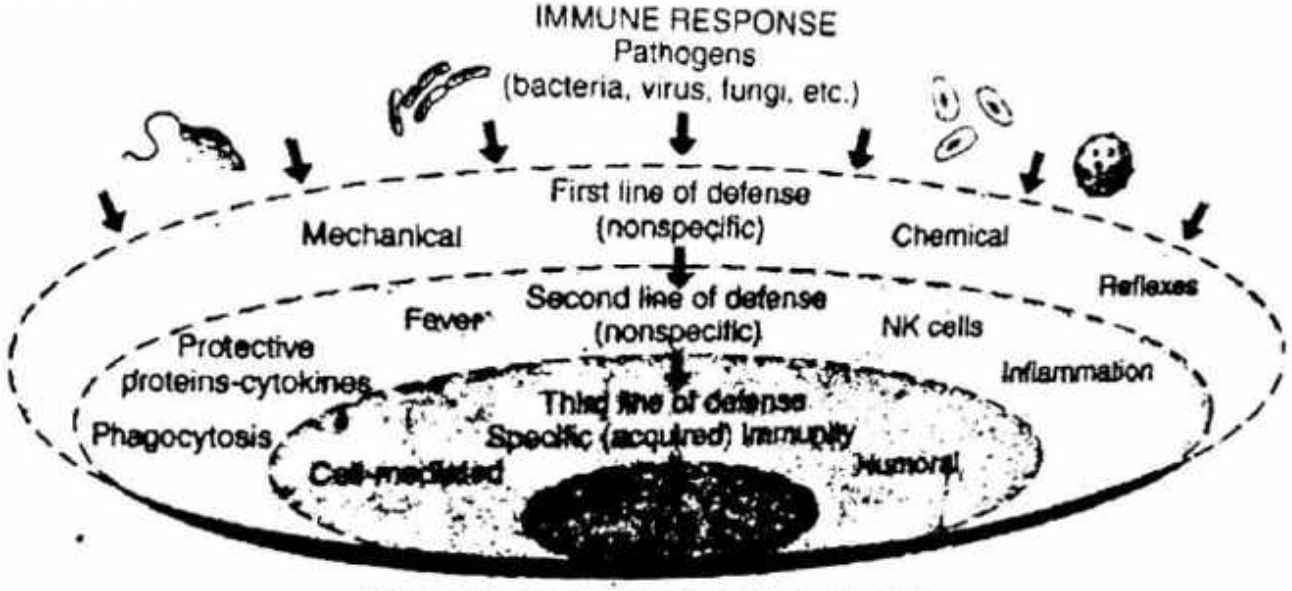
CHAPTER-13
IMMUNITY

Q1. Discuss body's three lines of defense.

Ans: First Line of Defence:

The first and obviously best, defence is to keep microbes out in the first place. The human body has two surfaces exposed to the environment: the skin and the mucous membranes of the digestive and respiratory tracts. These surfaces are external barriers to microbial invasion. Since these barriers inhibit generally ail kind of microbial invasion thus, first line of defence is supposed to be a non-specific defence.



Three lines of defence of the body

Second Line of Defence - Nonspecific Defence:

If microbes become successful to penetrate the skin or mucous membranes then a second line of defence takes action against these foreign invaders. The second line of defence comprises three nonspecific internal defence. First, the body has a standing army of phagocytic cells and **natural killer cells.** Second, invasion of microbes provokes an **inflammatory response.** Third, the body often produces **fever** or gives rise temperature response. In addition, some protective proteins are also the part of second line of defence. These defence are nonspecific because they attack wide variety of microbes, rather than targeting specific invaders as the immune response does.

Third Line of Defence – The Specific Defences:

If a pathogen is able to get past the body's nonspecific defence, the third line of defence interferes with a series of defence responses, often called immune responses that attack the particular pathogens having specific antigens. These antigens serve as the stimulus to produce an immune response. The term "agfigen" comes from ANTI-body GENerating substances. Viruses, bacteria and other pathogen have specific antigens on their surface.

Since, the third line of defence respond against particular infections and acts as the most powerful means of resisting infections therefore it is also called **specific defence.** Its response can be of two types **Humoral immune response** and **cell-mediated immune response.** These immune responses are particularly carried out by two components B-lymphocytes or B cells and T-lymphocytes or T cells However, third line of defence also involves role of monocytes (macrophages) that participate in activation of these lymphocytes

Q2. Recognize the role of the acids and enzymes of the digestive track in killing the bacteria present in food.

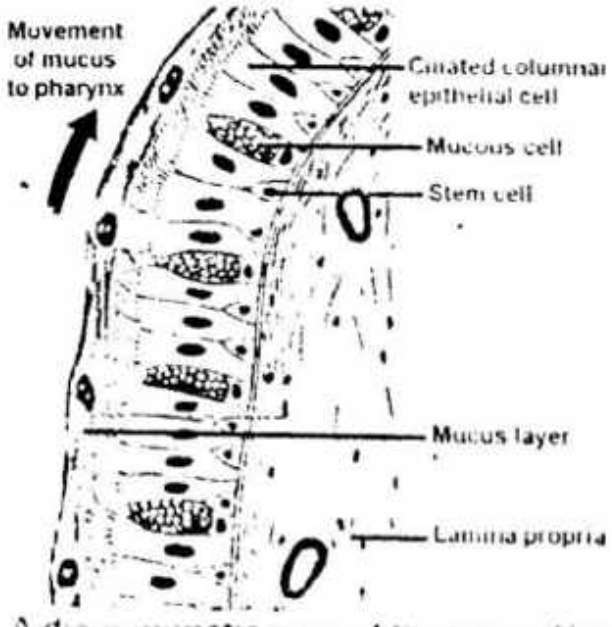
Ans: Epithelium of digestive tract: an impenetrable barrier against microbial invasion:

The gastrointestinal tract (GIT) is covered by mucous membrane which protects the GIT against microbial invasion by means of its various kind of secretions. Such as **hydrochloric** acid in the stomach is secreted by oxyntic or parietal cells that kills the bacteria present in food In addition various **digestive enzymes** present in gastric juice intestinal juice and pancreatic juice also digest the bacteria present in food

Q3. State the role of ciliated epithelium of nasal cavity of the mucous of the bronchi and bronchioles in trapping air borne microorganisms.

Ans: Epithelium of respiratory tract: an impenetrable barrier against microbial invasion:

The anterior part of nasal cavities that contain hairs is called **vestibule.** These vestibular hairs filter the large dust particles of the inhaled air The inner surface of nasal cavities is also lined by **ciliated mucous epithelium.** The **mucous** secreted by this epithelium is also involved in trapping of fine dust particles and microbes. The **cilia** of the epithelium sweep the trapped fine dust particles and microbes posterior to the pharynx, where they are swallowed and are eliminated by the digestive system. The trachea and the air passageways within the lungs are also lined by ciliated mucous epithelium that is also involved in trapping of fine dust particles and microbes The cilia in this region propel mucus and foreign particles towards the larynx where they enter the pharynx and are swallowed



A diagrammatic view of the respiratory epithelium of trachea showing the direction of movement of mucous containing trapped particles towards pharynx.

Teacher's Point

Teachers would guide the students to wire a brief research paper on the history of discovery of immunity

Skills: Initiating and Planning

- **Justify the inflammatory response in arthritis as an example of a misdirected immune response.**

In this disease autoantibodies are formed against IgG (antibody or immunoglobin of class G) These autoantibodies are called rheumatoid factors The agent that induces these autoantibodies is unknown Within the inflamed joints, the synovial membrane is infiltrated with T cells plasma cells and macrophages and the synovial fluid contains high levels of macrophage- produced inflammatory cytokines

Science Titbits

Several experiments have suggested that interleukin-1 causes fever by first inducing the formation of one of the prostaglandins When drugs block prostaglandin formation the fever is either completely abrogated or at least reduced In fact this may be the explanation for the manner in which aspirin reduces the degree of fever because aspirin impedes the formation of prostaglandins from arachidonic acid It also would explain why aspirin does not lower the body temperature in a normal person because a normal person does not have any interleukin-1 Drugs such as aspirin that reduce the level of fever are called antipyretics

Skills: Initiating and Planning

- **Justify why physician prescribe antihistamine therapy to the patients of runny nose or skin rashes.**

Runny nose or skin rashes are a type of hypersensitivity reaction in which histamine is released from the mast cells and basophils Its release causes vasodilation, increased capillary permeability and smooth muscle contraction Antihistamine drugs block histamine receptor sites so histamine action cannot take place So in this way they are effective in allergic rhinitis i e runny nose and skin rashes

Science, Technology and Society Connections

- **Justify why the physician prescribe antipyretic drugs, when fever is a nonspecific defence against microbial infections.**

Antipyretic drugs create their effects by inhibiting prostaglandin production in the hypothalamus which has the effect of blocking set point elevation and maintaining the set point at nearer normal levels

Science Titbits

Early investigators of the immune system found that, when plasma from an immune animal was injected into the blood of a non-immune animal, the non-immune animal became immune. Because the process involved body fluids (humors), it was called humoral immune response. As in this response antibodies are responsible, hence, it is also called antibody mediated immune response. It was also discovered that blood cells transferred from an immune animal could be responsible for immunity and this process was called cell-mediated immunity.

Teacher's Point

Teacher would guide the students to make a model of antibody.

Teacher's Point

Teacher would guide the students to make a list of diseases for which vaccines are available.

Science Titbits

In 1717 Mary Montagu, the wife of an English ambassador to the Ottoman Empire, observed local women inoculating their children against smallpox. **Edward Jenner** observed and studied Miss Sarah a milkmaid who had previously caught cowpox and was found to be immune to smallpox.

Skills: Initiating and Planning

- **Justify why physician prescribe antihistamine therapy to the patients of runny nose or skin rashes.**

Runny nose or skin rashes are a type of hypersensitivity reaction in which histamine is released from the mast cells and basophils. Its release causes vasodilation, increased capillary permeability and smooth muscle contraction. Antihistamine drugs block histamine receptor sites so histamine action cannot take place. So in this way they are effective in allergic rhinitis i.e. runny nose and skin rashes.

- **Explain why a transplant recipient is given immune suppressant drugs and determine what implications does this has on his life.**

Organ transplantation has become a routine procedure due to improvement of surgical techniques, better tissue typing and the availability of drugs that more selectively inhibit rejection of transplanted tissues and prevent the patient from becoming immunologically compromised. Transplant rejection occurs as a delayed hypersensitivity reaction as a function of lymphocytes and not due to antibodies. Administration of immunosuppressive drugs enhances tolerance. People receiving immunosuppressive drugs have side effects like pain, diarrhoea, leukopenia, sepsis

lymphoma. thrombocytopenia skin rashes, anaphylactic reaction, hypertension, hyperkalemia and neurotoxicity (tremors, seizures, hallucination). Hence, each system is affected, so the person starts to feel weakness and gets fatigue easily.

