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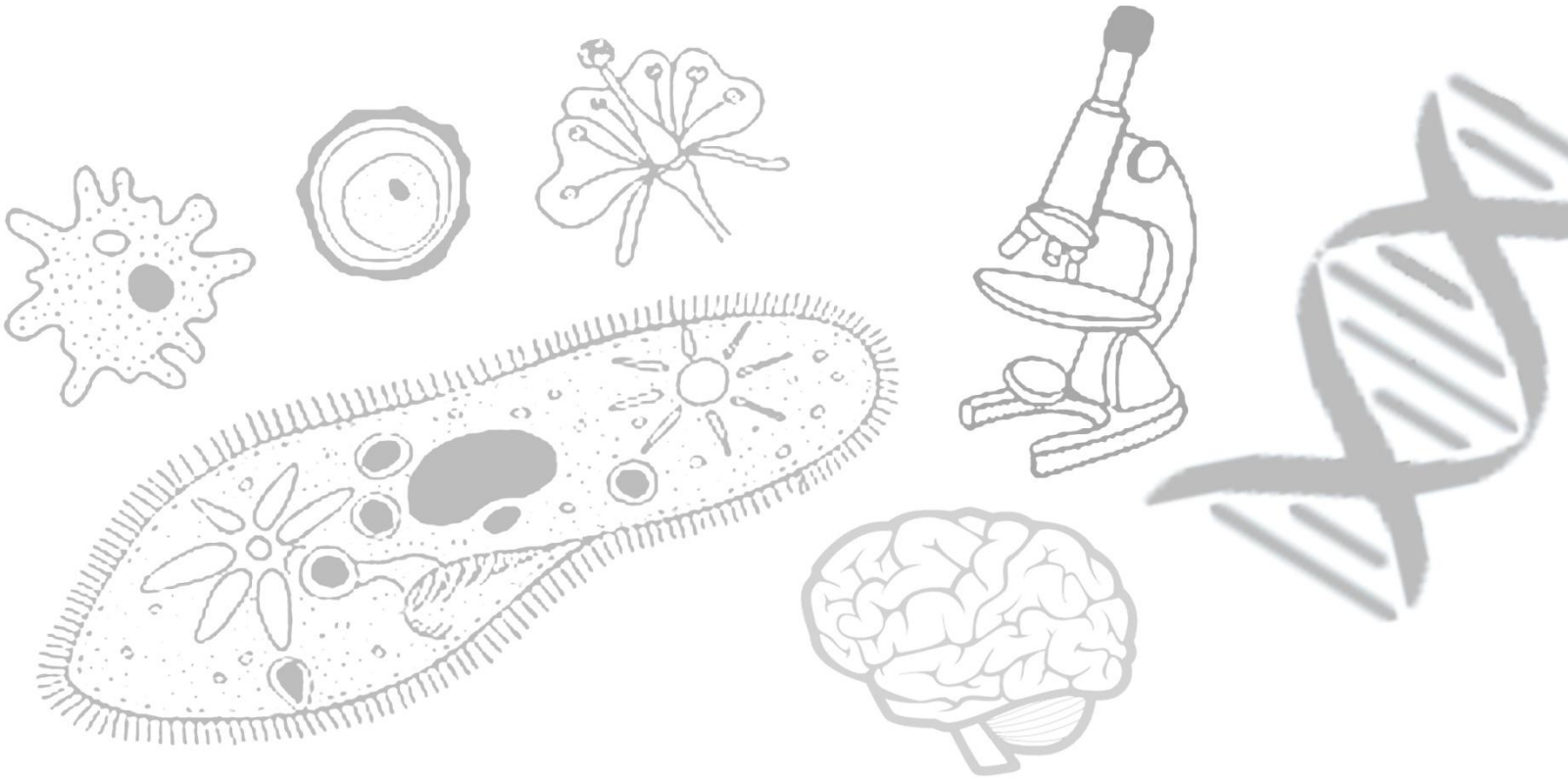
Chapter Notes

BIOLOGY



Diseases in Humans and Immunity

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Diseases in Humans

- Health is defined as a state of complete physical, mental and social well-being. When people are healthy, they are more efficient at work.
- The health of an individual relies on many factors. It is affected by

Genetic disorders (defects which a child inherits from parents since birth)

Infections

Lifestyles, habits, rest and exercise

- Good health of an individual is the collective effort of the individual, the community, the society in which he lives and his physical environment. Health is a biological and a social phenomenon.
- A healthy body is the first step towards a happy life. A basic understanding of how to improve our health and how to prevent and eradicate different diseases are some of the steps which can be taken towards attaining better health.

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Diseases and their Causes

- A condition of the body in which vital functions are disturbed physiologically or psychologically is called a disease.
- Disease is the departure from normal health through a structural or functional disorder of the body.

