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+2 ZOOLOGY
UNIT III CHAPTER 8
IMMUNOLOGY
FULL STUDY MATERIAL

1. **Given below are some human organs. Identify one primary and one secondary lymphoid organ. Explain its role.**
   Liver, thymus, stomach, thyroid, tonsils.
   Thymus is an example for a primary lymphoid organ.
   Thymosin hormone from thymus gland stimulates the T – cells to become mature and immunocompetent.
   Tonsils is an example for a secondary lymphoid organ.
   Tonsils help to fight infections. They stop invading germs including bacteria and viruses.
2. **How does saliva act in body defence?**
   The enzyme lysozyme present in saliva inhibits the growth of bacteria in the oral cavity.
3. **How does immune system work?**
   Immune system initiates the destruction and elimination of invading organisms and any toxic molecules produced by them. These immune reactions are made in response only to molecules that are foreign to the host and not to the molecules of host itself.
4. **Name and explain the type of barriers which involve macrophages.**
   Phagocytic barrier
   Specialized cells (monocytes, neutrophils, tissue macrophages) phagocytose and digest whole microorganisms.
5. **What are interferons? Mention their role.**
   Interferons are proteinaceous, antiviral, species specific substances produced by mammalian cells when infected with viruses.
   They stimulate the cellular DNA to produce antiviral enzymes which inhibit viral replication and protect the cells.
6. **List out chemical alarm signals produced during inflammation.**
   Tissue damage and infection that occur during inflammation induce leakage of vascular fluid, containing chemotactic signals like serotonin, histamine and prostaglandins. They drive the phagocytic cells into the affected area.These phagocytic cells destroy pathogens.
7. **Differentiate between:**
   (A) Innate immunity and acquired immunity
   (B) Primary and secondary immune responses
   (C) Active and passive immunity
   (D) Humoral / antibody mediated immunity and CMI immunity

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(A) Innate immunity and acquired immunity

Innate immunity	Acquired immunity
It is the natural phenomenon of resistance to infection present in an individual right from the birth.	This is the resistance developed or acquired in an individual after birth.
It is a non-specific resistance against a wide range of infectious agents.	It is a specific resistance against a particular pathogen.
It is otherwise known as non-specific or natural immunity.	It may be active acquired or passive acquired immunity.

(B) Primary and secondary immune responses

Primary immune response	Secondary immune response
It occurs as a result of primary contact with an antigen.	It occurs as a result of second and subsequent contacts with the same antigen.
Antibody level reaches peak in 7 to 10 days.	Antibody level reaches peak in 3 to 5 days.
Prolonged period is required to establish immunity.	A short period is enough to establish immunity.
There is rapid decline in antibody level.	Antibody level remains high for longer period.
It appears mainly in the lymph nodes and spleen.	It appears mainly in the bone marrow, followed by spleen and lymph nodes.

(C) Active and passive immunity

Active immunity	Passive immunity
It is produced actively by host's immune system.	It is produced passively without the participation of host's immune system.
It is produced due to contact with pathogen or by its antigen.	It is produced due to antibodies obtained from outside.
It is durable and effective in protection.	It is transient and less effective.
Immunological memory is present.	Immunological memory is absent.
Booster effect on subsequent dose is possible.	Subsequent dose is less effective.

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Immunity is effective only after a short period.	Immunity is effective immediately.

