BT302 – IMMUNOLOGY

FINAL TERM MOST IMPORTANT QUESTIONS

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1. What is oxygen dependent mechanism?

The term "oxygen-dependent mechanism" often refers to the role of reactive oxygen species (ROS) in the immune response. Immune cells, particularly phagocytes like neutrophils and macrophages, utilize oxygen-dependent mechanisms to combat pathogens. Examples are:

1. Respiratory Burst: Phagocytes undergo a process known as the respiratory burst during the immune response. This involves the rapid release of reactive oxygen species (ROS) such as superoxide anion (O_2^-), hydrogen peroxide (H_2O_2), and hydroxyl radicals (OH^-). These reactive oxygen species have potent antimicrobial properties and play a crucial role in destroying engulfed pathogens.

2. Myeloperoxidase Activity: Myeloperoxidase (MPO) is an enzyme present in neutrophils and some other immune cells. It utilizes hydrogen peroxide to produce hypochlorous acid, a powerful antimicrobial agent. This process is part of the oxygen-dependent killing mechanism employed by these cells to eliminate invading microorganisms.

2. Define immunodeficiency.

Immunodeficiency refers to a condition where the immune system is compromised, weakened, or unable to function properly. Individuals with immunodeficiency are more susceptible to infections and may have difficulty mounting effective immune responses against pathogens, leading to increased vulnerability to various diseases.

3. Define inflammation.

Inflammation is a natural and protective response of the body to injury, infection, or irritation, characterized by redness, swelling, heat, and pain. It involves the activation of the immune system and various molecular signals to eliminate the cause of cell injury, clear out damaged cells and tissues, and initiate tissue repair.

4. Differentiate between BCR and TCR.

TCR (T-cell receptor) and BCR (B-cell receptor) are key components of the adaptive immune system. TCR is expressed on the surface of T cells and recognizes antigens presented by major histocompatibility complex (MHC) molecules. TCR facilitates cell-mediated immune responses. In contrast, BCR is found on B cells and binds to antigens directly. BCR initiates humoral immune responses by leading to the production of antibodies. While both receptors play crucial roles in recognizing and responding to antigens, TCR interacts with peptide-MHC complexes, and BCR directly binds to antigens, reflecting the distinct mechanisms through which T cells and B cells contribute to immune surveillance and defense.

5. Write role of Th1 and Th2 cells in immune response.

Th1 (T-helper 1) and Th2 (T-helper 2) cells are subtypes of CD4+ T cells, and they play distinct roles in the immune response:

1. Th1 Cells:

- Th1 cells primarily organize cellular immune responses against intracellular pathogens, such as viruses and certain bacteria.
- Th1 cells secrete cytokines like interferon-gamma (IFN-γ) and tumor necrosis factor-beta (TNF-β).
- Th1 cells promote the activation of cytotoxic T lymphocytes (CTLs), which are crucial for the elimination of infected cells.
- Th1 cells enhance the activation of macrophages, assisting in the destruction of engulfed pathogens.

2. Th2 Cells:

- Th2 cells are involved in humoral immune responses, particularly against extracellular parasites and allergens.
- Th2 cells secrete cytokines such as interleukin-4 (IL-4), interleukin-5 (IL-5), and interleukin-13 (IL-13).
- Th2 cells stimulate B cells to produce antibodies (humoral immunity), promoting the elimination of extracellular pathogens.
- Th2 cells contribute to the activation of eosinophils, which are important in defense against parasitic infections.

6. Explain natural and artificial immunity.

Natural Immunity:

Natural immunity is the body's inherent defense against pathogens acquired through regular life experiences. It includes innate components like physical barriers and non-specific immune responses, as well as adaptive immunity developed over time through exposure to specific pathogens.

Artificial Immunity:

Artificial immunity is achieved through medical interventions. Vaccinations or immunizations introduce harmless forms of pathogens or their components to stimulate an immune response. This process helps the body "remember" the pathogen, providing protection against future exposures without causing the actual disease. Immunotherapy may also manipulate the immune system to combat diseases like cancer.

7. Differentiate between class 1 MHC and class 2 MHC.

MHC Class I:

Location: Found on the surface of all nucleated cells.

Antigen Presentation: Presents endogenous antigens (originating within the cell), such as viral or intracellular bacterial proteins.

Peptide Binding: Binds to short peptides (typically 8-10 amino acids) derived from cytoplasmic proteins.

Function: Presents antigens to cytotoxic T lymphocytes (CD8+ T cells), triggering a cellular immune response against infected or abnormal cells.

Cell Types: Expressed by virtually all nucleated cells, serving to identify and eliminate cells with intracellular infections or abnormalities.

MHC Class II:

Location: Found on the surface of antigen-presenting cells (APCs) like dendritic cells, macrophages, and B cells.

Antigen Presentation: Presents exogenous antigens (acquired from the external environment), typically from extracellular pathogens or proteins.

Peptide Binding: Binds to longer peptides (usually 13-25 amino acids) derived from proteins that have been engulfed and processed within the cell.

Function: Presents antigens to helper T lymphocytes (CD4+ T cells), initiating a humoral immune response and coordinating various aspects of the immune system.