Sources of Diseases

Intrinsic/internal factors

- Disease-causing factors which exist within the human body
- Malfunctioning of any body part or an organ. Example: Cardiac failure
- Genetic disorders. Example: Haemophilia
- Hormonal imbalance. Example: Dwarfism
- Malfunctioning of the immune system of the body. Example: Allergy

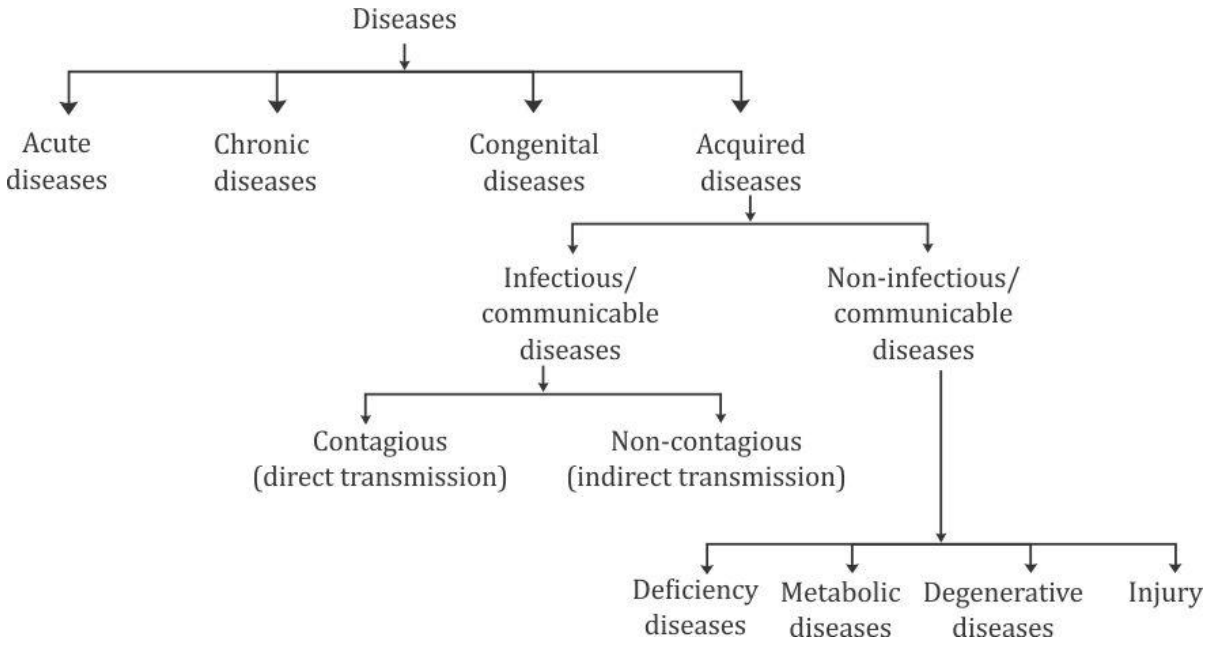
Extrinsic/external factors

- Disease-causing factors which enter the human body from outside and cause a disease
- Unbalanced or inadequate diet. Example: Kwashiorkor
- Disease-causing microorganisms. Example: Malaria
- Environmental pollutants. Example: Lung cancer
- Tobacco, alcohol, narcotic drugs. Example: Liver cirrhosis

Levels of immediate causes

- First-level cause: Causative agent: Bacteria, virus
- Second-level cause: Secondary cause: Lack of good nourishment
- Third-level cause: Tertiary cause: Poverty

Types of Diseases



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- Acute diseases: Diseases in which the symptoms are quickly visible in the body and last for a shorter duration are called acute diseases. Examples: Common cold, malaria
- Chronic diseases: Diseases which are long-term, with their symptoms lasting for months or years are called chronic diseases. Examples: Elephantiasis, tuberculosis
- Congenital diseases: Diseases which are caused by a single gene mutation, chromosomal aberrations and environmental factors are called congenital diseases. Examples: Alkaptonuria, Haemophilia, Turner's Syndrome
- Acquired diseases: Diseases which develop after birth are called acquired diseases. They are broadly classified into two types:

  Communicable or infectious diseases: Diseases caused by infectious agents or pathogens are called communicable or infectious diseases. Examples: Tuberculosis, chickenpox, measles

  Non-communicable or non-infectious diseases: Diseases which do not spread from one person to another are called non-communicable or non-infectious diseases. Examples: Beriberi, scurvy, arthritis


Elephantiatis


Chickenpox

Infectious Diseases

Infectious Agents

- There is a vast diversity of pathogens found on the Earth. Some of them are unicellular like bacteria and protozoa, whereas some are multicellular like worms. All pathogens cause diseases.
- Diseases caused by viruses include chikungunya, poliomyelitis, common cold, chickenpox, rabies, influenza, measles, yellow fever, AIDS, small pox and cowpox. These diseases are called viral diseases.
- Bacteria cause typhoid, cholera, leprosy, tetanus, plague, whooping cough and tuberculosis. These are bacterial diseases.
- Fungi cause several types of skin infections, dandruff and ringworm.

