# ABDUR REHMAN BIOLOGY

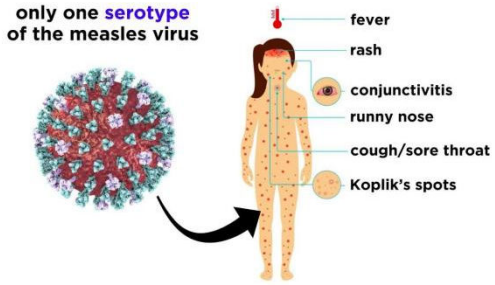
# 12 Disease and immunity

## 12.1 Disease.

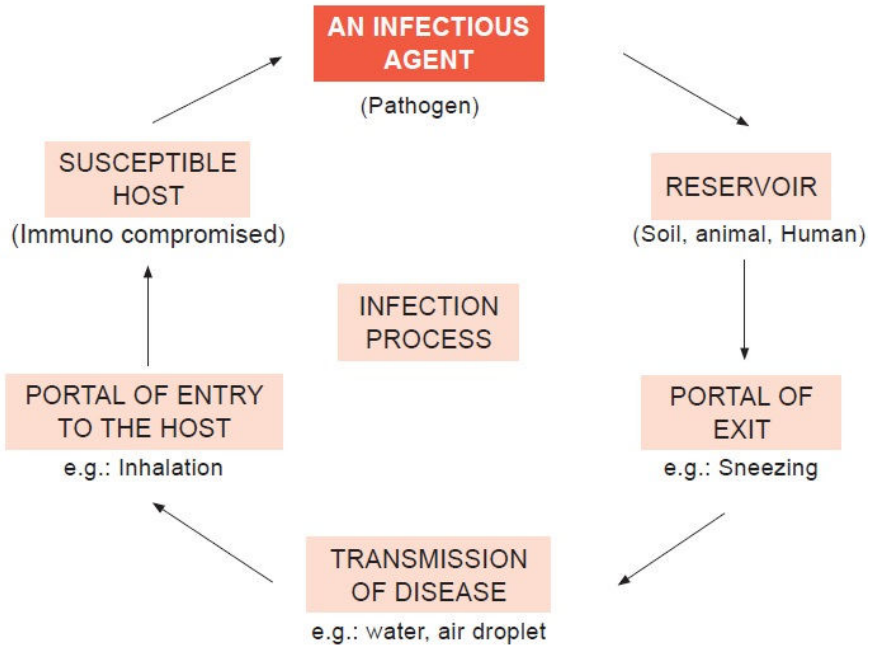
## Describe a pathogen as a disease-causing organism.

## Describe a transmissible disease as a disease in which the pathogen can be passed from one host to another.

A pathogen is a microorganism, such as a virus, bacterium, fungus, or parasite, that can cause diseases in its host (plants, animals, or humans). Pathogens have the ability to invade and multiply within the host, leading to infections. They often trigger an immune response as the host's defense mechanism attempts to neutralize or eliminate the invading pathogen. Examples of pathogens include influenza viruses, bacteria like Escherichia coli, fungi causing athlete's foot, and parasites like Plasmodium, which causes malaria.




A transmissible disease, also termed communicable or infectious, is an ailment caused by infectious agents like bacteria, viruses, fungi, or parasites. These diseases can spread from one person to another through various means, including direct contact, respiratory droplets, contaminated food or water, insect vectors, or contact with contaminated surfaces. Examples include the flu, tuberculosis, COVID-19, and common colds.

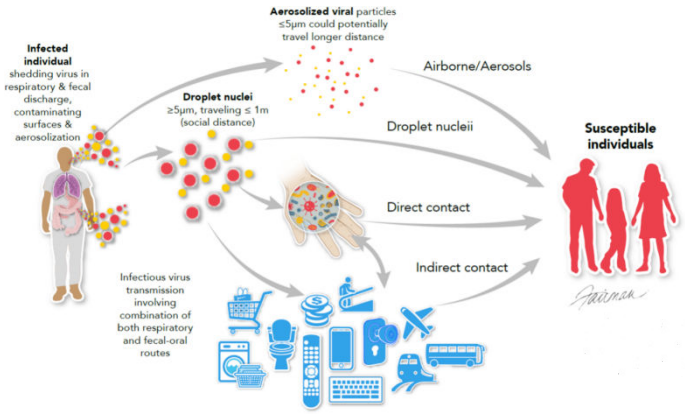


**Understand that a pathogen may be transmitted:**
**(a) through direct contact, including through blood or other body fluids (b) indirectly, including from contaminated surfaces or food, from animals, or from the air.**
**Describe the human body's barriers to the entry of pathogens, limited to: skin, hairs in the nose, mucus, stomach acid.**

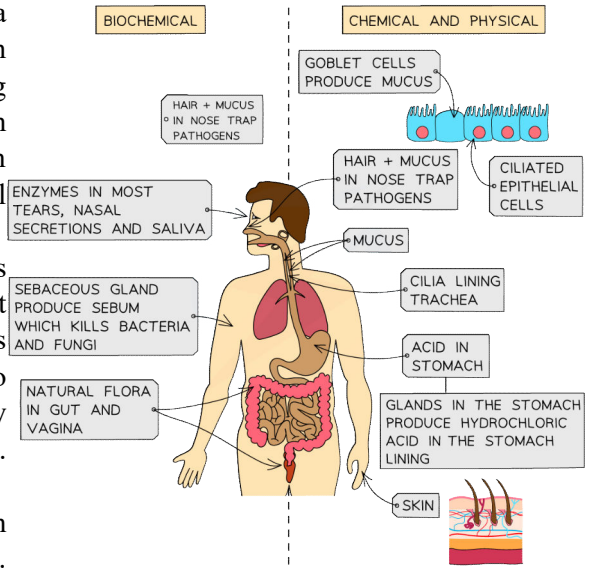
A pathogen can be transmitted:

(a) Through direct contact, involving blood or other body fluids.

