Immunology Lesson plan for international medical students

Kermanshah University of medical sciences (KUMS) international affairs

School of medicine

Department of Immunology

Lecturers:

Dr. Ali Gorgin Karaji

Associated professor of immunology

Dr. Mahdi Taghadosi

Assistant professor of immunology

Dr. Farhad Salari

Assistant professor of immunology

Dr. Alireza Rezaeimanesh

Assistant professor of immunology

Dr. Hanieh Tarokhian

Assistant professor of immunology

Number of units: 2 Unites

Main purpose of the course:

Students will recognize the immune system, Immune responses and mechanisms of recognition of foreign substances by Immune system. They will also learn about development and maturation of Immune cells and the ways they recognize antigens and make response to them, and furthermore they can describe the immunological concepts such as tolerance.

A- Main purposes of sessions:

1-Introducing the immunology discipline, general features of the immune response and student tasks during the semester.

2- Cells and Organs of immune system.

3- Antigens and Immunogenes and Antibodies

4 - Antibody and antigen interaction and its applications.

5- Innate immunity and its components.

6- Lymphocytes recirculation and homing.

7- Cytokines and their roles in the immune response.

8- Major histocompatibility complex (MHC) and the cellular and molecular mechanism of antigen presentation.

9- Genetic basis of antibody and B cell maturation.

10- B cell activation and antibody production.

11- Effector mechanisms of humoral immunity and complement system.

12- T cell Development and Activation

13- Effector mechanisms of cell mediated immunity (CMI).

14- Immunological tolerance.

B- Special purposes for each session:

1- Session one: Introducing the immunology discipline, general features of the immune response and student tasks during the semester.

By finishing this session, the students will be able to:

1-1 Explain the history of immunology discipline
1-2 Define the science of immunology and explain immune response
1-3 Describe different types of immune responses
1-4 Describe properties of innate immunity
1-5 Explain barrier defenses of natural immunity and their roles in defense against microbes.
1-6 Explain characteristics of adaptive immunity.
1-7 Name types of adaptive immunity and their properties.
1-8 Express types of humoral immunity (in terms of their origins).

2- Session two: Cells and Organs of the immune system

By finishing this session, the students will be able to:

2-1 Describe the origin of immune cells, their development and differentiation.
2-2 Explain the development of the phagocytic cells (neutrophils, macrophages and monocytes) and their roles in immune system.
2-3 Describe development of non-phagocytic cells such as eosinophils, basophils and mast cells and their roles in immune system.
2-4 Eexplain the differentiation of B cells from hematopoietic stem cells (HSCs) and will explain the role of B cells in immune response.
2-5 Describe the differentiation of T cells from hematopoietic stem cells (HSCs) and will explain the role of T cells in immune response.
2-6 Explain the differentiation of NK cells from hematopoietic stem cells (HSCs) and will explain the role of NK cells in immune response.
2-7 Name primary (central) and secondary (peripheral) lymph organs.
2-8 Describe differences between primary and secondary lymph organs in terms of immunological responses.

2-9 Describe bone marrow structure and the role of bone marrow in hematopoiesis and lymphopoiesis.

2-10 Explain the histological structure of thymus and its role in T cell maturation and education.

2-11 Describe Digeorge syndrome (the impairment in thymus development).

2-12 Describe lymphatic system, lymph nodes, lymphatic recirculation

2-13 Explain the structure of lymph nodes and B cells and T cells location in lymph nodes.

2-14 Describe the histology of the spleen.

2-15 Outline the immunological and hematological functions of spleen.

2-16 Delineate the importance of spleen in immune response to pathogenic bacteria with capsular polysaccharide.

3- Session three: Antigens, Immunogens and Antibody.

By finishing this session, the students will be able to:

3-1 Define antigen and immunogen

3-2 Describe properties of immunogen

3-3 Define hapten and carrier.

3-4 Define antigenic determinants

3-5 Describe characteristics of B cell epitope.

3-6 Describe characteristics of T cell epitope

3-8 Describe antibodies.

3-9 Delineate molecular structure of antibody

3-10 Describe different light chains of antibody.

3-11 Discriminate various classes of antibodies.

3-12 Describe terms such as: isotypes, allotypes and idiotypes.

3-13 Name various isotypes of immunoglobulins.

3-14 Describe properties of IgG and its clinical functions and importance

3-15 Describe properties of IgA and its clinical functions and importance

3-16 Explain properties of IgM and its clinical role and importance.

3-17 Describe biological functions and properties of IgD.

3-18 Explain properties of IgE, its effector function and its clinical importance

3-19 Define polyclonal and monoclonal antibody

3-20 Describe TCR and its structure

4- Session four: Antibody and antigen interactions and its applications.