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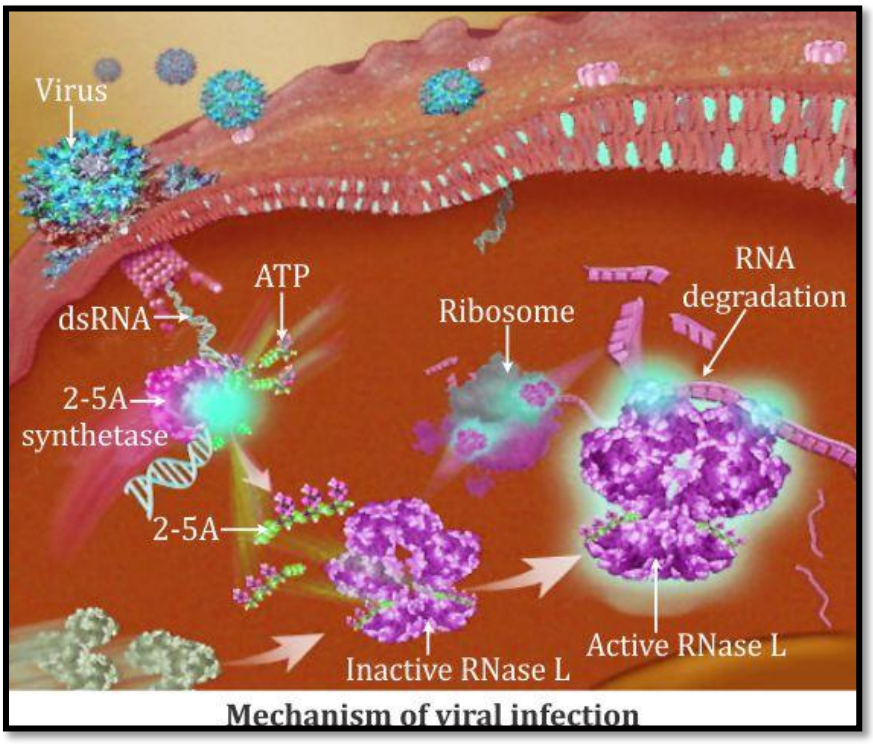
- Protozoa are common disease-causing agents. Malaria, amoebic dysentery and Kala-azar are some of the diseases caused by protozoa.
- Metazoans tend to cause a variety of intestinal infections. They are also responsible for causing diseases such as elephantiasis and ascariasis.



Mechanism of viral infection

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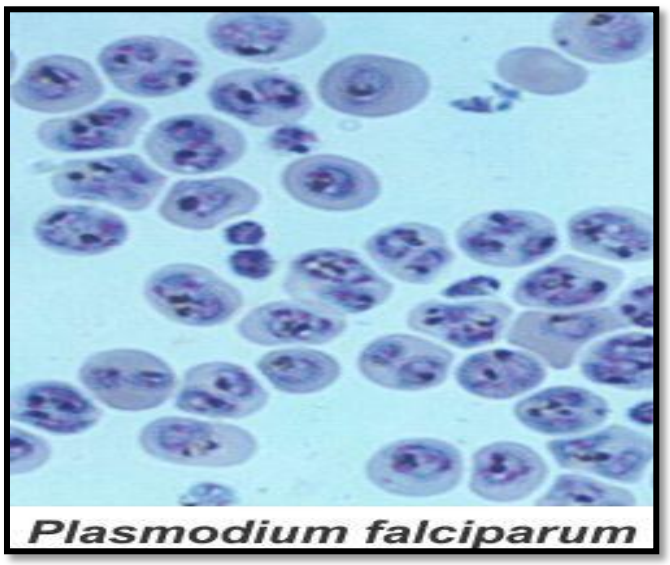
Diseases Caused by Microorganisms

Diseases Caused by Protozoa

INCUBATION PERIOD	MODE OF TRANSMISSION	SYMPTOMS	PREVENTIVE MEASURES
Malaria (*Plasmodium falciparum*) 			
About 3 weeks	Female *Anopheles* mosquito acts as a carrier.	1. Cold stage characterised by sudden onset of fever with rigour and sensation of chilling cold. 2. During the hot stage, body temperature may rise to 41°C or 106°F with severe headache, nausea, vomiting, fatigue and body pain. 3. The sweating stage is characterised by profuse sweating and lower body temperature. 4. In children, the blockage of capillaries supplying blood to the brain results in haemorrhage. 5. Enlargement of the spleen.	1. Population of mosquitoes should be reduced or eliminated. 2. Mosquito bites should be prevented by using mosquito nets, applying mosquito repellents to the body. 3. Water boiled with leaves and inflorescence of neem should be used for drinking.

