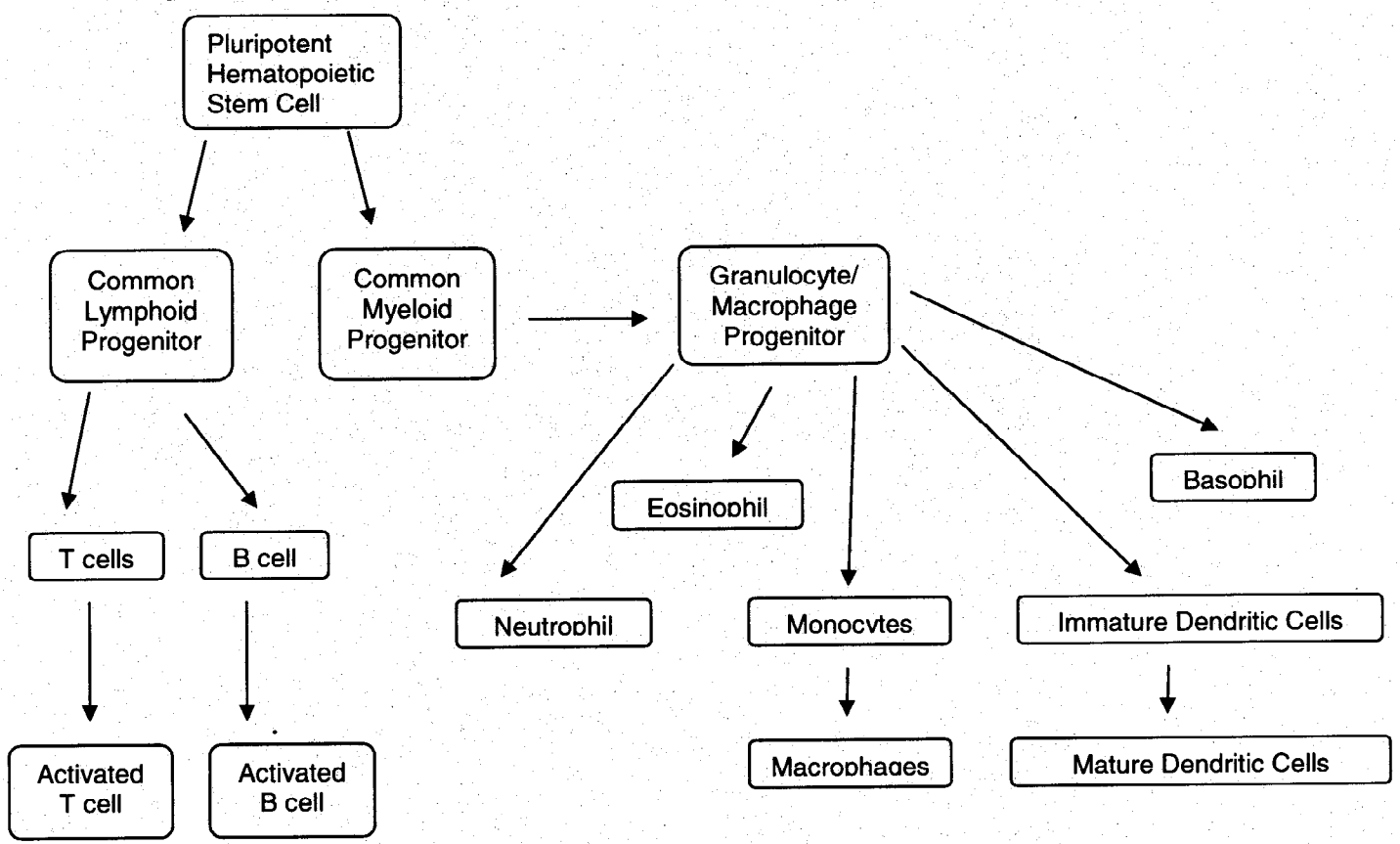
- Blood from the circulatory system contains…
  - Leukocytes
  - Neutrophils
  - Mast cells
  - Basophils
  - Eosinophils
  - NK cells
- Lymphatic system consists of lymphatic organs
  - Primary organs: thymus (T cells), bone marrow (B cells)
  - Secondary organs: spleen, lymph nodes (eg. tonsils), bone marrow

* These two systems are connected through the thoracic duct near the heart where lymphatic fluid drains back to the circulatory system

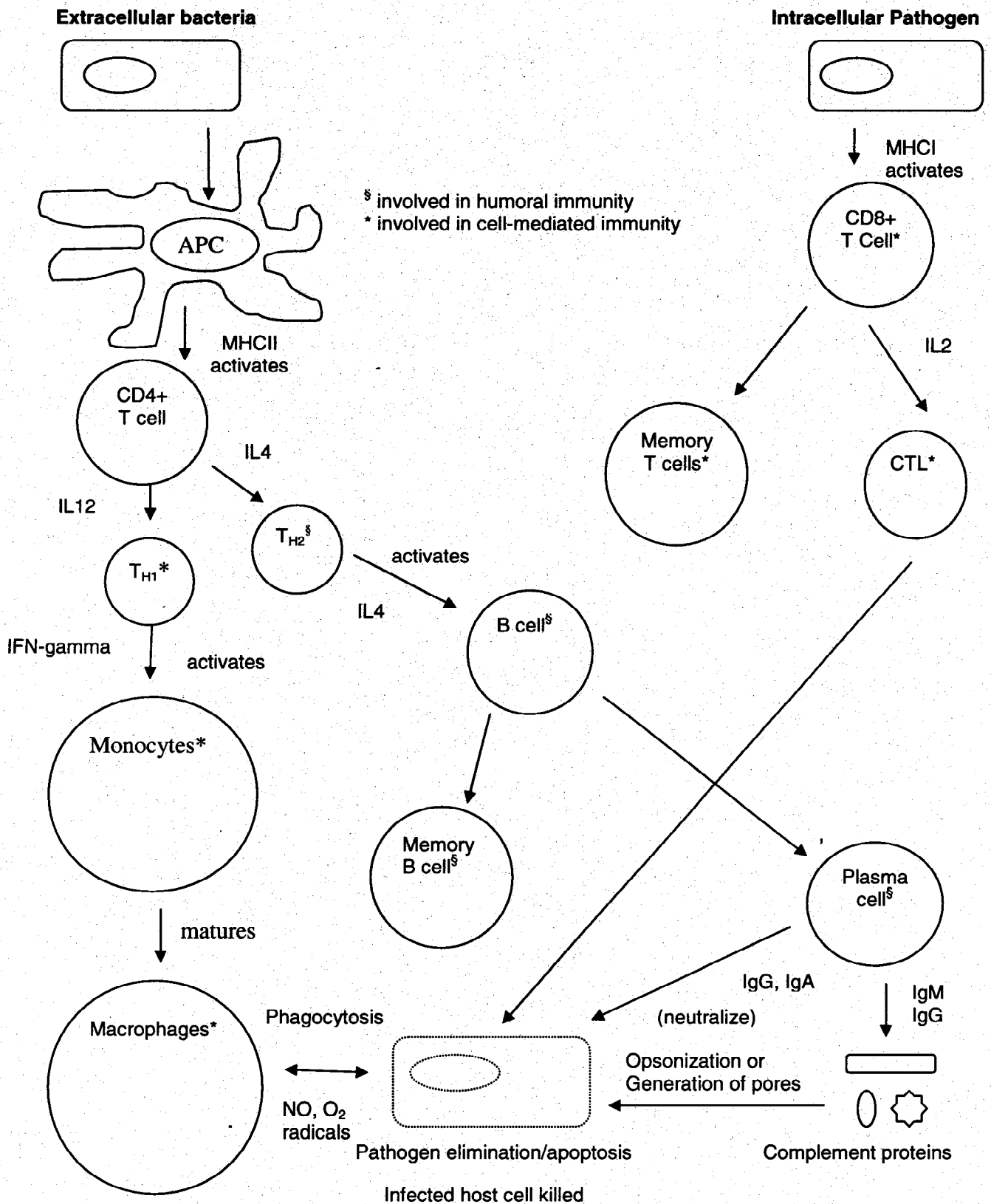
Life of a T cell



A family tree of Immune cells



Cell Interactions in the Immune System – Adaptive Immunity



The Second Line of Defense – Adaptive Immunity and its Role Players

- 95% of infections are prevented by the innate immune system
- the last 5% has to be dealt with by the adaptive immune system
- adaptive immune system often clears off the most of that 5%
- in terms of diseases, there is the <1% of infections that break the adaptive immune response

Does that mean that the adaptive immune system is not good?