Cell Types: Expressed mainly by immune cells involved in antigen presentation, facilitating the activation of helper T cells and the coordination of adaptive immune responses.

8. Write importance of antibodies.

- Antibodies bind to pathogens, preventing them from infecting host cells.
- Antibodies mark pathogens for phagocytosis by immune cells, enhancing their clearance.
- Antibodies activate the complement system, facilitating pathogen destruction.
- Antibodies attract immune cells to sites of infection, aiding in the elimination of pathogens.
- Antibodies contribute to immunological memory, providing faster and more robust responses upon re-exposure to pathogens.
- Secretory antibodies (IgA) protect mucosal surfaces, such as those in the respiratory and gastrointestinal tracts, against infections.

- Antibodies help regulate the immune system and prevent it from attacking the body's own tissues.
- Maternal antibodies passed to infants provide passive immunity during early life.
- Antibodies are used in laboratory tests, diagnostics, and medical research.

9. What is importance of monoclonal antibodies?

- Monoclonal antibodies are designed to specifically target a single type of antigen, ensuring precision in treatment.
- Used in the treatment of various diseases, including cancers, autoimmune disorders, and infectious diseases.
- Due to their targeted nature, monoclonal antibodies often have fewer side effects compared to traditional treatments.
- Used in medical diagnostics, such as pregnancy tests and disease detection, due to their specificity.
- Widely used in scientific research to study specific proteins and their functions.
- Monoclonal antibodies can stimulate the immune system to recognize and attack cancer cells, contributing to cancer immunotherapy.
- Effective in neutralizing viruses and toxins, providing a potential treatment for infectious diseases.
- Can be engineered for individual patients based on their specific disease characteristics, allowing for personalized treatment approaches.
- Some monoclonal antibodies are designed with an extended half-life, requiring less frequent dosing in therapeutic applications.

10. What are cytokines?

Cytokines are small proteins involved in cell signaling, playing a pivotal role in regulating immune responses and inflammation. Produced by various cells, particularly immune cells, cytokines serve as messengers that facilitate communication between cells. They contribute to the coordination of immune and inflammatory processes, influencing cell activation, proliferation, and differentiation. Cytokines play diverse roles in maintaining homeostasis and responding to infections, injuries, and other challenges. Due to their significance, cytokines are studied extensively in the context of immunology and are key targets in therapeutic interventions for various diseases.

11. Write role of humoral antibodies.

Humoral antibodies, produced by B cells as part of the adaptive immune response, play crucial roles in immune defense:

1. Antibodies bind to pathogens, preventing them from entering or infecting host cells. This neutralization is a primary mechanism for limiting the spread of infections.

2. Antibodies mark pathogens for destruction by phagocytic cells, such as macrophages and neutrophils. This process, known as opsonization, enhances the efficiency of phagocytosis.

3. Antibodies can activate the complement system, a group of proteins that work together to destroy pathogens directly or enhance their removal by phagocytes.

4. Antibodies can block the adherence of pathogens to host cells, hindering their ability to establish infections.

5. Antibodies form immune complexes with pathogens, making them more easily recognized and engulfed by phagocytic cells.

6. Antibodies contribute to immunological memory, allowing the immune system to mount a faster and more robust response upon re-exposure to the same pathogen.

7. Secretory antibodies, such as IgA, protect mucosal surfaces in the respiratory, gastrointestinal, and genitourinary tracts, serving as a first line of defense against infections.

8. Antibodies play a role in regulating the immune system, preventing it from attacking the body's own tissues and maintaining self-tolerance.

12. How immune responses work for transplants? How they are induced?

Immune responses to transplants involve the recognition of foreign antigens, potentially leading to rejection.

Recognition of Foreign Antigens:
Transplanted tissues carry antigens that may trigger immune responses. Mismatched MHC molecules can be a major factor in rejection.

Types of Rejection:
Hyperacute, acute, and chronic rejection can occur.

Immunosuppression:
Recipients often receive immunosuppressive drugs to prevent rejection. Common drugs include corticosteroids, calcineurin inhibitors, and antimetabolites.

Induction of Immune Tolerance:
Research aims to induce immune tolerance for transplants without continuous immunosuppression. Strategies involve regulatory T cells and other tolerance-inducing approaches.

13. What are types and subtypes of antibodies?

Types of Antibodies:

1. IgM (Immunoglobulin M): First antibody produced in response to an infection; efficient in activating the complement system.

2. IgG (Immunoglobulin G): Most abundant antibody; provides long-term immunity; crosses the placenta from mother to fetus.

3. IgA (Immunoglobulin A): Predominant in mucosal areas; found in saliva, tears, and breast milk.

4. IgE (Immunoglobulin E): Involved in allergic responses; defends against parasitic infections.

5. IgD (Immunoglobulin D): Found on the surface of B cells; function not fully understood.

Subtypes of Antibodies:

1. IgG Subtypes: IgG1, IgG2, IgG3, IgG4 - Differ in their effector functions and distribution in the body.

2. IgA Subtypes: IgA1, IgA2 - Found in different mucosal secretions; differ in structure and function.

3. IgE and IgD do not have distinct subtypes.

14. What is use and side effects of artificial passive immunity?

Use of Artificial Passive Immunity:

Rapid Protection: Provides immediate and temporary protection against specific pathogens.