By finishing this session, the students will be able to:

4-1. Describe clinical and diagnostic applications of antibody-antigen reaction

4-2. Explain induced fit model for antigen antibody interaction

4-3. Describe affinity and avidity in antibody- antigen reaction

4-4. Explain pre- zone and post-zone in antibody-antigen interaction

4-5. Describe terms such as cross-reactivity, specificity and non reactivity

4-6. Introduce some clinical and therapeutic application of antibodies.

4-7. Name tests which have been designed based on antibody - antigen interaction.

4-8. Describe Immunoassay and its application in clinical diagnosis.

4-9. Describe Radioimmunoassay (RIA) and Enzyme-linked immunoaay (ELISA).

4-10. Describe principles of flow cytometry and its clinical application.

4-11. Explain Immunohistochemical (IHC) methods and their clinical applications.

5- Session five: Innate immunity

By finishing this session, the students will be able to:

5-1. Describe general principles of innate immunity such as physical barrier.

5-2. Describe the importance of innate immunity and compare it with acquired immunity.

5-3. Explain pathogen associated molecular pattern (PAMP) and Damage associated molecular pattern (DAMP) in innate immune responses.

5-4. Explain different types of innate immune receptors such as: Toll-like receptor, NOD like receptor, and RIG like receptor, and scavenger receptors.

5-5. Describe soluble pattern recognition receptors such as complement protein, pentraxin, collectins, and ficollins.

5-6. Explain the importance of antibacterial peptides such as defensins in innate immune response.

5-7. Describe the role of mononuclear phagocytes (macrophages and monocytes), neutophils, eosinophils, mast cells, dendritic cells and Natural killer cells in immune response.

5-8. Describe the process of phagocytosis and the terms such as opsonin, phagosome, phagolysosome, respiratory burst, and reactive oxygen species (ROS).

5-9. Describe the role of innate immunity in the activation of co-stimulatory signals and adaptive immunity.

6- Session six: Lymphocytes recirculation and homing

By finishing this session, the students will be able to:

6-1. Describe adhesive molecules (selectins and integrins) and their ligands.

6-2. Describe the function of adhesive molecules in lymphocytes recirculation.

6-3. Describe the various types of chemokines and their structure.

6-4. Explain different types of chemokine receptors.

6-5. Describe biologic roles of chemokine in immune response

6-6. Describe inflammation, mechanisms of inflammation and cells and molecules involved in this process.

6-7. Describe B cells recirculation through blood and lymph.

6-8. Describe T cells recirculation through blood and lymph.

6-9. Describe the recirculation of effector B cells.

6-10. Describe mechanisms of effector T cells recirculation.

6-11. Describe importance of adhesive molecules in the pathogenesis of inflammatory diseases.

6-12. Describe therapeutic effect of anti inflammatory drugs which inhibits adhesive molecules and chemokines.

7- Session seven: Cytokines and their roles in the immune response.

By finishing this session, the students will be able to:

7-1. Explain the definition of cytokine molecules.

7-2. Describe mechanisms of cytokine action.

7-3. Describe the effect of cytokines in systemic and local inflammation.

7-4. Describe pleotropic, redundancy, synergistic, and antagonistic effects of cytokines.

7-5. Describe cytokines involved in the innate immunity.

7-6. Describe cytokines involved in the adaptive immunity.

7-7. Describe hematopoietic cytokines.

7-8. Describe biologic effect of proinflammatory cytokine including TNF-α, IL-1 and IL-6.

7-9. Describe IL-10 and IL-12, their cellular source and their roles in the immune system.

7-10. Describe type 1 Interferons (IFN-α and IFN-β), their cellular source and their function.

7-11. Describe the pathogenic effect of proinflammatory cytokines in inflammation and septic shock.

7-12. Introduce cytokines such as IL-2,IL-4, IL-5, IFN-γ, and TGF-β which involved in adaptive immune responses.

7-13. Describe the role of G-CSF, M-CSF, GM-CSF, IL-7, IL-3 in proliferation and maturation of bone marrow precursor cells.

7-14. Describe the clinical application of cytokines.

7-15. Describe anti-cytokines monoclonal antibodies that are used as a biologic drugs.

8- Session eight: Major Histocompatibility Complex (MHC) and the cellular and molecular mechanism of antigen presentation.

By finishing this session, the students will be able to:

8-1. Describe the mechanisms of antigen recognition by T lymphocytes.

8-2. Describe ant igen presenting cells (APCs) and their roles in the immune system.

8-3. Explain the history of HLA discovery as a great scientific achievement.

8-4. Describe using the term of HLA instead of MHC and the limitations of this nomenclature.

8-5. Describe the reason that why T cells are restricted to MHC molecules for recognition of peptide antigens.

8-6. Describe the structure of MHC locus genes and also define three classes of MHC genes.