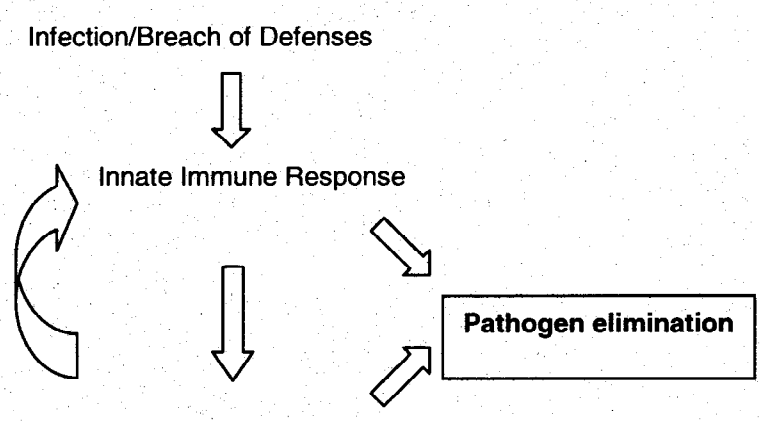
No! It is very good. It is just that while our adaptive immune system has evolved to better eliminate a pathogen, that pathogen has also evolved to avoid or subvert our adaptive immune system

DIVERSITY, SPECIFICITY, MEMORY

- These terms are the fundamental principles of the adaptive immune system
- The diversity and specificity of the adaptive immune system relies on antibodies, T cells and antigen presentation
- Not only does the adaptive immune system provide the second line of defense, it also helps the innate immune system be more effective

RELATED and INTERCONNECTED SYSTEMS

- The adaptive immune system and the innate immune system rely on each other in order to collectively mount the immune response



ADAPTIVE IMMUNE RESPONSE

Antigens: a macromolecule that contains a particular surface (3D shape) that can be recognized by antibodies or receptors for that surface

- Recognition is a physical interaction of two surfaces that are complementary to each other.
- All antigens contain epitopes that are 3D structures with unique surfaces that antibodies and receptors recognize and bind to; an antigen may have more than one epitope
- Remember that antigens may or may not directly induce the adaptive immune system
- Haptens are non-immunogenic that cannot induce an immune response, but have antigenic epitope; haptens require another macromolecule to elicit an immune response
- Immunogens are the antigens that alone can induce an immune response

The Adaptive Immune System

- Adaptive immunity is either antibody induced or cell mediated; which action is undertaken depends on the nature of infection by the pathogen
- Immunological memory is a powerful weapon against disease
- The immune system has modified cells that have seen a given antigen and enabled those cells to bypass some of the checkpoints that a naïve cell would normally have to go through before an immune response can be initiated

Clonal Selection Theory

- The current theory is that the immune system has the capability to recognize any given antigen. Those cells that are specific for one particular antigen are very few in numbers. Only when the antigen makes it

presence known the immune system will specifically start the mass production (clonal expansion) of all the key players in adaptive immunity. This is clonal selection.
- The immune system goes through some vigorous selection process to eliminate any immune cell that will react with self antigens. This is called clonal deletion.

The Humoral Response
- Antibody-driven response that helps eliminate or neutralize extracellular pathogens
- Antibodies can be raised to intracellular pathogens, but it is useless in conferring protection for the individual once the pathogen is inside cells
- MHCII presentation is critical for T cell differentiation into helper cells that activate B cells

Table 1. Key Components of the Humoral Response

Key Player	Role	Requirements	Effector Function and Changes
B cell	Provide secreted antibodies to a specific epitope	Needs to uptake antigen via the BCR and present it on MHC II as "Signal #1" Needs to be activated by activated T_{H2} cells as "Signal #2"	Secretes mostly IgM, will undergo class switching later on and most likely secrete more effective IgG antibodies. Cells either become plasma cells that can secrete Abs or memory B cells that cannot (memory B cells are "ready-to-go" versions of naïve B cells). Memory B cells only need the signal provided by activated T helper cells in order to begin proliferation
T cell (T_{H0})	Provide the necessary cytokines to initiate the humoral response and activate B cells	Needs to be activated by interacting its TCR and CD4 co-receptor with MHCII:peptide complexes	T cells in the humoral response become T_{H2} helper cells T cells can either become effector or memory cells. With memory cells, the "threshold" of activation has been decreased, making it much easier to activate them during a secondary response
Antibody	Bind epitope assisting in phagocytosis, complement killing, or neutralization	Activated B cell required	Class switching possible. Class switching affects affinity for epitope as well as location of antibodies in the body. Keep in mind the differences between antibody classes
APCs capable of presenting MHCII	To present Ag to naïve or memory T cells and activate them	Antigen required and also the capability to express MHC II on the surface. Macrophages, dendritic cells, and B cells are examples of cells with that can express MHC II	Antigen presentation leads to the immune response Gene expression of various cytokines, receptors and adhesion molecules change in order to optimize interactions between the APC and the T cell
Complement components	To provide a pathway in which the humoral response can assist complement-mediated killing	Antibodies that can bind complement and Ag and initiate that pathway.	Complement pathway either leads to assisted phagocytosis or the MAC (membrane attack complex)
Antigen	"Red flag" for immune cells	For an adaptive immune response to occur without vaccine assistance, must be immunogenic	nothing particularly happens to the antigenic surface. The organism that carries this antigen will be affected

Cell Mediated Response

- T cell mediated response that induces the killing of cells that are infected by an intracellular pathogen such as virus or bacteria
- MHC I presentation of cytosolic/cytoplasmic derived proteins are essential for the cell-mediated immune response to occur

Table 2. Key Components of the Cell-Mediated Response

Key Player	Role	Requirements	Effector Function and Changes
T cell	Most important cell in the cell mediated response to induce cell killing and provide the cytokines that favour this response	MHC I:CD8 interaction for CTL killing MHCII:CD4 interaction for macrophage activation. The correct cytokines needed to favour the T_{H1} response over the T_{H2} (antibody) response	Differentiation into many effector T cells. T_{H1} helper (have CD4 on cells secrete cytokines that activate macrophages. CTLs kill the cell that has presented Ag on MHCI (usually for viruses). Memory T cells that will wait for another infection by a pathogen.
APC	Present the necessary antigens on MHCI and MHCII	MHC proteins that can present foreign peptides that are recognizable by T cells	If you want to know, APCs can alter their gene expression levels to maximize their ability to warn the immune system of an infection.
Macrophages	Eating and killing infected cells through the release of more potent antimicrobial agents	Activated T_{H1} cells	Releases more potent antimicrobials such as NO and H_2O_2 and other powerful oxidizing agents.
Antigen	"Red flag" for immune cells	For an adaptive immune response to occur without vaccine assistance, Ag must be immunogenic.	Strictly speaking, nothing particularly happens to the antigenic surface. The organism that carries this antigen will be affected.
NK cell	Natural killer cell that somehow recognizes and kills infected cells that cannot be killed by CTLs	Doesn't need much. It kills cells that that lack MHCI and do not need to undergo clonal expansion.	Actually part of the innate immune system. However, its action mirrors that of CTLs. Facilitates the cell-mediated immune response.

