一、選擇題

單選題: 每題 1 分，共 15 分

1. Which of the following T-helper 2 cytokines are related to alternatively activated M2 macrophages?
   (A) Lipopolysaccharides, interleukin 12
   (B) Interferon-alpha, interleukin 23
   (C) Interleukin 4, interleukin 13
   (D) Interleukin 12, interleukin 23
   (E) Interferon-gamma, interleukin 18

2. Which of the following is an immune checkpoint receptor on T cells that inhibits the CD8+ T-cell response?
   (A) Cluster of differentiation 3
   (B) Major histocompatibility complex class I
   (C) Programmed death-ligand 1
   (D) Major histocompatibility complex class II
   (E) Programmed cell death protein 1

3. Which of the following is the best description for single positive T cells?
   (A) Mature T helper or cytotoxic T cells.
   (B) Only in the thymus.
   (C) Ready to undergo positive selection.
   (D) They divide rapidly before leaving the thymus.
   (E) Undergo apoptosis if they leave the thymus and encounter foreign antigens.

4. Which of the following is a major difference between B-cell receptors (BCR) and T-cell receptors (TCR)?
   (A) TCRs are highly specific.
   (B) TCRs are part of the adaptive immune system, while BCRs are part of the innate immune system.
   (C) BCRs are highly specific.
   (D) TCRs can be found on the cell surface.
   (E) B-cell receptors can be secreted.

5. Which of the following description regarding the rearrangement of both TCR and BCR gene segments is **NOT** correct?
   (A) Generate diversity of antigen binding by recombination of a large pool of germline V, D, and J segments.
   (B) Lead to CDR3 being the most hypervariable region in the receptor chains.
   (C) Require RAG-1 and RAG-2

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(D) Require TdT
(E) Result in isotype switching after antigen stimulation of the mature lymphocytes

6. Which amino acid sequences in lymphocyte signal transduction complexes are phosphorylated following antigen binding?
(A) ITAMs
(B) ITIMs
(C) MAPs
(D) Syks
(E) PTKs

7. Which of the following molecule is responsible for the generation of DAG and IP3 from PIP2?
(A) Adaptor protein.
(B) Phospholipase C
(C) TdT
(D) small G protein.
(E) Protein kinase C

8. Which of the following types of hypersensitivity reactions is IgE mediated?
(A) Type I
(B) Type V
(C) Type IV
(D) Type II
(E) Type III

9. Which receptor binds to immunoglobulin E and mediates mast cell degranulation in type I hypersensitivity reactions?
(A) Fc epsilon RI (FcεRI)
(B) Complement receptor
(C) Cluster of differentiation 5a
(D) Peptide-major histocompatibility complex class II (pMHCII)
(E) T-cell antigen receptors

10. Which of the following cell activation sequences most accurately represents sensitization in type 1 hypersensitivity reaction?
(A) B cells stimulate cytotoxic T cells to activate T helper 1 cells.
(B) T helper 1 cells stimulate T helper 2 cells to activate class switching of B cells.
(C) Dendritic cells stimulate T helper 2 cells to activate class switching of B cells.
(D) Dendritic cells stimulate T helper 1 cells which activate cytotoxic T cells.

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(E) cytotoxic T cells stimulate T helper 2 cells to activate class switching of B cells.

11. What is molecular mimicry?
(A) Destruction of healthy tissue cells because they resemble damaged tissue cells
(B) A similarity of structures or sequences between self and foreign antigens, leading to autoimmunity
(C) Inability to clear antigens that are deposited in damaged tissues, leading to tissue destruction
(D) Autoimmune complexes that mimic antigens and deposit in lymphocytes
(E) A B-cell-mediated reaction which results in the production of identical autoantibodies

12. Autoantibodies against which of the following proteins are most implicated in the pathogenesis of multiple sclerosis?
(A) Acetylcholine receptor
(B) Calcium channel
(C) Glycoproteins 120
(D) Myeloperoxidase
(E) Myelin protein

13. Which of the following diseases is an example of a type II hypersensitivity reaction?
(A) Asthma
(B) Autoimmune hemolytic anemia
(C) Contact dermatitis
(D) Rheumatoid arthritis
(E) Multiple sclerosis

14. Which of the following statements regarding the pathogenesis of a type III hypersensitivity reaction?
(A) The release of vasoactive amines and cytokines from mast cells.
(B) Cell-mediated cytotoxicity.
(C) Autophagy.
(D) Antibody-dependent cellular cytotoxicity.
(E) The deposition of immune complexes in tissues and small blood vessels.

15. What is immunotherapy with chimeric antigen receptor (CAR) T cells?
(A) Modification of T cells to proliferate at a higher rate
(B) Modification of T cells to recognize and avoid destruction of host cells
(C) Modification of T cells to recognize and destroy cancer cells more effectively
(D) Modification of T cells to stimulate B-cell antibody production
(E) Modification of T cells to resist apoptosis

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單選題: 每題 2 分, 共 26 分

16. The stages of B-cell development occur in the chronological order. The stages involved during the development include a, b, c, d, e stages as follows.

a. early pro-B cell
b. large pre-B cell
c. immature B cell
d. late pro-B cell
e. small pre-B cell

Which order is CORRECT?