(b) Indirectly, encompassing transmission from contaminated surfaces or food, through animals, or via airborne means.




- The skin, our body's largest organ, acts as an initial physical defense, forming a robust barrier against pathogens. Composed of multiple layers of cells, it serves as a protective shield, preventing direct entry. It is an example of physical barrier.
- Within the nasal passages, fine hairs play a crucial role. These hairs act as a filtration system, trapping and immobilizing airborne pathogens, preventing them from reaching deeper into the respiratory system It also come under the example of physical barrier.
- Mucus, a sticky fluid produced by mucous glands, further fortifies our defenses. It serves a dual purpose, trapping pathogens and facilitating their removal, while also ensuring that mucous membranes stay moist and protected from potential irritants. It is an example of chemical barrier.




- Moving to the digestive system, stomach acid becomes a formidable defender. Hydrochloric acid, secreted by gastric glands in the stomach, creates an acidic environment that not only aids in digestion but also serves as a hostile territory for ingested pathogens. This acidity is a vital component of the body's strategy to destroy or inhibit the growth of potential threats. It also comes under the example of chemical barrier.

## Understand the role of the mosquito as a vector of disease.

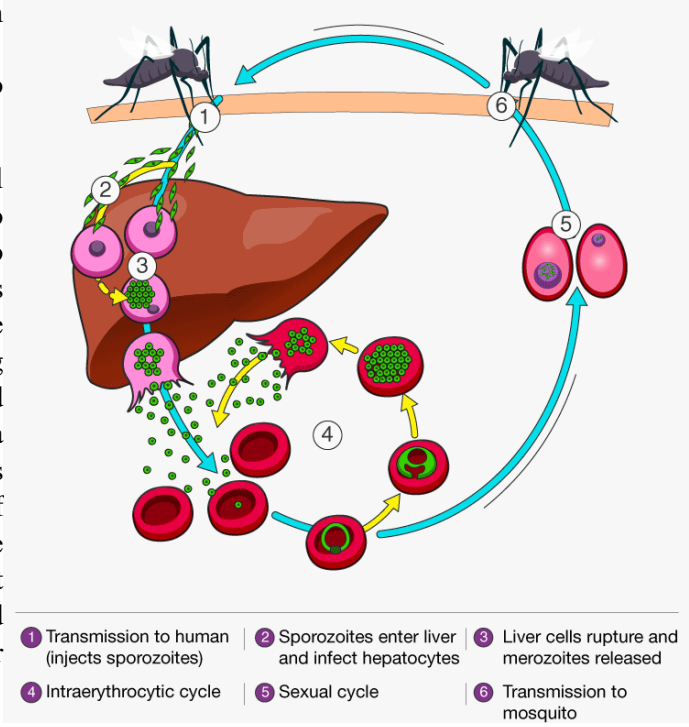
## Describe the malarial pathogen as an example of a parasite and explain how it is transmitted.

## Describe the control of the mosquito that transmits malaria with reference to its life cycle.

Male mosquitos feed on plant juices whereas female mosquitos, during breeding season feed on animal blood which is rich in proteins needed for egg laying. Female Anophelese mosquito bites a malarial patient and sucks blood. When the same mosquito bites a healthy person, she injects saliva which contain malarial parasites. They multiply in liver cells and red blood cells and produce signs and symptoms of malaria. So female anopheles mosquito acts as a vector of the malarial parasite.

**Method of Transmission of malaria.**

- Female Anopheles mosquito sucks the blood of a malaria infected person.
- Plasmodium taken up.
- Enters stomach and multiply in stomach.
- Migrate to salivary glands.
- When this mosquito sucks blood of another person.
- Injects Saliva as it contains an anticoagulant.
- Plasmodium transferred to uninfected person.



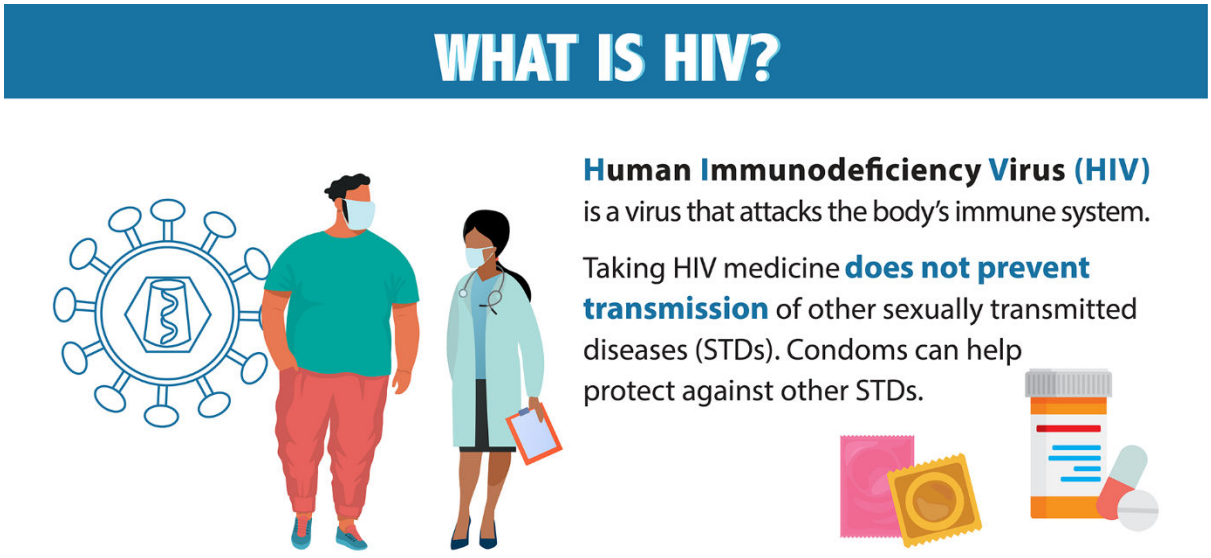

Infected mosquitoes transmit malarial oathogen during a blood meal. It travels to the liver, and multiply. After a week or two the daughter cells break out of the liver cells and are released into the bloodstream,where they invade red blood cells, causing symptoms. Here they reproduce repidly and wil develop into gametocytes. When a mosquito bites an infected person, it ingests gametocytes. These enter the gut of mosquito and after maturation move to the mosquito's salivary glands, ready to infect another human during a subsequent blood meal. Interruption of this cycle is crucial for malaria control.

