

SECTION I: MULTIPLE CHOICE QUESTIONS (MCQs)
(60 Minutes)

1. CD 8 molecule binds to;
a) $\alpha 3$ domain of MHC class I ✓
b) The hypervariable region of MHC class I
c) $\alpha 2/\beta 2$ domain of MHC class II
d) $\alpha 1/\alpha 2$ domain of MHC class I
e) $\beta 2$ microglobulin of MHC class I
2. Which of the following encode MHC class III genes;
a) MICA
b) C5 convertase
c) Factor B ✓
d) $\beta 2$ microglobulin
e) C3 convertase
3. Ig supergene family EXCLUDE;
a) TCR genes ✓
b) Heat shock proteins ✓ MHC I/II
c) FC receptor genes ✓
d) Antibody genes ✓
e) MHC protein genes ✓
4. The following are features of a mature B cell except:
a) Intracellular λ chain ✗
b) VDJ rearranged heavy chain of BCR ✓
c) VJ rearranged light chain of BCR ✓
d) IgD surface molecule ✓
e) IgM surface molecule ✓ immature
5. Which of the following chromosomal location matches the right gene in human;
a) γ light chain 12 heavy chain 14
b) Kappa light chain 2 ✓ tcr b chain 7
c) Heavy chain 6 Tcr a chain 14
d) TCR β chain 12 heavy chain 14
e) TCR α chain 7 lambda light chain 22
b2 microglobulin 15
6. Antigenic – binding regions of T cell receptor is formed by;
a) VL and VH domains
b) $V\alpha 1$ and $V\beta 1$ domains ✓
c) $V\alpha 2$ and $V\beta 2$ domains
d) $V\gamma$, $V\beta$ and CD3 chains
e) $V\gamma$ and $V\delta$ chains

7. Which of the following is TRUE concerning Ig heavy chain formation?
- a) D-J joining by DNA splice
 - b) VJ-C joining by RNA splice ✗
 - c) V-DJ joining by RNA splice ✗
 - d) Class switching by RNA splice ✗
 - e) V-JC joining by DNA splice ✗
8. The following is CORRECT concerning HLA haplotypes EXCEPT;
- a) There are four (4) haplotypes within a family
 - b) Haplotypes are inherited codominantly
 - c) Haplotypes show linkage disequilibrium
 - d) Defined as a set of HLA antigens inherited from each parent
 - e) There are six (6) haplotypes within a family
9. Which of the following does not describe the characteristics of a $\alpha\beta$ TCR?
- a) It is a membrane bound protein
 - b) Affinity maturation and somatic hypermutation does not occur like in BCR ✗
 - c) Its alpha (α) chain has variable (v) joining (J) segments only
 - d) Its beta (β) chain has variable (v) diversity (D) and joining (J) subunits
 - e) It has four (4) subunits and two (2) antigen binding sites.
10. The most polymorphic HLA class II genes are?
- a) HLA - DM ✓
 - b) HLA - A ✗
 - c) HLA - B ✗
 - d) HLA - DRB ✓
 - e) HLA - DRA ✗
11. The importance of Medical Immunology does NOT involve;
- a) Biological control and prevention of certain infections and infestations
 - b) Immunodiagnostics in treatment and management of patients ✓
 - c) Determination of anthropological migration patterns of populations using HLA profiles ✓
 - d) Paternity identity and criminal identification employing DNA typing profiles ✓
 - e) Immune based therapies in the treatment and management of immune mediated disorders ✓
12. Landmarks in Immunology EXCLUDE;
- a) Germ theory of disease developed by Louis Pasteur ✓
 - b) Ogden Bruton found hypergammaglobulinaemia in a male child ✓
 - c) MHC- restricted T cell activation by Doherty and Zinkernagel ✓
 - d) Jennifer Doudna discovery of CRISPR new technology of genome editing ✓
 - e) Jules Hoffman et al discovered Toll-like receptors (TLRs)