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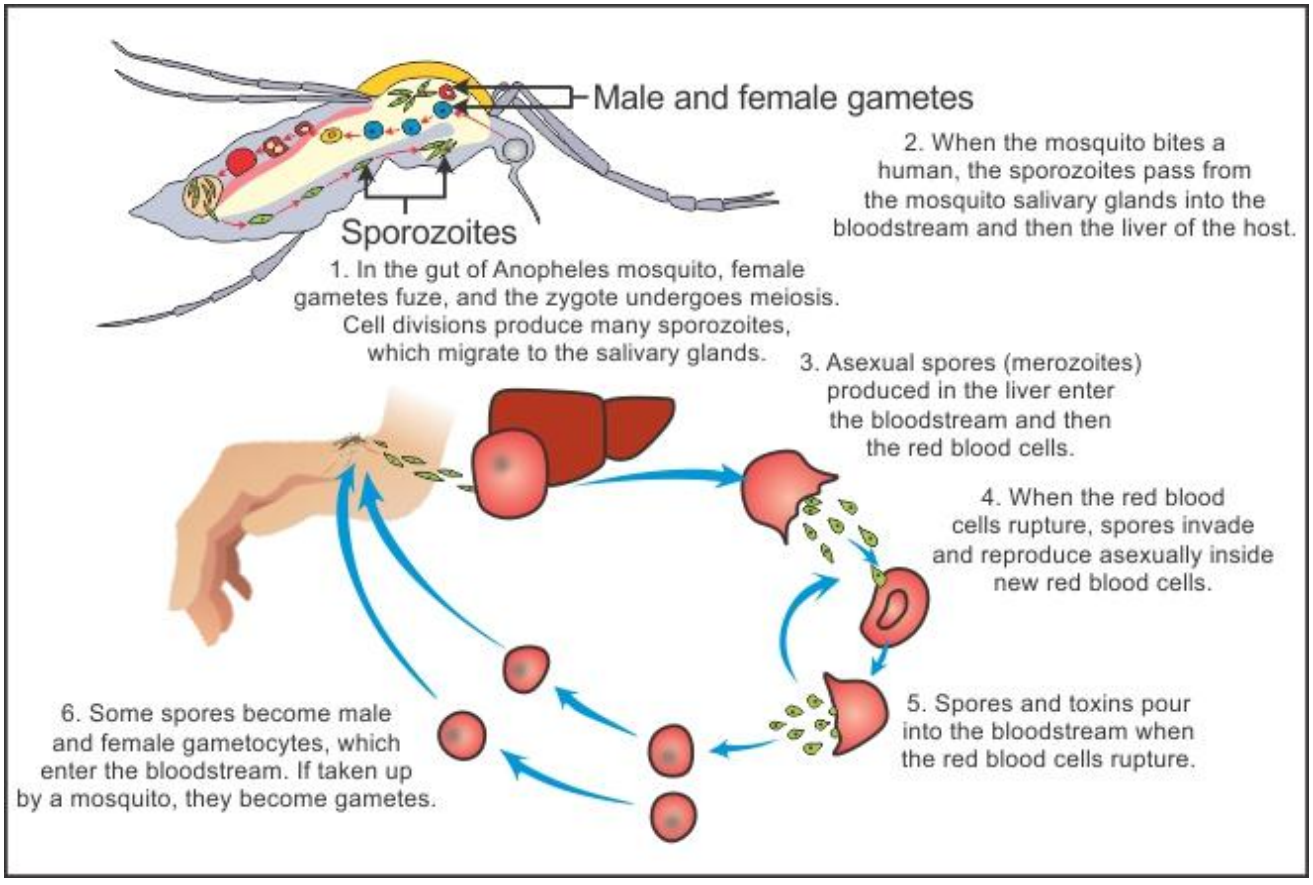
Life Cycle of Malarial Parasite (*Plasmodium*)

- The Plasmodium undergoes asexual reproduction when the parasites burst the liver cells by multiplying itself and are released into the blood.
- Plasmodium bursts the RBCs by entering the RBCs, multiplying by the means of asexual reproduction.
- Along with the bursting of RBCs, a toxic element called haemozoin is released which causes chills in the body of the human being.
- Gametocytes multiply forming from the sporozoites that multiply sexually.
- Gametocytes are introduced into the mosquito when the female *Anopheles* mosquito bites the diseased person.
- Gametocytes again form sporozoites by fertilising inside the intestine of the mosquito.
- These sporozoites are stored in the salivary glands of mosquito and are released when the healthy person is bitten by this mosquito.



The term 'malaria' was proposed by Macculloch (1827). C. L. A. Laveran (1880), a French physician, discovered the malarial parasite *Plasmodium* in the blood of a malaria patient. He received the Nobel Prize for this discovery in 1907. Sir Ronald Ross (1897), a British physician, confirmed that malaria is caused by the malarial parasite and that mosquito is the vector. He received the Nobel Prize for this discovery in 1902.

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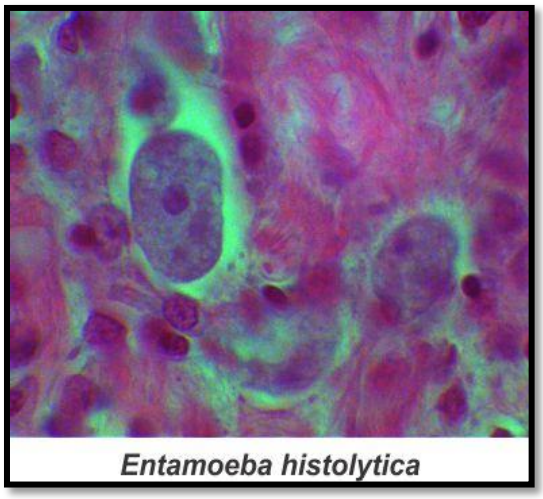
Amoebic dysentery or Amoebiasis (*Entamoeba histolytica*)



Entamoeba histolytica

About 1 week	Through food and water contaminated by flies or through faeces of an infected person.	1. Diarrhoea or watery motions containing mucus or blood and pain in the abdomen. 2. The intestinal lining is destructed completely. 3. Constipation alternating with diarrhoea. 4. Stomach convulsions.	1. Food should be kept covered properly to avoid contamination by flies and dust carrying cysts. 2. Avoid eating spicy and fried food. 3. Population of flies should be controlled or eliminated. 4. Clean, boiled and cooled water should be used for drinking. 5. Raw vegetables and fruits bought from the market should be cleaned and washed properly before storing and eating.