(D) Humoral / antibody mediated immunity and CMI immunity

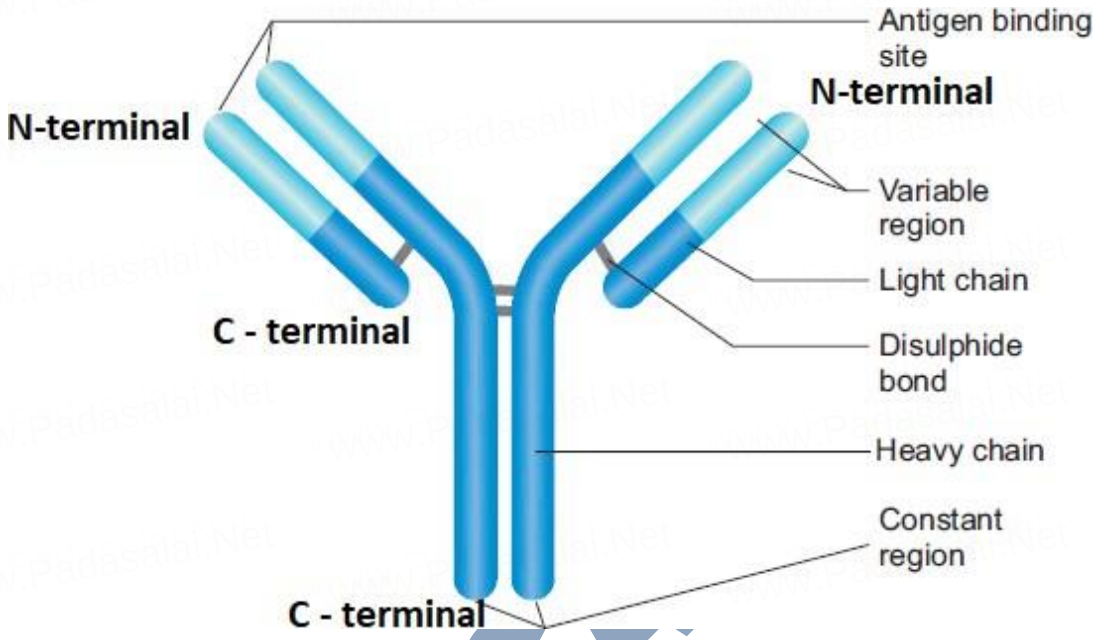
Humoral immunity	Cell mediated immunity
Pathogens are destroyed by the production of antibodies.	Pathogens are destroyed by cells without the production of antibodies.
This is brought about by B cells with the help of antigen presenting cells and T helper cells.	This is brought about by T cells, macrophages and natural killer cells.

8. Where is B-cells and T-cells produced in the human body? How do they differ from each other? Mention any two differences.
   B- cells and T- cells are produced in bone marrow.
   The differences are:

B-cells	T- cells
B- cells stay in bone marrow until they mature.	T- cells leave bone marrow and mature in Thymus gland.
B- cells when receive antigens, multiply to become plasma cells, which in turn produce antibodies.	T- cells do not produce antibodies, but recognize antigen presenting cells and destroy them.

9. Explain the process of replication of retro virus after it gains entry into the human body.
   After getting into the body of the person, the virus enters into macrophages where RNA genome of the virus replicates to form viral DNA with the help of the enzyme reverse transcriptase. This viral DNA gets incorporated into the DNA of host cells and directs the infected cells to produce viral particles. The macrophages continue to produce virus and in this way acts like a HIV factory.
10. Why is an antibody molecule represented as H_2 L_2?
    An antibody molecule consists of four polypeptide chains, two identical light chains (L) and two identical heavy chains (H). Hence, an antibody is represented by H_2 L_2.
11. Explain the structure of immunoglobulin with suitable diagram.
    - An antibody molecule is Y shaped structure that comprises of four polypeptide chains, two identical light chains (L) of molecular weight 25,000 Da (approximately 214 amino acids) and two identical heavy chains (H) of molecular weight 50,000 Da (approximately 450 amino acids).
    - The polypeptide chains are linked together by di-sulphide (S-S) bonds. One light chain is attached to each heavy chain and two heavy chains are attached to each other to form a Y shaped

structure. Hence, an antibody is represented as $H_2 L_2$.



- Each chain (L and H) has two terminals. They are C - terminal (Carboxyl) and amino or N-terminal.
- Each chain (L and H) has two regions. They have variable (V) region at one end and a much larger constant (C) region at the other end.
- Antibodies responding to different antigens have very different (V) regions but their (C) regions are the same in all antibodies.

12. What are the cells involved innate immune system?
Lymphocytes, monocytes, neutrophils, macrophages, dendritic cells etc.
13. Why is opsonization efficient in phagocytosis?
Opsonization is a process in which pathogens are coated with a substance called an opsonin, marking the pathogen out, for destruction by the immune system. This results in a much more efficient phagocytosis.
14. What is vaccine? What are its types?
A vaccine is a biological preparation that provides active acquired immunity to a particular disease and resembles a disease-causing microorganism.
It is often made from weakened or attenuated or killed forms of the microbes, their toxins, or one of its surface proteins.
The vaccines are classified as first, second and third generation vaccines.
First generation vaccine is further subdivided into live attenuated

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vaccine, killed vaccine and toxoids.

Live attenuated vaccines:

To prepare live attenuated vaccines weakened (attenuated), aged, or less virulent form of the virus are used. Ex. Measles, mumps and rubella (MMR) vaccine and the Varicella (chickenpox) vaccine

Killed (inactivated) vaccines:

In this type vaccines are prepared using killed virus or inactivated virus by heat and other methods. Ex. Salk's polio vaccine.