Interaction between T cell and Antigen Presenting Cell

- antigen presentation is one of the most critical parts of the immune response
- To promote CTL differentiation of T cells, the TCR, CD8 and MHC I:peptide complex must interact.
- To promote T helper differentiation, the TCR, CD4 and MHC II:peptide complex must interact.
    - Favouring differentiation into T_{H1} helper cells requires the necessary cytokines that are typically produced when intracellular pathogens are present
    - To get T_{H2} cells, it also requires its own combination of cytokines that will favour the antibody response. Usually these cytokines are produced in response to extracellular pathogen, although there are exceptions. For example, antibodies are raised to HIV even though it is an intracellular pathogen.

Table 3. Disorders of the Immune System

	Disease	Traits	Outcome
Self-reactive autoimmune diseases	**Autoimmune hemolytic anemia**	make antibodies against red blood cells complement proteins lyse antibody-coated red blood cells	less oxygen is delivered to tissues
	Myasthenia gravis	antibodies bind to acetylcholine receptors on muscle cells and prevent muscle cells from responding to neurotransmitter released by nerve cells	block muscle contractions may result in paralysis
	Lupus	antibodies against many self components	kidney blockage by Antigen-antibodies precipitates
	Diabetes (one type of it)	self-reactive T_{H1} cells	inflammatory response due to cytokines tissue damage such as destruction of pancreatic insulin-producing cells due to proteases released by macrophages
Non-functional immunodeficiency diseases	**Severe Combined Immunodeficiency (SCID)**	no functional B cells or T cells eg. no immunoglobulin or T cell receptor gene rearrangements	lymphocytes cannot detect pathogens infections cannot be stopped
	Immunoglobulin deficiency	failure to make IgG	recurrent bacterial infections
		failure to make IgA	recurrent infection
	Complement deficiency	failure to make complement proteins	recurrent bacterial infections complement is needed to help opsonize bacteria
Acquired immunodeficiency diseases	**Acute Immunodeficiency Syndrome (AIDS)**	HIV infects macrophages → spreads to CD4 T cells antibodies against HIV but useless because virus hides inside cells latency stage is inactive, so HIV stays inside cells infection → activates T cell or macrophage → activates virus → spread of HIV to other cells	loss of T helper cells B cells cannot make antibodies macrophages cannot kill intracellular bacteria opportunistic infections may lead to death

Table 4. Treatments for AIDS

	Target	Effect
Old idea	gp120 vaccine	gp120 mutates too rapidly, therefore not effective
Current treatments	AZT, ddI	block DNA synthesis by reverse transcriptase
	protease inhibitor combination of AZT, ddI, protease inhibitors	blocks the cutting of one HIV protein into two
New ideas	target CD4	CD4 is needed for T cells to interact in antigen presentation, so CD4 is not a good target since we do not want antibodies against it
	target the chemokines CCR5, CXCR4	people who are deficient in CCR5 are still healthy, so it may not be necessary for the immune system inject with CCR5, CXCR4 altered versions that do not cause inflammation → HIV binds to these instead of the normal receptors, so CCR5, CXCR4 may be good targets

END OF MIDTERM REVIEW NOTES

Questions

1. Which of the following statements about the function of antibodies is true?
   a) Antibodies protect against intracellular pathogens but not viruses
   b) Antibodies protect against extracellular pathogens but not viruses
   c) Antibodies protect against extracellular pathogens and viruses
   d) Antibodies protect against intracellular pathogens and viruses

2. B lymphocytes produce immunoglobulin proteins that protect against pathogens in several ways. Which of the following is not a mechanism of protections by immunoglobulins?
   a) Increased blood flow to the area of infection
   b) Preventing the entry of toxins into the cells
   c) Increasing the efficiency of the complement system
   d) Targeting antigens for phagocytosis by macrophages

3. Upon binding antigen, the B lymphocyte will...
   a) continue to circulate through the blood; lymph and secondary lymph organs to ensure antibodies reach all parts of the body
   b) migrate to the bone marrow where they will secrete antibodies, which will then circulate through the body
   c) stay in the secondary lymph organs, such as the spleen and lymph nodes, where the cell will secrete antibodies, which will then circulate through the body
   d) b and c
   e) a and b

4. Which is a potential sequence of events in a B cell?
   I. Bacteria bind the membrane bound antibodies of a B cell
   II. B Cells begin to divide
   III. Dendritic cells with antigen on the surface activate helper T cells. T cells activate B cells
   IV. Antibody secretion begins
   V. B cells become "primed" and ready to be activated by T cells

   a) I and II
   b) I, II, VI
   c) I, II, III
   d) VI only
   e) II only
   f) all of the above

   a) I, II, V, III, IV
   b) I, V, II, IV, III
   c) I, V, III, II, IV
   d) V, II, I, III, IV

5. Antibodies bind immunogens to induce an immune response. Which of the following statements about this interaction is true?
   a) Any foreign molecule regardless of size can be bound by an antibody
   b) Each antibody can bind more than one epitope of an antigen
   c) More than one antibody may bind to an antigen if the antigen has multiple distinct epitopes
   d) All organic macromolecules are immunogenic and therefore have the potential to be bound by antibody

6. Which of the following are possible combinations of light and heavy chain in an antibody?

	Light Chain	Heavy Chain
I	kappa kappa	lambda lambda
II	lambda lambda	mu mu
III	lambda kappa	gamma gamma
IV	gamma kappa	delta delta
V	epsilon kappa	kappa epsilon
VI	gamma gamma	kappa kappa

7. Given gamma chain = 50kDa, alpha = 50kDa, mu/delta/epsilon = 70kDa and kappa/lambda= 25kDa. What are the masses of an IgA and an IgG antibody?
   a) Identical
   b) There is not enough information given to determine this, the type of light chain should have been specified
   c) This can only be determined through SDS page gel electrophoresis of each unique antibody
   d) None of the above

8. If the quaternary structure of the antibody molecule is disrupted the result would be...
    a) the dissociation of the light chains from the heavy with the heavy still joined
    b) a pair of light chains and a pair of heavy chains
    c) four separate pieces, the two light and the two heavy chains
    d) no change in structure

9. If we were to randomly compare a human IgM antibody (2 mu chains and 2 kappa) to a goat IgM antibody (2 mu and 2 kappa) we would find...
    a) Sequence identity in the constant region of the H chains as these regions confer the antibody function
    b) Sequence identity in the heavy and the light chain constant regions
    c) Sequence identity in the variable regions of both the heavy and light chains for these two antibodies
    d) No sequence identity in the antibodies
    e) Complete sequence identity in the two molecules

10. The gene encoding the constant region of the Kappa chain undergoes a spontaneous mutation. This would affect antibody function by...
    a) Completely altering the function because the constant region of the antibody is what determines its function
    b) Only a mild functional change because it is the entire interacting antibody structure which confers function
    c) No change in the function of the antibody because it is the light chain variable region which is important for antibody function
    d) No change in antibody function because it is the heavy chain constant region which confers antibody function

11. The antibodies' antigen binding sites are composed of the hyper-variable regions of the heavy and light chains. This means that...
    a) The antigen binding site of the antibody varies with time.
    b) Each antibody can only bind one distinct antigen, one at each of the two distinct binding domains
    c) The antigen binding pocket is shaped by the amino acids of both the hyper-variable regions of the heavy and light chains, which vary widely in different antibodies
    d) B and C

12. Which is the correct sequence of events for assembly and secretion of an antibody?
    a) mRNA is made, the mRNA is translated in the ribosome, the transcript is modified in the smooth endoplasmic reticulum, secretion to extracellular fluid
    b) mRNA is made, mRNA is translated by the ribosome, the antibody is assembled in the endoplasmic reticulum, the assembled antibody is then modified in the golgi apparatus then secreted to the extracellular fluid
    c) mRNA is made, translated by a ribosome, assembled and modified in the Golgi apparatus and then secreted into the extracellular fluid.
    d) mRNA is made, translation by a ribosome, then the protein is secreted into the extracellular fluid

