

[This question paper contains 11 printed pages.]

1379

Your Roll No. ....

B.Sc. (Hons.)/III

A

BIOCHEMISTRY : Paper XV

(Immunology)

(Admissions of 2000 and onwards)

Time : 3 Hours

Maximum Marks : 60

*(Write your Roll No. on the top immediately  
on receipt of this question paper.)*

*Attempt Five questions in all, including  
Question No. 1 which is compulsory.*

1. (A) Choose the one Best answer –

1. The ability of a single B cell to express both IgM and IgD molecules on its surface at the same time is made possible by

- (i) allelic exclusion.
- (ii) isotype switching.
- (iii) simultaneous recognition of two distinct antigens.
- (iv) selective RNA splicing.
- (v) use of genes from both parental chromosomes.

P.T.O.

2. A 19-year-old African-American presents to her primary care physician with an extranodal mass involving the mandible. Biopsy revealed lymphoma cells with the following characteristics: germline TCR genes, surface IgM+, surface IgD+, CD19+. What normal cell component markers are most similar to those expressed by the lymphoma cell?

- (i) Pre-B cell
- (ii) Immature B cell
- (iii) Mature B cell
- (iv) Immature T cell
- (v) Mature T cell

3. An individual does not make an immune response to a self-protein because

- (i) self-proteins cannot be processed into peptides.
- (ii) peptides from self-proteins cannot bind to MHC class I.
- (iii) peptides from self-proteins cannot bind to MHC class II.
- (iv) lymphocytes that express a receptor reactive to a self-protein are inactivated by deletion or anergy.

4. Two dissimilar inbred strains of mice, A and B, are crossed to yield an F1 hybrid strain, AB. If a large dose of spleen cells from an adult A mouse is injected into an adult AB mouse, which one of the following is MOST likely to occur ?
- (i) The spleen cells will be destroyed.
  - (ii) The spleen cells will survive and will have no effect in the recipient.
  - (iii) The spleen cells will induce a graft-versus-host reaction in the recipient.
  - (iv) The spleen cells will survive and induce tolerance of strain A grafts in the recipient.
5. A line of tumor cells prepared from one mouse is injected into an MHC-matched recipient. The tumor was destroyed within 5 days. When tissues from the recipient were analyzed, the animal had a negligible cytotoxic T lymphocyte (CTL) response against the tumor. Flow cytometry revealed that the tumor cells expressed very low levels of MHC class I molecules. The BEST explanation for the destruction of the tumor cells in the recipient is that :

- (i) CTL had an MHC-induced alloreaction against the tumor cells
  - (ii) CTL specific for the tumor antigens killed the tumor cells
  - (iii) Mast cells released histamine and other inflammatory mediators that clear the tumor.
  - (iv) Natural killer cells recognized the absence of MHC class I molecules and killed the tumor cells.
6. If an IgG antibody preparation specific for hen egg lysosome (HEL) is treated with papain to generate Fab fragments, which of the following statements concerning the avidity of such fragments is true :
- (i) they will have a lower avidity for HEL as compared with the intact IgG.
  - (ii) they will have a higher avidity for HEL as compared with the intact IgG.
  - (iii) there will have the same avidity for HEL as the intact IgG.
  - (iv) they will have lost their ability to bind to HEL.
  - (v) they will have the same avidity but will have a lower affinity for HEL.

7. In old age, which component of the immune system appears to be most impaired ?

- (i) B cells
- (ii) Neutrophils
- (iii) NK cells
- (iv) Macrophages
- (v) T cells (7)

(B) Identify on the basis of the descriptions listed below –

- (i) A cytokine that is an endogenous pyrogen.
- (ii) A co-stimulatory signal molecule on the surface of T cell that interacts with B7 on APC.
- (iii) The process where a phagocyte migrates through the endothelial wall into tissues.
- (iv) Calmodulin dependent phosphatase that generates active form of NFAT during T cell activation.
- (v) Conserved DNA sequences, located adjacent to V, D and J segments that help direct gene rearrangements.
- (vi) Nucleotides added by TdT enzyme during D-J and V to DJ joining in heavy chain gene sequences.

P.T.O.