Science, Technology and Society Connections

Describe malignant melanoma as due to the inability of tumour-infiltrating lymphocyte (TIL) to control the tumour of skin cancer and correlate it with the scientific" c advancements of inserting a gene of tumour necrosis factor in the lymphocyte ·

Cancer starts when cells in the body begin to grow out of control. Melanoma is a cancer that usually starts in the melanocytes a type of skin cell. Melanomas can develop anywhere on the skin, but they are more likely to start on the trunk (chest and back) in men and on the legs in women. The neck and face are other common sites. The cancerous growths develop when unrepaired DNA damage o **skin** cells (most often caused by ultraviolet radiation from sunshine or tanning beds) triggers mutations (genetic defects) that lead the skin cells to multiply rapidly and form malignant tumours. These tumours originate in the pigment-producing melanocytes in the basal layer of the epidermis. Tumour-infiltrating lymphocytes are believed to represent the immune reaction/response to melanoma cells. Tumour (tumor)-infiltrating lymphocytes (TIL), are white blood cells that have left the bloodstream and migrated into a tumour. They are mononuclear immune cells, a mix of different types of cells (i e . T cells. B cells, NK cells. macrophages) in variable proportions, T cells being the most abundant cells. They can often be found in the stroma and within the tumour itself.

TILs are not strong enough to control certain types of tumors e.g., malignant melanoma. For the gene therapy of malignant melanoma first the TIL cell are removed from the patient and reinserted a gene that codes for the protein tumour necrosis factor (TNF). The protein kills tumour cells by preventing them from establishing a blood supply. The engineered TIL cells were then returned to the patient blood stream to seek out and invade the malignant melanoma tumours.

Science, Technology and Society Connections

- **Describe the discovery of monoclonal antibodies and justify how this accomplishment revolution many aspects of biological research.**

In 1970 Cesar Milstein and Georges Kohler working in Cambridge solve the problem of developing a technique for producing monoclonal antibodies, for which they were awarded Nobel Prize in 1984. Monoclonal means belonging to one clone. Each type of antibody is made by one type of B cells which cloned itself, in other words multiplies to make many identical copies of itself in response to a particular antigen. Milstein and Kohlar fused B cells with cancer cells, which are immortal to form hybridoma cells. The hybridoma cells continue to multiply and can be cloned

so that large quantities of antibodies can be produced. Monoclonal antibodies are harvested from cell cultures rather than animals. The ability to make monoclonal antibodies has been spawned a new industry. A common area of application is medical diagnosis. Monoclonal antibodies are used for determining pregnancy and for diagnosing diseases such as, hepatitis, rabies, cancer, streptococcal throat infections, herpes viruses, leukaemias (cancers of white blood cells) and lymphomas etc. A monoclonal antibody has been developed which is very effective at preventing rejection of transplanted kidneys. Monoclonal antibodies can be used to find out the types of antigens present in the donor and increase the accuracy of matching.

Science Titbits

A group of antimicrobial proteins called **defensins** are secreted by activated macrophages. These small proteins damage broad groups of pathogens by various mechanisms without harming the body cells.

Activity

1. Recognizing phagocytes and lymphocytes while observing prepared slides

EXERCISE

MCQs

1. Select the correct answer.

(i) Plasma cells are

(A) the same as memory cells
(B) formed from blood plasma
(C) B cells that are actively secreting antibody
(D) inactive T cells carried in the plasma

(ii) Antibodies combine with antigens

(A) at variable regions (B) at constant region
(C) only if macrophages are present (D) both A and C are correct

(iii) Vaccines are

(A) the same as monoclonal antibodies
(B) treated bacteria or viruses or one of their proteins
(C) major histocompatibilty complex proteins
(D) not destroyed by heating

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(iv) In addition to the immune system, we are protected from disease by

(A) body temparature
(B) hormones
(C) antigens
(D) mucous membrane and cilia

(v) Fevers

(A) decrease interferon production
(B) decrease the concentration of iron in the blood
(C) decrease the activity of phagocytes
(D) decrease the reproduction of invading bacteria

(vi) T and B cells are

(A) lymphocytes (B) macrophages
(C) natural killer cells (D) red blood cells

(vii) Foreign molecules that evoke an immune response are called

(A) pathogens (B) antibodies
(C) lymphocytes (D) histamines

(viii) When B-cells are presented with antigen they differentiate into

(A) T-cells (B) helper T-cells
(C) plasma cells (D) bursa cells

(ix) Memory cells are

(A) modified T-cells (B) B-cells
(C) killer T-cells (D) suppressor cells

(x) When one receives a booster shot for polio which type of cell is most directly stimulated?

(A) killer T-cells (B) memory cells
(C) phagocytes (D) suppressor cells

Answers

(i) C	**(ii) A**	**(iii) B**	**(iv) D**	**(v) B**
(vi) A	**(vii) B**	**(viii) C**	**(ix) B**	**(x) B**

SHORT QUESTIONS

2. What is immune response?

Ans: Immune Response:

The body's response to foreign particles such as the production of antibodies directed against a specific antigen is called an **immune response.**

The term immune is derived from Latin word *immunis* meaning "safe" or free of burden.

3. List the ways of defence of the human body against invading microbes.

Ans: Immunology:

Immunology is the study of foreign particles that can affect the living body and the defence mechanisms which are taken by the body to eliminate these particles.

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The human body has three lines of defence against microbial attack

i. First line of defence comprises **external barriers** that keep microbes out of the body

ii. Second line of defence consists of **nonspecific internal defence** (innate immunity) that combats all invading microbes

iii. Third line of defence includes the **specific internal defence** (adaptive/ acquired immunity) also called **immune system** that directs its assault against specific microbes

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iii. **Third line of defence** includes the **specific internal defence** (adaptive acquired immunity) also called **immune system** that directs its assault against specific microbes

5. How oil and sweat glands take part in defence against microorganisms?

Ans: Sebaceous Glands and Sweat Glands:

In addition the dermis part of skin also contains the sebaceous glands and sweat glands **Sebaceous glands** produce **sebum,** an oily substance whereas **sweat glands** secrete **sweat,** a salty fluid that generally provides cooling effect to the body Secretion from sweat glands and sebaceous glands usually cover the skin These secretions contain natural antibiotics such as lactic acid that inhibit the growth of bacteria and fungi These multiple defence make the unbroken skin an extremely effective barrier against microbial invasion

6. What is the role of acids and enzymes present in the digestive tract against bacteria?

Ans: Epithelium of digestive tract: an impenetrable barrier against microbial invasion:

The gastrointestinal tract (GIT) is covered by mucous membrane which protects the GIT against microbial invasion by means of its various kind of secretions Such as **hydrochloric** acid in the stomach is secreted by oxyntic or parietal cells that kills the bacteria present in food In addition various **digestive enzymes** present in gastric juice intestinal juice and pancreatic juice also digest the bacteria present in food

7. Name the parts of antibody molecule.

Ans: A typical antibody is a Y-shaped molecule which consists of four polypeptide chains two identical long chains called **heavy** chains, and two identical short chains called **light chains.**

Each chain has a **constant segment,** a functional segment and a **variable segment.**

8. What are the memory cells?

Ans: Any small, long-lived lymphocyte that has previously encountered a given antigen and that on reexposure to the same antigen rapidly initiates the immune

response (**memory T cell**) or proliferates and produces large amounts of specific antibody (**memory B cell**) the agent of lasting immunity

9. How does an antibody differ from an antigen?

Ans: **Antigens** are foreign particles usually proteins which are capable of generating an immune response in the body, a property known as immunogenicity. This immune response consists of specific **antibodies** which are generated by plasma cells as a result of exposure to a specific epitope presented by the **antigen**

Antibody versus Antigen comparison chart		
	Antibody	**Antigen**
What it is	A chemical that attaches to the antigen in order to sterilize or kill the cell	A 'hook' in the cell's surface, partially responsible for what goes in and out of the body
Significance	Medium needed for the destruction of pathogens in the body	High, exists in almost every cell in the entire world.
Importance	High without it a lot of us would probably be dead by a virus attack	Very high, needed for controlling what goes in and out of the cell Very important for it's inner function
Complexity	Very High Complex chemical that bonds to a very specific Antigen	Medium, exists due to random mutations in the cell's gene

OR (Second Answer)

Differences between Antigen and Antibody:

	Antigen	**Antibody**
1	Generally proteins but can be lipids, carbohydrates or nucleic acids	Antibodies are proteins.
2	Triggers the formation of antibodies	Variable sites has the antigen binding domain.
3	There are three basic kinds of antigens (Exogenous, Endogenous and Autoantigens)	There are five basic kinds of antibodies (Immunoglobulins M, G, E, D and A)
4	The region of the antigen that interacts with the antibodies is called epitopes.	The variable region of the antibody that specially binds to an epitope is called paratope.
5	Cause disease or allergic reactions	Protects the body by immobilization or lysis of antigenic material

10. Why does each antibody bind only to a specific antigen?

Ans: Antibodies (also called immunoglobulins or Ig's) are Y-shaped proteins that circulate through the blood stream and bind to specific antigens, thereby attacking microbes. The antibodies are transported through the blood and the lymph to the pathogen invasion site.

11. Why is passive immunity temporary?

Ans: **Passive immunity** can also be acquired naturally by the fetus due to the transfer of antibodies by the maternal circulation in utero through the placenta around the third month of gestation. **Immunity** in newborn babies is only **temporary** and starts to decrease after the first few weeks or months.

12. Name the disorders of immune system.

Ans: Disorders of Immune System:

Some conditions that stimulate a defective immune response or destroy immune system are called disorders of immune system.

i. Allergies
ii. Autoimmune Disease
iii. Tissue rejection reaction

13. What are the autoimmune diseases?

Ans: Autoimmune Disease:

Sometimes, a person's immune system does not normally respond to the antigens (self-molecules) borne on the body's own cells and the antibodies are going to produce against bodies own components and begin to destroy them. This problem is called an **autoimmune disease.**

For example:

a) Some types of anemias are caused by antibodies that destroy a person's red blood cells.

b) Many cases of insulin-dependent (juvenile-onset) diabetes occur because the insulin-secreting cells of the pancreas are the victims of a misdirected immune response

Unfortunately, at present there is no way to cure autoimmune diseases. The autoimmune response can be suppressed with drugs.

OR (Second Answer)

Autoimmune Disease:

An autoimmune disease is a condition in which your immune system mistakenly attacks your body.

The immune system normally guards against germs like bacteria and viruses. When it senses these foreign invaders, it sends out an army of fighter cells to attack them.

Normally, the immune system can tell the difference between foreign cells and your own cells.

In an autoimmune disease, the immune system mistakes part of your body — like your joints or skin — as foreign. It releases proteins called autoantibodies that attack healthy cells.

Some autoimmune diseases target only one organ. Type 1 diabetes damages the pancreas. Other diseases, like lupus, affect the whole body.

13. Justify the inflammatory response in arthritis as an example of a misdirected immune response.

Ans: In this disease autoantibodies are formed against IgG (antibody or immunoglobin of class G). These autoantibodies are called rheumatoid factors. The agent that induces these autoantibodies is unknown. Within the inflamed joints, the

synovial membrane is infiltrated with T cells plasma cells and macrophages and the synovial fluid contains high levels of macrophage- produced inflammatory cytokines

14. Justify why physician prescribe antihistamine therapy to the patients of runny nose or skin rashes.

Ans: Runny nose or skin rashes are a type of hypersensitivity reaction in which histamine is released from the mast cells and basophils Its release causes vasodilation increased capillary permeability and smooth muscle contraction Antihistamine drugs block histamine receptor sites so histamine action cannot take place So in this way they are effective in allergic rhinitis i e runny nose and skin rashes

15. Justify why the physician prescribe antipyretic drugs, when fever is a nonspecific defence against microbial infections.