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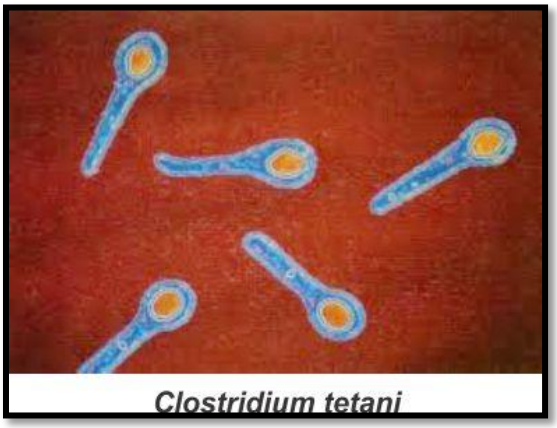
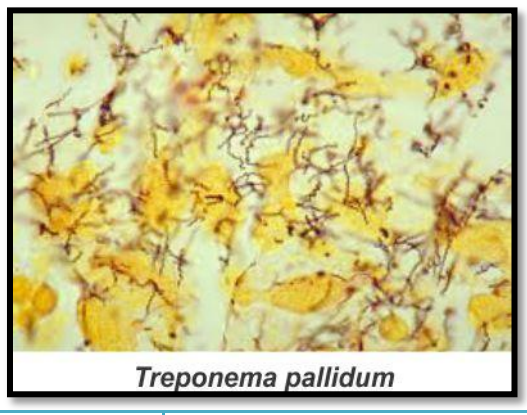
Diseases Caused by Bacteria

INCUBATION PERIOD	MODE OF TRANSMISSION	SYMPTOMS	PREVENTIVE MEASURES
Tetanus (*Clostridium tetani*)  *Clostridium tetani*			
4–20 days	Through cuts or wounds on the skin and enters through blood into the spinal cord.	1. Person initially gets fever and headache. 2. Painful contractions or spasms of muscles of neck and jaw. 3. Body becomes rigid and may even bend like a bow. 4. Paralysis and even death may occur in extreme cases.	1. Wounds and cuts should be cleaned immediately. 2. Rusted or dirty pins and needles should not be used. 3. Playing in soil, manure heaps or cattle dung should be avoided. 4. Anti-tetanus vaccine should be given.
Syphilis (*Treponema pallidum*)  *Treponema pallidum*			
1–12 weeks	Sexually transmitted	1. Skin rash, ulcers on penis	1. Avoid sexual contact

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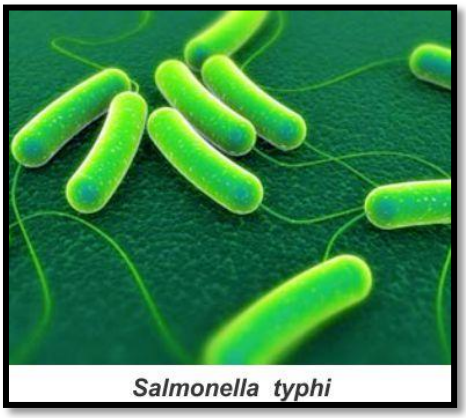
INCUBATION PERIOD	MODE OF TRANSMISSION	SYMPTOMS	PREVENTIVE MEASURES
	or close contact.	or on rectum, lips, tongue and nipples. 2. Fever 3. Pus-like discharge in the genital tubes. 4. Death in extreme cases.	with an infected person. 2. Treatment of antibiotics, especially that of penicillin.
Typhoid (*Salmonella typhi*)  *Salmonella typhi*			
7–21 days	Contaminated water or milk, or through flies.	1. Tender abdomen, abdominal pain, coated tongue, fatigue in legs, body ache and dull headache. 2. Fever is usually as high as 104°F, especially in the afternoon accompanied by cold. 3. Diarrhoea, nausea, vomiting, loss of appetite and constipation. 4. Enlargement of the spleen. 5. Rose-coloured rashes or eruptions appear on the chest and abdomen. 6. Body weight is reduced significantly because of weakness. 7. Spasmodic convulsions.	1. Control of insects such as houseflies and mosquitoes by destroying their breeding grounds. 2. Treatment with antibiotics (e.g. chloromycetin). 3. Personal hygiene, cleanliness of the surroundings and consumption of well-cooked, nutritious food. 4. Continuous intake of liquid food such as juices. 5. Typhoid vaccine should be given.

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Diseases Caused by Parasitic Worms

INCUBATION PERIOD	MODE OF TRANSMISSION	SYMPTOMS	PREVENTIVE MEASURES
Ascariasis (*Ascaris lumbricoides*) 			
About 4–8 weeks	Through soil, food and water contaminated with eggs of female worm. Flies act as carriers.	1. Bleeding in liver, heart and lungs. 2. Sudden contraction of muscles, fever and anaemia. 3. Irritation of the intestine, colic pains, fever, gastric ulcers, dizziness, vomiting, abdominal discomforts such as indigestion, bloated abdomen and vitamin A deficiency. 4. Malnourishment of children.	1. Human faeces should be properly disposed. 2. Maintenance of personal hygiene. 3. Hands should be washed properly before eating, cooking and after visiting the toilet. 4. Nails should be cut regularly. 5. Fruits and vegetables growing on soil contaminated with human faeces should be thoroughly washed and adequately cooked before eating. 6. Food should always be kept covered with fly-proof nets to prevent contamination by flies. 7. Boiled–cooled, fresh water should be used for drinking.
Taeniasis (*Taenia solium*)			

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About 8–14 weeks	Consumption of infected pork and beef.	Extreme weakness	1. Avoid raw meat. Cook meat at a temperature more than 140°F for about 5 min. 2. Freeze meat to temperature of −4°F for 24 hours. 3. Maintenance of personal hygiene. 4. Wash hands before eating, cooking and after visiting the toilet.

