1. Introduction to Immunology

1.1. A historical perspective of immunology.
1.2. The basics of hematopoiesis, focused on the development of myeloid, lymphoid and erythroid cells. The categories of cells types in terms of characteristics and function in an immune response.
1.3. The anatomy of the lymphoid organs, tissues, and the movement of leukocytes in the body.
1.4. General properties of receptor-ligand interactions.
1.5. Overview of signaling molecules and pathways.

2. Innate Immune Responses

2.1. Overview of the characteristics and functions of the innate immune system.
2.2. Functional elements of innate immunity: barriers, cells, tissues, soluble mediators.
2.3. Pattern recognition receptors, pathogen (damage)-associated molecular patterns.
2.4. Activation of innate immune cells and signaling pathways.
2.5. Mechanisms of extravasation, phagocytosis, and pathogen destruction.
2.6. Function and components of the inflammatory response and the subsequent outcomes of localized and systemic inflammation.
2.7. Acute phase response and the resulting systemic changes in the body.
2.8. Complement system components, activation and regulation of the complement system and its role in the recognition and elimination of pathogens, cooperation with the inflammatory response and hemostatic/coagulation pathways.
2.9. The role of NK cells and interferons in the recognition and elimination of virally-infected cells.
2.10. Characteristics and functions of innate lymphoid cells.
2.11. Processes performed by innate immune cells that result in the activation of T and B lymphocytes to a specific pathogen.

3. Lymphocyte Development and Activation

3.1. Organization and expression of lymphocyte receptor genes.
3.2. Discriminate between BCR and TCR gene rearrangements, functional parts of each receptor, cell signaling events through these receptors, and cell surface marker expression during development and on mature lymphocytes.
3.3. B and T cell development from a stem cell to a mature cell.
3.4. Positive and negative selection of T cells in the thymus contrasted with positive and negative selection of B cells in the bone marrow, along with the role of other secondary lymphoid organs during these developmental processes.
3.5. Genetic organization of the Major Histocompatibility Complex (MHC) including the concepts of co-dominant expression, polygeny, polymorphism, and linkage disequilibrium.
3.6. Structure, function, and expression patterns of MHC Class I and MHC Class II proteins.
3.7. The role of antigen presenting cells and antigen processing and presentation pathways in T lymphocyte activation.
3.8. Mechanisms of B cell activation, through both T-independent and T-dependent antigens.
3.9. Antibody structure, structural isoforms, isotypes, antigen-antibody interactions.

4. Humoral and Cell-mediated Immune Responses

4.1. T-independent B cell responses
4.2. T-dependent B cell responses, linked recognition
4.3. The role of T cells, co-receptors and cytokines in the processes of isotype switching, somatic hypermutation, affinity maturation, and the development of memory versus plasma B cells.
4.4. Antibody-mediated effector functions.
4.5. The role of antigen presenting cells (APCs) and cytokines on the differentiation of T cell subsets, and the development of memory T cells.
4.6. CD4+ T cell-mediated functions.
4.7. CD8+ T, NK, and NKT functions.
4.8. Regulation of humoral and cell-mediated responses.
4.9. Characteristics and function of memory responses.

5. Mucosal Immunity

5.1. The cells and tissues of the mucosal immune system, with emphasis on the gastrointestinal tract.
5.2. Prominent species of the human microbiome and the contribution of non-bacterial species to the microbiome: mycobiome and virome
5.3. The ability of the mucosal immune system to switch from a tolerant response to an active immune response against pathogens
5.4. Characteristics of the mucosal immune system and the microbiome that facilitate the maintenance of intestinal homeostasis
5.5. Microbial dysbiosis and alterations in mucosal immune components that contribute to aberrant immune responses and disease.

6. Immunopathologies

6.1. Hypersensitivities
6.1.1. Characteristics of Type I hypersensitivity reactions, roles of immune components contributing to Type I HS and clinical outcomes – allergy, asthma (driven by Th2/Th17), anaphylactic shock, food allergy/tolerance to food antigens, hygiene hypothesis
6.1.2. Similarities of and differences between Type II and Type III hypersensitivity immune mechanisms and clinical outcomes.
6.1.3. Immune components and mechanisms of delayed-type (Type IV) hypersensitivity and clinical outcomes – granuloma formation, contact dermatitis, celiac disease
6.2. General principles of immune regulation
6.2.1. Immune dysregulation and chronic inflammation, causes and consequences
6.3. Autoimmunity
6.3.1. Mechanisms of central and peripheral tolerance.
6.3.2. Processes that result in a break in tolerance.
6.3.3. Causes of autoimmune diseases, the genetics of autoimmune disease including both MHC and non-MHC links to disease, and the HLA-associate risk factors for these diseases.