13. Which of the following statements about IgM is false?
    a) IgM pentamers are joined together by ionic bonds
    b) IgM pentamers have a low affinity
    c) IgM is produced mainly during a primary immune response
    d) IgM binds complement proteins and also to bacteria to aid in the innate immune response

14. Which type of antibodies produced in the secondary immune response help kill the bacteria by both opsonization and the complement pathway?
    a) IgG
    b) IgM (membrane bound only)
    c) IgE
    d) IgA (monomeric form only)

15. What would be the most likely result if the IgA antibody J chain was mutated so that it can no longer bind to IgA?
    a) A severe immuno-compromised state
    b) Degradation of all of the IgA antibodies

c) Reduced immunity in areas such as the mucosal lining of the gut
d) No change

16. Which of the following statements best describe the theory behind allergy shots?
    a) Allergies are the result of IgE on a mast cell or basophil binding an antigen. Allergy shots introduce high levels of allergen into the bloodstream until levels reach the point where the body sees the allergen as akin to self and stops responding to it
    b) Allergies are the result of IgE on a mast cell or basophil binding an antigen. Allergy shots introduce small amounts of allergens into the blood stream on a regular basis with the hope that an IgG response will be initiated; upon further exposure to an allergen the IgG will neutralize the allergen before it has a chance to interact with IgE.
    c) The allergy shots work on the same principle as passive immunization; another individual's antibodies to the allergen are introduced into your body to prevent an allergic attack. The passive immunity is short lived and this is why it is necessary to get allergy shots on a regular basis
    d) Allergy shots work by inducing the formation of antibodies that act in a neutralizing manner. Upon the induction of an immune response the cells secreting the neutralizing antibodies proliferate and then begin to secrete antibodies that bind to histamine. The histamine is the neutralized and so are the effects of an allergic response

17. Which antibodies are correctly matched with the processes they are involved in?
    a) IgM, IgG and IgA with complement mediated lysis
    b) IgM and IgG with neutralization
    c) IgG with opsonization
    d) All of the above

18. The B cell receptor is...
    a) A membrane bound receptor for antibodies
    b) Membrane bound IgM
    c) Membrane bound antibody of any type
    d) Membrane bound IgM or IgD with Igα/Igβ

19. Based on your knowledge of antibody function, which of the following is not a potential medical use for antibodies?
    a) Inhibition of auto immune responses through the injection of self antibodies which will act in a neutralizing manner blocking the self antigens causing the problem
    b) Injection to induce passive immunity
    c) Testing for pregnancy
    d) Monitoring the progression of AIDS

20. How many epitopes can a single B cell recognize and how many antigens can it recognize?
    a) 1 epitope, 1 antigen
    b) 1 epitope, a limited number of antigens
    c) a limited number of epitopes, an unlimited number of antigens
    d) 1 epitope, an unlimited number of antigens

21. You are presented with a patient who does have a functional thymus (ie no mature T cells). This person is infected with a bacterium that causes a severe upper respiratory tract infection. To your surprise, this patient generates an antibody response to the bacterium. What will happen when the patient is subsequently exposed to the same pathogen?
    a) The patient will mount a more robust immune response more quickly (within 2-3 days)
    b) The patient will experience the same symptoms as he/she did when initially exposed
    c) The patient will become more ill upon subsequent exposure because IgE is generated
    d) The patient will experience different and unrelated symptoms from the initial exposure

22. What is the molecular weight of IgM?
    a) 70 kDa
    b) 150 kDa
    c) 190 kDa
    d) impossible to determine without more information

23. Self proteins in normal individuals do not elicit an immune response because...
    I. MHC class I and MHC class II proteins only present foreign antigens.
    II. T cells that recognize MHC and self peptides are eliminated by negative selection in the thymus.
    III. self-reactive T cells are clonally deleted in the thymus before entering the periphery
    IV. only T cells recognizing foreign proteins are positively selected in the thymus.

    a) one statement is correct
    b) two statements are correct
    c) three statements are correct
    d) four statements are correct
    e) none of the statements are correct

24. What would be the effect of a defect in the gene that encodes the TAP protein, such that the protein is nonfunctional?
    a) compromised immune responses to most viruses
    b) inability to activate CD4+ T cells
    c) impaired presentation by MHCI
    d) impaired presentation by MHCII
    e) a and c
    d) a and d

25. Which of the following can influence the antigen specificity of the TCR?
    I. CD3 complex
    II. TCR α and β constant regions
    III. CD4
    IV. CD8

    a) I
    b) II
    c) III
    d) IV
    e) all of the above
    f) none of the above

26. Which of the following is not true about resting macrophages?
    a) they express low levels of MHCII
    b) they do not express B7
    c) they are not capable of providing the co-stimulatory signal to T cells
    d) they are poorly phagocytic

27. Which of the following is/are true of T_{H1} cells?
    a) their development is induced by IL12 and IFNγ
    b) their development is induced by IL4
    c) they carry out cell-mediated responses
    d) they carry out humoral responses
    e) b and d
    f) a and c

28. A UBC student at age 21, has been diagnosed with tuberculosis (TB). TB is a deadly and highly contagious disease caused by an intracellular pathogen, *Mycobacterium tuberculosis*. *M. tuberculosis* actually infects the cells that help fight infection - macrophages. They persist in macrophages, ultimately causing lung tissue damage. A pharmaceutical/biotechnology company has come out with a new prophylactic drug that enhances the T_{H2} response. The student decides to try it out because the drug will enhance his adaptive immune response and help clear out the infection by *M. tuberculosis*. What is his rationale for enhancing his T_{H2} response?
    a) the drug increases antibody production to neutralize the bacteria
    b) the drug causes macrophages to be activated and the intracellular bacteria is destroyed
    c) the drug will activate CTLs
    d) none of the above rationales is correct and Timothy is an idiot

29. Influenza is a virus that we are all familiar with. Did you know that there existed extremely deadly strains in the past? For example, the Spanish Flu of 1918 killed 20 million people while the Hong Kong flu virus that should have only infected chickens crossed the species barrier and infected humans, killing people at an alarming 33% rate. The rationale for the high death toll is that the human immune system has never seen this strain of viruses before and could not initiate a fast enough response to combat the virus. Viruses (in

general) have the notorious ability of producing errors in their genome at a high frequency. Using the knowledge of MICB 202's Immunology section, how would this high mutation frequency benefit Influenza in evading this immune system?

a) the antigenic epitope is continuously changing
b) it avoids the complement system by preventing its binding
c) it prevents viral antigen presentation on MHC I proteins
d) the body does not have memory B cells that recognizes this new strain
e) more than one are the above are true

30. Bob has B cells and T cells with normal BCRs and TCRs, respectively, yet he has severe immunodeficiencies in providing an adaptive immune response. Neutrophils, macrophages, are all present, yet when Bob needs to respond to intracellular or extracellular pathogens, he cannot. What is going on here? Where is the deficiency in the response?

a) there is a defect in the light chain production of his antibodies
b) there is a defect in MHC II presentation
c) there is a defect in MHC I presentation only
d) there is a defect in both MHC I and II presentation

31. You isolate an antigenic epitope of interest. However, when you inject this molecule, the body does not mount an antibody response. What is the most likely explanation for this phenomenon?

a) the epitope contains a special motif that is only recognized by IgM
b) the epitope is on a hapten that is not recognized by the immune system
c) the epitope is immunogenic
d) the epitope is from another species and therefore humans cannot make a response to it
e) more than one of the above are correct

32. All of the following are tests that employ ELISA except for...

a) testing concentration of antigens
b) sequencing of the antigenic epitope
c) hybridoma screening
d) blood typing
e) HIV testing.

