

1. (3 points) Immediately after a pathogen enters the body, it faces the cells and soluble proteins of the innate immune system. Which of the following are characteristics of innate immunity?
 - a. inflammation
 - b. activation of complement
 - c. phagocytosis of pathogens
 - d. b and c
 - e. **all of the above**

2. (3 points) Which of the following properties are unique to the adaptive immune system and NOT shared with the innate immune system?
 - a. rapid response
 - b. **the ability to impart long term memory**
 - c. the ability to produce cytokines that induce vascular dilation
 - d. a and b
 - e. all of the above

3. (1 point) Which of the following provides a highly specialized defense against one pathogen that is of little effect against infection by a different pathogen? (Note: there are only three choices for an answer)
 - a. innate immunity
 - b. **adaptive immunity**
 - c. both

4. (3 points) Which of the following derive from pluripotent hematopoietic stem cells?
 - a. B lymphocytes
 - b. neutrophils
 - c. macrophages
 - d. b and c
 - e. **all of the above**

5. (3 points) In an adult, pluripotent hematopoietic stem cells are located in the
 - a. thymus
 - b. spleen
 - c. lymph nodes
 - d. **bone marrow**
 - e. none of the above

6. (3 points) Which of the following cells function primarily in innate immunity?
 - a. lymphocytes
 - b. plasma cells
 - c. dendritic cells
 - d. b and c
 - e. **none of the above**

7. (3 points) A pathogen will meet naïve lymphocytes for the first time in the
- bone marrow
 - spleen
 - lymph nodes
 - b and c**
 - all of the above
8. (3 points) Which of the following areas of the body contain lymphoid tissue?
- stomach
 - lungs
 - oral cavity
 - b and c
 - all of the above**
9. (3 points) Which of the following is/are TRUE regarding immunoglobulin molecules (antibodies)?
- they are produced by the adaptive immune system, but can enhance the function of cells of the innate immune system (e.g., macrophages)**
 - they recognize (bind) degraded antigens presented by helper T cells (T_H cells)
 - in an individual, the entire amino acid sequence of all IgGs is identical
 - a and b
 - none of the above
10. (3 points) Which of the following is/are TRUE regarding B cell receptors for antigen (BCRs)?
- DNA that encode BCRs is present in a fragmented form in all nucleated cells, but is only rearranged to form functional genes in developing B cells
 - Two of the five isoforms of the heavy chain function as BCRs
 - all of the BCRs on a SINGLE B cell will recognize the same epitope
 - a and b
 - all of the above**
11. (3 points) The clonal selection theory applies:
- only to T cells
 - only to B cells
 - only to professional antigen presenting cells (APCs)
 - b and c
 - none of the above**
12. (3 points) Which of the following is/are part of the lymphatic system?
- heart
 - spleen
 - lymph nodes**
 - a and b
 - none of the above

13. (3 points) Which of the following bind to peptides degraded from proteins present in pathogens?

- a. TCRs
- b. MHC I
- c. MHC II
- d. b and c
- e. **all of the above**

14. (3 points) Which will be MOST effective against a viral infection?

- a. **cells expressing MHC I**
- b. cells expressing MHC II
- c. plasma cells
- d. dendritic cells
- e. b and c

15. (3 points) Moonbeam develops a rare disease where small peptides precipitate in her joints causing her to leap about when least expected. A physician who failed to pay attention in immunology class prescribed a drug called “Problock” that specifically inhibits the proteasome found in the cytosol of cells, but does NOT inhibit the proteases found in lysosomes. Which of the following is MOST likely to be a side effect of “Problock”?

- a. Moonbeam will be more susceptible to bacterial infections
- b. **Moonbeam will be more susceptible to viral infections**
- c. Moonbeam will fail to generate plasma cells
- d. Moonbeam’s macrophages will fail to phagocytose
- e. a and c

16. (3 points) Which of the following is/are TRUE regarding the generation of diversity in the immune system?