8-7. Describe polymorphism and polymorphic genes including MHC genes.

8-8. Describe MHC class I and Class II proteins and compare them.

8-9. Describe the genes which are located in class III region of MHC genes.

8-10. Describe the concept of antigen presentation and mention different antigen presentation pathways.

8-11. Describe class I pathway (cytosolic) of antigen presentation to the CD8+ T cells and importance of this pathway in tumor immunology and antiviral responses.

8-12. Describe the structure of proteasome and its role in processing of cytosolic antigens.

8-13. Describe the class II pathway (endosomal-lysosomal) of antigen presentation to the CD4+ helper T cells.

8-14. Describe the importance of the cross-presentation pathway in priming CD8+ response.

9- Session Eleven: Genetic basis of antibody diversity and B cell maturation.

B y finishing this session, the students will be able to:

9-1. Describe somatic recombination in the BCR gene loci.

9-2. Explain genetic loci of immunoglobulin light chains (Kappa and lambda) and their location on chromosomes.

9-3. Describe genetic loci of immunoglobulin heavy chains (gamma, alpha, mu, delta, and epsilon) and their location on chromosomes.

9-4. Describe Recombination signal sequences (RSS) including heptamer and nonamer sequences and spacer sequences in the germ line arrangement of immunoglobulin and TCR genes.

9-5. Describe the role of Recombination activator gene-1 (RAG-1) and RAG-2 in somatic recombination of Immunoglobulin and TCR genes.

9-6. Describe the role of combinational diversity and junctional diversity in Immunoglobulin and TCR diversification.

10- Session Ten: B cell activation and antibody production.

By finishing this session, the students will be able to:

10-1. Describe the importance of B cell activation.

10-2. Explain the general feature of humoral immune response.

10-3. Describe B cell subpopulation and describe types of antigen recognized by each of them.

10-4. Describe the anatomic site of B cell activation and describe the ways in which different antigens with various molecular weight are presented to these cells.

10-5. Describe the role of antigen in the activation of T cells and how this process is facilitated by accessory molecules.

10-6. Describe the functional effect various antigens on B cell activation.

10-7. Describe the role of T cells in the activation of B cell in response to protein antigens.

10-8. Introduce the order of events in B cell response to the protein antigen

10-9. Introduce the ligation of CD40-ligand on T cells to CD40 on B cells and its role in B cell activation.

10-10. Explain B cell response to protein antigen in the germinal center of secondary lymphoid follicles and in outside of germinal center.

10-11. Introduce the underlying mechanisms of isotype switching, affinity maturation, creation of memory B cells and long live d plasma cells in the germinal center.

10-12. Explain the effect of follicular helper T cells (Tfh) on isotype switching, affinity maturation, creation of memory B cells and long lived plasma cells.

10-13. Describe molecular mechanisms of isotype switching and affinity maturation.

10-14. Describe mechanisms of plasma cell and B cell differentiation from activated B cells.

10-15. Describe mechanisms of B cell activation by thymus independent antigens.

10-16. Describe properties of T cell independent humoral immune response.

11- Session Eleven: Effector mechanisms of humoral immunity and complement system

By finishing this session, the students will be able to:

11-1. Name effector functions of antibodies.

11-2. Describe the various type of antibody receptors.

11-3. Describe complement system.

11-4. Describe pathways of complement activation.

11-5. Describe steps in classical pathway of complement activation.

11-6. Explain steps in activation of alternative pathway of complement and molecules which activate this pathway.

11-7. Describe lectin pathway of complement activation.

11-8. Describe terminal pathway or membrane attack complex (MAC) of complement activation.

11-9. Describe regulatory molecules in complement activation.

11-10. Describe complement receptors and their role in immune system.

11-11. Describe biologic function of complement.

11 12. Describe immunodeficiencies related to the complement system.

12- Session Twelve: T cell Development and Activation

By finishing this session, the students will be able to:

12-1. Describe stages of T cell development in thymus.

12-2. Describe positive and negative selection and their role in formation of mature T cells repertoire

12-3. Describe order of TCR gene rearrangement.

12-4. Describe allelic exclusion in T cell development.

12-5. Describe the importance of T cell activation

12-6. Introduce place of naïve T cells activation.

12-7. Explain necessary signals for the activation of T cells and the source of these signals.

12-8. Describe co-stimulatory molecules on the surface of APCs and their relevant ligands on the surface of T cells.

12-9. Introduce critical molecules for activation of T cells.

12-10. Name important transcription factors which become activated during T cell activation.

12-11. Describe T cell inhibitory receptors.

12-12. Explain alteration in surface molecules of T cells after their activation.

12-13. Name cytokine which are produced during T cell activation and explain their effector functions.