- (vii) An immunological assay to detect complement component C3 on glomerular basement membrane.
  - (viii) A complement component that has C5 convertase activity. (4)
- (C) Mention briefly the contribution of the following scientists in the field of immunological research –
- (i) Elie Metchnikoff
  - (ii) Jules Bordet
  - (iii) Rodney R. Porter and Gerald M. Edelman
  - (iv) Susumu Tonegawa
  - (v) F. M. Burnet and Peter Medawar (5)
2. (a) Distinguish between the following pairs (any 5) –
- (i) Primary and Secondary Immune Response
  - (ii) Hapten and Carrier
  - (iii) Type II and Type III Hypersensitivity Reaction
  - (iv) TCR and BCR
  - (v) Active and Passive Immunization
  - (vi) Allotypic and Idiotypic antibodies
  - (vii) Direct and Indirect Immunofluorescence

- (b) Outline the procedure developed by Milstein and Kohler for the production of monoclonal antibodies. What would be the consequences if you omitted aminopterin from the HAT medium used in the production of monoclonal antibodies? (7.5,3.5)
3. (a) Describe the most likely diagnosis to the three clinical cases below –

Case I: A 29-year-old woman visited her doctor after experiencing joint pain and stiffness in the mornings for several months. A blood test for antiphospholipid antibody was ordered and came back positive. Results from other blood tests revealed elevated titers of serum IgG and antibodies specific for ribonucleoproteins.

Case II: A 65-year-old construction worker went to see his physician complaining about double vision (diplopia). He also reported having difficulty in chewing and swallowing food and slurring of speech at times. He was referred to a neurologist who observed a weakness in the patient's facial muscles and tongue and an abnormality in his ocular movements and droopy eyelids (ptosis). An ELISA on serum antibodies revealed elevated titers of antibodies to the acetylcholine receptor.

Case III: A 16-year-old male went to see his dermatologist because of a red rash he developed on his left earlobe. The young man reported that he had been wearing a surgical steel earring for two months without any problem. He had recently replaced the steel with a gold earring and observed the rash the following day. A skin biopsy revealed the presence of T cells, macrophages and fibrin.

- (b) Outline the alternative pathway for complement activation. Predict what would happen to individuals suffering from a congenital deficiency of properdin.
  - (c) List some salient factors that contribute to the immunogenicity of a molecule. Which is likely to be more immunogenic – Hen egg white lysozyme (HEL) or Hen collagen? Explain. (4.5,3,3.5)
4. (a) Explain the following – (any 6)
- (i) Innocent Bystander lysis
  - (ii) Somatic Hypermutation
  - (iii) ADCC
  - (iv) Phagocytosis
  - (v) Affinity maturation



- (vi) Anaphylatoxins
  - (vii) Adjuvants
  - (viii) Clonal Selection theory
- (b) Splenectomy in the adult human results in the persons becoming very susceptible to overwhelming bacterial infection. Explain. (6×1.5=9,2)
5. (a) Describe the endocytic pathway for presentation of exogenous antigen by antigen presenting cells. If chloroquine is added to an incubation mixture comprising of CD4+ T<sub>H</sub> cells, APCs and native lysozyme, presentation of the native protein is inhibited. Explain why this occurs and if chloroquine addition is delayed for 2 hrs, presentation of the native protein is not inhibited. Explain.
- (b) Draw diagrams illustrating the general structure, including the domains of class I and Class II MHC molecules. You cross a BALB/c (H-2<sup>d</sup>) mouse with a CBA (H-2<sup>k</sup>) mouse. What MHC molecules will the F1 progeny express on (a) liver cells and (b) its macrophages? (5,6)
6. (a) Activation and differentiation of B cells in response to thymus dependent (TD) antigens and thymus independent (TI) antigens differ. Discuss the

differences in the structure of TD and TI-1 and TI-2 antigens and the characteristics of the humoral responses induced by them.

- (b) T cells are subject to both positive and negative selection during fetal development in vertebrates. Why are both needed?
  - (c) Explain the mechanisms by which Antibody diversity is generated. (3,3,5)
7. (a) Describe the sequence of events involved in the differentiation and maturation of progenitor B cell (pro-B cell) to precursor B cells (pre B cell) in the bone marrow.
- (b) Superantigens have been implicated in several diseases and have been useful as research tools. What properties of superantigens distinguish them from conventional antigens? Give some examples of superantigens.
  - (c) For each of the antigen or antibody below, indicate an appropriate assay method keeping in mind the sensitivity of the assay and the expected concentration of the protein.
    - (i) IgG in serum.
    - (ii) Horsemeat contamination in hamburger.
    - (iii) Insulin in serum.

- (iv) Anti A antibodies to blood group antigen A in serum.
  - (v) IgE in serum.
- (d) Skin grafts are rejected faster than other tissues like kidney, heart, etc. Explain why. (3,2.5,3,2.5)
8. (a) In which sites specifically would a pathogen or its antigen would end up if they (i) entered the body through a small wound in the skin (ii) entered the body from the gut (iii) got into the bloodstream?
- (b) Explain with examples how different cytokines can generate the same signal in a tissue and how different cytokines can have antagonistic effects in a tissue.
- (c) How does autoimmunity arise? Describe the proposed mechanisms to account for the generation of autoimmune diseases in man.
- (d) Explain the relationship between the incubation period of a pathogen and the approach needed to achieve effective vaccination. (3,3,3,2)