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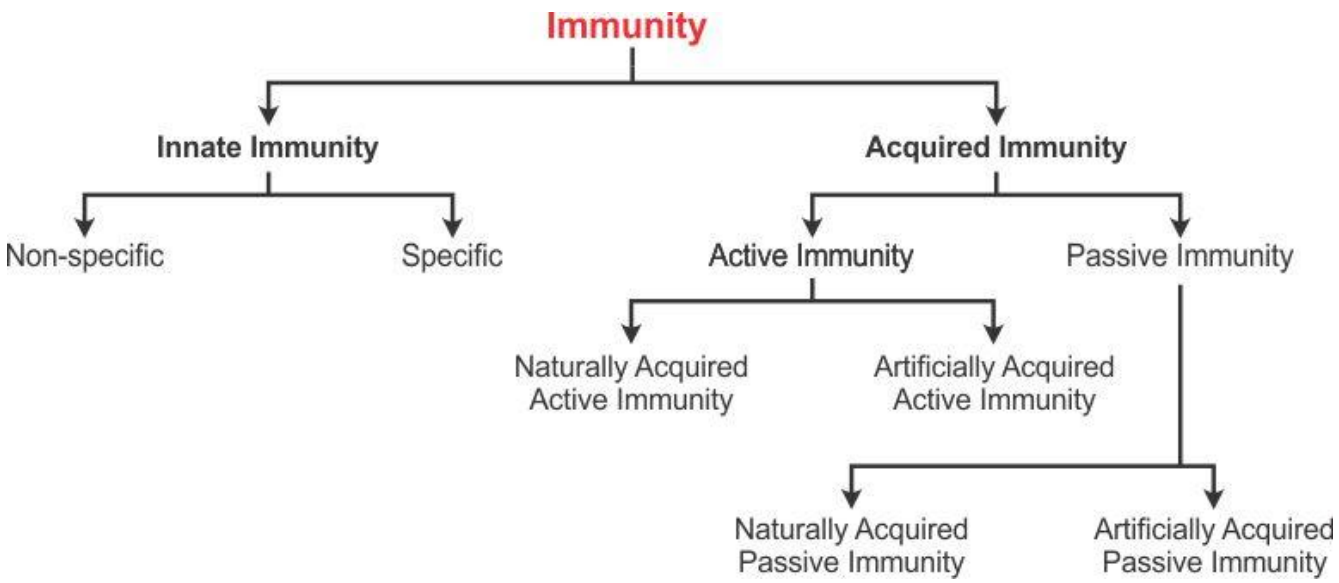
Immunity

- Immunity is the body's defence against disease.
- It can be defined as the ability of an organism to resist the attack of antigens or pathogens.
- It can also be defined as the resistance to the onset of a disease after an infection by harmful germs.
- Various harmful substances, such as pollutants and pathogens, may enter our body through four ways—the skin, mucous membranes of the eyes, nose and urinary or genital tracts, food or water intake and air we breathe.
- The defence system of our body works at two levels:

A. **Local Defence System**: This system prevents the entry of germs.
• Protective mechanical barriers
• Thrown out if entered
• Germ-killing secretions
• Germ-fighting white blood cells (WBCs)
B. **Immune System**: This system deals with the germs after they have entered the body tissues.

Immune System

Immunity can be classified into two main categories:



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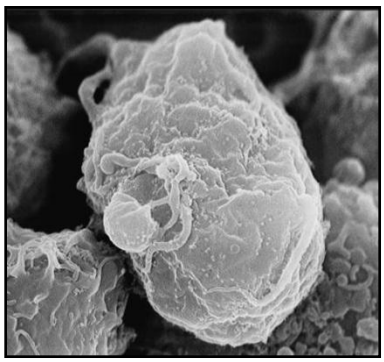
<table>
<tr><td colspan="2">1. INNATE IMMUNITY (natural/inherited/native immunity):
It is inherited from the parents.</td></tr>
<tr><td>I. Non-specific Innate Immunity</td><td>• General natural resistance to all infections.
• Four types of barriers provide innate immunity—physical barriers, physiological barriers, cellular barriers and cytokine barriers.
• Skin and mucus coating form body's main physical barriers against pathogens. They do not allow entry of pathogens and foreign agents inside the body.
• Acidity of gastric secretion, lysozyme present in the saliva forms the physiological barriers which prevent microbial growth.
• The cellular barriers provide internal defence such as two types of phagocytic leucocytes—polymorphonuclear leucocytes (PMNL) and monocytes destroy microbes.
• Cytokine barriers work against viral infections. Cells infected by a virus produce an antiviral protein called interferon which protects non-infected cells from further viral infection.
• For example, plant diseases from which humans do not suffer.</td></tr>
<tr><td>II. Specific Innate Immunity</td><td>• Natural resistance to a particular kind of germ.
• For example, human beings are immune to a highly infectious disease of dogs known as distemper.</td></tr>
<tr><td colspan="2">2. ACQUIRED IMMUNITY:
Resistance to a disease is acquired during the lifetime of an organism.</td></tr>
<tr><td>I. Actively Acquired Immunity</td><td>• Resistance is developed because of a previous infection.
• Lymphocytes produce antibodies which freely circulate in the blood and lymph. These antibodies bind to the harmful organisms and kill them.
• Lymphocytes produce killer cells which carry specific receptors for foreign antigens found on invading germs.
 