Toxoid vaccines:

These vaccines contain a toxin or chemical secreted by the bacteria or virus. They make us immune to the harmful effects of the infection, instead of to the infection itself. Ex. DPT vaccine (Diphtheria, Pertussis and Tetanus).

Second generation vaccines:

These are the pure surface antigen of the pathogen. Ex. Hepatitis-B vaccine.

Third generation vaccines:

These are the purest and the highest potency vaccines which are synthetic in generation.

15. A person is infected by HIV. How will you diagnose for AIDS?
The ELISA test (Enzyme Linked Immuno Sorbent Assay) detects the presence of HIV antibodies. It is a preliminary test. Western blot test is more reliable and a confirmatory test. It detects the viral core proteins. If both tests detect the presence of the antibodies, the person is considered to be HIV positive.
16. Autoimmunity is a misdirected immune response. Justify.
Autoimmunity is due to an abnormal immune response in which the immune system fails to properly distinguish between self and non-self and attacks its own body. Our body produces antibodies (auto antibodies) and cytotoxic T cells that destroy our own tissues. If a disease-state results, it is referred to as auto-immune disease. Thus, autoimmunity is a misdirected immune response.

Additional questions:

17. What is immunology? What is its significance?
Immunology is the study of immune system. This system protects an individual from various infective agents.
18. What is immunity?
The overall ability of body to fight against the disease - causing pathogen is called immunity. It is also called disease resistance.
19. What does susceptibility mean?
It means lack of immunity.
20. What do you mean by antigen?
Any substance capable of eliciting immune response is called an

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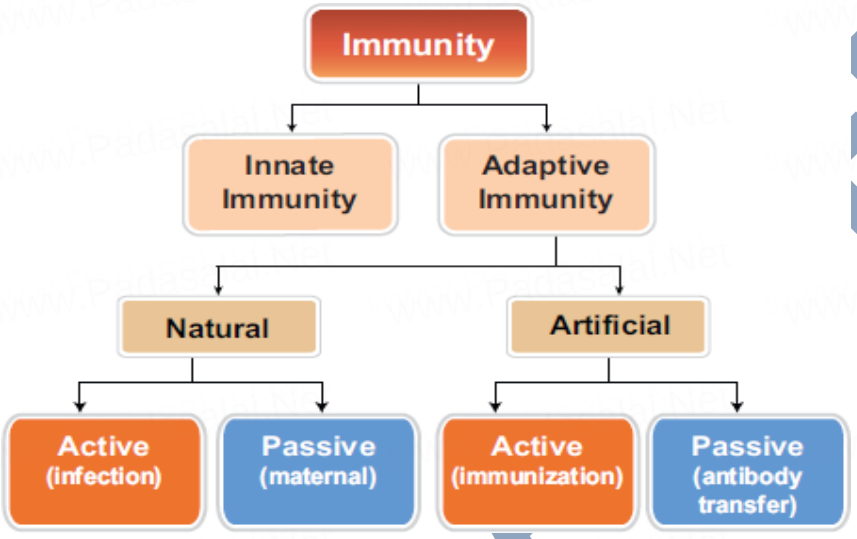
ANTIGEN (ANTIbody GENerator).

21. What are the two broad classes of immune response and their types?

There are two broad classes of immunity responses namely, innate immunity (also called non-specific or natural immunity) and adaptive immunity or acquired immunity.

Adaptive immunity is divided into natural and artificial.

Each type is again divided into active and passive immunity.



22. What are the two components of acquired immunity?

The two components of acquired immunity are, cell mediated immunity (CMI) and antibody mediated immunity or humoral immunity.

23. What is hematopoiesis?

The process of production of blood cells in the bone marrow is called hematopoiesis.

24. What are lymphoid organs?

The organs involve in the origin, maturation and proliferation of lymphocytes are called lymphoid organs.

25. How are lymphoid organs classified?

Primary or central lymphoid organs and secondary or peripheral lymphoid organs.

26. Say about primary lymphoid organs.

Bursa of Fabricius of birds, bone marrow and thymus gland of mammals constitute the primary lymphoid organs.

They involve in the production and early selection of lymphocytes.

27. When do lymphocytes become immunocompetent cells?

They become immunocompetent cells, only when they mature in the primary lymphoidal organs.