(A) a→b→ c→ d→ e
(B) a→b→ d→ e→ c
(C) a→e→ b→ d→ c
(D) a→d→ b→ e→ c
(E) a→d→ e→ b→ c

17. A single IgG antibody is composed of unique peptide sequences totaling ~600 700 amino acids. Using this estimate, the predicted molecular weight of an antibody protein would be ~70–75 kDa. However, an intact antibody protein has a molecular weight of ~150 kDa. **Which statement is CORRECT?**

(A) IgG antibodies are produced as dimers of two identical IgG monomers.
(B) Each IgG antibody is a complex of two identical light chains and two identical heavy chains.
(C) IgG antibodies tend to aggregate together during purification, thereby distorting molecular weight estimates.
(D) Each IgG antibody is a complex of four identical polypeptides.
(E) IgG antibodies have many heavier amino acids in them than most other proteins.

18. Figure A shows antibodies bound to repetitive epitopes on the surface of a bacterial pathogen. Even though all of these epitopes are identical, not all of them have antibodies bound to them.

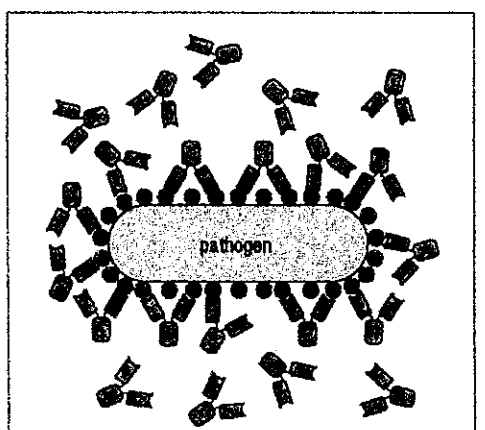

Figure A

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Which statement is CORRECT to explain why some of the antibodies fail to bind to every possible epitope on the surface of the pathogen?

(A) There is an insufficient amount of antibody to saturate all the epitopes.

(B) The pathogen has an immune evasion strategy to avoid antibody binding to all epitopes.

(C) Some of the epitopes cannot bind antibody due to steric hindrance.

(D) The antibodies are only able to bind when both antigen-binding sites are engaged on the pathogen surface.

(E) The epitopes on the pathogen are not all in the same conformation, so not all will bind the same antibody.

19. IgM is particularly efficient at fixing complement **Because it** _____.

(A) is a much larger antibody than the other isotypes

(B) has an extra CH domain

(C) is made first in an immune response and therefore has first access to C1q

(D) has five binding sites for C1q

(E) has easy access to extravascular areas.

20. Which one of the following antibodies does **NOT** activate the classical pathway of complement?

(A) IgM

(B) IgG1

(C) IgD

(D) IgG3

(E) IgG2a.

21. A primary focus forms after a circulating naive B cell forms a conjugate pair with _____ in the medullary cords of a lymph node, whereas a secondary focus of B-cell expansion creates the _____.

(A) TH1 cell; Plasma cells

(B) Cytotoxic T cell; T-cell zone

(C) Follicular dendritic cell (FDC); Germinal center

(D) Follicular helper T cells (TFH); Germinal center

(E) CD40 ligand; T-cell zone.

22. _____ is a mechanism that drives the preferential selection of immunoglobulins with the highest affinity for antigen.

(A) Gene rearrangement

(B) Isotype-switching

(C) Affinity maturation

(D) Antibody-dependent cell-mediated cytotoxicity

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(E) Apoptosis.

23. The evolution of the influenza virus that causes global pandemics of severe disease is referred as _____.
(A) Serotype-specific immunity
(B) Gene conversion
(C) Antigenic drift
(D) Antigenic shift
(E) Latency

24. Herpes simplex virus-infected cells are poor targets for CD8 T cell killing because _____.
(A) the virus inhibits HC class I expression
(B) infected cells do not express any viral proteins during latency
(C) the virus escapes from the phagosome into the cytosol
(D) the virus blocks phagosome-lysosome fusion
(E) the proteasome cannot generate viral peptides for presentation by MHC class I molecules.