**Control measures.**

- Eliminate standing water to prevent breeding.
- Use larvicides to target larvae and pupae.
- Employ insecticide-treated bed nets.
- Apply indoor residual spraying with insecticides.
- Manage the environment to reduce mosquito habitats.
- Engage communities in awareness and prevention efforts.
- Vaccines are still not much successful in preventing malaria but still trials are being done.

## Explain that human immunodeficiency virus (HIV) is a viral pathogen.

HIV, or Human Immunodeficiency Virus, is a pathogenic virus that attacks the human immune system. It is a type of retro virus which affects lymphocytes weakening the body's ability to defend against infections. Transmission occurs through specific body fluids. Left untreated, HIV can progress to AIDS, a severe immune system impairment.



## Describe how HIV is transmitted.

## Describe the methods by which HIV may be controlled.

The following are the three ways of transmission of HIV.


- Through blood or blood products.
- Through reproductive fluids.
- From mother to baby through placenta or breast feeding.
- Through the use of non sterile tools.

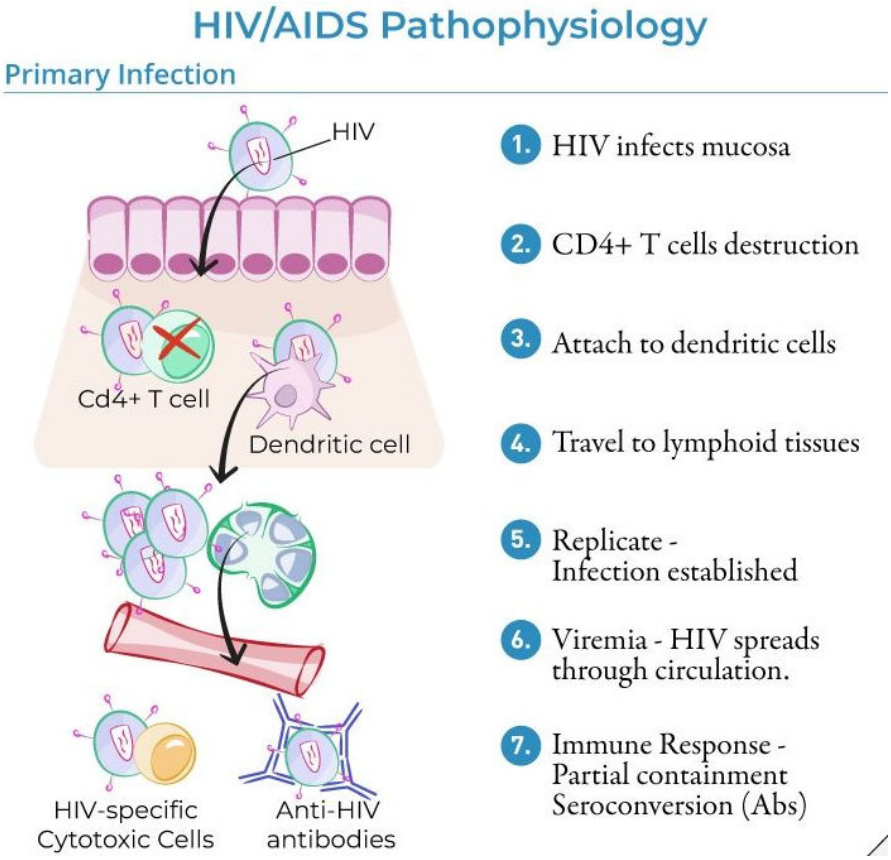
There are several ways to safeguard yourself from HIV, including

- Consistently using a contraceptive/condom whenever engaging in sexual intercourse.
- Refraining from sharing needles, syringes, or any injecting equipment if you use drugs.
- Opting for HIV treatment if you are a new or expectant mother living with HIV, as this significantly diminishes the risk of transmitting HIV to your baby during pregnancy, childbirth, and breastfeeding.
- Inquiring with your health-care provider about the HIV testing status of blood products you receive (blood transfusion, organ or tissue transplant).
- Taking precautions if you are a health-care worker, such as donning protective gear (like gloves and goggles), practicing hand hygiene after contact with blood and bodily fluids, and safely disposing of sharp equipment.

## Understand that HIV infection may lead to Acquired Immune Deficiency Syndrome (AIDS)

## Outline how HIV affects the immune system, limited to: decreased lymphocyte numbers and reduced ability to produce antibodies, which weakens the immune system.

HIV infection can advance to Acquired Immune Deficiency Syndrome (AIDS), a state marked by profound damage to the immune system.

