國立臺灣大學 114 學年度碩士班招生考試試題

一、選擇題 請用 2B 鉛筆作答於答案卡，並先詳閱答案卡上之「畫記說明」。

單選題: 每題 2 分，共 10 題

1. Which of the following is the primary difference between how B cells and T cells recognize antigens?
   (A) T-cell receptors can bind antigen only after secretion of the T-cell receptor from the surface of the T cell
   (B) Antibodies can bind only to denatured proteins
   (C) T-cell receptors can only bind to carbohydrate groups or clusters of amino acids
   (D) B cells recognize degraded proteins bound to major histocompatibility molecules
   (E) T cells recognize antigens bound to major histocompatibility molecules.

2. Which of the following correctly describes the principal origin of antigens presented by MHC class I and MHC class II molecules?
   (A) MHC I: extracellular; MHC II: intracellular
   (B) MHC I: intracellular; MHC II: extracellular
   (C) MHC I: opsonization; MHC II: neutralization
   (D) MHC I: neutralization; MHC II: opsonization
   (E) None of the above

3. During the process of positive selection in the thymus, a developing T cell interacts with an MHC class I molecule. What is the outcome of this interaction?
   (A) The T cell stops expressing CD8
   (B) The T cell commits to the CD8 lineage
   (C) The T cell starts rearranging its alpha chain to have two receptors
   (D) The T cell differentiates into a CD4 T cell
   (E) The T cell increases the expression of CD4

4. Which of the following best describes MHC restriction?
   (A) Elimination of thymocytes with T-cell receptors that cannot interact with self-MHC molecules.
   (B) Preferential survival and proliferation of thymocytes that survive negative selection.
   (C) T-cell recognition of a peptide antigen only when it is bound to a particular form of MHC molecule.
   (D) A state of non-responsiveness to a peptide antigen.
   (E) A condition in which either MHC class I or class II molecules are not expressed on cells.

5. In the thymus, a T cell with both CD4 and CD8 receptors (double-positive thymocyte) interacts with a self-peptide presented by a self-MHC class I molecule. If the binding affinity between the T cell receptor and the self-peptide: MHC complex is low, what is the outcome?
   (A) Negative selection and apoptosis
   (B) Cell activation
   (C) Rearrangement of the second β-chain locus

見背面

(D) Positive selection of a CD4 T cell

(E) Positive selection of a CD8 T cell

6. When a T cell is activated by a specific antigen, it undergoes several changes. Which of the following is "NOT" one of those changes?

(A) It receives co-stimulatory signals through CD28

(B) It increases the expression of CD25

(C) It takes several days to differentiate into an effector T cell

(D) It stops secreting and responding to interleukin-2 (IL-2)

(E) It starts expressing CTLA4, which helps limit T cell proliferation

7. Which of the following statements about naive T cells is "incorrect"?

(A) Naive T cells can enter lymph nodes from both the blood and the lymph

(B) Naive T cells are activated in secondary lymphoid tissues

(C) Naive T cells become effector T cells after they are activated

(D) Naive T cells are found in both the cortex and medulla of lymph nodes

(E) Only dendritic cells, not macrophages or B cells, can activate naive T cells

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. Failure of self-tolerance can result in pathological autoimmune states, there are several mechanisms to control self-tolerance, which of the following is "NOT" the type of tolerance?

(A) Central tolerance

(B) Clonal anergy

(C) Antibody secretion

(D) Antigen segregation

(E) Clonal deletion

10. The immunological synapse is critical for T cell activation. Which of the following molecules is NOT typically found in this essential structure?

(A) CD28

(B) LFA-1

(C) MHC

(D) Toll-like receptor

接次頁

(E) T cell receptor

單選題: 每題 2.5 分，共 12 題

11. In terms of antibody structure, which statement is NOT CORRECT?
(A) Antigen binding domain of an antibody is determined by CDR1, CDR2, and CDR3 of both heavy and light chain
(B) After activation, B cells differentiate into plasma cells and then undergo class switching from IgM to either IgD, IgA, IgG, or IgE
(C) The production of membrane-bound or secreted form of IgM in B cells is determined by RNA splicing
(D) Heavy chains and light chains of an antibody are brought together by disulfide bonds