Ans: Antipyretic drugs create their effects by inhibiting prostaglandin production in the hypothalamus which has the effect of blocking set point elevation and maintaining the set point at nearer normal levels

16. Define/Describe/Explain briefly:
immunity, immunology, microbe, phagocytes, monocyte, macrophages, perforins, granzymes, complementary proteins, interferon, cytokines, histamines, pyrogens, interleukin-1, cell mediated immunity, immunization, helper T cells, memory cells, plasma cells, T cells and B cells, antibody, antigen, lymphocytes, antibody mediated immunity, immunization, clostrum, vaccine, vaccination, allergies, transplant rejection, autoimmune diseases,

Ans: Immunity:

Immunity is the ability to resist damage from foreign substances such as microorganisms and harmful chemicals, e.g. toxins released by microorganisms.

Immunology:

Immunology is the study of foreign particles that can affect the living body and the defence mechanisms which are taken by the body to eliminate these particles

Microbe:

A microorganism or microbe is a microscopic organism, which may exist in its single-celled form, or in a colony of cells

Phagocytes:

There are white blood cells in the body called **phagocytes**. A phagocyte is a cell that destroys other abnormal body cells (cancerous cells) or invaded microorganisms by engulfing or ingesting them. This process is called **phagocytosis.**

Two types of blood cells are phagocytes macrophages and neutrophils.

Monocyte:

Monocytes are formed in bone marrow From bone marrow, through blood macrophages are transported to the areas of the body where they are needed

OR

Monocytes are a type of leukocyte or white blood cell They are the largest type of leukocyte and can differentiate into macrophages and myeloid lineage

dendritic cells As a part of the vertebrate innate immune system **monocytes** also influence the process of adaptive immunity

Macrophages:

Macrophages are derived from monocytes or the monocytes that leave the blood are called macrophages Macrophages are generally found in the organs such as the lungs, liver, spleen kidney and lymph nodes rather than remaining in the blood

Perforins:

Natural killer (NK) cells kill their target by releasing proteins called **perforins**, which punch holes through the membranes of the infected cells

Granzymes:

The pores formed by these proteins allow for the passive diffusion of certain apoptotic proteases, known as the **granzymes**, into the target cell. The cell dies by apostosis NK cells also attack cancer cells at an early stage of tumor

Complementary Proteins:

There are some amino acids that the body cannot make in required amounts These are called essential and they must come from the diet Combining two or more foods with incomplete **proteins**, to form **complementary proteins**, can provide adequate amounts of all the essential amino acids

Interferon:

Interferons (IFNs) belong to the large class of proteins known as **cytokines**, molecules used for communication between cells during infection They are made and released by host cells in response to the presence of several pathogens specially viruses Interferons are named for their ability to **"interfere"** with viral replication as interferons activate molecules which prevent the virus from producing and replicating its RNA or DNA In this way, interferons limit cell-to-cell spread of viruses in the body IFNs also activate immune cells such as natural killer cells and macrophages that in turn destroy virally infected cells

Cytokines:

Cytokines are a broad and loose category of small proteins that are important in cell signalling Their release has an effect on the behavior of cells around them

Histamines:

Histamine is an organic nitrogenous compound involved in local immune responses, as well as regulating physiological function in the gut and acting as a neurotransmitter for the brain spinal cord, and uterus

Pyrogens:

Fever or **pyrexia** is the raised body temperature than normal The invaded microorganisms often release certain chemicals which are generally termed as **pyrogens**.

Interleukin-1:

When macrophages perform phagocytosis of invaded microorganisms, after digesting them they not only display microbial antigens on their surfaces but also begin to secrete about 100 different compounds including various enzymes interferons and a protein called **interleukin-1**

Cell Mediated Immunity:

Cell-mediated immunity is an immune response that does not involve antibodies, but rather involves the activation of phagocytes, antigen-specific cytotoxic T-lymphocytes, and the release of various cytokines in response to an antigen.

OR

The activation of T-cells by a specific antigen is called **cell-mediated immunity.**

Immunization:

There are two ways to acquire adaptive immunity: (a) Active Immunity (b) Passive Immunity. Both types may be acquired naturally or artificially. Providing immunity artificially is called **immunization.**

Helper T Cells:

These cells secrete **interleukin 2** which stimulates cell division of T cells and B cells. In other words, these cells recruit even more cells to help fight the pathogen.

Memory Cells:

These cells remain dormant after the initial exposure to an antigen. If the same antigen presents itself again, even if it is years later, the memory cells are stimulated to convert themselves into helper T cells and help fight the pathogen.

Plasma Cells:

A **plasma cell** can produce more than 10 million molecules of antibody per hour. If the same antigen enters the body later, the memory B cells divide to make more plasma cells and memory cells that can protect against future attacks by the same antigen. The stimulation of B cells to divide into plasma clone cells and memory B cells and the secretion of antibodies by plasma clone cells is called **humoral and cell mediated** immune **response.**

T cells and B cells:

T cells (thymus cells) and B cells (**bone marrow**- or bursa-derived cells) are the major cellular components of the adaptive **immune** response. T cells are involved in cell-mediated immunity, whereas B cells are primarily responsible for humoral immunity (relating to **antibodies**).

Antibody:

Antibodies (also called immunoglobulins or Ig's) are Y-shaped proteins that circulate through the blood stream and bind to specific antigens, thereby attacking microbes. The antibodies are transported through the blood and the lymph to the pathogen invasion site.

Antigen:

In immunology, an antigen is a molecule capable of inducing an immune response in the host organism. Sometimes antigens are part of the host itself in an autoimmune disease. Antigens are "targeted" by antibodies.

Lymphocytes:

Lymphocytes are one of several different types of white blood cells. Each type of white blood cell has a specific function, and they all work together to fight illness and disease.

OR

Lymphocytes are a type of white blood cell generated by the immune system to defend the body against cancerous cells, pathogens, and foreign matter.

Antibody mediated immunity:

Antibody-Mediated (Humoral) **Immunity** (AMI) On exposure to antigenic determinants in lymphatic organs, B-lymphocytes are activated and differentiated to form plasma cells. Plasma cells are specialized, differentiated cells that synthesize and secrete **antibodies** specific for an antigen.

Immunization:

Providing immunity artificially is called **immunization.**

Colostrum:

Passive immunity may also be provided by **colostrum,** the first secretion of the mammary glands. The baby absorbs the antibodies through its gut.

OR

Colostrum is a form of milk produced by the mammary glands of mammals during pregnancy. Most species will generate colostrum just prior to giving birth. Colostrum contains antibodies to protect the newborn against disease.

Vaccine:

A vaccine is a biological preparation that provides active acquired immunity to a particular disease.

Vaccination:

Artificial Active Immunity (vaccination) is achieved by injecting (or administering orally) small amounts of antigen, called the vaccine, into the body of an individual. The process is called **vaccination.**

Allergies:

Allergies are actually a form of immune response. A foreign substance, such as a pollen grain, enters the bloodstream and is recognized as an antigen by a particular type of B cell. This B cell proliferates, producing plasma cells that pour out IgE antibodies. attach to the plasma membranes of histamine-containing cells located in the respiratory and digestive tracts.

Transplant Rejection:

It is occasionally desirable to transplant some tissue or an organ such as the skin, kidney, heart, or liver, from one person to another to replace a non-functional damaged or lost body part. In such cases, there is a danger that the recipient cells may recognize the donor's organ or tissue as being foreign. This triggers the recipient's immune mechanisms, which may act to destroy the donor tissue. Such a response is called transplant rejection.

Autoimmune Diseases:

Sometimes, a person's immune system does not normally respond to the antigens (self-molecules) borne on the body's own cells and the antibodies are going to produce against bodies own components and begin to destroy them. This problem is called an **autoimmune disease.**

17. Write the differences between:

(a) sebaceous gland and sweat gland

(b) macrophages and neutrophils

(c) interleukin-1 and interleukin-2

(d) antibody-mediated immune response and a cell-mediated immune response.

(e) cytotoxic T cells and suppressor T cell

(f) plasma cells and memory cells

(g) antibody and antigen

(h) inborn immunity and acquired immunity

(i) natural passive immunity and artificial passive immunity

Ans: (a) sebaceous gland and sweat gland:

Sebaceous Glands and Sweat Glands:

In addition the dermis part of skin also contains the sebaceous glands and sweat glands. **Sebaceous glands** produce **sebum,** an oily substance whereas **sweat glands** secrete **sweat**, a salty fluid that generally provides cooling effect to the body. Secretion from sweat glands and sebaceous glands usually cover the skin. These secretions contain natural antibiotics such as lactic acid that inhibit the growth of bacteria and fungi. These multiple defence make the unbroken skin an extremely effective barrier against microbial invasion.

OR (Second Answer)

Sweat	Sebum
It is secreted by sweat glands (skin surface)	It is secreted by sebaceous (oil) glands
It is fluids in nature	It is oily in nature
It is composed of mainly sodium chloride and water. Some other substances are also present in small amount.	It is composed of oil or wax like secretion. Other hydrocarbons and fatty acids are also present
Function: Temperature control and Excretion	**Function:** Lubrication

(b) macrophages and neutrophils:

Macrophages:

Macrophages are derived from monocytes or the monocytes that leave the blood are called macrophages.

Monocytes:

Monocytes are formed in bone marrow. From bone marrow, through blood, macrophages are transported to the areas of the body where they are needed.

Macrophages are generally found in the organs such as the lungs, liver, spleen, kidney and lymph nodes, rather than remaining in the blood.

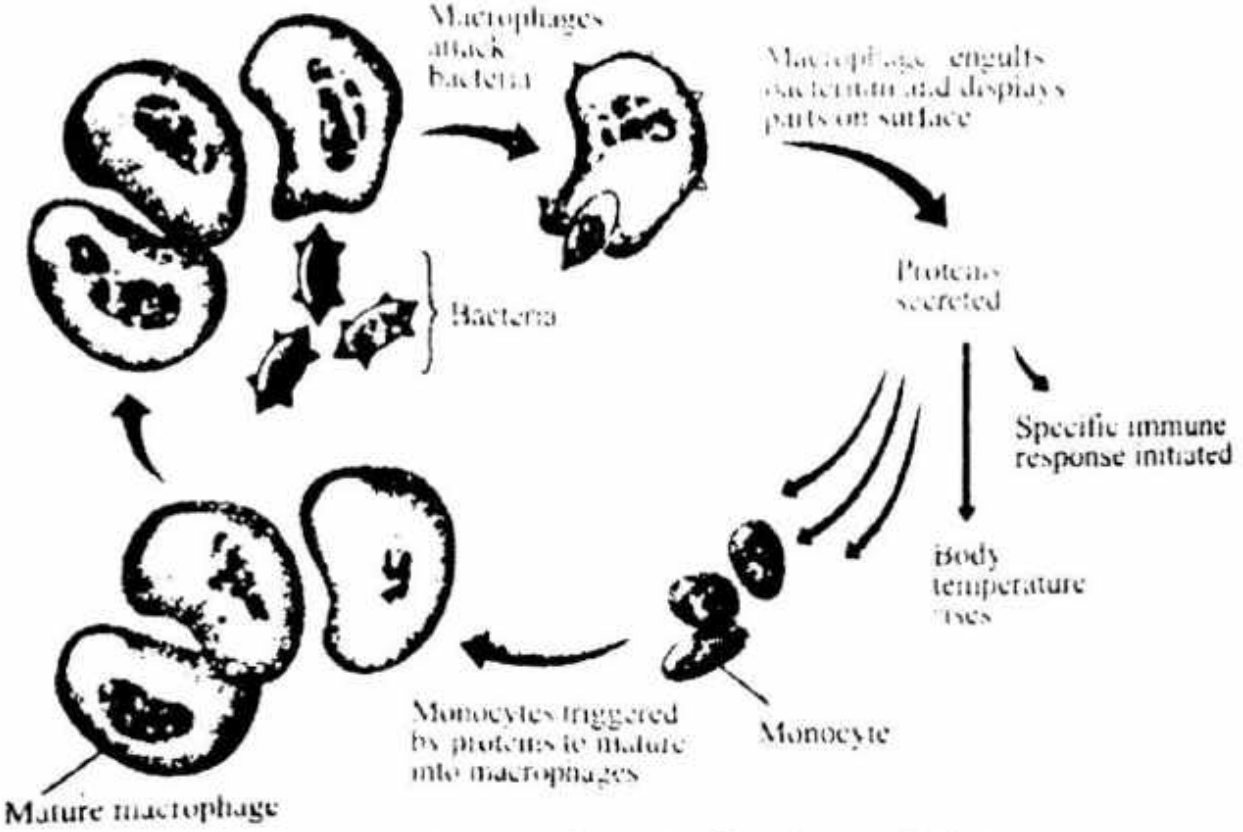
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iii. The macrophages also secrete many different proteins when they perform phagocytosis of the microbes. Some of these proteins trigger the maturation of monocytes into macrophages, thereby increasing their numbers.