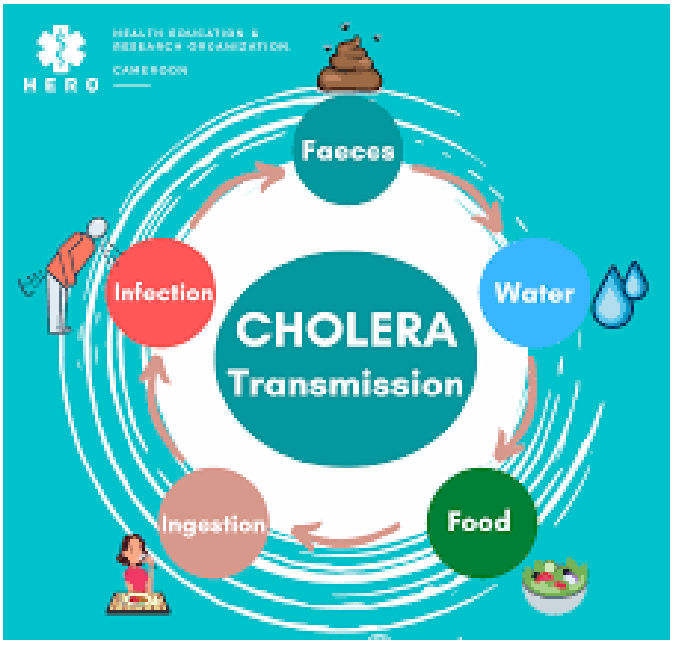



Untreated HIV weakens the body's defenses, making individuals more vulnerable to opportunistic infections and specific cancers. Progression to AIDS is often characterized by a notable decline in CD4+ T cell (lymphocytes) count and the emergence of particular illnesses.

The human immunodeficiency virus specifically attacks helper T cells. HIV causes AIDS by killing or interfering with the normal functioning of helper T cells. An uninfected person normally has between 800 and 1200 helper T cells in each $mm^3$ of blood. In a person suffering from AIDS this number can be as low as $200mrn^3$. Helper T cells are important in cell mediated immunity.
Without a sufficient number of helper T cells, the immune system cannot stimulate B cells to produce antibodies or the cytotoxic T cells that kill cells infected by pathogens. Memory cells may also become infected and destroyed. As a result, the body is unable to produce an adequate immune response and becomes susceptible to other infections and cancers. Many AIDS sufferers develop infections of the lungs, intestines, brain and eyes, as well as experiencing weight loss and diarrhea. It is these secondary, diseases that ultimately cause death.
HIV does not kill individuals directly. By infecting the immune system, HIV prevents it from functioning normally. As a result, those infected by HIV are unable to respond effectively to other pathogens. It is these infections, rather than HIV, that ultimately cause ill health and eventual death.

**Describe cholera as a disease caused by a bacterium, which is transmitted in contaminated water.**

**Explain the importance of a clean water supply, hygienic food preparation, good personal hygiene, waste disposal and sewage treatment in controlling the spread of cholera (details of the stages of sewage treatment are not required)**




Cholera is an infectious disease caused by the bacterium Vibrio cholerae. It is primarily transmitted through the ingestion of contaminated water or food. Water and food can be contaminated through the following ways.

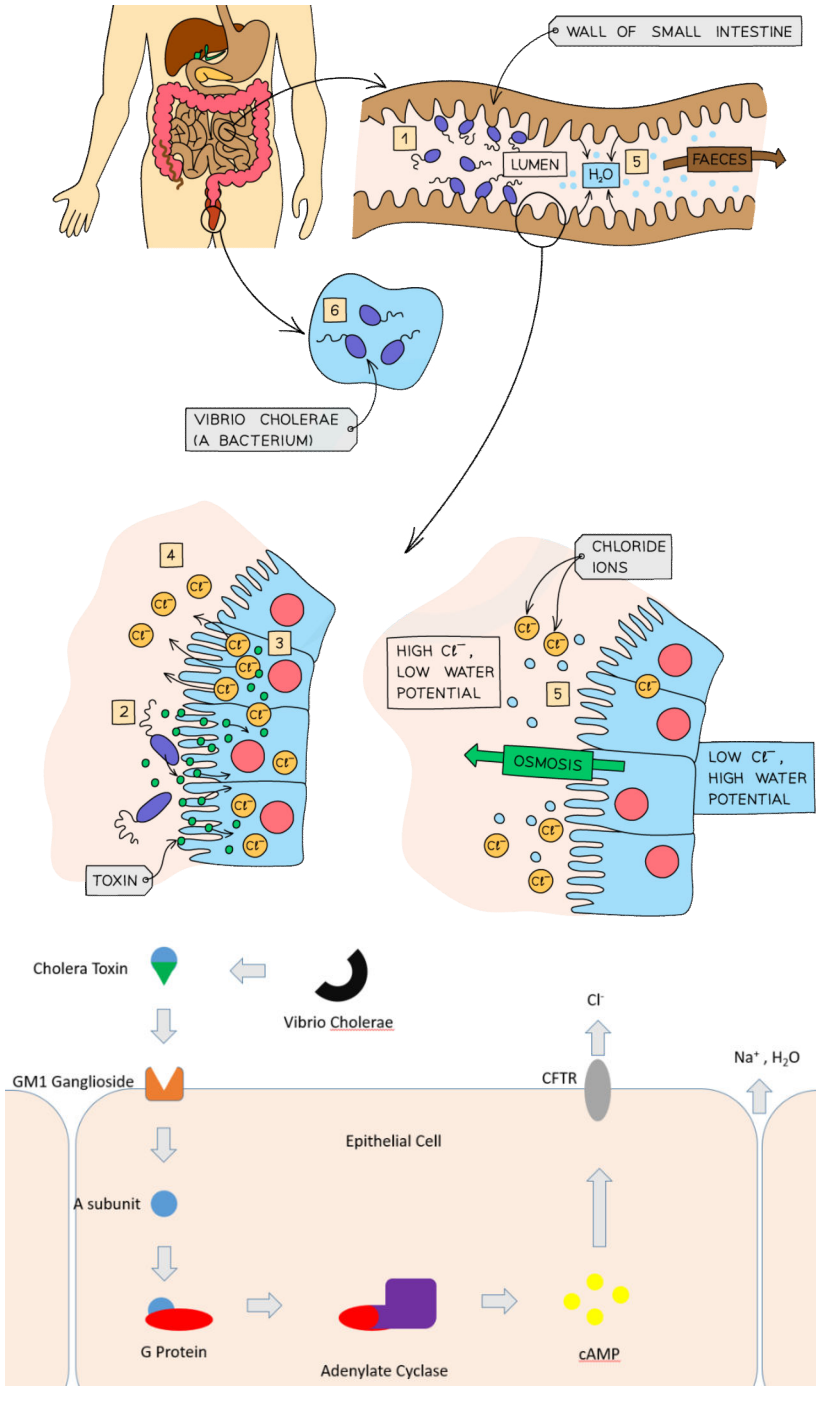
- Poor sanitation.
- House flies.
- Rodents.
- Sewerage water.
- Earth quick.