13. This is MOST UNLIKELY in the development of vaccines;
- First demonstration by Edward Jenner of vaccination against small pox using cowpox virus ✓
 - Calmette and Guerin discovered vaccine against tuberculosis (BCG) using attenuated live bovine *Mycobacterium bovis* ✓
 - Variolation and inhaling dried powder of small pox crust lesions by Sung Dynasty, China ✓
Ming Dynasty
 - John Salk developed trivalent oral polio vaccine ✓
 - Use of DNA or specific peptides as therapeutic vaccines in the treatment of infectious and non-infectious diseases ✓
14. Which is MOST UNLIKELY in the body defense mechanisms?
- Anatomical and chemical barriers involve mucocilliary elevation, stomach acid, defensins and skin ✓
 - Intrinsic barriers include interferons, autophagy and apoptosis ✓
 - Cellular immunity involve T lymphocytes tailored to the pathogen ✓
 - Antibody dependent mechanisms mediated by various isotypes ✓
 - Extracellular pathogens eliminated predominantly by cellular mechanisms ✓
15. Which is NOT associated with the functions of colon commensal bacteria;
- Recruit protective macrophages and natural killer (NK) cells ✓
 - Synthesis of vitamins ✓
 - Induce protective IgG, IgA and T cells against respiratory pathogens ✓
 - Digestion of polysaccharides dependent on host enzymes ✓
 - Inhibiting/killing pathogenic bacteria and competing for nutrients ✓
16. This is UNTRUE of antimicrobial peptides;
- Consist of defensins and cathelicidins expressed predominantly in neutrophils and epithelial cells ✓
 - Defensins directly inactivate and inhibit viral replication ✓
lysis
a punch lethal holes in bacteria
 - Defensins have secondary alpha helix structures ✓
cathelicidins
 - Defensins reduce bacterial infection by neutralizing secreted toxins ✓
 - Cathelicidins interact with bacterial cell wall and perforate cytoplasmic membranes resulting in bacterial cell death ✓
17. In secondary lymphoid organs this is (MOST UNLIKELY);
- Stem cells from the bone marrow mature and educated in thymus and differentiate into thymus derived T lymphocytes ✓
 - Lymphoid organs morphologically divided into cortex, paracortex and medulla ✓
 - Sites where lymphocytes encounter antigen ✓
 - Interact with other cells and enlarge in response to antigenic stimulation ✓
 - Poorly developed in germ-free animals ✓