iv. Another protein **interleukin-I** signals the brain to raise the body temperature producing fever Some other proteins also stimulate the specific immune response



Response of macrophages to foreign particles

Neutrophils:

These belong to the granulocyte type of WBCs They are highly short-lived and highly mobile as they squeeze between cells of capillary walls and can enter parts of tissue where other cells/molecules would not be able to enter otherwise

Functions of Neutrophils:

i. They move like *Amoeba* forming pseudopodia

ii. They proceed rapidly to infected area to perform their duty and they often die after a single phagocytic event

iii. Neutrophils also release lysosomal enzymes and certain chemicals that kill microorganisms and cause inflammation

OR (Second Answer)

Difference between Neutrophils and Macrophages:

Neutrophils	Macrophages
Definition:	
Neutrophil is a granular leukocyte comprising of a nucleus with three to five lobes	Macropnage is a large white blood cell that engulfs foreign particles in the body
Shape of the Nucleus:	
Neutrophils have a multi-lobed nucleus	Macrophages have a large rounded shape nucleus

Granulocytes/Agranulocytes:	
Neutrophils are granulocytes.	Macrophages are agranulocytes.
Makeup:	
Neutrophils make up 50-70% of circulating white blood cells.	Monocytes make up 2-8% of circulating white blood cells.
Difference in Phenotype:	
Neutrophils consist of Ly6G$^+$ and MPO$^+$ receptors on the cell membrane.	Macrophages consist of EMR1$^+$, CD107b$^+$ (Mac-3$^+$), and CD68$^+$ receptors on the cell membrane.
Site of Maturation:	
Neutrophils mature in the bone marrow.	Macrophages mature in tissues.
Mature Cells in Circulation:	
Mature neutrophils are found in circulation.	Very few macrophages can be found in circulation.
Mature Cells Recruited into Tissues from Circulation:	
During innate and acquired immunity, mature neutrophils migrate from circulation into tissues.	Only immature monocytes migrate from the circulation into tissues.
Normal Residence of Mature Cells in Connective Tissues:	
Mature neutrophils do not reside in connective tissues.	Mature macrophages normally reside in connective tissues.
Phenotypically Distinct Sub-Populations in Different Tissues:	
No phenotypic variations are observed in neutrophils.	Macrophages comprise of phenotypically varied sub-populations in distinct tissues.
Proliferative Ability of Mature Cells:	
Generally mature neutrophils are incapable of proliferating.	M2 macrophages are capable of proliferating in certain circumstances.
Lifespan:	
The lifespan of neutrophils is typically several days.	The life span of macrophages is weeks to months.
Role:	
Neutrophils are the first to attack bacteria at the site of infection. The action of neutrophils forms pus.	Monocytes from the circulation enter the peripheral tissues, becoming tissue macrophages, which engulf large particles and pathogens.

(c) interleukin-1 and interleukin-2:

Interleukin-1	Interleukin-2
Interleukin-1 alpha (IL-1α) is a protein that in humans is encoded by the	Interleukin-2 (IL-2) is an interleukin, a type of cytokine immune system

IL1A gene The protein encoded by this gene is a cytokine of the interleukin-1 family Interleukin-1 alpha possesses a wide spectrum of metabolic physiological, haematopoietic activities and plays one of the central roles in the regulation of the immune responses	signaling molecule which is a leukocytotrophic hormone that is instrumental the body's natural response to microbial infection and in discriminating between foreign (non-self) and self It mediates its effects by binding to IL 2 receptors which are expressed by lymphocytes the cells that are responsible for immunity

(d) antibody-mediated immune response and a cell-mediated immune response:

antibody-mediated immune response	cell-mediated immune response
1. It consists of B-lymphocytes which produce the antibodies that circulate in the body fluids.	**1.** It consists of T-lymphocytes which produce normally 4 types of T-cells
2. It defends the body against viruses and bacteria	**2.** It defends the body against all pathogens including fungi and protozoa
3. It does not respond to transplants.	**3.** It reacts against transplants
4. It does not provide immunity against cancer.	**4.** It provides immunity against cancer

OR (Second Answer)

	Antibody mediated Immunity	Cell mediated Immunity
Main cells	B lymphocytes	T lymphocytes
Maturation	Generated and matured in bone marrow	Originate in bone marrow and complete development in thymus
Protect against	Extracellular microbes and their toxins toxin induced diseases infections (virulence related to polysaccharide capsule)	Intracellular microbes viruses parasites-(leishmania) bacteria (mycobacteria listeria) kill tumor cells
%age of lymphocytes	10-20% circulating peripheral lymphocyte population	60-70%
Location in lymph nodes	Superficial cortex	Paracortical areas
Location in spleen	White pulp	Periarteriolar sheaths
Receptors	B-cell antigen receptor complex consisting of main IgM and IgD	In 95% T cells á alpha/beta TCR In minority á gamma, T

	immunoglobulins	cells
Accessory surface molecules	Igα Igβ Fc receptors CD40, CD21	CD3 molecular complex Dimer of ∑ chain CD4, CD8, CD2, CD28 integrins
End result of activation	Differentiation of B cells into antibody secreting cells called plasma cells	Secrete locally acting proteins called cytokines
Hypersensitivity reactions	I, II, III are antibody mediated	IV is cell mediated
Role of MHC molecules	Antigen receptor recognizes whole unprocessed proteins and has no requirement for presentation by MHC protein	Antigen receptor recognizes only processed peptides in association with MHC protein
Regulator of antibody synthesis	No	Yes
Onset	Rapid	Delayed type hypersensitivity
Antibodies	Formed	Not formed
Evaluation	From plasma level of antibodies	Skin test for development of delayed type of hypersensitivity
Cells involved	Ab synthesis requires 3 cells t lymphocytes b lymphocytes macrophage	macrophage helper T cells natural killer T cells cytotoxic T cells

(e) cytotoxic T cells and suppressor T cell:

Cytotoxic T cells	Suppressor T cells
These cells secrete **cytotoxin** which triggers destruction of the pathogen's DNA or **perforin** which is a protein that creates holes in the pathogens plasma membrane The holes cause the pathogen to lyse (rupture)	When infection is successfully removed, these cells begin to secrete certain proteins that inhibit further proliferation of T cell. Therefore, they shut down the immune response

(f) plasma cells and memory cells:

After binding with specific type of antigen the B cells divide to produce two type of cells **plasma** clone **cells** and **memory B cells.**

Plasma Clone Cells:

The plasma clone cells are specialized to secrete bulk quantity of antibodies After B cells become plasma cells they live only for a few days but secrete a great

deal of antibody during the time A **plasma cell** can produce more than 10 million molecules of antibody per hour

Memory B Cells:

If the same antigen enters the body later the memory B cells divide to make more plasma cells and memory cells that can protect against future attacks by the same antigen The stimulation of B cells to divide into plasma clone cells and memory B cells and the secretion of antibodies by plasma clone cells is called **humoral and cell mediated** immune **response.**

OR (Second Answer)

Plasma cells	Memory cells
1. are immediatley active and act against pathogens (viruses, or bacteria) the first time they invade the body	**1.** act rapidly against antigens (pathogen) the 2nd, 3rd 4th time they re- enter the body
2. produce antibodies that identify and stop any crazyness going on	**2.** When a antigen (pathogen) occurs again memory cells have already been imprinted by the invading antigens (pathogens) meaning, a quick response can occur due to memory cells recognition of a antigen (pathogen).
3. they don't last that long	**3.** they last longer

(g) antibody and antigen:

- Both antigen and antibody are paramount for immunology Both partake in autoimmune diseases and the end result is the same
- Both antigens and antibodies are microscopic particles and contain proteins Antigens has combinations from polysaccharides as well whereas antibodies are purely made up of proteins.
- Antigens can be cells, but antibodies are never cells.
- Antigens act as the key, whereas the antibodies act as the lock
- There are mainly two types of antigens, which are self and non self.
- Antibodies are made of five main subcategories according to the proteins constructs. Depending on the permissive nature, it projects aspects of the antibody like placental transference, secretion etc

Thus, consider the antigen or the causative particle as a key to lock on the antibody or the disease fighter The key can take several forms but the epitope has to be the same as the paratrope

OR (Second Answer)

antigen	Antibody
An antigen is a foreign body in the blood Examples of antigens include foreign proteins, pathogenic bacteria, and viruses.	An antibody is a globular protein that recognizes an antigen and attaches to its surface forming an antibody-antigen complex
The antibody-antigen complex is recognized by a macrophage which ingests the whole complex by the process of phagoctytosis	

(h) inborn immunity and acquired immunity:

The two basic types of immunity are (a) inborn or innate immunity (b) acquired immunity

The ability of the innate immune system to kill microorganisms is not specific. First and second line of defence that you have already studied in this chapter are the part of innate of inborn immunity. Highly specific protection is provided by the **acquired (adaptive) part** of the immune system, but it takes several days for this system to become fully functional. The two components of the acquired immune system are **cell-mediated immunity** and **antibody mediated (humoral) immunity.**

OR (Second Answer)

Difference Between Innate Immunity and Acquired Immunity:

Innate Immunity	Acquired Immunity
Definition:	
Innate immunity is the form of immunity that is inborn in an organism and is activated immediately in response to an invading microorganism	Acquired immunity, also referred to as adaptive immunity or specific immunity is the type of immunity that is adapted by the body to defend the body against the invading pathogen
Nature:	
Innate immunity is generic or non-specific in nature	Acquired immunity is specific in nature
Acquisition:	
Innate immunity is present from the point of birth	Acquired immunity develops over growth
Inheritance:	
Innate immunity is inheritable	Acquired immunity is not inheritable, with the exception of one form of passive immunity acquired by a baby from its mother during gestation
Defense Mechanisms:	
Aspects of innate immunity such as mechanical barriers exert their defensive mechanics irrespective of the presence or absence of an invading pathogen	In the case of acquired immunity, contact with a pathogen is essential to build up defensive mechanisms
Response:	
Innate immunity is triggered immediately in response to infection	Acquired immunity takes a while to develop and exert its effects
Cells:	
The major immune cells involved in innate defensive mechanisms are NK cells, neutrophils macrophages, eosinophils, basophils etc	The major immune cells involved in the acquired system are majorly the lymphocytes, the B cells and T cells

OR (Second Answer)

	Innate Immunity	Acquired (Adaptive) Immunity
1	Present from birth itself	Develops during life time
2	The immunity remains throughout life	Can be short lived or lifelong
3	Contact or exposure with pathogen or its antigen is not essential	Contact with pathogen or its antigen is essential
4	Innate immunity is inheritable	Acquired immunity cannot be passed to the next generation, except for a brief period to neonates
5	It protects the individuals from contraction of diseases of other organisms	It protects the individuals from pathogens present on other members of the same species

(i) natural passive immunity and artificial passive immunity:

Natural passive immunity:

It may be gained naturally. For example, antibodies from a mother can cross the placenta and enter her foetus. In this way they provide protection for the baby until its own immune system is fully functional. Passive immunity may also be provided by **colostrum**, the first secretion of the mammary glands. The baby absorbs the antibodies through its gut.