Short-Term Immunization: Useful in situations where the immune response needs to be quick, but long-term protection is not required.

Side Effects of Artificial Passive Immunity:

Allergic Reactions: Risk of allergic responses to foreign proteins in the administered antibodies.

Transmission of Infections: Potential transmission of infections if the antibodies are derived from human or animal sources.

Short Duration: Temporary protection; requires repeated administration for sustained effects.

15. Write mechanism of activation of B cell with the independent antigen.

The activation of B cells with T-cell-independent antigens involves direct recognition of antigens by B cells without the need for assistance from T cells. This process typically occurs when the antigens are highly repetitive and can cross-link multiple B cell receptors (BCRs) simultaneously. The mechanism can be summarized as follows:

1. Recognition of Antigen:

- T-cell-independent antigens are often large and repetitive, such as certain polysaccharides or lipopolysaccharides found on the surface of bacteria.
- B cell receptors (BCRs) on the surface of B cells directly bind to these repetitive epitopes without the need for processing or presentation by antigen-presenting cells.

2. Cross-Linking of BCRs:

- Binding of the BCRs to the repetitive epitopes leads to cross-linking of multiple BCRs on the B cell surface. This cross-linking is a crucial step for B cell activation.

16. What is direct and indirect ELISA? Write its uses.

Direct ELISA

In this type of ELISA, unknown antibody can be determined in patient's serum. Principally, known antigen is coated on solid phase which can be a Glass or plastic surface. Patient's serum containing unknown antibody is added for reacting with the specific coated antigen. Afterward, another antibody which is pre-coated with an enzyme e.g horseradish peroxidase is usually used. Then the activity of enzyme is determined by adding its substrate i.e hydrogen peroxide in the form of colour change in the reaction mixture. Moreover, the intensity of color determines the concentration of unknown antibody in the patient's serum indirectly.

Indirect ELISA

In this type of ELISA, unknown antigen can be determined in patient's serum. Principally, known antibody against the unknown antigen is coated on solid phase which can be a Glass or plastic surface. Patient's serum containing unknown antigen is added for reacting with the specific coated antibody. Afterward, another antibody which is pre-coated with an enzyme e.g horseradish peroxidase is usually used, thus the unknown antigen get sandwiched between two antibodies, that's why it is also called as sandwiched ELISA. Then the activity of enzyme is determined by adding its substrate i.e hydrogen peroxide in the form of color change in the reaction mixture. Moreover, the intensity of color determines the concentration of unknown antibody in the patient's serum indirectly.

Both direct and indirect ELISA are versatile and widely employed techniques in research, clinical diagnostics, and quality control, allowing for the detection and quantification of various antigens and antibodies.

17. Write role of immune system.

- Recognizes and eliminates viruses, bacteria, fungi, and parasites.
- Identifies and destroys abnormal cells, including cancerous cells.
- Contributes to tissue repair and homeostasis.
- Remembers previous infections, providing faster and more effective responses upon re-exposure.
- Controls and regulates allergic responses.
- Recognizes and eliminates cells that pose a threat due to autoimmune reactions.
- Identifies and rejects foreign tissues in transplant situations.
- Secures mucosal surfaces, preventing infections in the respiratory, gastrointestinal, and genitourinary tracts.
- Responds to vaccines, providing long-term protection against specific pathogens.
- Triggers inflammation for defense and facilitates tissue healing after infection or injury.

18. Write role of adjuvant in immune system.

Role of Adjuvant in the Immune System:

- Adjuvants boost the effectiveness of vaccines by stimulating a stronger and more prolonged immune response.
- They help improve the presentation of antigens to immune cells, promoting a more robust and long-lasting immune memory.
- Adjuvants can be substances or compounds that, when added to vaccines, enhance their efficacy. Common types include alum, oil-in-water emulsions, and toll-like receptor agonists.
- Adjuvants contribute to the success of vaccines by enhancing their ability to induce protective immunity against pathogens.

19. What are good immunogens?

Good Immunogens:

These immunogens are substances capable of inducing an immune response.

Characteristics of Good Immunogens:

- **Foreignness:** The immunogen should be recognized as foreign by the immune system.
- **Complexity:** Complex molecules with diverse epitopes are often more immunogenic.
- **Stability:** Stability influences the persistence of the immune response.
- **Size:** Intermediate-sized molecules (1000-100,000 Daltons) are often more immunogenic.

- **Solubility:** Soluble antigens are generally more immunogenic than insoluble ones.
- **Examples:** Proteins, polysaccharides, and complex molecules often serve as effective immunogens.
- **Applications:** Used in vaccines to induce specific and protective immune responses against pathogens, leading to immunological memory and protection upon subsequent exposure.

20. Explain vaccine or artificial active immunity.

Vaccine or Artificial Active Immunity:

A vaccine is a biological preparation that stimulates the immune system to recognize and remember a pathogen without causing the disease. Vaccines contain weakened or inactivated forms of the pathogen, its toxins, or specific antigens. Upon vaccination, the immune system recognizes the antigens in the vaccine as foreign and mounts an immune response. The immune system "learns" to recognize and remember the pathogen, providing rapid and specific responses upon subsequent exposure.