Killer Cell
• This immunity is long-lasting, and it is carried out by</td></tr>
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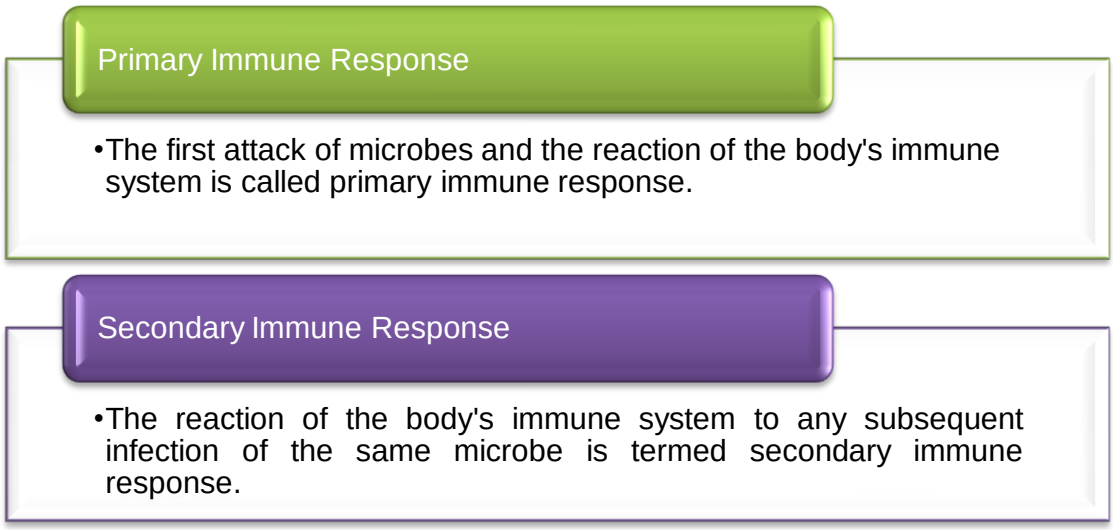
	memory lymphocytes.
II. Passively Acquired Immunity	• Immunity is provided from an outside source in the form of antibodies.
a) Naturally Acquired Passive Immunity	• Mother's antibodies reach the foetus through the placenta. • Here, the mother is the outside source of antibodies.
b) Artificially Acquired Passive Immunity	• Antibodies are produced in horse or other animals by injecting germs into that animal. • Serum of such animals containing antibodies against the injected germ is collected. This serum is called **antiserum injection**. • For example, antivenin given for snake bites. • Haffkine Institute, Mumbai, prepares such antisera.

Immune Response

- It is produced by acquired immunity which develops because of the presence of a pathogen or its antigen.
- There are two types of immune responses:



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Cells of the Immune System

- The major groups of cells involved in acquired immunity are the lymphocytes. Two major types of lymphocytes are the B-lymphocytes and T-lymphocytes.

B- lymphocytes

- These are short-lived cells of the immune system.
- They are named B- lymphocytes because they were first studied in the lymphatic organ of birds called Bursa of Fabricius.
- They produce an army of proteins called antibodies.

T- lymphocytes

- These cells have a long lifespan.
- T-cells are thymus-derived, i.e they mature inside the thymus.
- During maturation, T-cells acquire the ability to respond to specific antigens.

Humoral Immune Response: Antigens and Antibodies

- The humoral immune response denotes immunologic responses which are mediated by antibodies. However, both B and T lymphocytes as well as dendritic cells and other antigen presenting cells are necessary for the formation of antigen-specific antibodies.
- Humoral immunity includes the primary and secondary immune responses to antigen. During the primary immune response, an antigen is encountered by the host for the first time. The secondary antibody response results from the activation of a memory B cell, is faster and more effective in halting the progress of infection because of increased antibody-binding affinities.

Antibodies

- Specialised cells of the immune system which can recognise organisms which invade the body (such as bacteria, viruses and fungi) are called antibodies.
- Basically, they are serum glycoproteins called immunoglobulins.
- Each antibody molecule is Y-shaped and is formed of four peptide chains—two small called light chains and two longer called heavy chains. Light and heavy chains are bound together by disulphide bonds (S–S).
- The stem of 'Y' is formed by heavy chains, whereas in the arms, both light and heavy chains occur parallel to each other.
- An antibody has a variable portion in the arms. It is called the V-region or antigen-binding filament (Fab). The remaining part of the antibody is called the constant portion or crystalline fragment.