Cholera is spread from an infected person to a healthy person through contaminated water and food from stool from an infected person. To prevent the spread of the cholera the following steps can be taken.

- Clean water supply.
- Hygienic food preparation.
- Good personal hygiene.
- Waste disposal.
- Sewage treatment.

**Explain that the cholera bacterium produces a toxin that causes secretion of chloride ions into the small intestine, causing osmotic movement of water into the gut, resulting in diarrhoea, dehydration and loss of ions from the blood.**

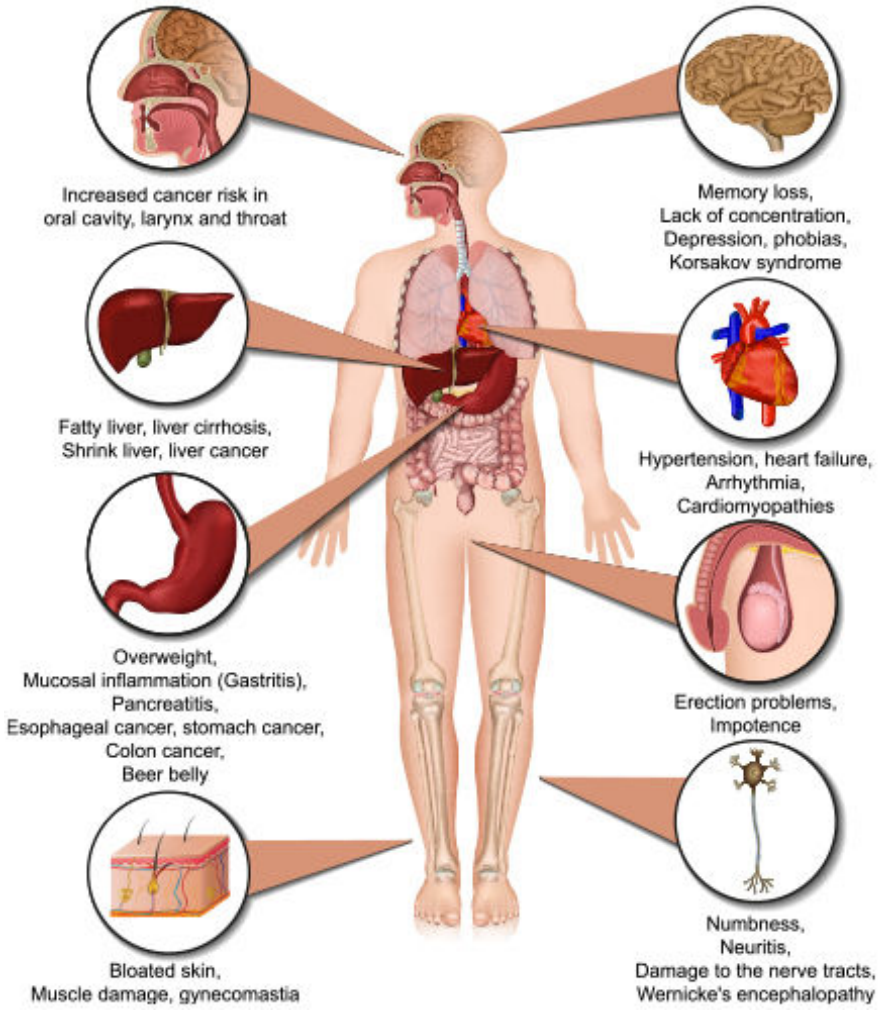
The cholera bacterium adheres to the epithelium and secretes the cholera toxin CT. CT enters the epithelial cells and activates a chloride ion channel in the cell membrane. This causes chloride ions to diffuse out of the cells into the lumen. This lowers the water potential in the lumen of the gut. So water is lost from cells to the lumen by osmosis, producing diarrhea and dehydration.



# Describe the effects of excessive consumption of alcohol: reduced self-control, depressant, effect on reaction times, damage to liver and social implications.

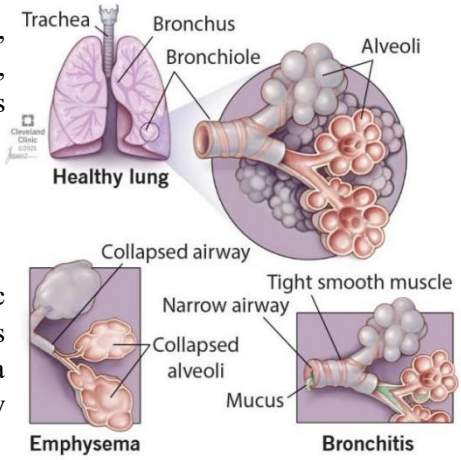
**Effects Of excessive consumption of alcohol.**

- Diminished self-control.
- Impaired cognitive function.
- Reduced behavioral awareness.
- A potent depressant.
- Diminished responsiveness, leading to delayed reactions in situations.
- Blurred vision.
- Speech becomes indistinct.
- Inadequate nutrition, lacking a balanced diet.
- Onset of kidney failure.
- Development of cardiovascular diseases.
- Susceptibility to hypothermia.
- Reduced sperm count.
- Induces severe liver damage, leading to Cirrhosis.
- Fatality due to liver failure.



# Describe the effects of tobacco smoke and its major toxic components (nicotine, tar and carbon monoxide): strong association with bronchitis, emphysema, lung cancer, heart disease, and the association between smoking during pregnancy and reduced birth weight of the baby.