Types of Vaccines:

- ***Live attenuated:*** Weakened forms of the pathogen.
- ***Inactivated:*** Killed forms of the pathogen.
- ***Subunit, conjugate, or recombinant***: Specific components or proteins.

21. How diagnosis of Hypersensitivity I is done?

Diagnosis of Hypersensitivity I:

Medical History: Detailed inquiry about symptoms and potential triggers.
Physical Examination: Evaluation of signs related to allergic reactions.
Allergy Testing: Skin prick tests, blood tests (e.g., IgE levels) to identify specific allergens.
Challenge Tests: Controlled exposure to suspected allergens under supervision.
Elimination Diet: For food allergies, a systematic elimination and reintroduction of foods.
Symptom Diary: Recording symptoms and activities for a comprehensive assessment.

22. Explain structure of TcR.

The T-cell receptor (TCR) is a complex structure found on the surface of T cells and is crucial for their role in the immune response. The TCR is composed of two distinct protein chains, alpha (α) and beta (β) chains, or gamma (γ) and delta (δ) chains in the case of gamma-delta T cells. Each chain consists of different regions contributing to the overall structure:

1. Variable (V), Diversity (D), Joining (J), and Constant (C) Regions:

Both alpha and beta chains have V, D, and J gene segments, arranged in a variable region that contributes to antigen recognition. The constant region determines the isotype of the TCR (e.g., alpha-beta TCR isotypes include αβ-TCR1 and αβ-TCR2).

2. Complementarity-Determining Regions (CDRs):
These are loops within the variable region that directly interact with the antigen. CDR3, in particular, plays a key role in antigen specificity and diversity.

3. Transmembrane Region:
Anchors the TCR in the cell membrane, facilitating its interaction with antigen-presenting cells.

4. Cytoplasmic Tail:
The intracellular part of the TCR that interacts with signaling molecules involved in T cell activation.

5. Heterodimeric Structure:
Alpha-beta TCRs form a heterodimer, where the alpha and beta chains combine to create a single functional TCR complex.

23. Explain combination of VDJ.

The combination of VDJ refers to the recombination of gene segments during the development of T and B cells, contributing to the diversity of antigen receptors.

V (Variable), D (Diversity), and J (Joining) Segments:

- TCR and immunoglobulin genes undergo VDJ recombination during lymphocyte development.
- Random combinations of V, D, and J gene segments create diverse antigen receptor structures.
- This process occurs in the bone marrow for B cells and the thymus for T cells.
- Results in a vast repertoire of antigen receptors, allowing recognition of a wide range of antigens.

24. What are tumor species and tumor transplantation?

Tumor Species:

Tumor species refers to a group of tumors or neoplastic cells derived from the same individual. Tumor species may share genetic mutations, histological features, and immunological properties.

Tumor Transplantation:

Tumor transplantation involves transferring tumor cells or tissues from one individual to another. Used in experimental settings to study tumor growth, immunological responses, and potential therapeutic interventions. Tumor transplantation can face challenges related to host immune responses and variations in tumor behavior.

25. What are co-stimulatory molecules of B cells to mount co-effector response?

Co-stimulatory Molecules of B Cells for Co-Effector Response:

CD40: Interaction with CD40 ligand (CD40L) on T cells provides essential co-stimulatory signals for B cell activation.

B7 Molecules (CD80/CD86): Interaction with CD28 on T cells enhances B cell activation and antibody production.

ICOS (Inducible T-cell Co-stimulator): Interaction with its ligand on B cells promotes T cell-dependent B cell responses.

BAFF (B-cell Activating Factor): Stimulates B cell survival, proliferation, and antibody production.

APRIL (A Proliferation-Inducing Ligand): Enhances B cell survival and immunoglobulin class-switching.

26. How cellular immunity provide protection?

Cellular Immunity for Protection:

Cytotoxic T Cells (CTLs):

- Directly target and kill infected or abnormal cells.
- Recognize specific antigens presented on the surface of target cells.

Helper T Cells:

- Coordinate immune responses by activating other immune cells.
- Stimulate cytotoxic T cells and B cells for an effective response.

Memory T Cells:

- Provide long-lasting immune memory.
- Enable rapid and robust responses upon re-exposure to familiar pathogens.

Regulatory T Cells:

- Suppress excessive immune responses.
- Maintain immune system balance, preventing autoimmune reactions.

Natural Killer (NK) Cells:

- Recognize and eliminate abnormal cells, such as virus-infected or cancerous cells.
- Contribute to early defense against infections.

Phagocytes (Macrophages):

- Engulf and digest pathogens, clearing infections.
- Present antigens to activate T cells and initiate immune responses.

27. Explain autoimmunity.

Autoimmunity:

Autoimmunity is a condition where the immune system mistakenly attacks and damages the body's own tissues, considering them as foreign. Loss of self-tolerance leads to the production of autoantibodies and activation of autoreactive T cells. Autoimmune reactions can cause inflammation, tissue damage, and contribute to various autoimmune diseases, such as rheumatoid arthritis, lupus, and type 1 diabetes.