12. Regarding Toll-like receptors (TLRs), which statement is NOT CORRECT?
(A) TLR4 recognizes lipopolysaccharide or LPS of gram-negative bacterial cell wall
(B) All the TLRs are expressed on the plasma membrane of innate cells, like macrophages
(C) All TLRs signal through either MyD88 or TRIF adaptor molecule
(D) TLRs belong to pattern recognition receptors (PRRs) that recognize pathogen-associated molecular patterns

13. Regarding cytokines and cytokine receptor-mediated signaling pathways, which statement is NOT CORRECT?
(A) Cytokine receptors signal through the JAK-STAT pathway, in which both JAK and STATs are tyrosine kinases
(B) Cytokines can regulate the synthesis and action of other cytokines
(C) The actions of cytokines can be either local or systemic
(D) Chemokines belong to part of cytokines

14. B cell receptors (BCRs) are antigen receptors of B cells. Which statement regarding BCRs is NOT CORRECT?
(A) BCRs are surface immunoglobulin composed of 2 heavy and 2 light chains
(B) BCR gene segments are rearranged beginning from the light chain gene during B cell development
(C) Each B cells express BCRs of different specificity
(D) The Fab structure of BCRs is able to bind antigens

15. Macrophages and neutrophils are phagocytes and a front-line defense system in the body. Which statement regarding macrophages and neutrophils is NOT CORRECT?
(A) The phagocytic mechanisms of macrophages and neutrophils are similar
(B) After phagocytosis, the phagosomes inside the cells will increase pH to digest bacteria
(C) Both macrophages and neutrophils produce antimicrobial peptides to facilitate the killing of pathogens

見背面

(D) Neutrophils, but not macrophages, can undergo a special way of apoptosis, called NETosis, to trap and kill bacteria

16. Which statement concerning complement activation is NOT CORRECT?
(A) Only antigen-bound antibodies and not free circulating antibodies can initiate the classical pathway
(B) IgG has better complement fixation ability than IgM
(C) Patients with deficiencies in C3 are more severe than those with deficiencies in membrane attack complex
(D) C6-C9 are structurally related proteins without enzymatic activity

17. Regarding ITAM and ITIM, which statement is NOT CORRECT?
(A) NK cells express different NK receptors that either contain ITAM or ITIM
(B) Tyrosine residue(s) in ITAM or ITIM are phosphorylated in response to stimulation
(C) ITAMs are found in the intracellular domain of BCR, i.e. surface immunoglobulin
(D) Once activated, ITIM recruits protein phosphatases to negatively regulate downstream signal pathways

18. Monoclonal antibody (mAb) is a powerful research tool and a drug for treating diseases. Regarding mAb, which statement is NOT CORRECT?
(A) mAb can be used to kill tumor cells or to block the binding of viruses or bacteria to host cells
(B) Hybridoma technology is one way to generate mAbs
(C) mAbs for immune checkpoint blockade are successfully used for treating cancer patients
(D) mAbs can be used to target molecules located on the cell surface and inside the cells

19. Antimicrobial peptides (AMPs) belong to one component of the innate immune system. Which statement concerning AMPs is NOT CORRECT?
(A) AMPs can be produced by non-immune cells in the skin, lung, and gut where the host is exposed directly to the outside environment
(B) AMPs are produced in an inactive form and become active when cleaved
(C) AMPs are peptides that have a hydrophilic end and a hydrophobic end, which will help degrade bacterial membrane
(D) AMPs have a selective killing activity toward bacteria but not host cells

20. CAR-T and Immune checkpoint blockade (ICB) are two breakthroughs in recent years for tumor immunotherapy. Which statement concerning these two approaches is NOT CORRECT?
(A) CAR-T approach bypasses the requirement of recognition of MHC-peptide and 2 signals to activate antigen-specific T cells
(B) The ICB approved for treating cancer patients is to block molecules that transduce inhibitory signals in T cells, not in antigen-presenting cells

接次頁

(C) CAR-T and ICB both work for solid tumors and leukemia efficiently

(D) The mechanisms for anti-CLT4 and anti-PD-1 ICBs are different; therefore, there is increased therapeutic activity when combining both treatments

21. After activation, naive B cells differentiate into antibody-secreting plasma cells and secrete different isotypes of immunoglobulin or antibodies. Regarding the functions of different isotypes of antibodies, which statement is NOT CORRECT?