Tobacco smoke, containing toxic elements like nicotine, tar, and carbon monoxide, exerts profound health impacts, establishing a robust connection with several serious conditions:

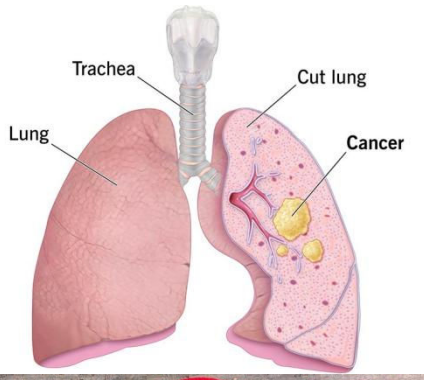



**Chronic Bronchitis and Emphysema.**

Prolonged exposure to tobacco smoke can instigate chronic bronchitis and emphysema. Chronic bronchitis involves persistent inflammation of the bronchial tubes. Emphysema manifests as damage to lung air sacs, resulting in respiratory challenges.

**Lung Cancer.**

Smoking significantly heightens the risk of lung cancer, fostering the development of malignant lung tumors. Carcinogenic components in tobacco smoke, such as tar, play a pivotal role in initiating and advancing lung cancer.




**Cardiovascular Disease.**

Carbon monoxide in tobacco smoke binds to hemoglobin, diminishing blood's oxygen-carrying capacity. Nicotine contributes to increased heart rate and blood pressure, fostering the onset of cardiovascular diseases.

**Smoking During Pregnancy and Low Birth Weight.**

Smoking while pregnant correlates with unfavorable outcomes, including diminished birth weight. Nicotine and other detrimental elements in tobacco smoke can effect fetal growth, resulting in reduced birth weight.

## 12.2 Antibiotics

**Describe a drug as any substance taken into the body that modifies or affects chemical reactions in the body.**

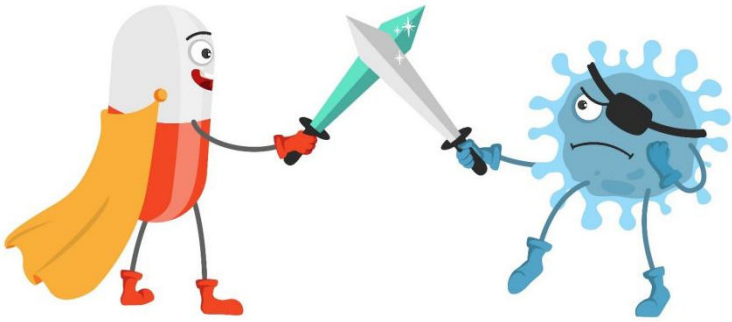
**Describe the use of antibiotics for the treatment of bacterial infection.**

**State that antibiotics kill bacteria but do not affect viruses.**

A drug is a substance that, when taken, affects the body's functions or alters the mind. It can be used for medical purpose. Drugs vary widely, including medications and substances used for enjoyment, but their use should be approached responsibly due to potential effects and risks.

Antibiotics are a class of medications that inhibit the growth or destroy bacteria, effectively treating bacterial infections in humans and animals. They work by targeting specific aspects of bacterial function, such as cell wall formation or protein synthesis, and are not effective against viral infections. Antibiotics play a crucial role in modern medicine by helping to control and eliminate bacterial infections, contributing to improved health outcomes.

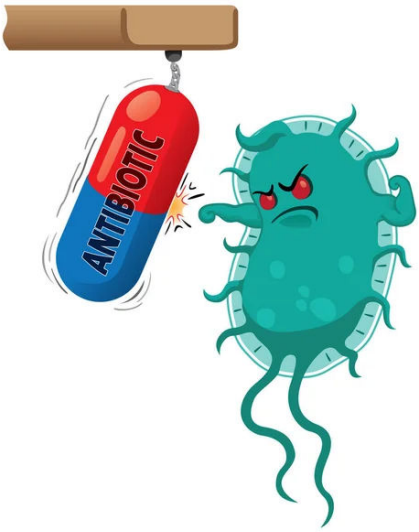
- Antibiotics kill bacteria.
- Stops cell wall synthesis.
- Alters membrane permeability.
- Stops protein synthesis enzymes.



**Affects of use of antibiotics**

- Antibiotics have lots of side effects. e.g. Diarrhea / loss of appetite.
- Some people are allergic to antibiotics.
- Bacteria develop resistance against an antibiotic if full course of the antibiotic is not used.

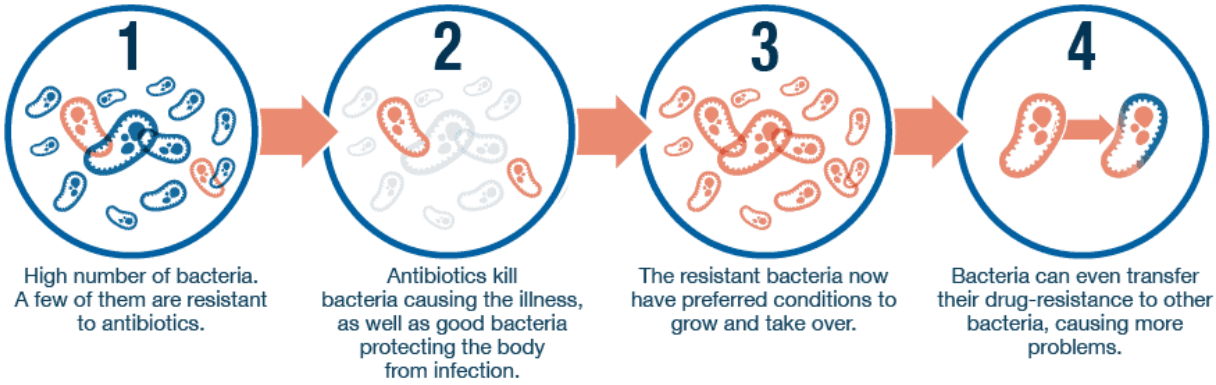
Antibiotics are not effective in the treatment of diseases caused by viruses. The reason antibiotics are not effective against viral diseases is because antibiotics work by disrupting structures in bacteria like cell walls and membranes. They can also disturb processes to do with protein synthesis and the replication of DNA. Viruses have totally different characteristics to bacteria, so antibiotics do not affect them.