28. What is affinity maturation?

Affinity Maturation:

A process in the immune system where B cells undergo iterative rounds of mutation and selection to improve the binding strength (affinity) of antibodies to antigens. It occurs primarily during the germinal center reaction in secondary lymphoid organs. Result leads to the production of high-affinity antibodies, enhancing the effectiveness of the immune response over time.

29. Write effective functions of complement protein?

Effective Functions of Complement Proteins:

- ***Opsonization:*** Enhances phagocytosis by marking pathogens for destruction.
- ***Membrane Attack Complex (MAC) Formation:*** Directly lyses and kills target cells.
- ***Inflammation:*** Induces inflammation by attracting immune cells to the site of infection.
- ***Enhancement of Antibody Response***: Amplifies the effectiveness of antibody-mediated immune responses.
- ***Clearance of Immune Complexes:*** Removes immune complexes and cellular debris from circulation.

30. Differentiate between primary and secondary antibody response.

Primary Antibody Response:

First Exposure: Occurs upon the initial encounter with an antigen.
Latency: Lag phase before the production of specific antibodies.
Antibody Types: IgM antibodies are the first to be produced.
Peak Response: Generally lower and peaks later.
Duration: Shorter duration of antibody presence.
Memory: Forms the basis for the development of immunological memory.

Secondary Antibody Response:

Subsequent Exposures: Occurs upon re-exposure to the same antigen.
Rapid Response: Shorter lag phase due to memory cells.
Antibody Types: IgG antibodies dominate the response.
Peak Response: Higher and occurs more rapidly.
Duration: Longer-lasting antibody presence.
Memory: Reflects the immunological memory from the primary response.

31. What is clonal selection of lymphocytes? What are principles of clonal selection?

Clonal Selection of Lymphocytes:

A concept in immunology proposes that each lymphocyte carries a specific receptor for an antigen, and upon encountering the corresponding antigen, undergoes clonal expansion to produce a population of identical cells.

Principles of Clonal Selection:

1. Diversity of Receptors: Lymphocytes express a diverse array of receptors capable of recognizing a wide range of antigens.

2. Specificity: Each lymphocyte has unique receptor specificity for a particular antigen.

3. Encounter with Antigen: When a lymphocyte encounters its specific antigen, it binds to the antigen, leading to activation.

4. Clonal Expansion: Activated lymphocytes undergo clonal expansion, resulting in the proliferation of identical daughter cells derived from a single activated cell.

5. Effector Functions: The expanded clone differentiates into effector cells, which carry out various functions such as antibody production (B cells) or cytotoxic activity (T cells).

6. Memory Cell Formation: Some cells from the clone differentiate into memory cells, providing a faster and more robust response upon re-exposure to the same antigen.

32. How cytokine network communicate between lymphocytes, macrophages and other common immunity systems?

The cytokine network is a complex signaling system that facilitates communication between various components of the immune system, including lymphocytes, macrophages, and other immune cells. Cytokines are signaling molecules that play a crucial role in orchestrating immune responses. Here's how the cytokine network facilitates communication:

1. Lymphocytes and Antigen Presentation:

Antigen-presenting cells (APCs), such as macrophages, present antigens to T lymphocytes. Interleukin-12 (IL-12) produced by macrophages stimulates the differentiation of T helper cells into Th1 cells.

2. T Helper Cells (Th Cells):

Th1 cells release cytokines like interferon-gamma (IFN-γ). IFN-γ activates macrophages, enhancing their ability to eliminate intracellular pathogens.

3. T Helper Cells (Th Cells) and B Cells:
Th2 cells release cytokines like interleukin-4 (IL-4). IL-4 stimulates B cells to differentiate into plasma cells and produce antibodies.

4. Feedback Loops:
Cytokines produced by lymphocytes and macrophages create feedback loops. For example, macrophages release IL-10, which can suppress excessive inflammation.

5. Chemotaxis and Cell Recruitment:
Cytokines act as chemotactic factors, guiding immune cells to the site of infection or inflammation. Macrophages, neutrophils, and other immune cells are recruited to enhance the immune response.

6. Interplay with Innate Immunity:
Cytokines bridge the gap between innate and adaptive immunity. They regulate the activation and function of both macrophages and lymphocytes.

7. Immunoregulation:
Cytokines contribute to the balance between pro-inflammatory and anti-inflammatory responses, ensuring an appropriate and controlled immune reaction.

8. Memory Response:
Cytokines play a role in the formation of immunological memory, aiding in the rapid and efficient response upon re-exposure to the same pathogen.

33. How immune system responses to tumor cells?

Immune System Response to Tumor Cells:

Cytotoxic T Cells (CTLs):
Recognize and kill tumor cells, targeting specific antigens.

Natural Killer (NK) Cells:
Detect and eliminate abnormal cells, including tumor cells.

Tumor-Infiltrating Lymphocytes (TILs):
Lymphocytes found within tumor tissues contribute to immune responses against the tumor.

Tumor Antigens:
Tumor-specific antigens can be targeted by the immune system for destruction.