18. This MOST UNLIKELY of Toll-Like Receptors (TLRs);
- a) Extracellular TLR+TLR2 dimer recognize peptidoglycan/Lipoprotein ✓
 - b) Intracellular TLR9 recognizes dsRNA viruses ✓
 - c) TLR-4 recognize lipopolysaccharide (LPS) of Gram-negative bacteria
 - d) Intracellular TLR7+TLR8 dimer recognize ssRNA viruses
 - e) PAMP-TLR interaction leads to signal transduction and production of Th1 cytokines and chemokines
19. Activated macrophage associated functions are UNLIKELY to involve;
- a) Assembly of NADPH oxidase in microbicidal mechanisms
 - b) Leukotrienes and prostaglandins as potent mediators of inflammation ✓
 - c) Reactive oxygen species and nitric oxide mediated intracellular killing of pathogens
 - d) Secondary granules containing lactoferrin, gelatinase and cytochrome B558 for intracellular extracellular killing of pathogens
 - e) Activation of protein kinase C and phospholipase releasing acid hydrolases and proteolytic enzymes
20. This is MOST UNLIKELY of Natural Killer (NK) cells;
- a) Provide early protection against intracellular infections
 - b) Possess CD16, CD56, CD94, lectin-like and Ig-like receptors ds RNA
 - c) Activated by IFN- α and IFN- β produced in response to dsDNA viruses
 - d) Respond to LPS by producing IFN- γ that prime macrophages to secrete TNF and IL-12
 - e) Primed NK cells kill viral and tumour cells through apoptosis ✓
21. Mediators of inflammation are NOT associated with;
- a) Mast cell derived histamine causing vasodilation, redness and swelling
 - b) Heat shock proteins (HSP) linked to activation of immune responses
 - c) Bradykinin and prostaglandin from damaged cell membranes cause pain ✓
 - d) Mast cell derived Th1 cytokines recruit and activate inflammatory cells
 - e) Platelet derived serotonin serves as neurotransmitters
22. Which is MOST UNLIKELY in the following important chromosomes in Immunology?
- a) Shorter arm of chromosome 6 encodes major histocompatibility (MHC) system genes
 - b) Chromosome 14 encodes Ig (V, D and C) genes
 - c) TCR (α and δ) chains genes are encoded on chromosome 7
 - d) Chromosome 2 encodes Ig λ (lambda) light chain genes
 - e) Chromosome 22 encodes Ig k (kappa) light chain genes
23. ✓ The first three and last two isotype genes to be transcribed and expressed are;
- a) $C\mu$, $C\delta$, $C\gamma_3$ and $C\epsilon$ and $C\alpha_2$ ✓
 - b) $C\gamma_3$, $C\gamma_1$, $C\alpha_1$ and $C\epsilon$, $C\gamma_4$
 - c) $C\alpha_1$, $C\gamma_2$, $C\gamma_4$ and $C\mu$, $C\delta$
 - d) $C\mu$, $C\delta$, $C\gamma_3$ and $C\gamma_3$, $C\alpha_2$
 - e) $C\gamma_2$, $C\gamma_4$, $C\epsilon$ and $C\gamma_3$, $C\gamma_1$

24. These are UNLIKELY to be members of cell adhesion molecules;
- Intercellular adhesion molecules (ICAM-1, 2,3) ✓
 - Vascular adhesion molecule (VCAM-1) ✓
 - Lymphocyte function-associated antigen (LFA-1) ✓
 - Very late antigen alpha - 4 (VLA-4) ✓
 - Costimulatory PD-L1 and CD80/CD86 molecules ✓
25. Which factors are UNLIKELY to promote immunogenicity of a substance?
- High degree of foreignness ✓
 - Molecular weight of greater than 6 kDa ✓
 - Intravenous route of antigen administration ✓
 - Easily degradable antigen by phagocytosis ✓
 - Suitable genetic constitution and age of individual ✓
26. This is UNTRUE of Immunoglobulins;
- Constitute about 20% of normal plasma proteins ✓ ^{37%}
 - Are negatively charged gamma globulins ✓
 - IgG antibody neutralizes pathogens in tissue spaces ✓
 - Secretory IgA antibody confers protection in sub epithelial mucosal surfaces ✓
 - IgG efficient in placental transmission and protection to infants ✓
27. Which is a MOST UNLIKELY polyclonal B cell activator?
- Protein A - bearing staphylococci and gram- positive bacterial lipopolysaccharides ✓
 - C3d and Epstein - Barr virus (EBV) ✓
 - Pokeweed mitogen ✓
 - Bacterial and parasite derived products ✓
 - Tumour promoting agents ✓
28. This is UNTRUE of complement system;
- Involved in body defense, inflammation and immune system regulation ✓
 - Activated through classical, alternative and mannan binding lectin (MBL) pathways ✓
 - Associated with decreased B cell memory generation ✓
 - Terminal complement complex (TCC) generated on activation leads to osmotic lysis and cell death ✓
 - IgA, IgE and IgD associated immune complexes effectively bind to C1q ✓

29. Helper T cell functions in protection against pathogens are NOT associated with;
- a) Th1 derived cytokine stimulation of mucous production and expulsion of parasites from the gut
 - b) Th 17 cell derived cytokines mediate damage of fungi and extracellular bacterial infections
 - c) Th2 cytokines support B cells to produce IgE that binds on helminthes damaged by activated eosinophils
 - d) Follicular helper T cells support B cells in production of IL-17 to clear microbial infections
 - e) Th1 CD4 T cell derived cytokines activate macrophage mediated intracellular killing of microbes