- a. An individual inherits millions of conventional genes (i.e., contiguous coding sequences) encoding T-cell antigen receptors. However, only a SUBSET of these genes are expressed in any given T cell.
- b. An individual inherits millions of conventional genes (i.e., contiguous coding sequences) encoding MHC I proteins. However, only a SUBSET of these genes are expressed in any given nucleated cell.
- c. An individual inherits millions of conventional genes (i.e., contiguous coding sequences) encoding CD4. However, only a SUBSET of these genes are expressed in any given T_H cell.
- d. a and c
- e. **none of the above**

17. (3 points) Which of the following is/are TRUE regarding the immune system?
- a. Millions of T cells, each with a different specificity (i.e., ability to recognize a given antigen) are generated BEFORE a pathogen enters the body. After a pathogen enters the body, those T cells that can recognize peptides derived from proteins present in the pathogen are stimulated to divide.
 - b. Millions of B cells, each with a different specificity (i.e., ability to recognize a given antigen) are generated BEFORE a pathogen enters the body. After a pathogen enters the body, those B cells that can recognize the pathogen are stimulated to divide.
 - c. For both B and T cells, antigen receptors for a given pathogen do NOT exist BEFORE that pathogen enters the body, but are generated in response to the presence of the pathogen
 - d. **a and b**
 - e. none of the above
18. (3 points) Which of the follow is/are TRUE regarding how antibodies combat infection?
- a. they can bind directly to bacteria and immobilize them
 - b. they can bind directly to bacteria and facilitate (make easier) their phagocytosis by macrophages
 - c. they can bind directly to virus particles or bacterial toxins and prevent their interaction with host cells
 - d. a and c
 - e. **all of the above**
19. (3 points) In 1796 Dr. Edward Jenner inoculated a small boy with pus from a cowpox lesion. After awhile he purposely inoculated the boy with small pox virus. Miraculous for the time, the boy did not develop small pox. Which of the following statements are likely to be CORRECT?
- a. The boy was lucky. All of the MHC genes he inherited from his parents could present small pox antigens.
 - b. If Dr. Jenner had re-exposed the boy to the small pox virus AGAIN, the boy would have likely developed small pox.
 - c. If the boy had never had measles and Dr. Jenner purposely exposed the boy to the measles virus AFTER the FIRST exposure to the small pox virus, the boy would most likely NOT develop measles
 - d. both b and c are likely to be correct
 - e. **none of the above statement are likely to be correct**

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20. (3 points) During B lymphocyte development, a variable region (V) DNA segment is moved next to a joining (J) region DNA segment. In case 1, the fifth variable region (V5) DNA segment is moved next to the third joining region (J3) DNA segment to create a V5J3 DNA segment that is linked to the constant region of the kappa (κ) chain DNA. In case 2, the fifth variable region (V5) DNA segment is moved next to the fifth joining region (J5) DNA segment to create a V5J5 DNA segment that is linked to the constant region of the kappa (κ) chain DNA. Both V5J3 κ and V5J5 κ code for functional proteins. Which of the following is/are true?

- a. case 1 and case 2 occur in different developing B cells
- b. V5J3 κ and V5J5 κ will have the same CDR2 region
- c. V5J3 κ and V5J5 κ will have the same CDR3 region
- d. V5J3 κ and V5J5 κ will be bound to each other by disulfide bonds to form the antigen binding region of the BCR
- e. **a and b**

21. (3 points) Which of the following is/are TRUE regarding the binding of antigen to immune receptors?

- a. The CDR regions of the BCR light chain, but NOT the CDR regions of the BCR heavy chain make contact with the antigen
- b. The CDR regions of the BCR heavy chain, but NOT the CDR regions of the BCR light chain make contact with the antigen
- c. **CDR3 is the MOST variable of the three CDR regions**
- d. a and c
- e. none of the above are TRUE

22. (3 points) Poor Rimshot was born with a genetic defect in his recombination activating genes (RAG-1 and RAG-2), such that these enzymes can no longer bind to recombination signal sequences (RSSs) in the DNA. What will be the consequences of this defect?

- a. Rimshot will have no red blood cells
- b. Rimshot's B cells won't develop because no functional BCRs can be made
- c. Rimshot's T cells won't develop because no functional TCRs can be made
- d. **b and c**
- e. all of the above

23. (3 points) The heavy chain has several different versions called isotypes. How do DEVELOPING B cells (not yet encountered antigen) know which CONSTANT region to "choose"?

- a. they don't, it is totally random
- b. **they always "choose" IgM and IgD**
- c. they may initially "choose" IgG, but have the option to "switch" to IgM and IgD
- d. they may initially "choose" IgA, but have the option to "switch" to IgM and IgD
- e. developing B cells don't make heavy chains

24. (3 points) Stargazer was born with DNA that was defective in switch sequences (switch regions), such that the switch regions could not interact with each other. Which of the following is/are TRUE regarding Stargazer's immune system?