6.3.4. The role of humoral versus cell-mediated immune responses in autoimmune disease mechanisms and pathologies.
6.3.5. Therapeutic approaches for treating autoimmune disease.

6.4. Transplantation
6.4.1. HLA antigens and their role in the organ/tissue transplantation of Auto-, Allo-, Iso-, and Xeno- grafts.
6.4.2. The immunologic mechanisms involved in the rejection of transplanted tissues and organs.
6.4.3. The concept of bone marrow transplantation and the role of the immune response in graft versus host disease (GVHD).

6.5. Cancer
6.5.1. Tumor associated antigens and their recognition on cancer cells by the immune system.
6.5.2. Mechanisms used by tumor cells to evade detection and destruction by the immune system.
6.5.3. Cancer-specific immunotherapies, including CAR-T, anti-CTLA4, anti-PD1 and similar checkpoint inhibitors, Tumor-infiltrating lymphocyte (TILs) and other breakthrough technologies used to attack cancer cells.

7. Immunodeficiencies

7.1. Primary immunodeficiencies of the innate and adaptive immune systems and the effect on the elimination of pathogens.
7.2. Pathogens and infectious diseases associated with specific immunodeficiencies.
7.3. Secondary immunodeficiencies of the adaptive immune responses associated with poor nutrition, immunosuppressive drugs, and chronic infections.
7.4. The history of HIV/AIDS, interactions of HIV with immune cells and the consequences of the ongoing immune response, pathogens associated with HIV infection and AIDS.

8. Infectious Disease and Vaccines

8.1. Structural and physiological features used for classification and identification of infectious agents.
8.2. Features of infectious agents that contribute to their pathogenicity.
8.3. Common events that occur in infectious diseases such as host encounter and entry, adherence and colonization, spread, evasion of host defenses, and tissue damage.
8.4. The spectrum of pathogenicity from commensal to obligate pathogens.
8.5. The immune response to viruses.
8.6. The immune response to bacteria.
8.7. The immune response to parasites.
8.8. The immune response to fungi.
8.9. Evasion of innate and adaptive immune mechanisms by pathogens.
8.10. History of vaccination.
8.11. Protective immunity through passive and active immunization.
8.12. Characteristics, strengths and weaknesses of varying vaccine strategies. Memory responses and original antigenic sin.

8.13. Purpose and immunologic outcome of conjugate and multivalent component vaccines and adjuvants.

9. Immunologic Methods and Experimental Systems

9.1. Monoclonal and polyclonal antibody generation and applications.
9.2. Purpose and use of immunoprecipitation and agglutination reactions.
9.3. Enzyme-linked immunosorbent assays
9.4. Immunofluorescence-based imaging techniques.
9.5. Flow cytometry and cell sorting.
9.6. Use of mouse model systems – inbred and congenic strains, adoptive transfer experiments, transgenic mice: knock-in, knockout, cre/lox systems

10. Immunotherapies

10.1. History of development
10.2. Activating immunotherapies
10.3. Suppressive immunotherapies

401 – INNATE IMMUNITY

1. Introduction to Immunology

1.2. The basics of hematopoiesis, focused on the development of myeloid, lymphoid and erythroid cells. The categories of cells types in terms of characteristics and function in an immune response.

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5.5. Microbial dysbiosis and alterations in mucosal immune components that contribute to aberrant immune responses and disease.

6. Immunopathologies

6.2. General principles of immune regulation

6.2.1. Immune dysregulation and chronic inflammation, causes and consequences

7. Immunodeficiencies

7.1. Primary immunodeficiencies of the innate ~~and adaptive~~ immune systems and the effect on the elimination of pathogens.

402 – ADAPTIVE IMMUNITY

Brief review of 2.1, 2.3, 2.11

3. Lymphocyte Development and Activation

3.2. Organization and expression of lymphocyte receptor genes.
3.3. Discriminate between BCR or TCR gene rearrangements, functional parts of each receptor, cell signaling events through these receptors, and cell surface marker expression during development and on mature lymphocytes.
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403- PATHOGEN-IMMUNE SYSTEM INTERACTIONS

Review 2.5 – 2.9
Review 3.8, 3.9
Review 4.4, 4.6, 4.7, 4.9

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404 – IMMUNE-MEDIATED DISEASES

Review 4.8
Review PLO 9

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