## Explain how development of antibiotic-resistant bacteria, including MRSA, can be minimised by using antibiotics only when essential.

Antibiotic resistance including Methicillin Resistant Staphylococcus aureus may have developed as:

- On taking antibiotics majority bacteria are destroyed.
- Some bacteria that have mutated gene remain.
- These now multiply.
- So new antibodies have to be developed.




Resistance in bacteria against antibiotics can be minimised:

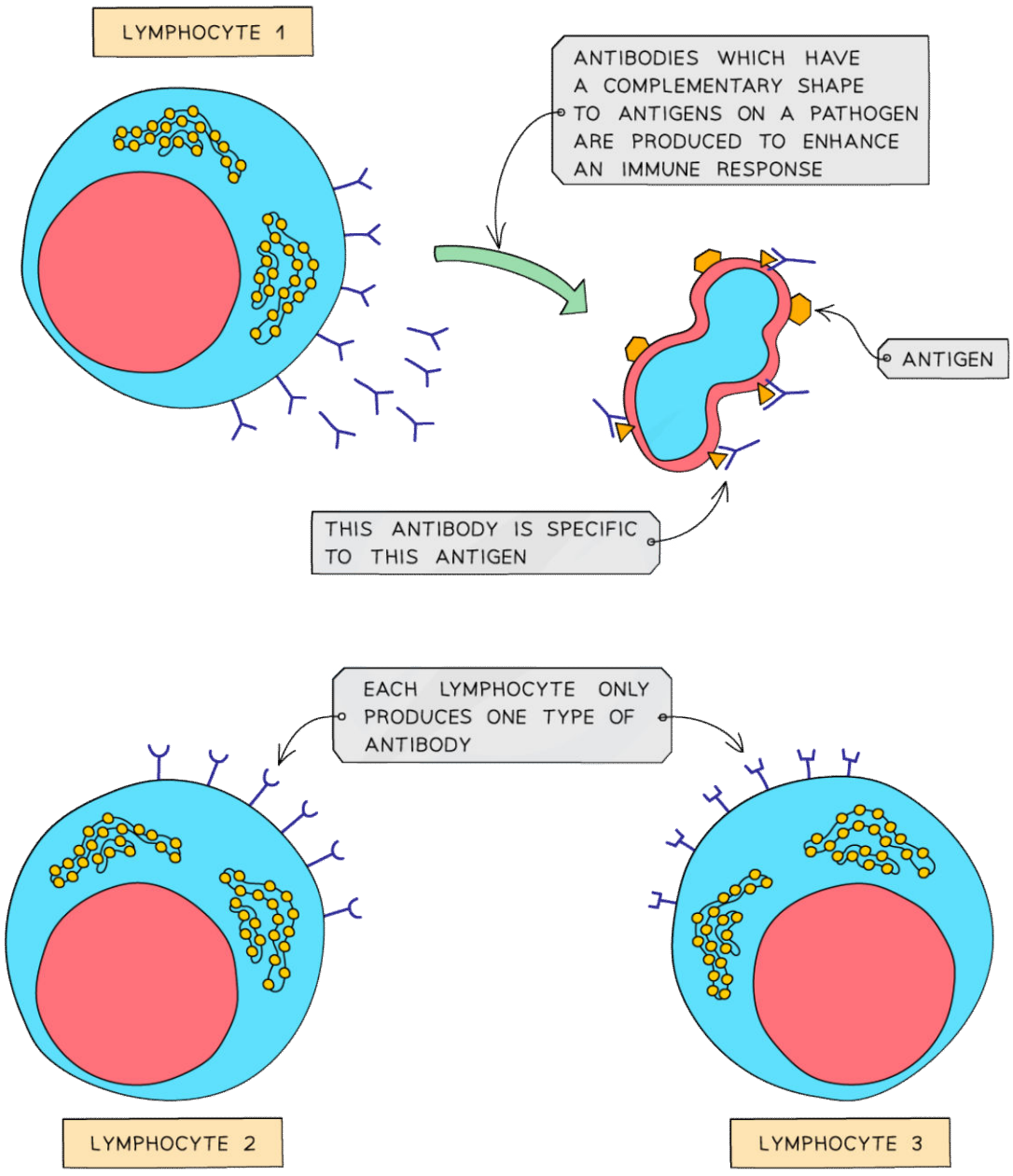
- One should take antibiotics only when prescribed.
- One should not misuse antibiotics.
- One should complete the course of antibiotic

## 12.3 Immunity

## Describe active immunity as defence against a pathogen by antibody production in the body.

### Active Immunity.

Active immunity is the body's defense mechanism developed in response to exposure to antigens, either through encountering pathogens or receiving vaccines. It involves the immune system producing its own antibodies and forming memory cells, providing prolonged protection against specific infections upon subsequent exposures. Active immunity is a fundamental aspect of the immune system's ability to recognize and defend against specific threats, contributing to the body's long-term resilience to infections.