- a. there would be no BCRs on Stargazer's B cells
- b. there would be no TCRs on Stargazer's T cells
- c. **the only antibodies Stargazer could make would be of the IgM and IgD isotypes**
- d. the only antibodies Stargazer could make would be of the IgA isotype
- e. the only antibodies Stargazer could make would be of the IgG isotype

25. (3 points) Somatic hypermutation is the process of introducing single-nucleotide substitutions (point mutations) in the DNA. This process

- a. is important for generating antibodies with increased affinity for antigen
- b. is a mechanism for increasing diversity in the immune system
- c. occurs AFTER a B cell has encountered an antigen
- d. b and c
- e. **all of the above**

26. (3 points) Which of the following is/are TRUE regarding the B cell antigen receptor (BCR)?

- a. BCRs of the IgM and IgD isotypes are simultaneously (at the same time) present on a single B cell
- b. the BCR is composed of an immunoglobulin molecule that bind antigen and $Ig\alpha$ and $Ig\beta$ subunits that are responsible for signaling
- c. the variable regions of all the light chains on a single B cell are identical
- d. a and c
- e. **all of the above**

27. (3 points) Which of the following is/are TRUE regarding T cell antigen receptors (TCRs)?

- a. **the binding subunits are composed of two chains, each of which has a variable and a constant region**
- b. they are generated by random mutation of the DNA AFTER a pathogen has entered the body
- c. in addition to the antigen binding subunits, they containing signaling subunits
- d. **a and c**
- e. none of the above

28. (3 points) MHC molecules "present" antigen. Who do they present antigen to?

- a. B cells
- b. T helper cells (T_H cells)
- c. T cytotoxic (killer) cells T_C cells
- d. **b and c**
- e. all of the above

29. (3 points) Unlike B cells, T cell function by making contact with other cells and inducing them to change. Which of the following cells are contacted by T cells?
- virus infected cells
 - B cells
 - red blood cells
 - a and b**
 - none of the above
30. (3 points) CD4 recognizes a binding site on a given class of MHC molecules. Which of the following best explains how CD4 can interact with all the different allotypes of a given class of MHC molecules?
- each CD4 molecule is different (has a different amino acid sequence) and a given CD4 molecule will only bind to selected MHC molecules that will recognize that CD4 molecule
 - all CD4 molecules are identical and all MHC molecules of a given class (i.e., class I or class II) are identical, so all CD4 molecules will bind all molecules of the appropriate class
 - MHC molecules have variant and invariant regions and CD4 binds to the invariant region on the appropriate class of MHC molecules**
 - CD4 does not directly bind a given class of MHC molecules, but binds to $\beta 2$ microglobulin, which is invariant
 - none of the above correctly explains how CD4 can interact with all the different allotypes of a given class of MHC molecules
31. (3 points) Which of the following can happen to bacterial toxins found outside of cells?
- they can be engulfed by macrophages and presented on MHC I molecules
 - they can be internalized by B cells through the BCR and presented on MHC II molecules
 - during the course of an immune response they can be bound and neutralized by antibodies
 - b and c**
 - all of the above
32. (3 points) A virally infected cell
- will present viral antigens on MHC I molecules**
 - will present antigens on MCH II molecules
 - will present antigen on both MHC I and MCH II if the cell happens to be a APC
 - a and c
 - none of the above
33. (3 points) Calnexin, calreticulin and tapasin function to
- transmit signals through the BCR
 - transmit signals through the TCR
 - stabilize and localize MHC I molecules in the endoplasmic reticulum (ER)**
 - stabilize and localize MHC II in phagocytic vesicles
 - cleave viral proteins into peptides

QUESTION 34 IS ON THE NEXT PAGE

34. (3 points) Which of the following is/are TRUE regarding antigen presentation?
- a. both MHC I and MHC II molecules are synthesized on ribosomes and transported into the endoplasmic reticulum (ER)
 - b. MHC I molecules bind peptide in the ER
 - c. MHC II molecules bind peptides in the ER
 - d. MHC II molecules are prevented from binding peptides in the ER by the invariant chain
 - e. **a, b and d**