33. Which of the following are not common to both the humoral and cell-mediated immune response?

I. T helper cells
II. MHC II presentation
III. Cytokines
IV. B cells
V. Antigens

a) Only one is not common to both adaptive immune responses
b) Only two are not common to both adaptive immune responses
c) Three are not common to both adaptive immune responses
d) Four are not common to both adaptive immune responses
e) All are not common to both adaptive immune responses
f) None are not common to both adaptive immune responses

34. The adaptive immune response helps out the innate immune response by...

a) Producing antibodies that aid in opsonization and phagocytosis of pathogens
b) Activate macrophages to kill pathogens more efficiently
c) Causing the release of lysozyme into saliva to destroy the peptidoglycan of bacteria
d) Two of the above are true
e) All of the above are true

35. Consider the following statements...

I. MHCI:peptide complex interacts with CD8+ T cells to elicit the CTL response
II. MHCI:peptide complex interacts with CD4+ T cells to elicit the CTL response
III. MHCII:peptide complex interacts with CD4+ T cells to elicit the CTL response
IV. MHCII:peptide complex interacts with CD8+ T cells to elicit the humoral response

a) One statement is true
b) Two statements are true
c) Three statements are true

d) All statements are true
e) None of the statements are true

36. The secondary cell-mediated adaptive immune response is always faster than the humoral adaptive immune response. True or false?

37. B cells always become plasma cells. True or false?

38. Naïve B cells need just the signal from activated T helper cells in order to undergo clonal expansion. True or false?

39. T cells can differentiate into CTL's in response to a viral infection. True or false?

40. The T cell receptor (TCR) interacts only with the MHC molecule. True or false?

41. Cytokines are only good for the adaptive immune response. True or false?

42. Antibodies can be made in response to intracellular pathogens (e.g. virus). True or false?

43. Which of the following are a part of the clonal selection theory?
    I. Deletion of cells that recognize self antigens leaving cells that only recognize foreign antigens
    II. Activation of a large number of naïve cells that recognize one epitope on a given antigen and undergoing clonal expansion (clonal expansion = cell division)
    III. Activation of one or few naïve cells that recognize an epitope on a given antigen and undergoing clonal expansion

    a) I and II
    b) II and III
    c) I and III
    d) None of the above

44. Since the dawn of time, human beings have encountered pathogens of all kinds. From viruses and bacteria of a million years ago to the ones that plague the world today, such as HIV, Anthrax, and the West Nile Virus. Pathogens have evolved to evade the host immune system and to survive, replicate, and cause disease. However, the immune system has been equal to the task by evolving itself. Thus, there is a constant war going on between the immune system and the pathogens. Considering the immune system as you know it in MICB 202, which of the following statements are true?
    a) The adaptive immune system is "ready to go" regardless of challenges by pathogens
    b) Once the adaptive immune system is initiated, the infection will be cleared
    c) The flu virus evades the adaptive immune system via mutation of the epitopes that the immune system recognizes
    d) More than one statement is true
    e) None of the statements are true

45. Which of the following statements is correct?
    a) Bacteria capable of inhibiting phagolysosome fusion can prevent MHC II: peptide presentation of bacterial antigens via this pathway entirely
    b) The difference between MHC I and MHC II is that MHC II has one transmembrane chain where two of its domains interact with the peptide and T cell receptor
    c) The diversity of MHC presentation is enhanced by its broad specificity (ability to bind many peptides) and the ability to bind many intact proteins in its groove
    d) A person with a given MHC set is capable of responding to a certain array of antigens

46. Considering a mouse lacking both B cells and T cells, which of the following choices is correct?
    I. Introduction of peptides for MHC molecules and B cells will initiate the clonal expansion of B cells followed by the secretion of antibodies.
    II. Skin grafts to replace wounds of these mice will elicit graft rejection.

    a) Only I is true
    b) Only II is true
    c) Both statements are true
    d) Both statements are not true

47. Cytotoxic T lymphocytes can kill tumor cells because...
    a) Tumor cells express or make proteins that are not found in normal cells
    b) Some of these tumor antigens were not considered "self" during the deletion process of a developing thymus. Therefore, MHC II molecules that are capable of binding peptides derived from tumor Ag can elicit a proper CTL response
    c) CTL's can produce antibodies that can help kill tumour cells
    d) a and b
    e) None of the above

48. Put the following in order in which the adaptive immune system would respond to an extracellular pathogen secreting an antigenic toxin.
    I. T and B cell memory cells reactivated during a later infection
    II. Antibody secretion
    III. Antigen presentation on MHC
    IV. Binding and neutralization of toxin during the primary response
    V. Activation of T helper cells
    VI. Activation and differentiation of B cells

    a) III, II, IV, V, I, VI
    b) III, V, I, VI, V, IV
    c) III, V, VI, II, IV, I
    d) III, VI, V, II, IV, I
    e) III, V, VI, I, IV, II

49. The adaptive immune system is characterized by...
    a) Memory
    b) Specificity
    c) Uniformity
    d) a and b
    e) a, b, and c

50. Which of the following best characterizes the primary antibody response?
    a) IgM
    b) Class switching
    c) Memory cells
    d) Residual antibody level present

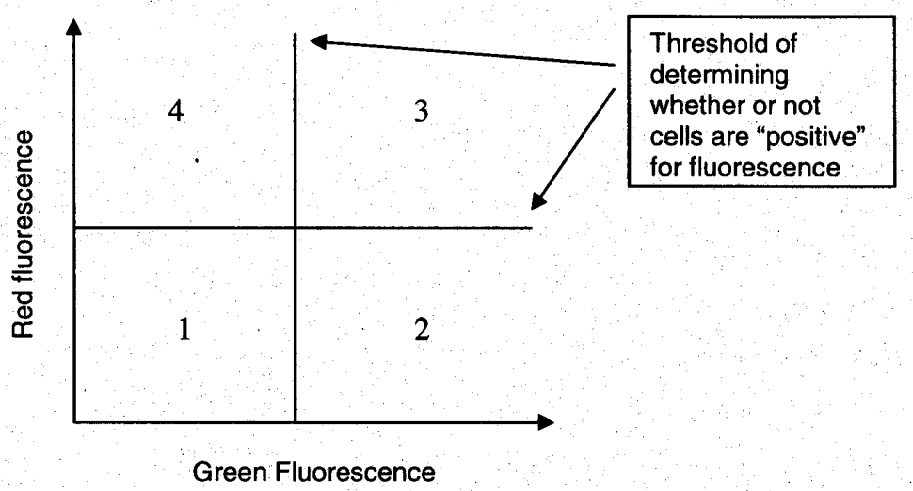
51. MHCI or MHCII deficiencies each show...
    a) Problems with presentation of antigens to different T cells
    b) The absence of both CD4+ and CD8+ T cells
    c) Defects in NK cell function
    d) An inability to deal effectively with extracellular parasites
    e) An absence of only CD8+ T cells

52. All of the following are possible uses of antibodies except...
    a) Detection of pathogens
    b) Detection of antibodies
    c) Detection of proteins
    d) Detection of 3D surfaces
    e) Two are valid statements
    f) Three are valid statements
    g) All are valid statements

53. The main point of using antibodies as diagnostic and research tools is that...
    a) Antibodies that can be used as treatment against viruses and bacteria.
    b) You can make antibodies can recognize any epitopes, and therefore we can isolate or detect for the presence of any antigen that carries our epitopes of interest via FACS analysis, ELISA, or immunofluorescence.
    c) Antibodies can be used to diagnose the presence of disease.
    d) Two statements are correct.
    e) All statements are correct.