Artificial passive immunity:

Antibodies which have been formed in one individual are extracted and then injected into the blood of another individual which may or may not be of the same species. They can be used for immediate protection if a person has been, or is likely to be, exposed to a particular disease. For example, specific antibodies used for combating tetanus and diphtheria used to be cultured in horses and injected into humans. Only antibodies of human origin are now used for humans. Antibodies against rabies and some snake venoms are also available. Antibodies against the human rhesus blood group antigen are used.

EXTENSIVE QUESTIONS

18. Describe the human skin as an impenetrable barrier against invasion by microbes.

Ans: Skin; an Impenetrable barrier against microbial invasion:

The skin is made up of two layers i.e., epidermis and dermis.

Epidermis is superficial multiple cell thickened layer while **dermis** is inner comparatively thick layer containing glands, hair follicles, receptors, nerves and blood vessels.

Keratin:

Most cells of epidermis are keratinocytes, which produce a protein mixture called **keratin.**

The outer surface of the skin also consists of dry dead cells. Consequently most microbes that land on the skin cannot obtain the water and nutrients they need.

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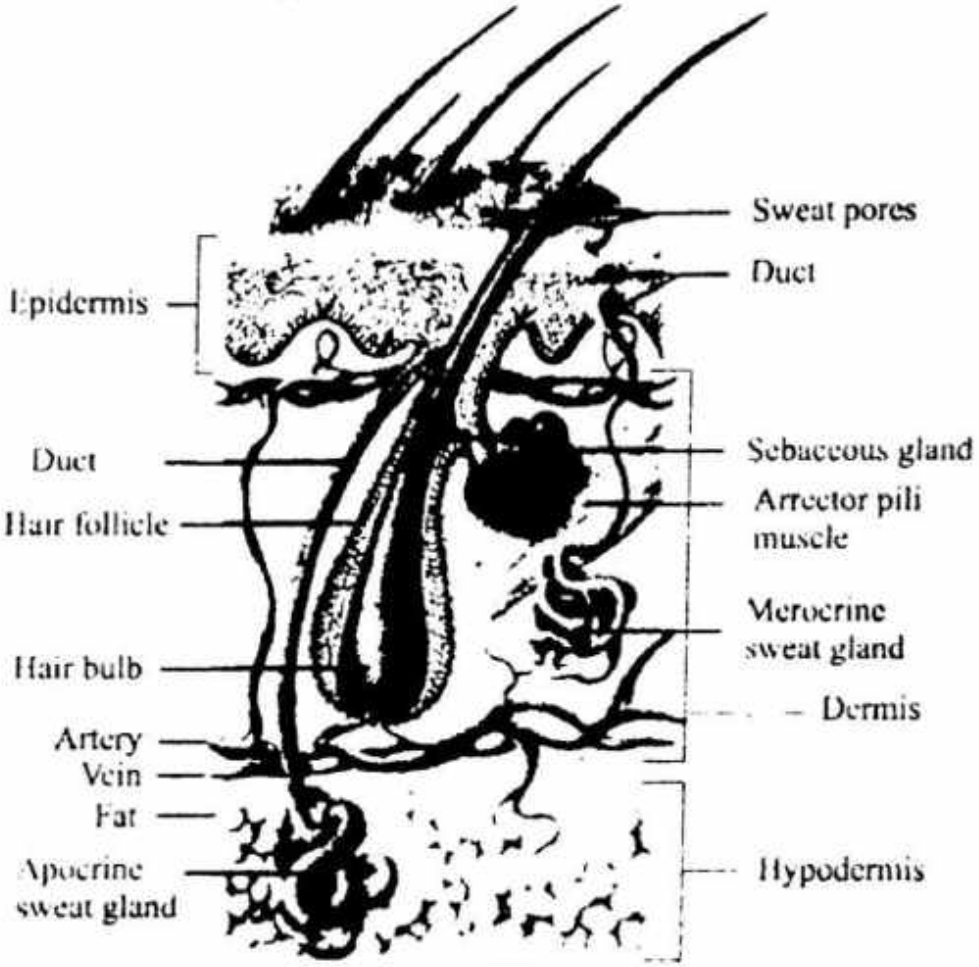
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Glands of Skin

Skin as an impenetrable barrier against microbial Invasion

19. What is the role of macrophages and neutrophils in killing bacteria?

Ans: Killing Cells of Blood:

Phagocytes:

There are white blood cells in the body called **phagocytes.**

Phagocytosis:

A phagocyte is a cell that destroys other abnormal body cells (cancerous cells) or invaded microorganisms by engulfing or ingesting them. This process is called **phagocytosis.** Two types of blood cells are phagocytes macrophages and neutrophils

Macrophages:

Macrophages are derived from monocytes or the monocytes that leave the blood are called macrophages.

Monocytes:

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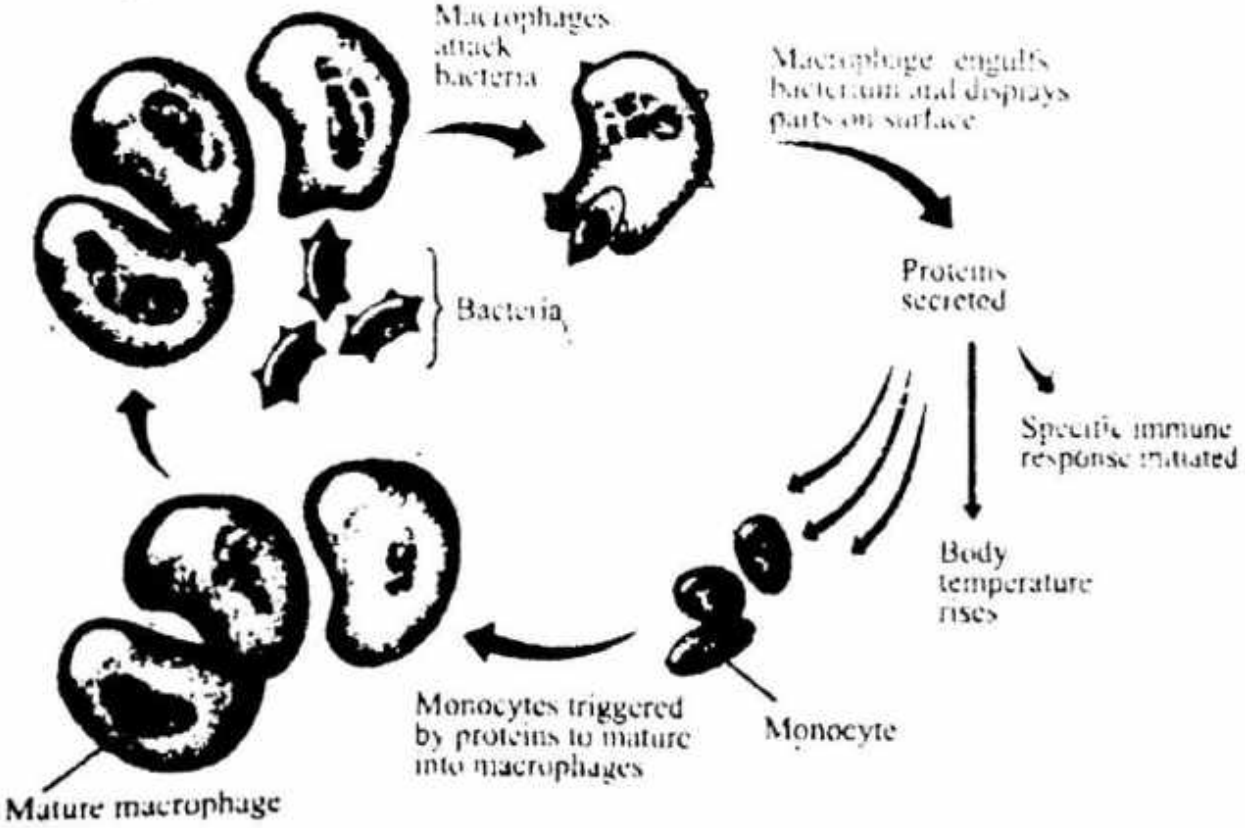
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Response of macrophages to foreign particles

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i. They move like *Amoeba* forming pseudopodia.

ii. They proceed rapidly to infected area to perform their duty and they often die after a single phagocytic event

iii. Neutrophils also release lysosomal enzymes and certain chemicals that kill microorganisms and cause inflammation

20. Explain the protective proteins of complementary system with diagram.

Ans: Protective Proteins of Complement System:

The complement system consists over thirty types of small proteins found in the blood, in general synthesized by the liver and normally circulating in inactive state

They are activated on the entry of foreign particles. Once a **complement protein** is activated, it activates another protein, which further activates other proteins of the system and so on. The result of this complement activation is stimulation of phagocytes to clear foreign and damaged material, development of inflammation to attract additional phagocytes at the site of infection and activation of the cell killing membrane attack complexes. The complement system is an important supporter of the immune system that enhances (complements) the ability of antibodies and phagocytic cells to clear microbes and damaged cells from the body, promotes inflammation, and attacks the pathogen's plasma membrane.



Action of the complement system against a bacterium

Example:

An example of protective proteins of complement system is **perforin,** a membrane attack complex that produces holes in the bacterial cell walls and plasma membranes of bacteria. The holes allow fluids and salts to enter the bacterial cell, thus, bacterial cell swells and eventually burst.

Interferons:

Interferons (IFNs) belong to the large class of proteins known as **cytokines,** molecules used for communication between cells during infection.

They are made and released by host cells in response to the presence of several pathogens specially viruses.

Functions of Interferons:

Interferons are named for their ability to **"interfere"** with viral replication as interferons activate molecules which prevent the virus from producing and replicating its RNA or DNA. In this way, interferons limit cell-to-cell spread of viruses in the body. IFNs also activate immune cells, such as natural killer cells and macrophages that in turn destroy virally infected cells

21. Explain in detail inflammatory response with diagram.

Ans: Inflammatory Response:

The inflammatory response is a major component of the non-specific defence. Any damage to tissue, whether caused by an infectious microorganism or by physical injury, even just a scratch or an insect bite triggers this response Inflammation can be localized or systemic (widespread). Local inflammation is an inflammatory response confined to a specific area of the body

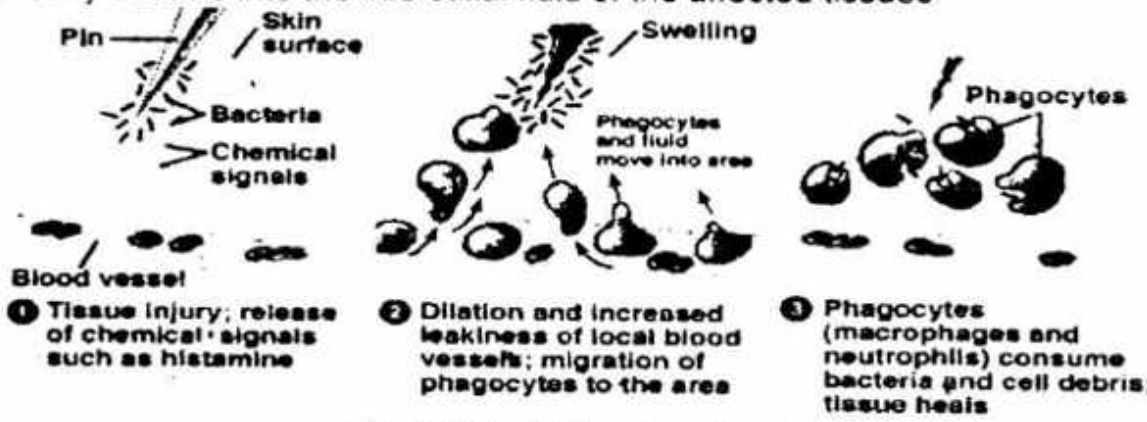
Signs of Inflammation:

The classical signs of inflammation are heat, pain redness, swelling, and loss of function.