Immunotherapy:
Approaches like checkpoint inhibitors, CAR-T cell therapy, and cancer vaccines harness the immune system to target and eliminate tumor cells.

34. Write the process of antigen processing and presenting.

Antigen Processing and Presenting:

1. Antigen Capture:
Antigens from pathogens or abnormal cells are captured by antigen-presenting cells (APCs) like dendritic cells, macrophages, or B cells.

2. Internalization:
Antigens are internalized by the APC through processes like phagocytosis, endocytosis, or pinocytosis.

3. Antigen Processing:
Antigens undergo enzymatic degradation within the APC, breaking them into smaller peptide fragments.

4. Peptide Loading onto MHC:
Peptide fragments are loaded onto major histocompatibility complex (MHC) molecules inside the endoplasmic reticulum (ER).

5. Transport to Cell Surface:
MHC-peptide complexes are transported to the cell surface, ready to be presented to T cells.

6. Recognition by T Cells:
T cells, particularly CD4+ helper T cells and CD8+ cytotoxic T cells, recognize the MHC-peptide complexes presented on the surface of APCs.

7. Activation of T Cells:
Binding of T cell receptors (TCRs) to MHC-peptide complexes activates T cells, initiating immune responses.

8. Co-stimulation:
Co-stimulatory signals, provided by molecules like B7 on APCs interacting with CD28 on T cells, ensure a robust and appropriate immune response.

9. Differentiation of T Cells:
Activated CD4+ T cells differentiate into various effector T cell subsets, such as Th1, Th2, or Treg cells. CD8+ T cells differentiate into cytotoxic T lymphocytes (CTLs).

10. Effector Functions:
Effector T cells perform functions like activating other immune cells, releasing cytokines, or directly killing infected or abnormal cells.

35. Explain delayed type hypersensitivity.

Delayed Type Hypersensitivity (DTH):

Type of Hypersensitivity: DTH is a type IV hypersensitivity reaction, also known as delayed-type hypersensitivity or cell-mediated hypersensitivity.

Mechanism: Involves the activation of T cells, particularly CD4+ T cells (Th1 cells), and the recruitment of macrophages to the site of antigen exposure.

Timeframe: Unlike immediate hypersensitivity reactions, DTH reactions take hours to days to develop.

Examples: Contact dermatitis (e.g., poison ivy reaction), tuberculin skin test for tuberculosis.

Clinical Features: Inflammatory response, tissue damage, and granuloma formation characterize DTH reactions.

36. Write process of phagocytosis.

Phagocytosis is a vital cellular process by which certain cells engulf and digest solid particles, such as bacteria, cellular debris, and other foreign particles. This mechanism is employed by specialized cells known as phagocytes, which are part of the body's immune system. Phagocytes play a crucial role in protecting the body against infections. The process of phagocytosis can be broken down into several stages:

1. ***Chemotaxis:*** Phagocytes are attracted to the site of infection or inflammation by chemical signals released by damaged cells, bacteria, or other foreign substances. This movement toward the source of the signals is known as chemotaxis.

2. ***Attachment:*** The phagocyte adheres to the surface of the foreign particle or microorganism. This is facilitated by specific receptors on the surface of the phagocyte that recognize and bind to molecular patterns present on the target.

3. ***Engulfment:*** The phagocyte extends its cell membrane to surround the particle, forming a pocket-like structure called a phagosome. The engulfed particle is now contained within the phagosome, which is essentially a vesicle formed by the cell membrane.

4. ***Phagosome Formation:*** The phagosome undergoes a series of maturation steps as it moves deeper into the cell. This involves fusion with intracellular vesicles, such as lysosomes, which contain enzymes capable of breaking down the engulfed material.

5. ***Digestion:*** The contents of the phagosome are broken down by enzymes within the lysosomes. This process, known as intracellular digestion, releases nutrients and eliminates potential threats to the organism.

6. ***Exocytosis:*** After digestion, the indigestible material is expelled from the cell through a process called exocytosis. The remaining waste products are released into the extracellular space.

37. What is cellular immunity?

Cellular immunity, also known as cell-mediated immunity, is a critical component of the immune system that involves the activation and response of immune cells to recognize and eliminate infected or abnormal cells. Unlike humoral immunity, which involves the production of antibodies by B cells, cellular immunity relies on the direct action of various types of immune cells. Key players in cellular immunity include T lymphocytes (T cells), natural killer (NK) cells, and macrophages. Here are some key aspects of cellular immunity:

1. T Lymphocytes (T Cells)
2. Recognition of Antigens
3. Cytotoxic T Cell Activity
4. Helper T Cell Functions
5. Natural Killer (NK) Cells
6. Macrophages

38. How immune system responds against intracellular pathogens?

The immune system employs various mechanisms to respond against intracellular pathogens, which are pathogens that replicate and survive inside host cells. These responses involve the activation of immune cells, particularly T lymphocytes (T cells), natural killer (NK) cells, and macrophages. Here's an overview of how the immune system responds to intracellular pathogens:

1. Antigen Presentation:
Infected cells present small fragments of pathogen-derived proteins (antigens) on their surface using major histocompatibility complex (MHC) molecules. Antigen-presenting cells (APCs), such as macrophages, dendritic cells, or infected cells themselves, present antigens to T cells.