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28. Where does the maturation of B cells and T cells occur?
In mammals, B cell maturation occurs in the bone marrow and T cells maturation occurs in the thymus.
29. What is thymus gland? Where is it present?
The thymus is a flat and bilobed organ, located behind the sternum, above the heart.
30. Differentiate cortex and medulla of thymus gland.
The outer cortex, is densely packed with immature T cells or thymocytes.
The inner compartment or medulla is sparsely populated with mature T cells or thymocytes.
31. Name the hormone secreted from thymus. What is its function?
Thymosin is the hormone secreted by thymus.
It stimulates the T cell to become mature and immunocompetent.
32. How long is the thymus active?
Thymus is most active during the neonatal and pre-adolescent periods. By the early teens, the thymus begins to atrophy and is replaced by adipose tissue.
33. What are hematopoietic cells? What are they capable of?
Bone marrow contains stem cells known as hematopoietic cells. These cells have the potential to multiply through cell division and either remain as stem cells or differentiate and mature into different kinds of blood cells.
34. Say about secondary or peripheral lymphoid organs with examples.
The antigen is localized in secondary or peripheral lymphoid organs, so that it can be effectively exposed to mature lymphocytes.
The best examples are lymph nodes, appendix, Peyer's patches of gastrointestinal tract, tonsils, adenoids, spleen, MALT (Mucosal-Associated Lymphoid Tissue), GALT (Gut-Associated Lymphoid Tissue), BALT (Bronchial/Tracheal-Associated Lymphoid Tissue).
35. Say briefly about the following tissues and organ.
a. Peyer's patches b. tonsils c. spleen
    a. Peyer's patches are oval-shaped areas of thickened tissue that are embedded in the mucus-secreting lining of the small intestine of humans and other vertebrate animals. Peyer's patches contain a variety of immune cells, including macrophages, dendritic cells, T cells, and B cells.
    b. The tonsils (palatine tonsils) are a pair of soft tissue masses located at the back of the throat (pharynx). The tonsils are part of the lymphatic system, which help to fight infections. They

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stop invading germs including bacteria and viruses.

c. Spleen is a secondary lymphoid organ located in the upper part of the abdominal cavity close to the diaphragm. Spleen contains B and T cells. It brings humoral and cell mediated immunity.

36. What are adenoids?

The adenoids are glands located in the roof of the mouth, behind the soft palate where the nose connects to the throat. The adenoids produce antibodies that help to fight infections. Typically, the adenoids shrink during adolescence and may disappear by adulthood.

37. What is a lymph node? What is its function?

Lymph node is a small bean-shaped structure and is part of the body's immune system. It is the first one to encounter the antigen that enters the tissue spaces.

38. What is lymph?

Lymph is a clear, transparent, colourless, mobile and extracellular fluid connective tissue.

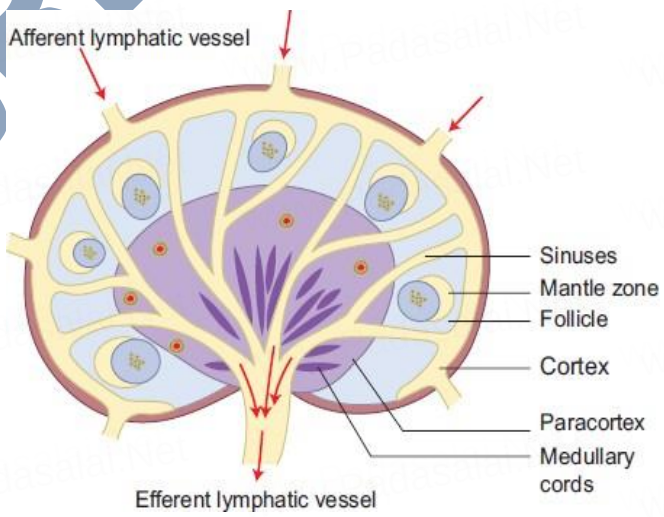
39. Briefly explain the structure of lymph node.

Lymph node has three zones. They are the cortex, paracortex and medulla.

The outer most layer of the lymph node is called cortex, which consists of B-lymphocytes, macrophages, and follicular dendritic cells.

The paracortex zone is beneath the cortex, which is richly populated by T- lymphocytes and interdigitating dendritic cells.

The inner most zone is called the medulla which is sparsely populated by lymphocytes, but many of them are plasma cells, which actively secrete antibody molecules.



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40. Say about MALT, GALT and BALT.

The Mucosa- Associated Lymphoid Tissue (MALT) is a diffuse system of small concentrations of lymphoid tissue in the alimentary, respiratory and urino-genital tracts.