30. Worldwide authorized COVID-19 vaccine types EXCLUDE;
- a) Nucleic acid vaccines (mRNA): Pfizer-BioNTech, Moderna
 - b) Replication-incompetent vector vaccines (DNA carriers using harmless adenovirus, Ad): Oxford-AstraZeneca, Johnson and Johnson J and Sputnik V (Ad26+Ad5)
 - c) Recombinant protein subunit vaccines (Spike protein nanoparticles + adjuvant): Novavax
 - d) Whole live attenuated virus vaccine: CoronaVac (Sinovac)
 - e) chAdOx1 - s (recombinant) COVISHI ELD Serum Institute of India vaccine

31. Genes that determine Immunoglobulin isotype are located in chromosome;
- a) 7
 - b) 2
 - c) 22
 - d) 14
 - e) 6

32. Biological functions of immunoglobulins are mediated by;
- a) Fab region
 - b) Paratopes
 - c) Light chains
 - d) Fc region
 - e) Hinge region

33. The immunoglobulin with highest molecular weight is;
- a) IgM
 - b) IgG
 - c) IgA
 - d) IgE
 - e) IgD

34. IgG2 and IgG4 are examples of;

- a) Allotypes
- b) Isotypes
- c) Idiotypes
- d) Genotypes
- e) Phenotypes

35. Small Pre-B cells are characterized by the following EXCEPT;

- a) Heavy chain VDJ re-arranged
- b) Light chain VJ re-arranged
- c) IgM on the cytoplasm
- d) IL-7 receptor expression
- e) IgM on the cell membrane

36. During maturation of B- lymphocytes, the first immunoglobulin heavy chain synthesized is the;

- a) Mu chain
- b) Alpha chain
- c) Gamma chain
- d) Epsilon chain
- e) Delta chain

37. Which of the following can especially neutralize viruses and toxins;

- a) IgM
- b) IgA
- c) IgG
- d) IgE
- e) IgD

38. If a patient is genetically unable to make J- chain, which immunoglobulin would be affected;

- a) IgG and IgA
- b) IgM and IgE
- c) IgA and IgE
- d) IgD and IgM
- e) IgA and IgM

39. Ig supergene family EXCLUDE;

- a) T cell receptor
- b) B cell receptor
- c) MHC I products
- d) MHC II products
- e) MHC III products

40. Specific regions in the antibody that make up the antigen-combining site are;

- a) Hypervariable regions
- b) Constant domain
- c) Hinge region
- d) Disulphide bonds
- e) Carboxyl terminals

41. Histamine is released from mast cells stimulated by;

- a) C1q
- b) C2a
- c) C4b
- d) C5a
- e) C3b

42. The amplification loop can be efficiently activated by;

- a) Antigen-antibody complexes
- b) C5-a
- c) Chemically cross-linked Fc fragments of IgG
- d) Ca^{2+}
- e) Properdin since it involves the alternative pathway

43. A deficiency of erythrocyte CRI receptors is associated with;

- a) Accumulation of C_3dg and C_3d in circulation
- b) Increased incidence of angioneurotic edema
- c) Paroxysmal nocturnal haemoglobinuria
- d) Increased deposition of antigen-antibody complexes in tissues
- e) Release of massive amounts of histamine

44. Which of the following is observed only when complement is activated by the classical pathway;

- a) Activation of C1s
- b) Activation of C2
- c) Activation of membrane attack complex
- d) Breakdown of C3 into C3a and C3b
- e) Generation of anaphylatoxins

45. The classical pathway of complement activation;

- a) Starts with the activation of the C3 component
- b) Is activated by lipopolysaccharide cell wall constituents
- c) Is activated by IgA immune complex
- d) Is activated by IgM immune complexes
- e) Is evolutionarily older than the alternative pathway