Inflammatory Response:

Inflammation literally means "setting on fire" The figure shows the chain of events that make up the inflammatory response. in case where a pin has broken the skin and infected it with bacteria The first thing that happened when a tissue is injured is that the damaged cells release chemical alarm signals such as **histamine.**

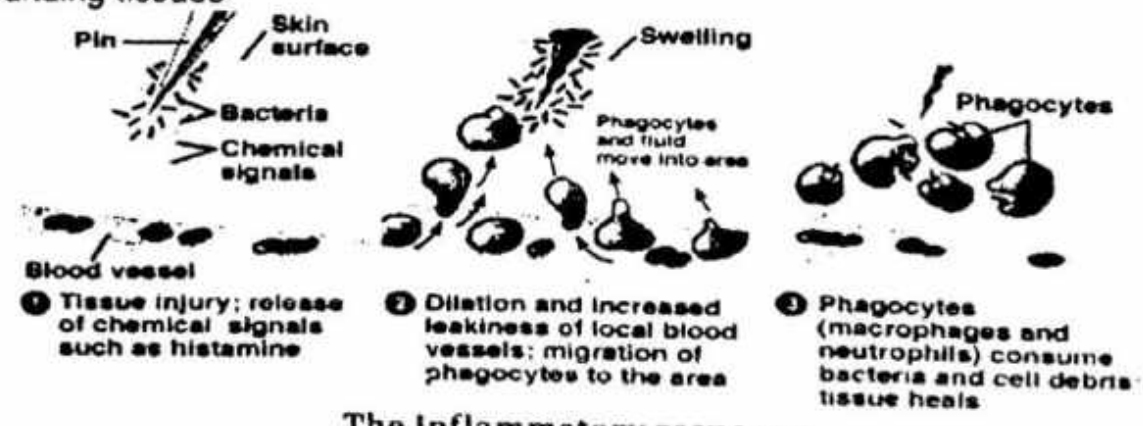
The chemical sparks the mobilization of various defence Histamine for instance induces neighbouring blood vessels to dilate and blood vessels start leaking Blood supply to the damaged area increases, and blood plasma passes out of the leaky vessels into the interstitial fluid of the affected tissues



The Inflammatory response

Functicn of Inflammation:

The function of inflammation is to eliminate the initial cause of cell injury, clear out necrotic cells and tissues damaged from the original insult (to attack physically) and the inflammatory process, and to initiate tissue repair The inflammatory response also helps to prevent the spread of infection to the surrounding tissues



The Inflammatory response

22. Explain temperature response against infection.

Ans: Temperature Response:

Pyrogens:

Fever or **pyrexia** is the raised body temperature than normal. The invaded microorganisms often release certain chemicals which are generally termed as **pyrogens.**

High Temperature:

These pyrogens cause the temperature set point of the **hypothalamic thermostat** of the body to rise: as a result, all the mechanisms for raising the body temperature are brought into play, such as heat conservation and increased heat production. Since, higher body temperature than normal facilitate the microbial growth in the body, this is the reason why invaded microorganisms want to increase the host's body temperature

Endogenous Pyrogens:

On the other hand, certain white blood cells in response to the infection, also release hormones collectively called **endogenous pyrogens** (self-produced fire makers) that further increase the temperature set point of hypothalamus because higher body temperature than normal increases the activity of phagocytic white blood cells that attack upon bacteria.

Effects of High Temperature:

i. The endogenous pyrogens also cause other cells to reduce the concentration of iron in the blood because many bacteria require more iron to reproduce at temperature of 38°C or 39°C than at 37°C, so fever and reduced iron in the blood combine to slow down their rate of reproduction.

ii. Fever also increases the production of interferons that travel to other cells and increase their resistance to viral attack.

iii. The higher body temperature may directly inactivate the virus particles, particularly enveloped viruses, which are more heat-sensitive than non-enveloped viruses

iv. Replication of some viruses is reduced at higher temperatures, therefore fever may inhibit replication.

However, fever is nonspecific defence against microbial infections, but often, high degree fever becomes destructive for body's own metabolic system and ultimately body is collapsed. Therefore, physicians use to prescribe antipyretic drugs to the patients of high degree fever.

23. What are the ways fever kills microbes?

Ans: **Fever** or **pyrexia** is the raised body temperature than normal.

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24. Describe the role of monocytes in immune system.

Ans: Role of Monocytes in third line of defence:

As already described in second line of defence that monocytes are kind of WBCs, **which are** produced by lymphoid tissues. The monocytes circulate in blood for 10 to 20 hours and ultimately they leave the blood and come into the intercellular space of tissues. In the tissues, they swell and attain a larger size to become tissue **macrophages.**

Interleukin-1:

When macrophages perform phagocytosis of invaded microorganisms after digesting them they not only display microbial antigens on their surfaces but also begin to secrete about 100 different compounds including various enzymes, interferons and a protein called **interleukin-1**.

Role of Interleukin-1:

The interleukin-1 secreted by macrophages activates the T cells that in turn begin to secrete interleukin-2, which then activates the B cells. Interleukin-1 also promotes a general response to injury, causing fever and activating other mechanisms that defend the body against invasion.

25. What is the role of T cells in cell mediated response.

Ans: Role of T Cells in third line of defence (Cell mediated immune response):

T cells originate from stem cells in the bone marrow. After early embryonic development the newly forming T cells migrate to **thymus gland** for processing. The thymus makes T cells immunocompetent that is capable of immunological response. The immune response provided by T cells is called **cell mediated immune response.**

Activations of T cells:

In case of infection, macrophages perform phagocytosis of invaded microorganism and detect particular **antigens (nonself molecules)** of the organism.

Major Histocompatibility Complex (MHC):

Macrophages isolate and display these antigens on their surface with the help of their own proteins (self-protein) called **major histocompatibility complex (MHC).**

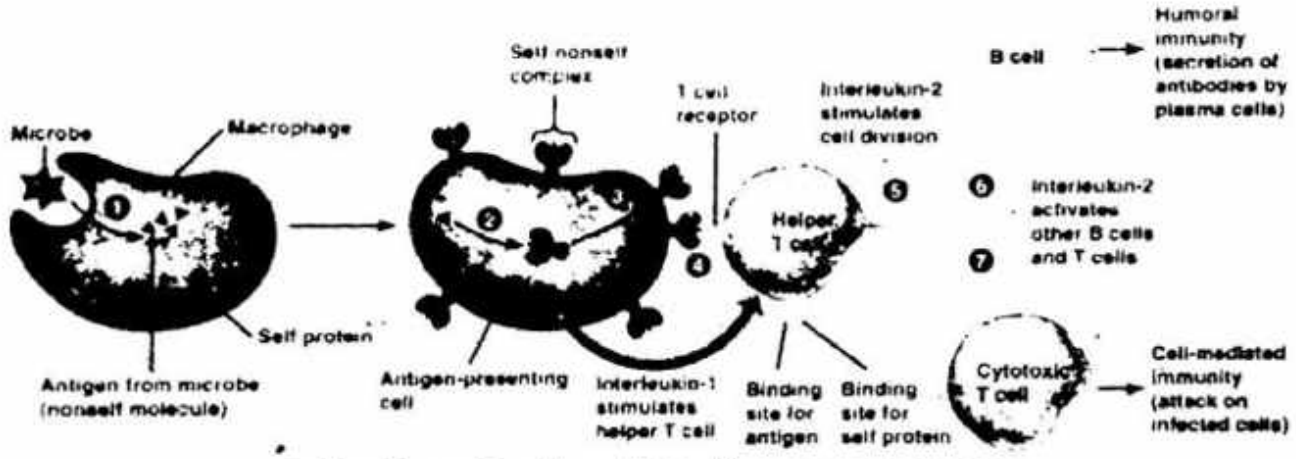
In this way macrophages become **antigen-presenting cells (APCs).** Macrophages also secrete **interleukin-1** that stimulates and attracts helper T cells towards the displayed antigen

T Cell Receptor (TCR):

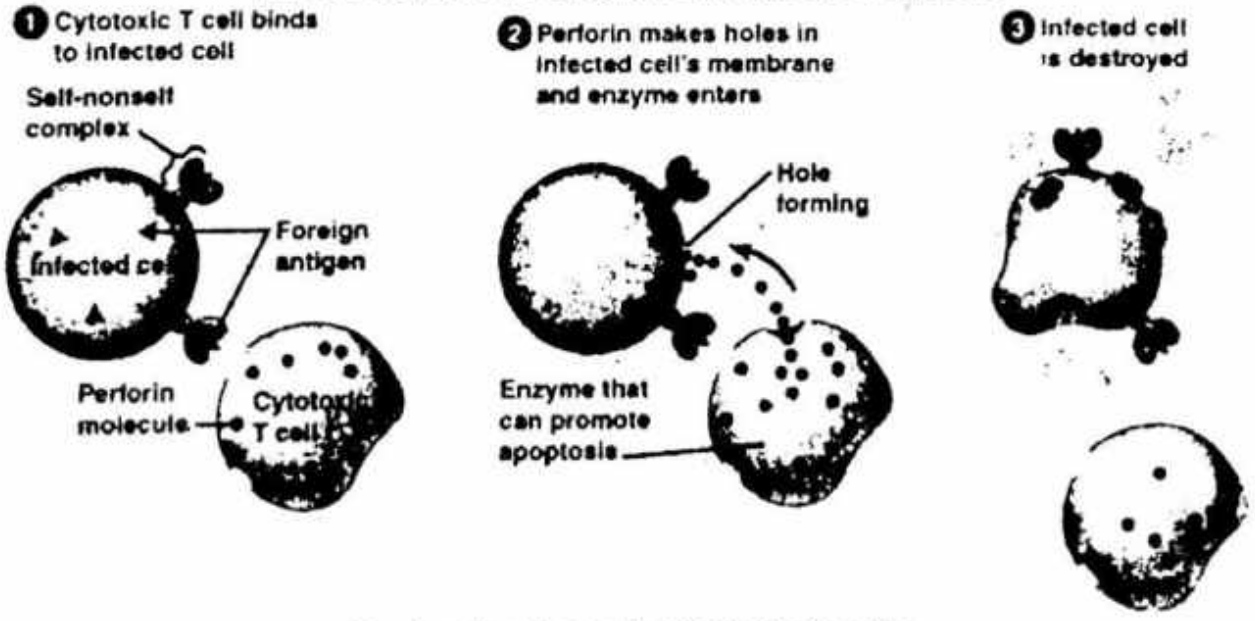
Helper T cells have specific receptor on their surface called T cell receptor (TCR) by which they bind with a particular antigen displayed on APC. Interleukin-1 also stimulates the helper T cells to secrete another protein, the interleukin-2 that not only compel the helper T cells to divide but also causes the proliferation of certain cytotoxic T cells and B cells

Cell-Mediated Immunity:

The activation of T-cells by a specific antigen is called **cell-mediated immunity.** The body contains millions of different T-cells each able to respond to one specific antigen.