MALT is populated by lymphocytes such as T and B cells, as well as plasma cells and macrophages, each of which is well situated to encounter antigens passing through the mucosal epithelium. It also possesses IgA antibodies.

Gut Associated Lymphoid Tissue (GALT) is a component of the mucosa associated lymphoid tissue (MALT) which works in the immune system to protect the body from invasion in the gut.

Bronchus Associated Lymphoid Tissues (BALT) also a component of MALT is made of lymphoid tissue (tonsils, lymph nodes, lymph follicles) is found in the respiratory mucosae from the nasal cavities to the lungs.

41. What are lymphocytes and what is the function of the lymphocytes?

About 20-30% of the white blood cells are lymphocytes. They are the only cells capable of specifically recognizing and producing an immune response.

42. What are the functions of other types of WBC's?

The other types of white blood cells play an important role in non -specific immune response, antigen presentation and cytokine production.

43. What are the types of lymphocytes?

The two main types of lymphocytes are B and T lymphocytes.

44. What are the two important types of T cells?

The two important types of T cells are Helper T cells and Killer T cells. Helper T cells release a chemical called cytokine which activates B cells. Killer cells move around the body and destroy cells which are damaged or infected.

45. Say about dendritic cells.

Dendritic cells are derived from hematopoietic stem cells. They are called so because they are covered with long, thin membrane extensions that resemble dendrites of nerve cells. These cells present the antigen to T-helper cells.

Four types of dendritic cells are known. They are Langerhans, interstitial cells, myeloid and lymphoid cells.

46. What do you mean by histocompatibility antigens?

They are the cell surface antigens that induce an immune response leading to rejection of allografts.

47. What is an immunogen?

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An immunogen is a substance capable of initiating an immune response.

48. What are Haptens?
Haptens are substance that are non-immunogenic but can react withthe products of a specific immune response.

49. What do you mean by adjuvants?
Substances that can enhance the immune response to an antigen are called adjuvants.

50. Differentiate between epitope and paratope.
Epitope is an antigenic determinant and is the active part of an antigen.
A paratope is the antigen – binding site and is a part of an antibody which recognizes and binds to an antigen.

51. What does the term antigenicity refer to?
Antigenicity is the property of a substance (antigen) that allows it to react with the products of the specific immune response.

52. How are antigens classified?
On the basis of origin, antigens are classified into exogenous antigens and endogenous antigens.

53. Differentiate between exogenous and endogenous antigens.
The antigens which enter the host from the outside in the form of microorganisms, pollens, drugs, or pollutants are called exogenous antigens.
The antigens which are formed within the individual are endogenous antigens. The best examples are blood group antigens.

54. What are antibodies?
Antibodies are immunoglobulin (Ig) protein molecules synthesized on exposure to antigen that can combine specifically with the antigen.

55. When do antibodies produced in our body?
Whenever pathogens enter our body, the B-lymphocytes produce an army of proteins called antibodies to fight with them.

56. Mention the five major categories of antibodies.
The five major categories antibodies are IgG (gamma), IgM (mu), IgA (alpha), IgD (delta) and IgE (epsilon).

57. Mention the types of reactions between antigen and antibody.
The functions of immunoglobulin are agglutination, precipitation, opsonization, neutralization etc.,

58. Name the factors responsible for the binding force between antigen and antibody.
The binding force between antigen and antibody is due to three

factors.

They are closeness between antigen and antibody, noncovalent bonds or intermolecular forces and affinity of antibody.

59. Name the bonds that hold the antigen to the antibody.

Hydrogen bonds, electrostatic bonds, Van der Waals forces and hydrophobic bonds.

60. Mention the chief applications of antigen antibody reactions. The chief application of antigen – antibody reactions are to,
    - ✓ determine blood groups for transfusion.
    - ✓ Study serological ascertainment of exposure to infectious agents to develop immunoassays for the quantification of various substances.
    - ✓ detect the presence or absence of protein in serum.
    - ✓ determine the characteristics of certain immunodeficiency diseases.

61. What is precipitin reaction?

The reaction between soluble antigen and antibody leads to visible precipitate formation, which is called precipitin reaction.

62. What are precipitins?

Antibodies that bring about precipitate formation on reacting with antigens are called as precipitins.

63. What is agglutination reaction?

Whenever a particulate antigen interacts with its antibody, it would result in clumping or agglutination of the particulate antigen, which is called agglutination reaction.