12-14. Explain T cell clonal expansion.

12-15. Explain differentiation of effector T cells after their clonal expansion.

12-16. Describe types of immune reaction which is created by various effector T cells.

12-17. Describe the role of each effector T cell in defense against pathogens and in pathogenesis of autoimmune diseases.

12-18. Describe the mechanisms of memory T cell differentiation and also explain the properties of these cells.

13- Session Thirteen: Effector mechanisms of T cell mediated immunity (CMI).

By finishing this session, the students will be able to:

13-1. Describe the mechanism of Th1 cell differentiation and the role microbes, cytokines, and transcription factor in this process.

13-2. Describe the mechanism of Th2 cell differentiation and the role microbes, cytokines, and transcription factor in this process.

13-3. Describe the mechanism of Th17 cell differentiation and the role microbes, cytokines, and transcription factor in this process.

13-4. Describe the mechanism of cytotoxic T cells differentiation and the role microbes, cytokines, and transcription factor in this process.

13-5. Describe various types of effector function of cell mediated immunity.

13-6. Describe different aspects of cell mediated immunity in the host defense.

13 -7. Describe the role of critical factors in selective migration of effector cells to the site of infection

13-8. Describe specific chemokine receptor on the surface of effector cells and their respective ligands.

13-9. Describe the role of Th1 cells on the promotion of macrophages and B cells function.

13-10. Describe factors that define migration or remaining of Th1 cells in the site of infection.

13-11. Describe the effector function of Th2 cells and their respective cytokines in immune response.

13-12. Describe the contradictory effect of Th1and Th2 cells on macrophages.

13-13. Describe the role of Th17 cells in defense against microbes and their unwanted effects in the pathogenesis of autoimmune diseases.

13-14. Describe cytokines elaborated by Th17 cells and their roles in immune system.

13-15. Describe the effector function of CTLs.

13-16. Describe the underlying mechanisms of cytotoxic action of CTLs.

14- Session Fourteen: Immunologic tolerance

By finishing this session, the students will be able to:

14-1. Describe tolerance and tolergen.

14-2. Describe central and peripheral tolerance.

14-3. Describe role of thymus in negative selection and the clinical consequence of this process.

14-4. Describe anergy and the mechanisms of peripheral tolerance.

14-5. Introduce inhibitory molecules and their role in the lymphocyte tolerance.

14-6. Explain the immuniological and molecular properties of Treg cells.

14-7. Describe how Treg cells control immune responses and explain the clinical conditions that are related to the impairment of regulatory T cells.

14-8. Describe apoptosis and its role in immunological tolerance.

14-9. Describe mechanisms of B cell tolerance.

14-10. Describe the concept of oral tolerance.

14-11. Explain clonal exhaustion and its importance in chronic viral infection such as HIV.

References:

Abbas, Abul K., Andrew HH Lichtman, and Shiv Pillai. *Cellular and molecular immunology E-book*. Elsevier Health Sciences, 5 th deition2016

. Abbas, Abul K., Andrew HH Lichtman, and Shiv Pillai. *Cellular and molecular immunology E-book*. Elsevier Health Sciences, 8 th edition 2018.

Teaching methods:

Lecture, answer and question, playing movie

Educational tools: PowerPoint, white board

Exam	Method	Share of the total score	date	Time
Midterm	Multiple choice Test	30%	Wednesday 97/08/23	12.15 PM
Final	Multiple choice Test	67%		
Class attendance	Presence & Question	3%		

No.	Session Order	Session Subject	Lecturer
1	First Session	Introduction to immune response and General properties of Immune system	Dr. Gorgin
2	Second Session	Cells and organs of Immune System	Dr. Taghadosi
3	Third session	Antigens ,Immunogens and antibodies	Dr.Tarokhian
4	Fourth Session	Antibody and antigen interaction and its applications	Dr. Taghadosi
5	Fifth Session	Innate immunity and its components	Dr. Salari
6	Sixth Session	Lymphocytes recirculation and homing	Dr. Salari
7	Seventh session	Cytokines and their roles in the immune response	Dr. Tarokhian
8	Eighth Session	. Major histocompatibility complex (MHC) and cellular and molecular mechanism of antigen presentation	Dr. Rezaei manesh

9	Ninth Session	Genetic basis of antibody and B cell maturation.	Dr. Rezaei manesh
10	Tenth Session	B cell activation and antibody production.	Dr,Tarokhian
11	Eleventh Session	Effector mechanisms of humoral immunity and complement system	Dr. Salari
12	Twelfth Session	T cell development and Activation	Dr. Gorgin
13	Thirteenth Session	Effector mechanisms of cell mediated immunity (CMI)	Dr. Gorgin
14	Fourteen Session	Immunological tolerance	Dr. Rezaei manesh