16. The alternative pathway of complement activation;
- Causes damage in the absence of C1INH
 - Occurs after the classic pathway is activated
 - Occurs only if the classical pathway is ineffective in pathogen clearance
 - Requires C3 ✓
 - Requires C4
47. If a person is born without C2 and C4;
- C5 can still be cleared by classical pathway ✗
 - C3b will not be able to bind to bacteria ✓
 - Ca will polymerize inappropriately and lyse host cells
 - The classical pathway will be changed into the alternative pathway ✗
 - The amount of C3b produced during bacterial infection will be reduced ✓
48. Complement receptor (CR);
- Activate complement on the surface of pathogen
 - Bind only activated complement proteins
 - Inhibit complement activation on the surface of host cells ✓✓
 - On erythrocytes remove immune complexes from the circulation ✓
 - On macrophages signal host cells to make opsonins
49. Complement-mediated bystander lysis of nearby host cells is prevented by;
- A long-lived thioester bond on active complement proteins
 - Covalent attachment of all active complement proteins to the pathogen surface
 - Plasma proteins that inactivate anaphylatoxins
 - Proteins on host cell membranes that inhibit MAC formation ✓
 - The slow catalytic rates of complement proteases
50. Complement fixation refers to;
- The ingestion of C3b-coated bacteria by macrophages
 - The destruction of complement in serum by heating at 56°C for 30 minutes
 - The binding of complement components by antigen-antibody complexes ✓
 - The interaction of C3b with mast cells
 - Control of complement system activation by regulatory components. ✓

SECTION II: SHORT ANSWER QUESTIONS (SAQs)
(85 minutes)

INSTRUCTIONS

- (I) THERE ARE SEVEN (7) QUESTIONS IN THIS SECTION
- (II) ANSWER ALL THE SEVEN (7) QUESTIONS
- (III) START EACH QUESTION ON A FRESH PAGE OF THE BOOKLET.

- 3 SAQ 1: State and briefly explain the genetic events in the synthesis of Immunoglobulin heavy chain. (10 minutes)
- 3 SAQ 2: Using a well-annotated diagram, illustrate the structure of MHC class II molecules. (10 minutes)
- SAQ 3: Explain the KEPI Program of immunization. (10 minutes)
- SAQ 4: State and explain the effector functions of antibodies. (10 minutes)
- 3 SAQ 5: Using annotated diagram, describe the structure of sIgA (secretory IgA). (15 minutes)
- SAQ 6: The complement system is important in many immune reactions. Describe the effects of key complement components. (10 minutes)
- 3 SAQ 7:
 - a) Describe the generation of membrane attack complex (MAC). (10 minutes)
 - b) Describe how the activation of the complement system is regulated. (10 minutes)

SECTION III: MODIFIED ESSAY QUESTIONS (SAQs) (45 Minutes)

INSTRUCTIONS

- (I) THERE IS ONE (1) QUESTION IN THIS SECTION
- (II) ANSWER THE ONE (1) QUESTION

"The overall emerging picture of SARS-CoV-2 infection, as in many other viral infections, shows that SARS-CoV-2 can be efficiently controlled in most infected individuals through coordinated activation of the innate and adaptive components of the immune system. The impairment of IFN- α function mediated by increased production of anti-IFN- α autoantibodies

has been associated with severe COVID-19 cases, while individuals able to control the infection without severe symptoms are able to rapidly mount a virus-specific antibody and T cell response" (Bertoletti A. et al, 2021).

1. Discuss the role of innate immune cells in activation of T cells. ✓ (10 minutes)
2. Discuss why impaired function of IFN- α and other cytokines affects T cell activation and function. (10 minutes)
3. Describe in detail the key steps in the development and maturation of T cells. (15 minutes)
4. Describe five (5) functions of T cells. (10 minutes)