54. A person with SCID (due to dysfunctional BCR and TCR rearrangement) donated a sample of his/her lymph node to a well known research laboratory for FACS analysis. The top-of-the-line FACS machine was set up so that it would detect for the BCR of B cells via a green fluorescent antibody and the TCR of T cells via the red fluorescent antibody.

    Observe the following FACS diagram:



Which region(s) would we find this person's B and/or T cells?
a) Regions 1 and 2
b) Regions 1 and 3
c) Regions 2 and 4
d) Regions 3 and 4
e) None of the above

58. Which of the following statements are true?
    a) vaccination provides long lasting immunity
    b) immunogen = antigenic determinant
    c) attenuate = inactivate
    d) none of the above
    e) more than one of the above

59. Steroids such as cortisone are used to suppress the immune system in order to treat which autoimmune disease?
    a) myasthenia gravis
    b) autoimmune hemolytic anemia
    c) those caused by self-reactive TH1 cells
    d) those caused by precipitates of Ag-Ab complexes in the kidneys (eg. lupus)

55. Imagine you are working in a hospital and a patient comes in with a severe allergic reaction to peanuts. How do you treat this patient?
    a) give vasodilators so more antibodies can enter the bloodstream
    b) give morphine to relax them
    c) give allergy shots
    d) give antihistamines
    e) supply more allergens in order to stimulate more antibodies

56. What is an epitope and what role does it have in a vaccine?
    a) it is a part of an antibody that binds to the antigen
    b) it is part of the BCR that recognizes antigens
    c) it is part of the antigen that is recognized by the BCR
    d) it is part of the pathogen that mutates at an alarming rate
    e) none of the above

57. How do you obtain passive immunization?
    a) vaccination with heat-killed bacteria
    b) injection with antibodies
    c) mother's blood
    d) mother's milk
    e) a,b,c
    f) a,b,d
    g) b,c,d
    h) all of the above

60. What is the result of faulty clonal deletion?
    a) will result in an autoimmune disease because T cells can no longer activate cells
    b) will result in an autoimmune disease because B cells are now unable to secrete antibodies
    c) will result in an autoimmune disease because the antibodies will not bind foreign antigens as well
    d) failure to negatively select B and T cells during development in the bone marrow
    e) more than one of the above is true

61. Todd has an inherited immunodeficiency disease where he is constantly acquiring bacterial infections. Which of the following is/are true?

I. deficiency in certain complement proteins and results in bacteriolysis
II. he has defects in producing specific classes of immunoglobulins
III. the ratio of memory T cells to memory B cells is too high
IV. developing T and B cells cannot rearrange their gene segments that make up the BCR and TCR

a) one of the above are true
b) two of the above are true
c) three of the above are true
d) all of the above are true
e) none of the above are true

62. Practical strategies for preventing the spread of HIV through T cells in an infected individual include...
a) transplant a new thymus to supply the body with healthier T cells
b) inject people with an antibody to CD4 so HIV virus cannot bind to it
c) induce a mutation in the TCR receptor
d) injecting altered version of chemokine for CCR5 or CXCR4

63. What is the clinical definition of AIDS?
a) >20% CD4 helper T cells
b) <20% killer T cells (CTLs)
c) >20% CD8 helper T cells
d) <20% CD4 helper T cells

64. How do azidothymidine (AZT) and dideoxyinosine (ddI) therapies prevent HIV replication?
I. Inhibit DNA polymerase
II. Inhibit HIV from making a DNA copy of its genome
III. Inhibit reverse transcriptase
IV. Inhibit HIV from making a RNA copy of its genome

a) I, IV, V
b) I, III, IV
c) II, III, IV
d) II, IV, V

67. Which of the following is not true?
a) I and II
b) III and IV
c) II and III
d) I and IV

65. ABO antigens on red blood cells are co-dominant. Which of the following statements is also true?
I. People with type O blood have no natural antibodies against ABO antigens on red blood cells.
II. People with type O blood cannot receive blood of all types.
III. Type B blood will agglutinate with anti-A antibodies.
IV. People with type AB blood have anti-A and anti-B antibodies.

a) One of the above statements is true.
b) Two of the above statements are true.
c) Three of the above statements are true.
d) All of the above statements are true.

66. What would be needed in an ELISA used to measure the amount of blood type antigen in a person with type A blood, assuming the antigen could be isolated from the red blood cells?
I. anti-A IgG primary antibody
II. anti-B IgG primary antibody
III. anti-IgG secondary antibody conjugated to enzyme
IV. enzyme substrate
V. anti-A IgG secondary antibody

a) Transgenes used to make transgenic mice are randomly inserted
b) To make transgenic and knock-out mice, pseudo-pregnant mice are used
c) Transgenes are inserted into embryonic stem cells to make transgenic mice

d) Knock-out mice are chimeric because they are derived from normal ES cells in the blastocyst and injected ES cells

68. Which of the following statements about cytotoxic T cells is true?
    a) CTLs kill macrophages infected with intracellular bacteria
    b) CTLs kill virus infected cells
    c) CTLs kill cells that do not present MHC II molecules
    d) none of the above

69. Even though a polyclonal antisera may contain many types of antibodies, its shortcomings include...
    a) They contain too much variety between different isolates to be standardized.
    b) They are not useful when it comes to detecting a single epitope
    c) It is tedious to make, when compared to a monoclonal serum
    d) You can only have a limited supply; You cannot create 'immortal' rabbits!
    e) All of the above
    f) All but one of a to d
    g) All but two of a to d

70. Should you use a polyclonal secondary antibody or a monoclonal secondary antibody to test for the presence of primary antibody binding in an ELISA?
    a) Polyclonal antibodies; they will produce a greater amplification of the signal of interest.
    b) Polyclonal antibodies; a higher chance of one of the antibodies attaching to the primary antibody
    c) Monoclonal antibodies. They are more specific so you can detect the signal better
    d) Monoclonal antibodies. Since you make hybridomas, you can have a ready supply to use
    e) None of the above

71. You get into a bloody accident and is in desperate need for a blood fusion. You have Type AB blood. The hospital luckily has blood of all blood types available. Which ones can you use and which ones do you have to watch out for agglutination?
    a) You can receive Type O as it is the 'universal donor' blood.
    b) You can receive Type A because your body already makes antibodies for the A antigen.
    c) You can receive Type B because your body already makes antibodies for the B antigen.
    d) You can only receive Type AB and Type O because your body will make antibodies against Type A and Type B, but not type O.
    e) Two of the statements above are true.
    f) Three of the statements above are true.

72. How can intracellular bacteria evade the immune system?
    a) they prevents the complement system to be activated
    b) they induces the production of reactive oxygen species
    c) they increase antigen presentation on MHC I proteins
    d) it prevents the fusion of the phagosome and lysosome and allows the bacteria to persist inside the macrophage
    e) more than one of these choices are correct

73. How do nude mice deal with intracellular bacterial infections?
    a) they cannot deal with bacterial infections
    b) in the thymus, CD4+ T_{H1} cells are activated which in turn activate macrophages
    c) in the thymus, CD8+ CTL cells are activated which in turn activate macrophages
    d) none of the above

74. One night when Pinky and Brain were trying to devise a plan to take over the world, Pinky accidentally drinks an unknown potion. Unbeknownst to Brain, as he bashes Pinky for his stupidity, this potion contains a very strong fluorescence tagged antibody. If Pinky was exposed to a piece of light sensitive film, and his whole body glowed, which of the following would be the correct explanation?
    a) Pinky is healthy and the antibody binds to B7 proteins on B cells
    b) Pinky is healthy and the antibody binds to MHC II
    c) Pinky has a lung infection and the antibody binds to alveolar macrophages
    d) Pinky is healthy and the antibody binds to MHC I
    e) none of the above

75. Dennis is allergic to peanuts. In fact, his allergies are so bad that he will die if he eats anything containing peanuts. Given your knowledge of the immune system, which of the following components are involved in this hypersensitive response?