Activation of cell mediated immune response



Mode of action of cytotoxic T cells

Types of T cells:

Two main categories of T cells have been identified.

CD8 Cells:

The first group, known as **CD8** cells because they have surface marker designated **CD8**, include cytotoxic T cells and suppressor T cells.

CD4 Cells:

The second group i.e., **helper T cells** also known as **CD4** cells because they have a surface marker designated **CD4**.

When helper T cells are activated, they divide and produce four types of cells which have specific role in cell-mediated immune response.

(i) **Cytotoxic T cells:** These cells secrete **cytotoxin** which triggers destruction of the pathogen's DNA or **perforin** which is a protein that creates holes in the pathogens plasma membrane. The holes cause the pathogen to lyse (rupture).

(ii) **Helper T cells:** These cells secrete **interleukin 2** which stimulates cell division of T cells and B cells. In other words, these cells recruit even more cells to help fight the pathogen.

(iii) **Suppressor T cells:** When infection is successfully removed, these cells begin to secrete certain proteins that inhibit further proliferation of T cell. Therefore, they shut down the immune response.

(iv) **Memory T cells:** These cells remain dormant after the initial exposure to an antigen. If the same antigen presents itself again, even if it is years later, the memory cells are stimulated to convert themselves into helper T cells and help fight the pathogen.

26. Describe the role of B cells in humoral antibody mediated immune response.

Ans: Role of B Cells in third line of defence:

Humoral/ Antibody Mediated Immune Response:

B cells are differentiated in bone marrow. B cells express specific receptors on their cell membrane, the B cell receptors (BCRs). BCRs allow the B cell to bind a specific antigen, against which it will initiate an antibody response. Like T cells, there are millions of B cells types, found in the body, each is specific for one particular antigen.

Activation of B cells:

B cell activation begins when the B cell binds to an antigen via its BCR. Actually, B cells are stimulated to bind with specific antigen by interleukin-2 proteins, which are secreted by helper T cells.

After binding with specific type of antigen the B cells divide to produce two type of cells: **plasma** clone **cells** and **memory B cells.**

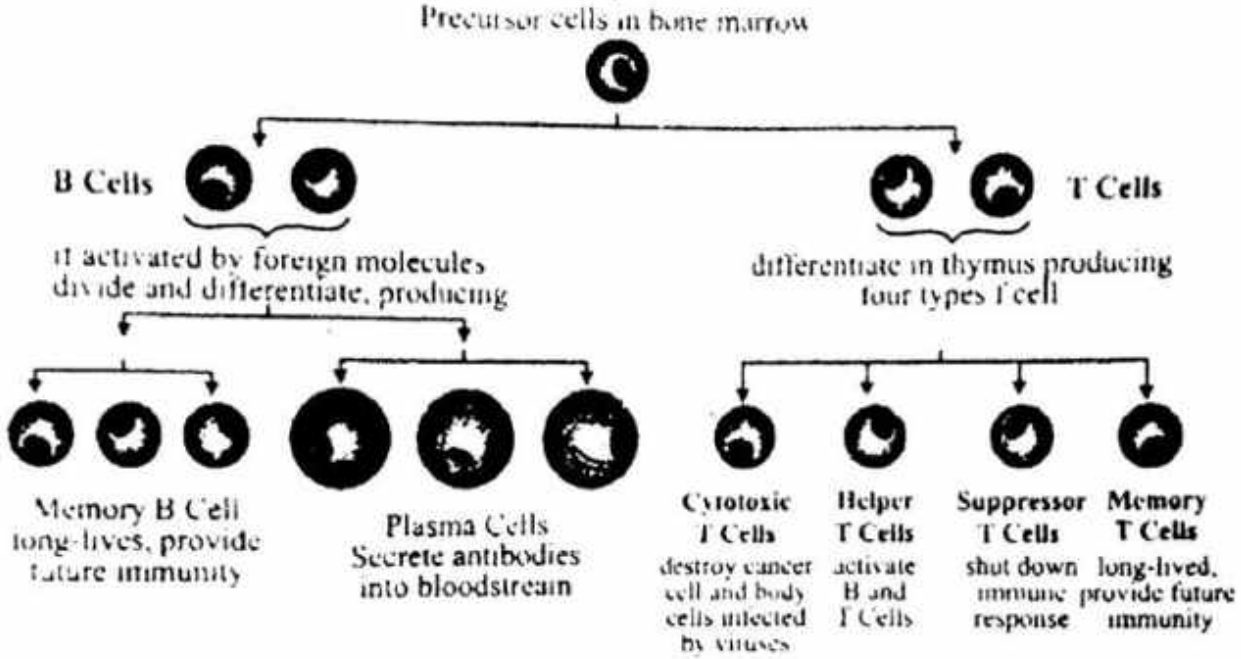
Plasma Clone Cells:

The plasma clone cells are specialized to secrete bulk quantity of antibodies. After B cells become plasma cells they live only for a few days but secrete a great deal of antibody during the time. A **plasma cell** can produce more than 10 million molecules of antibody per hour.

Memory B Cells:

If the same antigen enters the body later, the memory B cells divide to make more plasma cells and memory cells that can protect against future attacks by the

same antigen The stimulation of B cells to divide into plasma clone cells and memory B cells and the secretion of antibodies by plasma clone cells is called **humoral and cell mediated** immune **response.**

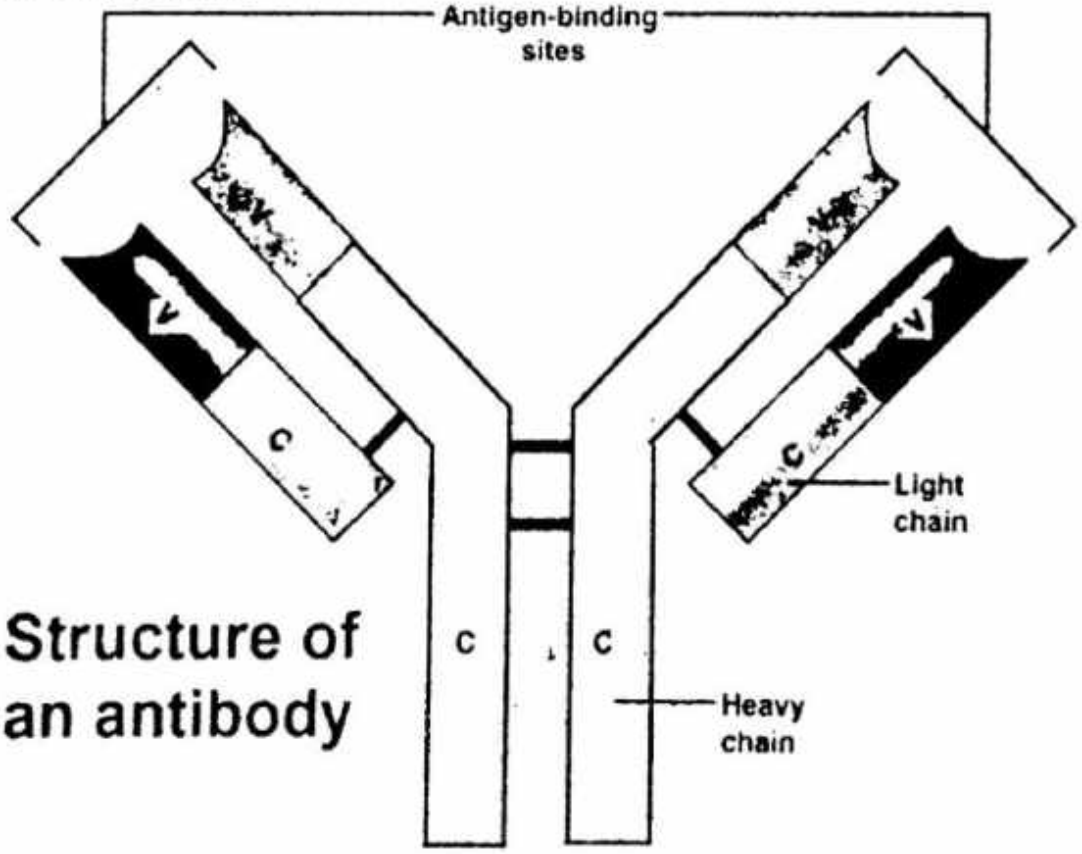


The major cells of Immune system and their roles in the immune system

27. Describe with diagram the structure of antibody.

Ans: Structure of an antibody:

Antibodies (also called immunoglobulins or Ig's) are Y-shaped proteins that circulate through the blood stream and bind to specific antigens, thereby attacking microbes. The antibodies are transported through the blood and the lymph to the pathogen invasion site



Structure of an antibody

A typical antibody is a Y-shaped molecule which consists of four polypeptide chains: two identical long chains called **heavy** chains and two identical short chains called **light chains.**

Each chain has a **constant segment,** a functional segment and a **variable segment.**

Constant Segment:

In the constant segment, (C) of the heavy chains, the amino acid sequence is constant within a particular immunoglobulin class.

Variable Segment:

On the other hand, the variable segment (V) consist of different amino acid sequences in every antibody. Therefore, they act as antigen-binding site. Each antibody has two antigen-binding sites.

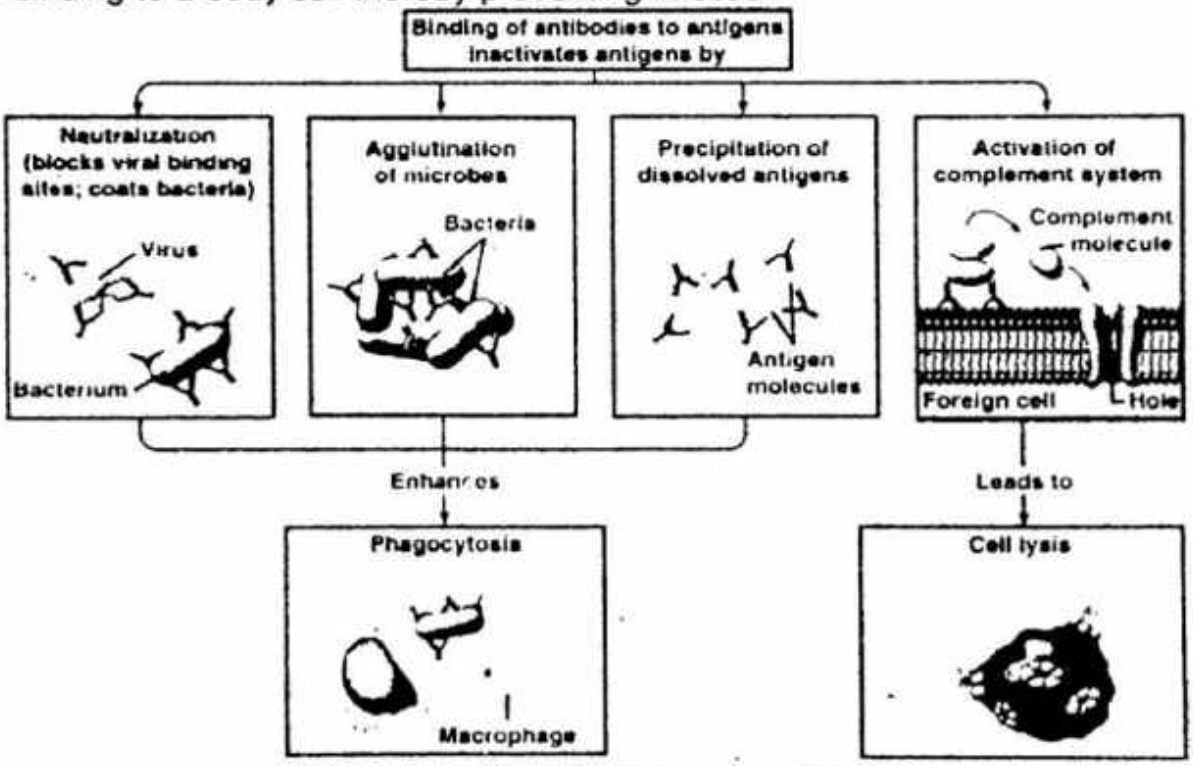
28. Describe the mode of action of an antibody.