(A) IgM antibodies usually form pentamer and are produced first in a humoral immune response

(B) IgA is the predominant antibody in mucosal sites, such as the intestinal and respiratory tracts

(C) IgG efficiently opsonizes pathogens for engulfment by phagocytes and activates the complement system

(D) IgE antibody is present in high levels in the blood or extracellular fluid and has a high affinity to bind and active mast cells

22. Antibodies are the effector molecules of the humoral immune response. Regarding the functions of antibodies, which statement is NOT CORRECT?

(A) Antibodies inhibit the toxic effects by binding to pathogens products, a process called neutralization

(B) Antibodies can bind viruses and directly kill them, a key effector function for humoral immunity

(C) When bound to pathogens, the Fab of antibodies will facilitate the recruitment of other immune cells, such as macrophages, to mediate phagocytosis, a process called opsonization

(D) Antibodies can trigger complement by activating C1, the first step in the classical pathway

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23. Cytotoxic T cells eliminate infected or cancerous cells through a tightly controlled process. Which of the following mechanisms are involved in this process? Select all that apply (Select all that apply)

(A) Activate Fas/FasL Signaling in the target cell

(B) Inducing apoptosis (programmed cell death) in the cytotoxic T cell

(C) Release of granzyme, perforin, and granulysin by the cytotoxic T cell

(D) Lower antigen presentation

(E) Inducing the target cell to undergo senescence

24. T cell activation is a tightly regulated process. Which of the following mechanisms contribute to the downregulation or suppression of T cell signaling? (Select all that apply)

(A) CTLA-4 binding to B7 molecules on antigen-presenting cells

(B) PD-1 binding to PD-L1 or PD-L2 on antigen-presenting cells or tumor cells

(C) Recruitment of the Cbl family of ubiquitin ligases

(D) Production of immunosuppressive cytokines like IL-10 and TGF-β

(E) Increased expression of co-stimulatory molecules like CD28

見背面

25. In a healthy individual without any ongoing infection, what is the most likely fate of a mature naive T cell that encounters a self-antigen outside the thymus? (Select all that apply)
(A) Initiate an autoimmune attack against the cell presenting the self-antigen
(B) Be suppressed by a regulatory T cell
(C) Undergo proliferation
(D) Become anergic (unresponsive to stimulation)
(E) Continue rearranging its α-chain genes

26. 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

27. Which of the following immune responses is most crucial for combating and eliminating helminths (parasitic worms)? (Select all that apply)
(A) Killing by cytotoxic T cells in the lamina propria
(B) TH1-induced inflammation
(C) TH2-associated cytokines
(D) Phagocytosis by intestinal macrophages
(E) IgE antibody production

二、簡答題 請於試卷內之「非選擇題作答區」標明題號依序作答。

1. Explain the process of naive T cell activation. What is the significance of co-stimulation in this process? **(4 points)**

2. CD4+ T cells differentiate into various effector subsets with specialized functions. Describe the main types of CD4+ effector T cells and their roles in the immune response? **(4 points)**

3. CAR T cell therapy is a revolutionary approach to cancer treatment. Explain how this immunotherapy works, including the modification of T cells and their mechanism of action against tumor cells.
(4 points)

4. The T cell receptor (TCR) complex is crucial for antigen recognition. Describe the key components of this complex and their respective functions. **(4 points)**

接次頁

5. What is immunological tolerance? **(4 points)**

6. The smallpox virus circulated and plagued the human population for many centuries until 1979, thanks to the advent of effective vaccines developed by Dr. Edward Jenner using the skin material of a milkmaid infected by the cowpox virus. Please describe the principle of vaccination against viral infection. **(4 points)** Please describe the potential mechanisms of how the cowpox virus vaccine protects humans from smallpox virus infection. **(4 points)** If you were to develop a new version of the smallpox virus vaccine using current technology, which approach would you take and why? **(4 points)**

7. Both innate and adaptive immunity are critical for combating the infections of pathogens. Please compare and contrast innate and adaptive immunity concerning specificity, diversity and components. **(4 points)** Dr. Lee recently identified a new type of immune cells. Please help him design two experiments to determine if this cell either belongs to the innate or adaptive immune system. **(4 points)**

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