2. Recognition by T Cells:
CD8+ cytotoxic T cells (CTLs) recognize MHC class I-presented antigens on infected cells. CD4+ helper T cells assist in coordinating the immune response by recognizing MHC class II-presented antigens on APCs.

3. Activation of Cytotoxic T Cells (CTLs):
Upon recognition of infected cells, CTLs become activated and undergo clonal expansion. Activated CTLs release cytotoxic substances, such as perforin and granzymes, inducing apoptosis (programmed cell death) in the infected cells.

4. Natural Killer (NK) Cell Activity:
NK cells recognize and target cells displaying abnormal features, including infected cells. NK cells release cytotoxic granules to induce apoptosis in target cells.

5. Macrophage Activation:
Macrophages, as part of the innate immune system, can be activated by cytokines released by T cells. Activated macrophages enhance their ability to phagocytose and digest intracellular pathogens.

6. Interferons:
Interferons are signaling proteins released by infected cells to signal neighboring cells and induce an antiviral state. They activate various immune responses, including the inhibition of viral replication.

7. Memory T Cell Formation:
Some T cells generated during the response to intracellular pathogens become memory T cells. Memory T cells provide rapid and enhanced responses upon re-exposure to the same pathogen.

39. What factors effect antigen and antibody reactions?

Factors Effecting on Antigen & Antibody Tests:

The good antigen & antibody reactions are known due to high specific & sensitive nature. Various factors are involved which determine the nature of antigen and antibody reactions which are as follows:

Affinity:

It is the strength of binding between single antigenic determinant & single antibody site. These are the sum of attractive & repulsive forces which make the Ag/Ab reactions stronger. Higher the affinity of Ab for Ag, more stable interaction. Similarly, if the affinity would be weak between Ag & Ab then the reaction would be less stable.

Avidity:

Avidity is the strength of binding of antigen with many antigenic determinant & multivalent antibody. It is also called as overall strength between multivalent antigens & antibodies. In contrast to affinity, avidity is influenced by valency of both Ag & Ab. Multivalent antibodies have more avidity as compare to univalent or oligovalent antibodies. That's why, the Ag/Ab reactions which have more avidity those are more stable & easy to detect.

Antigen & Antibody Ratio:

Ag/Ab ratio also considered as one of the important factor effecting on Ag/Ab reactions. It also determines the complex nature of Ag/Ab complex formation. For good Ag/Ab reaction, there would be the equal ratio between Ag/Ab and that point is also called as equivalence

point for Ag/Ab reaction. As a result a complex structure develops which is called as lattice which is easy to detect. However, in the case of unequal ratio between Ag/Ab doesn't form such kind of complex structure.

Physical Form:
Physical form of antigen & antibody also determines the nature of Ag/Ab reaction. Antigen and antibody can exsist in the following two physical forms:
a) Particulate form
b) Soluble form

40. What are uses of monoclonal antibodies?

Monoclonal antibodies (mAbs) have diverse applications across several fields due to their specificity and ability to target specific molecules. Here are some of their key uses:

1. Medical Treatments:
Cancer Therapy: Monoclonal antibodies can be designed to recognize and target specific proteins on cancer cells, aiding in the destruction or inhibition of tumor growth. Examples include trastuzumab (Herceptin) for breast cancer and rituximab (Rituxan) for certain types of lymphoma.
Autoimmune Diseases: mAbs are employed to modulate the immune system and treat autoimmune disorders such as rheumatoid arthritis (e.g., adalimumab, infliximab) and psoriasis (ustekinumab).
Infectious Diseases: Monoclonal antibodies have been developed for the treatment of viral infections, including the use of casirivimab and imdevimab for COVID-19.

2. Diagnostic Tools:
Monoclonal antibodies are used in various diagnostic assays. They can specifically bind to target molecules, aiding in the detection and quantification of specific proteins or pathogens. For example, pregnancy tests use monoclonal antibodies to detect human chorionic gonadotropin (hCG).

3. Imaging Agents:
Monoclonal antibodies labeled with imaging agents, such as radioactive isotopes, can be employed for diagnostic imaging. This allows for the visualization of specific tissues or biomarkers in techniques like positron emission tomography (PET) or single-photon emission computed tomography (SPECT).

4. Research Tools:
In laboratory research, monoclonal antibodies serve as valuable tools. They are used to identify, isolate, and study specific proteins, cells, or biological pathways. Researchers use them to investigate disease mechanisms and develop new therapeutic approaches.

5. Therapeutic Drug Delivery:
Monoclonal antibodies can serve as carriers for drugs or toxins. By attaching therapeutic agents to antibodies, they can be targeted to specific cells or tissues, enhancing treatment precision and minimizing side effects.

6. Allergy Treatment:
Monoclonal antibodies, such as omalizumab, are used to treat allergic conditions. They target specific components of the immune system involved in allergic responses, providing relief for conditions like allergic asthma.

7. Transplantation Medicine:
Monoclonal antibodies can be employed to suppress the immune response during organ transplantation. Drugs like basiliximab and alemtuzumab target specific immune cells to prevent transplant rejection.