Ans: Mode of action of an antibody:

Antibodies work in different ways.

1. Neutralizing an Antigen:

The antibody can bind to an antigen forming an antigen-antibody complex. This forms a shield around the antigen, preventing its normal function. This is how toxins from bacteria can be neutralized or how a cell can prevent a viral antigen from binding to a body cell thereby preventing infection.



Different modes of action of antibodies

2. Activating Complement:

Complement is a group of plasma proteins made by the liver that normally are inactive in the body. An antigen-antibody complex triggers a series of reactions that activates these proteins. Some of the activated proteins can cluster together to form a pore or channel that inserts into a microbe's plasma membrane. This lyses (ruptures) the cell. Other complement proteins can cause chemotaxis and inflammation, both of which increase the number of white blood cells at the site of invasion.

3. Precipitating Antigens:

Sometimes the antibodies can bind to the same free antigen to cross-link them. This causes the antigen to precipitate out of solution, making it easier for phagocytic cells to ingest them by phagocytosis (as describe above)

Also, the antigens within the cells walls of the bacteria can cross-link, causes the bacteria to clump together in a process called agglutination, again making it easier for phagocytic cells to ingest them by phagocytosis.

4. Facilitating Phagocytosis:

The antigen-antibody complex signals phagocytic cells to attack. The complex also binds to the surface of macrophages to further facilitate phagocytosis.

29. Describe the types of acquired immunity.

Ans: Types of Acquired Immunity —Active and Passive Immunity:

There are two ways to acquire adaptive immunity:

(a) Active Immunity **(b)** Passive Immunity

Both types may be acquired naturally or artificially.

Immunization:

Providing immunity artificially is called **immunization.**

(a) Active Immunity:

Natural Active Immunity:

Natural active Immunity is the kind of immunity, which is obtained as a result of an infection. The body manufactures its own antibodies when exposed to an infectious agent. This type of immunity is most effective and generally persists for a long time, sometimes even for life.

Artificial active immunity:

Artificial Active Immunity (vaccination) is achieved by injecting (or administering orally) small amounts of antigen, called the vaccine, into the body of an individual. The process is called **vaccination.** The antigen stimulates the body to manufacture antibodies against other antigen. Often a second, booster is given and this stimulates a much quicker production of antibody which is long lasting and which protects the individual from the disease for a considerable time. Several types of vaccine are currently in use.

In passive immunity antibodies from one individual are passed into another individual. They give immediate protection, unlike active immunity, which takes a few days or weeks to build up. However, it only provides protection against infection for a few weeks, for the antibodies are broken down by the body's natural processes, so their number slowly fall and protection is lost.

(b) Passive Immunity:

Natural passive immunity:

It may be gained naturally. For example, antibodies from a mother can cross the placenta and enter her foetus. In this way they provide protection for the baby until its own immune system is fully functional. Passive immunity may also be provided by **colostrum**, the first secretion of the mammary glands. The baby absorbs the antibodies through its gut.

Artificial passive immunity:

Antibodies which have been formed in one individual are extracted and then injected into the blood of another individual which may or may not be of the same species. They can be used for immediate protection if a person has been or is likely

to be, exposed to a particular disease For example, specific antibodies used for combating tetanus and diphtheria used to be cultured in horses and injected into humans. Only antibodies of human origin are now used for humans Antibodies against rabies and some snake venoms are also available Antibodies against the human rhesus blood group antigen are used.

30. Describe the disorder of immune system.

Ans: Disorders of Immune System:

Some conditions that stimulate a defective immune response or destroy immune system are called disorders of immune system.

Allergies:

Allergies are actually a form of immune response A foreign substance, such as a pollen grain, enters the bloodstream and is recognized as an antigen by a particular type of B cell. This B cell proliferates, producing plasma cells that pour out IgE antibodies attach to the plasma membranes of histamine-containing cells located in the respiratory and digestive tracts

When pollen grains encounter the attached antibodies, they trigger the release of **histamine**, which causes increased mucus secretion, leaky capillaries, and other symptoms of inflammation

Symptoms and Causes of Allergies:

Because pollen grains most often enter the nose and throat, the major reactions occur in these locations, resulting in the runny nose, sneezing, and congestion typical of "heavy fever" Antihistamine drugs block some of the effects of histamine, relieving the symptoms of allergies Food allergies cause equivalent symptoms, including cramps and diarrhea, in the digestive tract

Autoimmune disease:

Sometimes, a person's immune system does not normally respond to the antigens (self-molecules) borne on the body's own cells and the antibodies are going to produce against bodies own components and begin to destroy them This problem is called an **autoimmune disease**.

For example:

a) Some types of anemias are caused by antibodies that destroy a person's red blood cells.

b) Many cases of insulin-dependent (juvenile-onset) diabetes occur because the insulin-secreting cells of the pancreas are the victims of a misdirected immune response.

Unfortunately, at present there is no way to cure autoimmune diseases The autoimmune response can be suppressed with drugs

31. Describe the role of T cells and B cells in transplant rejection.

Ans: Transplant rejections:

It is occasionally desirable to transplant some tissue or an organ such as the skin, kidney, heart, or liver, from one person to another to replace a non-functional damaged or lost body part. In such cases there is a danger that the recipient cells may recognize the donor's organ or tissue as being foreign This triggers the recipient's immune mechanisms, which may act to destroy the donor tissue Such a response is called transplant rejection.

Role of T cells in transplant rejection:

Although the mechanism of rejection probably varies with the nature of the tissue and the degree of incompatibility, all the mechanisms require that the host helper T cells come into contact with the graft tissue's major histocompatibility complex (MHC) antigens. This contact is probably mediated by the dendritic cells of the graft tissue itself. At this point, three different possibilities exist. In the first, **antigen-specific TH cells** stimulate the activation and proliferation of appropriate T cells which then mount a focused attack on the transplant tissue. In the second, **responsive** antigen-specific TH cells move to the graft site, where they release **lymphokines.** These recruit monocyte/macrophages and T cells to the graft site and maintain them at the scene while they destroy the tissue.

Role of B cells in transplant rejection:

There is a third mechanism in which antibodies plays a role. The responsive helper T cell interacts with the appropriate B cell clone, producing a shower of antibodies to the implanted tissue's MHC antigens. These can trigger either complement-mediated graft damage or facilitating the phagocytosis of the grafted tissue by macrophages

32. Explain why a transplant recipient is given immune suppressant drugs and determine what implications this has on his life.

Ans: Organ transplantation has become a routine procedure due to improvement of surgical techniques, better tissue typing and the availability of drugs that more selectively inhibit rejection of transplanted tissues and prevent the patient from becoming immunologically compromised. Transplant rejection occurs as a delayed hypersensitivity reaction as a function of lymphocytes and not due to antibodies. Administration of immunosuppressive drugs enhances tolerance. People receiving immunosuppressive drugs have side effects like pain, diarrhoea, leukopenia, sepsis, lymphoma, thrombocytopenia, skin rashes, anaphylactic reaction, hypertension, hyperkalemia and neurotoxicity (tremors, seizures, hallucination). Hence, each system is affected, so the person starts to feel weakness and gets fatigue easily.

33. Describe malignant melanoma as due to the inability of tumour-infiltrating lymphocyte (TIL) to control the tumour of skin cancer and correlate it with the scientific advancements of inserting a gene of tumournecrosis factor in the lymphocyte.

Ans: Describe malignant melanoma as due to the inability of tumour-infiltrating lymphocyte (TIL) to control the tumour of skin cancer and correlate it with the scientific" c advancements of inserting a gene of tumour necrosis factor in the lymphocyte. Cancer starts when cells in the body begin to grow out of control.

Melanoma:

Melanoma is a cancer that usually starts in the melanocytes a type of skin cell. Melanomas can develop anywhere on the skin, but they are more likely to start on the trunk (chest and back) in men and on the legs in women. The neck and face are other common sites

Development of Melanoma:

The cancerous growths develop when unrepaired DNA damage to skin cells (most often caused by ultraviolet radiation from sunshine or tanning beds) triggers mutations (genetic defects) that lead the skin cells to multiply rapidly and form

malignant tumours. These tumours originate in the pigment-producing melanocytes in the basal layer of the epidermis.

Tumour-Infiltrating Lymphocytes:

Tumour-infiltrating lymphocytes are believed to represent the immune reaction/response to melanoma cells. Tumour (tumor)-infiltrating lymphocytes (TIL), are white blood cells that have left the bloodstream and migrated into a tumour. They are mononuclear immune cells, a mix of different types of cells (i.e., T cells, B cells, NK cells, macrophages) in variable proportions, T cells being the most abundant cells. They can often be found in the stroma and within the tumour itself.

TILs are not strong enough to control certain types of tumors e.g., malignant melanoma

Protein Tumour Necrosis Factor (TNF):

For the gene therapy of malignant melanoma first the TIL cell are removed from the patient and reinserted a gene that codes for the protein tumour necrosis factor (TNF). The protein kills tumour cells by preventing them from establishing a blood supply. The engineered TIL cells were then returned to the patient blood stream to seek out and invade the malignant melanoma tumours.

34. Describe the discovery of monoclonal antibodies and justify how this accomplishment revolution many aspects of biological research.

Ans: Discovery of Monoclonal Antibodies:

In 1970 Cesar Milstein and Georges Kohler working in Cambridge solve the problem of developing a technique for producing monoclonal antibodies, for which they were awarded Nobel Prize in 1984.

Monoclonal means belonging to one clone. Each type of antibody is made by one type of B cells which cloned itself, in other words multiplies to make many identical copies of itself in response to a particular antigen. Milstein and Kohlar fused B cells with cancer cells which are immortal to form hybridoma cells. The hybridoma cells continue to multiply and can be cloned so that large quantities of antibodies can be produced. Monoclonal antibodies are harvested from cell cultures rather than animals. The ability to make monoclonal antibodies has been spawned a new industry. A common area of application is medical diagnosis. Monoclonal antibodies are used for determining pregnancy and for diagnosing diseases such as, hepatitis, rabies, cancer, streptococcal throat infections, herpes viruses, leukaemias (cancers of white blood cells) and lymphomas etc. A monoclonal antibody has been developed which is very effective at preventing rejection of transplanted kidneys. Monoclonal antibodies can be used to find out the types of antigens present in the donor and increase the accuracy of matching.