    I. Mast Cells
    II. Lymphocytes
    III. Histamines
    IV. Phagocytes
    V. PMNs
    VI. T Cells
    VII. NK cells
    VIII. B Cells
    IX. Eosinophils
    X. Basophil

    a) One of the above components are involved
    b) Two of the above components are involved
    c) Three of the above components are involved
    d) Four of the above components are involved
    e) More than four of the above components are involved

76. Professor Gumby has some SCID mice. Because he has blown his research grant on his hobby - making floral arrangements – and thus, he wants to use as little material as possible to conduct his experiment. By injecting and/or transplanting, which would the best option to temporarily restore the mice's adaptive immune system?

    I. T cells and B cells
    II. a thymus
    III. granulocytes
    IV. bone marrow
    V. bone marrow and T cells

    a) Inject I
    b) Inject/transplant II and IV
    c) Inject/transplant II and V
    d) Transplant II
    e) None of the above

77. Professor Gumby also has some nude mice. By injecting and/or transplanting which of the following would restore the mice's adaptive immune system permanently?

    I. T cells and B cells
    II. a thymus
    III. Granulocytes
    IV. Bone Marrow
    V. Bone Marrow & T cells

    a) Inject I
    b) Inject/transplant II and IV
    c) Inject/transplant II and V
    d) Transplant II
    e) None of the above

78. Vancouver Canucks captain is slashed with a hockey stick. Redness and swelling occurs at the site of the injury. Which of the following would best describe the situation?

    a) increased blood flow due to vasodilation
    b) B cells are activated and they migrate to the site of infection
    c) complement proteins destroy tissue, releasing blood underneath the skin
    d) cells release substances that induce pain
    e) more than one of the above

79. Professor Gumby is again in his lab working with mice. He wanted to investigate the effectiveness of the innate and adaptive immune systems. He knocked out PMNs in one group of mice, knocked out T cells from another group and left one group as control (ie. did nothing to them). Which group had the highest mortality rate after infection with a virus?

    a) PMN knockouts and T cell knockouts have the same mortality rate
    b) T cell knockouts have a higher mortality rate
    c) PMN knockouts have a higher mortality rate
    d) the control had the higher mortality rate
    e) all groups had some mortality rate

80. Which of the following are characteristic of the innate immune system?

I. specificity inherited in the genome
II. same specificity expressed by all cells of a particular type
III. trigger immediate response
IV. recognize broad classes of pathogens
V. require gene rearrangement
VI. clonal distinction
VII. able to recognize a side variety of molecular structures

a) two of the above are true
b) three of the above are true
c) four of the above are true
d) five of the above are true

81. Professor Gumby has finished his work with mice and is moving on to experiments with making new drugs. He synthetically makes a new drug that raises the pH of lysosomes. He takes this drug himself and gets infected with extracellular bacteria. Given your background in immunology, predict what happens to Gumby.
    a) antigen peptides are presented more efficiently
    b) antibodies to pathogen is not made
    c) antigen peptides are not presented on MHCII proteins
    d) two of the above are true
    e) all three statements are true

82. Michael has a pet ant. One day, while Michael was playing with his ant, his pet received a cut upon a rather sharp, bacteria covered raspberry thorn. Which of the following best describe the ant's immune response?
    a) Innate immunity, followed by adaptive immunity when previous line of defense is overwhelmed
    b) Adaptive immunity, followed by innate immunity when previous line of defense is overwhelmed
    c) Adaptive immunity only
    d) Innate immunity only
    e) What immunity? Insects do not have an immune system!

83. How many of the following are leukocytes?
    T cells
    B cells
    Mast cells
    Basophils
    NK cells
    Red blood cells
    White blood cells
    Dendritic cells
    Monocyte
    Macrophages
    PMNs
    Eosinophils

    a) 2
    b) 4
    c) 6
    d) 8
    e) more than 8

84. Which of the following does NOT happen when T cells become activated?
    a) Increase production of ribosomes and ER
    b) T cells divide
    c) CD40 on B cells bind CD40L on T cells
    d) Activated T cells produce IL4, causing B cells to divide
    e) All of the above

85. Which of the following kill by phagocytosis?
    I. Macrophages
    II. PMNs
    III. CTL
    IV. B cells
    V. Langerhan cells
    VI. NK cells

    a) I, II, IV, V
    b) I, II, V
    c) III, VI
    d) III, V, VI
    e) all of the above

86. The inflammatory response includes everything except:
    a) increased permeability of blood vessels

b) increase release of histamines and tumor necrosis factor
c) increase recruitment of phagocytic cells
d) decrease production of complement protein

87. MHCI proteins can/are...
I. bind to CD8 protein
II. bind to exogenous antigens
III. found on Langerhan cells
IV. part of signal 1
V. found on plasma cells
a) I, III, IV
b) I, III, V
c) I, II, III
d) I, II, IV
e) I, IV, V

88. Which of the following compounds are not directly associated with infections from intracellular pathogens?
a) IL12
b) INF Gamma
c) Nitric Oxide
d) oxygen radicals
e) IL4

89. What cytokines are not released by T_{H1} cells to activate macrophages?
a) INF Gamma
b) TNF beta
c) IL10
d) IL3
e) GM-CSF

90. Which components of the immune response require T cells for functioning?
a) plamsa cells
b) dendritic cells
c) macrophages
d) all of the above
e) 2 of the above

END OF REVIEW QUESTIONS

Solutions

1. C. Think about where in the body antibodies act. They are present on the surface of B cells as well as in secreted forms in the blood and other bodily secretions

2. A. The first thing to realize is that immunoglobulin is another word for antibody. From there, move on to thinking about the functions dof antibodies and the adaptive immune system. The adaptive immune system provides the antibodies necessary to prevent toxin entry so B is true. The adaptive immune system works with the complement system (which is part of the innate defenses) to increase efficiency of lysis; therefore C is true. Answer D is also true of the adaptive immune system. Answer A is true only of the innate immune system and thereby is our answer.

3. C.

4. C. The first event in any antibody secretion process is the binding of antigen by a B cell, this activates the B cell but it can not divide or secrete antibodies before a helper T cell activated by the same antigen binds- this is a mechanism of ensuring self tolerance. Once the T cell binds the activated B cell the cells begin to divide and become either memory cells or antibody secreting cells.

5. C. A is not true because low molecular weight substances, call haptens, are too small to bind antibodies and are therefore non-immunogenic. B is false because each antibody is very specific and will bind only one distinct antigen. D is also false because not all nucleic acids are immunogenic. C is true; an antigen may have multiple epitopes and therefore be bound by several distinct specific antibodies.

6. E. A light chain consists of two distinct chains, these chains can be either kappa or lambda but they must be identical. In the heavy chain there again should be two identical chains, these chains can be 2 gamma, 2 epsilon, 2 mu, 2 alpha, or 2 delta. From this it can be seen that the only correct answer is number 2.

7. A. An IgA antibody has 2 light chains; either two kappa or two lambda with 2 alpha heavy chains therefore weighs 150kDa. An IgG antibody also has two light chains, either 2 kappa or 2 lambda and two gamma

heavy chains, therefore it weighs 150kDa. The mass of the two chains is identical. B is incorrect because the two potential light chains have the same mass; While C is a method for determining the mass of an antibody it is not the only method, especially when type is known.

8. C. Quaternary structure is the structure arising from the interaction between different protein subunits and is usually linked to things like the disulphide binds between the R groups of the amino acids. Light chain association with a heavy chain and the association of the two heavy chains is reliant on this and therefore if it were disrupted the end result would be four pieces of protein, the 2 light chains and the 2 heavy chains.

9. D. We would not expect to find any sequence identity between these two antibodies. Antibody sequence is species specific for all antibody regions. This difference is the basis for many assays using antibodies, which rely on the ability to have recognition of the constant region of one species antibody by the antigen-binding region of another species antibody.