8. Neurological Disorders:
Research is ongoing to explore the use of monoclonal antibodies in treating neurological disorders, such as Alzheimer's disease. These antibodies may target and clear specific pathological proteins associated with these conditions.

41. How to control vesicular pathogenesis?

Controlling vesicular pathogenesis involves identifying the cause and employing targeted treatments, such as antiviral medications for viral infections, immunosuppressive therapy for autoimmune conditions, and topical agents for bacterial or fungal infections. Pain management and maintaining good hygiene are also important aspects of control.

42. What are T dependent and T independent antigens?

T-Dependent Antigens:
T-dependent antigens are substances that require the involvement of T helper cells to stimulate a strong immune response. These antigens are often proteins or glycoproteins. B cells recognize and bind to T-dependent antigens, and the interaction with helper T cells is crucial for the activation and differentiation of B cells into antibody-producing plasma cells. T-dependent responses generally result in the production of high-affinity antibodies and immunological memory.

T-Independent Antigens:
T-independent antigens are capable of directly activating B cells without the need for T helper cell assistance. These antigens often have repetitive structures, such as polysaccharides or lipopolysaccharides. T-independent responses may lead to the production of lower-affinity antibodies and are less likely to generate immunological memory compared to T-dependent responses. T-independent antigens are commonly associated with the immune response to certain bacterial components.

43. How antigenic variation shift and drift?

Antigenic variation, shift, and drift are terms commonly associated with the ability of pathogens, particularly viruses and bacteria, to evade the host immune response through changes in their antigens.

1. Antigenic Drift:

Antigenic drift refers to small, gradual changes in the antigenic properties of a pathogen over time. This is commonly observed in viruses, particularly RNA viruses like influenza. During viral replication, errors in the viral genome can lead to point mutations. These mutations may affect the viral surface proteins (such as hemagglutinin and neuraminidase in the case of influenza viruses), resulting in minor changes in antigenic epitopes. The gradual accumulation of these mutations can lead to reduced recognition of the virus by the host immune system. This is one reason why seasonal flu vaccines may need regular updates to account for antigenic drift in circulating influenza strains.

2. Antigenic Shift:

Antigenic shift involves a major, abrupt change in the antigenic properties of a pathogen, often resulting in the emergence of a new subtype or strain. Antigenic shift is more likely to occur in viruses with segmented genomes, such as influenza A viruses. It can happen when two different strains of a virus infect the same host cell, leading to a reassortment of genetic material. This can result in the creation of a novel virus with a unique combination of surface proteins. Because of the significant changes in antigenic properties, the host population may have little to no pre-existing immunity to the new virus. Antigenic shift can be a factor in the emergence of pandemics, such as the influenza pandemics that occurred in the past.

44. Explain opsonization.

Opsonization:

Opsonization is an immune process where particles, such as pathogens or dead cells, are coated with opsonins, enhancing their recognition and phagocytosis by immune cells. Opsonins, like antibodies (IgG, IgM) or complement proteins (C3b), attach to the particle's surface, facilitating binding to phagocytic cell receptors and promoting efficient engulfment and elimination. This process is crucial for the effective clearance of foreign invaders and cellular debris from the body.

45. Explain endocrine, paracrine and autocrine.

1. Endocrine:

Endocrine signaling involves the release of hormones into the bloodstream by endocrine glands. These hormones travel to distant target cells or organs, where they exert their effects by binding to specific receptors.

2. Paracrine:
Paracrine signaling occurs when cells release signaling molecules (paracrine factors) that affect nearby target cells within the same tissue. The signaling molecules do not enter the bloodstream but act locally.

3. Autocrine:
Autocrine signaling involves cells releasing signaling molecules that bind to receptors on their own surface. This self-stimulation allows the cell to respond to its own signaling molecules, influencing its own activity or function.

46. What are defects of acute inflammation?

Defects in acute inflammation can include:

1. Inadequate Response:
Insufficient activation of the inflammatory response, leading to decreased immune cell recruitment and impaired pathogen clearance.

2. Excessive Response:
Overactivation of the inflammatory cascade, resulting in excessive tissue damage and inflammation, often seen in conditions like autoimmune diseases.

3. Failure to Eliminate Causative Agent:
Inability to completely eradicate the underlying cause of inflammation, such as persistent infections, which can lead to chronic inflammation.

4. Impaired Resolution:
Inability to effectively resolve the inflammatory process, resulting in prolonged inflammation and tissue damage. This can contribute to chronic inflammatory conditions.

5. Dysregulated Immune Response:
Aberrant immune responses, including inappropriate activation of immune cells or dysfunctional signaling pathways, can contribute to defects in acute inflammation.

6. Delayed or Impaired Healing:
Inadequate tissue repair and healing mechanisms, leading to prolonged recovery or tissue dysfunction following inflammation.

47. What are cellular barrier?

Cellular barriers are protective layers of cells that form physical and functional obstacles, preventing the entry of harmful substances and pathogens into tissues. Examples include skin epithelium, gastrointestinal lining, blood-brain barrier, and respiratory mucosa. These barriers help maintain tissue integrity and protect against external threats.

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