64. What is an agglutinin?

The antibody involved in bringing about agglutination reaction is called agglutinin.

65. What is opsonization?

Opsonization or enhanced attachment is the process by which a pathogen is marked of ingestion and destruction by a phagocyte.

66. Explain the process of Opsonization.

Opsonin i.e., antibody, binds to a receptor on the pathogen's cell membrane, so that, phagocytes are attracted to the pathogen. So, it is a process in which pathogens are coated with a substance called an opsonin, marking the pathogen out for destruction by the immune system. This results in a much more efficient phagocytosis.

67. What are neutralization reactions?

The neutralization reactions are the reactions of antigen-antibody that involve the elimination of harmful effects of bacterial exotoxins or a

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virus by specific antibodies.

68. What are antitoxins? Which produces these antitoxins?
The neutralizing substances i.e., antibodies are known as antitoxins. These specific antibodies are produced by a host cell in response to a bacterial exotoxin or corresponding toxoid (inactivated toxin).

69. What is vaccine?
A vaccine is a biological preparation that provides active acquired immunity to a particular disease and resembles a disease-causing microorganism and is often made from weakened or attenuated or killed forms of the microbes, their toxins, or one of its surface proteins.

70. How do vaccines defend our body?
Vaccines "teach" our body how to defend itself when viruses or bacteria, invade it. Vaccines deliver only very little amounts of inactivated or weakened viruses or bacteria, or parts of them. This allows the immune system to recognize the organism without actually experiencing the disease.

71. What are the types of vaccines?
The vaccines are classified as first, second and third generation vaccines.

72. Say briefly about the sub-divisions of first- generation vaccines.
First generation vaccine is further subdivided into live attenuated vaccine, killed vaccine and toxoids.
Live attenuated vaccines use the weakened (attenuated), aged, less virulent form of the virus. E.g., Measles, mumps and rubella (MMR) vaccine and the Varicella (chickenpox) vaccine.
Killed (inactivated) vaccines use killed or inactivated microorganisms by heat and other methods. E.g., Salk's polio vaccine.
Toxoid vaccines contain a toxin or chemical secreted by the bacteria or virus. They make us immune to the harmful effects of the infection, instead of to the infection itself. E.g., DPT vaccine (Diphtheria, Pertussis and Tetanus).

73. Differentiate between the second- generation vaccine and third generation vaccine.
Second generation vaccine contains the pure surface antigen of the pathogen. E.g., Hepatitis-B vaccine.
Third generation vaccine contains the purest and the highest potency vaccines which are synthetic in generation.

74. What is vaccino - therapy?
Vaccino- therapy is the method of using vaccine for treatment of diseases.

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75. Say about the discovery of vaccines by different scientists.

Dr. Edward Jenner prepared first vaccine for small pox in 1796.

Dr. Jonas Salk developed Polio vaccine consisted of inactivated microorganisms.

Dr. Albert Sabin developed live attenuated oral polio vaccine.

Louis Pasteur (1885) discovered vaccine against rabies, anthrax and cholera.

Calmette and Guerin developed BCG vaccine against tuberculosis in France in the year 1908.

76. Differentiate between vaccination and immunization.

"Vaccination is the process of administrating a vaccine into the body or the act of introducing a vaccine into the body to produce immunity to a specific disease."

"Immunization is the process of the body building up immunity to a particular disease. Immunization describes the actual changes in the body after receiving a vaccine."

77. What can cause allergy? What are the symptoms of allergy?

Allergy can be due to the release of chemicals like histamine and serotonin from the mast cells.

Symptoms of allergic reactions include sneezing, watery eyes, running nose and difficulty in breathing. What is hypersensitivity or allergy?

The excessive sensitivity of the individuals to some particles present in the environment is called hypersensitivity. This exaggerated response of the immune system to certain antigens present in the environment is also called allergy (allo-altered, erg-reaction).

78. Mention two examples of allergy.

Hay fever and asthma

79. Explain allergens with examples.

An allergen is an antigen that causes an allergic reaction. Allergic reactions begin within few seconds after the contact with the allergen and last about half an hour.

The common examples of allergens are mites in dust, pollens and some proteins in insect venom.

83. Mention a few symptoms of allergy.

Symptoms of allergic reactions include sneezing, watery eyes, running nose and difficulty in breathing.

84. What is Anaphylaxis?

It is a sudden, systematic, severe and immediate hypersensitivity reaction occurring as a result of rapid generalized mast-cell degranulation.