25. Complements and antibodies coat a microorganism and provide binding sites, enabling macrophages and neutrophils to uptake the organism. This phenomenon is termed _____.
(A) Opsonization
(B) Inflammation
(C) Phagocytosis
(D) Complement activation
(E) Pattern recognition

26. Primary lymphoid tissues are the sites where lymphocytes _____, whereas secondary lymphoid tissues are the sites where lymphocytes _____.
(A) are stimulated; develop and mature
(B) undergo clonal selection; differentiate from hematopoietic stem cells
(C) encounter pathogens; undergo apoptosis
(D) die; are phagocytosed after death
(E) develop and mature; become activated

27. Epitope _____.
(A) is presented by T cell to the dendritic cell
(B) is a site on an antigen recognized by an antibody or an antigen receptor
(C) binds to the constant region of an antibody
(D) is used by macrophages and dendritic cells to recognize pathogens
(E) is part of the T cell receptor

28. The specialized cells that provide the interface between the lumen of the gut and the underlying lymphoid tissue _____.
(A) make up the germinal center

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(B) are located in the periarteriolar lymphoid sheath
(C) are progenitors of monocytes
(D) are called M cells
(E) are specialized in killing encapsulated bacteria

複選題: 每題 2 分, 共 4 分

29. Which of the following is a feature of immunologically "cold" tumors? (Select all that apply)
(A) Exclusion of CD8+ T cells and NK cells from the tumor
(B) Immunosuppressive immune cells in tumor
(C) Poor prognosis and response to immunotherapy
(D) Low antigen presentation
(E) Elevated effector cytokine, such as Granzyme B

30. Which statement about antigen epitopes is **TRUE**? (Select all that apply)
(A) T cell and B cell recognize antigens identically
(B) A protein molecule usually contains multiple epitopes.
(C) T cells bind only processed antigen epitopes.
(D) Some epitopes are more immunogenic than others.
(E) An epitope may be shared by two different antigens.

二、是非題 True (T) or False (F)：每題 1 分, 共 6 分

_____ 1. The effector mechanisms that are recruited to clear an infection are always the same, regardless of the type of pathogens.
_____ 2. Inflammation is harmful and should be avoided at all stages of an immune response.
_____ 3. Lymphocytes encounter and respond to antigens at the site of infection.
_____ 4. A critical function of the immune system is to discriminate self from nonself.
_____ 5. Macrophages express only one type of receptor with unique specificity, whereas T cells express multiple types of receptors with different combinations.
_____ 6. Most infectious agents do not activate the innate immune system or induce an inflammatory response before they stimulate an adaptive immune response.

三、排序題: 每題 0.5 分, 共 5 分

Place the following events in the correct order when a body responds to an infection.
(A) Effector cells and antibodies are carried by efferent lymph and blood to the infected tissues.
(B) Antigen-presenting cells process pathogens and migrate to the secondary lymphoid organs to activate lymphocytes.
(C) Neutrophils are recruited to the site of infection to phagocytose and kill pathogens.
(D) Phagocytes are activated by effector lymphocytes to digest and eliminate pathogens.
(E) The skin and the mucosal epithelia form a physical barrier to prevent pathogens from entering

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the body.

(F) Phagocytes that reside in the tissues, such as macrophages, phagocytose pathogens.
(G) Phagocytes release cytokines and chemokines and induce inflammation.
(H) Lymphocytes proliferate and differentiate into effector cells.
(I) Effector cells develop into memory cells to provide long-lasting immunity to pathogens.
(J) Antimicrobial peptides and complements are activated to kill pathogens.

四、填充題 Fill-in-the-Blanks: 每題 1 分, 共 2 分

1. _____ is the receptor for SARS-CoV2.
2. _____ are microorganisms that normally live harmlessly in symbiosis with their host.

五、簡答題

1. Immune checkpoint blockade (ICB) and Chimeric antigen receptor (CAR)-T cells are two breakthroughs in cancer immunotherapy. Based on the signal transduction in T cells, please first explain the principles of how ICB and CAR-T work (5 分). Second, compare and contrast these two methods regarding the requirements for successful induction of antitumor immunity. (5 分)

2. Pattern recognition receptors (PRRs) are the first line of the defense system in innate immune cells. Please describe two PRRs and the pathogen-associated molecular patterns (PAMPs) they recognize in pathogens and their brief signaling pathways (5 分). After the ligation of PRRs with their PAMPs, the signaling events usually lead to the production of cytokines in innate cells. Please describe the functions of two cytokines produced following PRR signaling. (5 分)

3. BCR and TCR are B-cell and T-cell antigen receptors, respectively. Please compare and contrast the similarity and differences between these two receptors. (5 分)

4. Describe how a naïve T cell is activated and what is meant by co-stimulation in T cell activation? (3 分)

5. Briefly describe what characterizes the three different phases of "cancer immunoediting". (3 分)

6. An antibody molecule can be divided into two regions. One is called the constant region or C region, and the other one is known as the variable region or V region. The hypervariable sequences in the V region correspond to three loops localized to the surface of the molecule. The loops are termed complementary–determining regions, or CDRs.
Please explain: (1) What the "complementary" means, and (2) How important the CDRs function in antigen binding? (5 分)

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7. Neutralizing antibodies are effective at preventing infection or toxicity mediated by pathogens or their toxic products. In fact, nearly all vaccines currently in use function by eliciting neutralizing antibodies.
Please explain: (1) the effector activities of neutralizing antibodies; (2) why a booster dose is needed for non-infectious vaccines (e.g. inactivated whole cell vaccine, subunit vaccine, mRNA vaccines, etc.) (6 分)

試題隨卷繳回