10. D. The constant region of the antibodies heavy chain is the force deciding what the function will be, while disrupting the light chain constant region may alter the strength of the association between the two chains its effect on the functional specificity of the molecule will be little if any.

11. D. The antibody molecule binds only one distinct antigen through out its lifetime and binds the same antigen with both arms. The antigen, which is bound, is determined by the shape of the binding pocket, which is in turn decided upon by the amino acids making up the protein pocket. The amino acids making up the protein pocket do not vary with time.

12. B. As with any synthesis of protein, the mRNA transcript is produced first, followed by the translation of this transcript, which is done by ribosomes. In our case, theses are ribosomes bound to the rough ER. In the ER, this is the site of assembly of proteins for monomers to polymers, the next step is the modification which happens in the golgi apparatus followed by the secretion.

13. A. IgM monomers are joined by disulphide bonds to create pentamers. These molecules do have a low affinity, which is binding power and a high avidity, which is the cumulative strength of the bonds. The IgM antibodies are also involved in the support of the complement pathway therefore answer D is true.

14. A. IgG is the antibody involved in these functions. Secreted IgM is also involved.

15. C. There will be a reduced immunity in the gut because the J chain is involved in holding the 2 IgA monomers and the secretory piece together such that the antibody is capable of passing through the mucosal lining into the gut. A severe immuno-compromised state will not result, as this chain is not necessary for the rest of the immune system to function, it is also not necessary for stable formation of IgA antibodies.

16. B. Allergy shots work to change the type of antibody responding and therefore minimize the effects associated with the production of IgE. Answer a is not possible as self tolerance arises through clonal selection of massive amounts of antigen, c could in theory work if the introduced antibodies were IgG antibodies but this would be a poor system and is not the mechanism relied upon. Answer d is also not accurate as it would be very detrimental to the innate immune system if the body were neutralizing its own histamines.

17. C. Note the primary functions of the three most important secreted antibodies (we won't pay much attention to IgE which is also secreted)
IgM: complement-mediated killing of bacteria
IgG: complement-mediated killing of bacteria and opsonization
IgA: neutralization
Please be aware that all secreted antibodies are capable of neutralization, but make sure you know the primary functions listed above. Thus IgG = opsonization is the correct answer.

18. D. The BCR is a membrane bound IgM or IgD with it's associated co-stimulatory molecules Ig alpha/beta; it is a membrane bound antibody, it does not bind antibodies. Note: the only difference between secreted and membrane bound antibodies are that membrane bound

antibodies contain a hydrophobic signal sequence at their C-terminus that causes it to "get stuck" in the hydrophobic membrane.

19. A. The whole problem in an auto immune response is that antibodies are binding to self. This is not the type of interaction that can be dealt with through neutralization. Antibodies can be used to induce passive immunity, pregnancy can be tested by probing a sample with antibodies to hormones produced only during pregnancy and with aids the number of t cells still remaining in a sample of blood ca be tested through the use of antibodies linked to a substrate or enzyme.

20. B. A single B-cell has many copies of mIg, all with the same protein-binding groove. In other words, they all recognize the same protein. As such, a single antibody molcule binds only to a small portion of an antigen molecule, called the epitope (which may only be 4-5 amino acids long, very short...) However, different antigens may have small regions of similarity so that a B-cell with Igs recognizing the same epitope may bind more than one antigen. The number of antigens is limited because the antigens must be quite closely related in order to share the same epitope.

21. B. Most (if not all) bacteria possess LPS, which is an example of a molecule that can activate B-cells in the absence of T-cell help. However, this T-independent activation of B-cells does not generate immunological memory, which would create a quicker more robust response upon repeated exposure to the same pathogen. Therefore, the antibody response will not make the patient sicker upon subsequent exposure, but it also will not help.

22. C. IgM, like all antibodies, consists of two identical light chains, and two identical heavy chains. Light chains are 25 kDa each, and the μ heavy chain is 70 kDa each. (25 x 2) + (70 x 2) = 190 kDa.

23. B. Statements II and IV are correct.

24. E.

25. F.

26. D.

27. F.

28. D. TB is an intracellular pathogen. TH2 responses promote the humoral response. The production of antibodies to an intracellular pathogen is not the best solution. So Tim's rationale is not a good one, and the drug will not help. TB is a complicated disease, and people are still devising ways to kill the infected cells without causing damage to one's on body.

29. A. High mutation frequencies increase the likelihood of changing the epitopes that the immune system recognizes (or used to recognize). If a virus changes its epitopes, then the immune system may not be able to recognize the pathogen anymore OR it will have to resort to the primary response. This is a major problem because the basis of vaccines is immunological memory. Memory against epitopes that don't exist anymore forces the immune system to go back to a primary response, which can be too slow in providing protection against a virus.

30. D. If you wanted to block the entry of a virus, you could use an antibody. In order to get antibody production, you would need the TH2 response. Cytokines that promote TH2 differentiation and therefore antibody production would be the logical choice.

31. B.

32. B.

33. A. B cells are the only component on that list that is unique to what we classify as the humoral response. MHC II presentation affects both humoral and cell-mediated responses.

34. D. The release of lysozyme is a part of the innate immune system.

35. A. All the other answers have at least one component wrong.

36. False

37. False

38. False. They need to present on MHC II as well.

39. True

40. False. TCR recognizes a surface that is comprised of both the MHC and the peptide.

41. False

42. True. However, antibodies to viruses may not be effective if too many cells have been infected. A preventative antibody effect is useless at this point.

43. F. Answer B is wrong because there are only one or two cells in the entire naïve T and B cell population that will recognize a given epitope on a given antigen.

44. C. Answer A is wrong because the adaptive immune system must be induced by an infection before it can do anything.

45. D. We have many versions of MHC molecules that enhance the diversity of our ability to recognize antigens. The population of a species may be able to recognize all antigens possible, but on an individual basis, one can only possess the ability to recognize a certain set of antigens. Best to answer this question with process of elimination.

46. D. No B cells or T cells means no adaptive immune system. Graft rejection is a result of the reactivity of T cells to foreign MHC. No T cells, no rejection.

47. D. Answer C is false because CTLs do not excrete antibodies.

48. C. Antigen presentation occurs first, followed by activation of T cells. T cells then activate B cells. B cells excrete antibodies. Memory cells act when another infection occurs.

49. D. The adaptive immune system is not uniform, or broad. It is specific.

50. A. The primary response in terms of antibody production is the immunoglobulin type. IgM is secreted first most of the time.

51. A. While Answer D could be true, A is a much better answer. MHC is directly involved in antigen presentation.

52. G. All of the answers are valid uses of antibodies.

53. D. A is wrong because this is option is a treatment, not a tool for diagnosis and research.

54. E. No functional B or T cells in this case means to BCR and TCR. Therefore the fluorescent antibodies used will never bind to anything in the serum and you wouldn't see anything on the FACS diagram, except for background noise.

55. D.

56. C.

57. G.

58. C.

59. D.

60. D.

61. B. Statements II and IV are correct.

62. D.

63. D.

64. C.

65. B.

66. B.

67. C.

68. B.

69. F.

70. A.

71. F.

72. D.

73. A.

74. D. Answer A is not correct as B cells do not produce B7 unless they are activated. Answer B is not correct because only APC can present MHCII. Answer D is correct since MHCI is present on all nucleated cells in the body.

75. C. I, III, and X are involved in hypersensitive response.

76. A.

77. D.

78. E. Both answers A and D are correct.

79. B.

80. C.

81. C.

82. D.

83. E. All are leukocytes except for red blood cells.

84. A.

85. B.

86. D.

87. A.

88. E.

89. C.

90. D. CD4+ T cells are needed to activate naive B-cells and both dendritic cells and macrophages are antigen presenting cells which can present antigen to T cells for activation.

GOOD LUCK ON YOUR MICB 202 MIDTERM!