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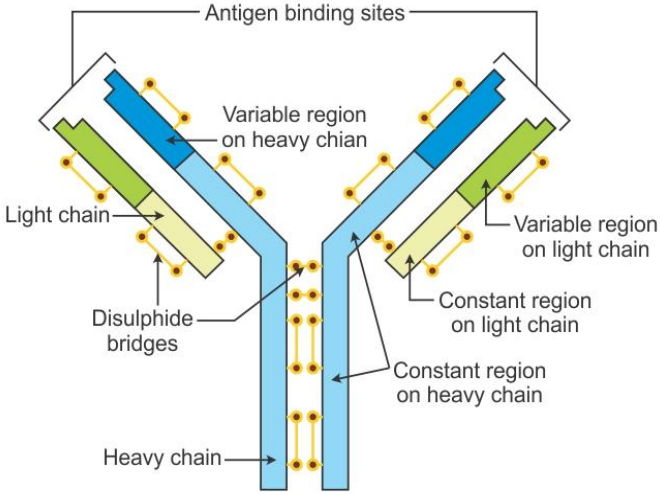

Structure of an antibody

Types of Antibodies

IgG

- 75-80% of normal human antibodies is IgG.
- It provides long-term resistance to a disease.
- Booster injection of vaccine raises the level of IgG antibody.
- IgG of maternal antibodies crosses the placenta and provides passive immunity to the foetus and child up to the age of 6 months.

IgD

- Only 1% IgD occurs in serum.
- It is effective against toxins and allergens. It activates B-lymphocytes to secrete other immunoglobulins.

IgE

- It forms only 0.002% of the total antibodies.
- It is mainly concentrated in mucous membranes, skin and lungs.

IgM

- It forms about 7% of antibodies.
- When B-lymphocytes are stimulated, this antibody appears first and produces primary antibody response.

IgA

- It accounts for about 10-13% of the total serum antibodies.
- It is present in all the body secretions such as tears, saliva, urine and colostrum.
- IgA provides the first line of defence against inhaled and ingested pathogens and fights against invading microorganisms.

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Vaccination and Immunisation

- The process of introducing a vaccine in the body to develop immunity against a particular disease is called vaccination.
- Developing resistance to disease-producing germs or their toxins by introducing killed germs or germ substances to induce the production of specific antibodies is called immunisation.
- When a vaccinated person is infected by a pathogen, the existing memory T-cells or B-cells recognise the antigen and induce a massive formation of T-cells, B-cells and antibodies for eliminating the invader.
- Vaccination which induces the generation of antibodies by the body's immune system is called active immunisation.
- Immunity acquired by the transfer of antibodies from another individual, as through injection or placental transfer to a foetus, is called passive immunisation.

Recombinant DNA technology has allowed the production of antigenic polypeptides of pathogens in bacteria or yeast. Vaccines produced by recombinant DNA technology have allowed large-scale production and greater availability for immunisation. Example: Hepatitis B vaccine produced from yeast

Disorders of the Immune System

1. Allergies

- Allergy is an inappropriate reaction or response of a person because of hyper-sensitivity to a substance which comes in contact with the body or enters the body from the environment.
- The substances to which a person develops allergic reactions are called allergens (includes dusts, mites, spores).
- The common allergic reactions are frequent sneezing, itching, skin rashes, inflammation of mucous membrane and watering of eyes.
- The antibodies produced for these allergens are of IgE type.
- Some forms of allergy are hay fever, allergic asthma and anaphylaxis.
- Drugs such as antihistamine, steroids or adrenaline reduce the symptoms of allergy.

2. Autoimmunity

- When an abnormality develops in the immune system 'itself', it is said to be an autoimmune disease. This means that instead of destroying foreign molecules, it starts attacking the body's own cells leading to serious consequences.
- Autoimmune diseases depend on the type of self-antigen involved.
- Some autoimmune diseases are chronic anaemia, myasthenia gravis, chronic hepatitis, Hashimoto's disease and rheumatoid arthritis.

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Immune System in the body

- The human immune system consists of lymphoid organs, tissue cells and antibodies.
- It plays a key role in allergic reactions, autoimmune diseases and organ transplantation.

Lymphoid Organs

- Lymphoid organs are the organs where origin, maturation and proliferation of lymphocytes take place.
- Two types of lymphoid organs are the primary lymphoid organs and the secondary lymphoid organs.

PRIMARY LYMPHOID ORGANS

- Bone marrow and thymus are the primary lymphoid organs.
- Bone marrow is the main lymphoid organ where all blood cells including lymphocytes are produced.
- Maturation of B-lymphocytes occurs.
- Thymus is the site for the development and maturation of T-lymphocytes which is situated near the heart beneath the breastbone.

SECONDARY LYMPHOID ORGANS

- Spleen, lymph nodes, tonsils, Peyer's patches of small intestine and appendix are the secondary lymphoid organs.
- Spleen contains lymphocytes and phagocytes and acts as a filter of the blood as it traps the blood-borne microorganisms.
- Lymph nodes trap the antigens that enter the lymph and tissue fluid which activates the lymphocytes causing immune response and enlargement of lymph glands.
- Tonsils also act as filters to protect the body from bacteria and assist in the formation of WBC.
- Another secondary lymphoid organ is the mucosal-associated lymphoid tissues (MALT) which are located within the lining of digestive, respiratory and urinogenital tracts and constitute 50% of the lymphoid tissue.

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