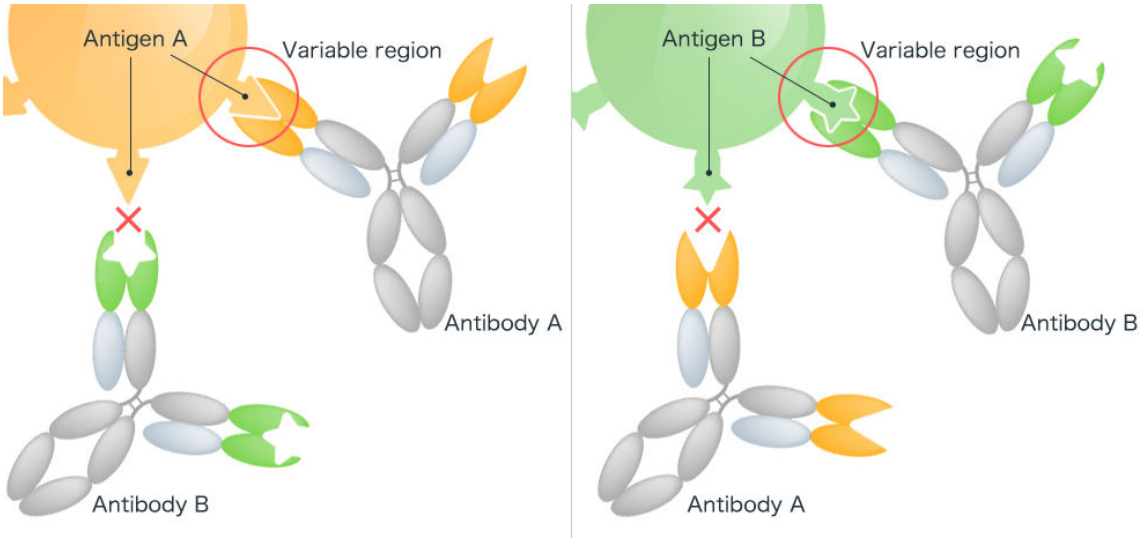


# State that each pathogen has its own antigens, which have specific shapes.

**Antigens**

These are molecules, often proteins or polysaccharides, that are present on the surface of pathogens like bacteria, viruses, and other microorganisms. These antigens act as unique identifiers, distinguishing one type of pathogen from another. The specific shapes of antigens are crucial because they determine how the immune system recognizes and responds to a particular invader.

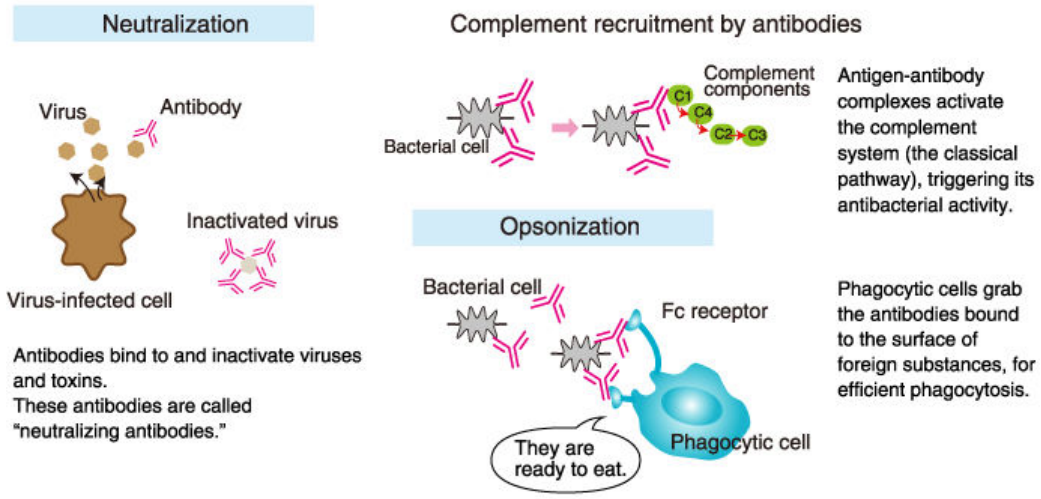
The uniqueness of antigens means that each type of pathogen has its own set of distinctive antigens. For example, the antigens on the surface of the influenza virus differ from those on the surface of a bacterium like Streptococcus. This diversity is a key aspect of the immune system's ability to mount specific and targeted defenses against a wide range of pathogens.



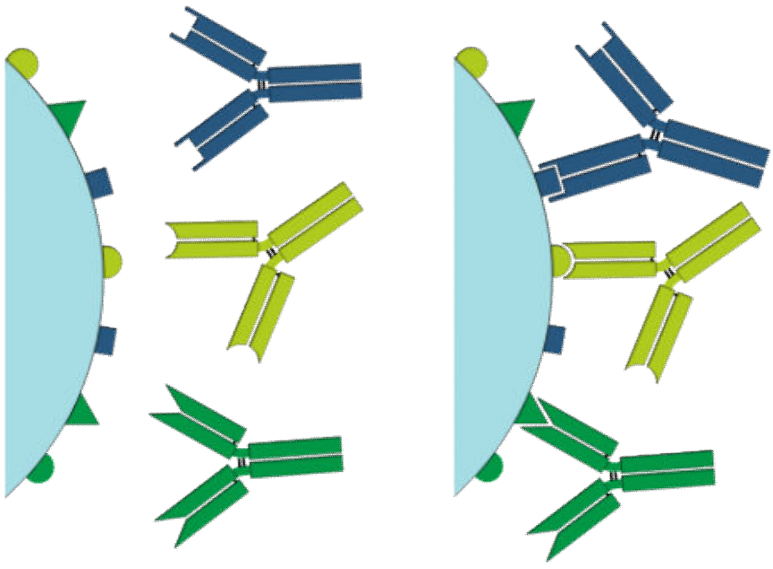
**Describe antibodies as proteins that bind to antigens leading to direct destruction of pathogens, or marking of pathogens for destruction by phagocytes.**

**State that specific antibodies have complementary shapes which fit specific antigens.**

Antibodies are proteins produced by the immune system that specifically bind to antigens, which are foreign molecules found on the surface of pathogens such as bacteria and viruses. This binding can lead to the direct destruction of the pathogen by neutralizing it, clumping it together (agglutination), or triggering processes that break down its cell membrane. In addition to direct destruction, antibodies also serve as markers that signal phagocytes (white blood cells) to engulf and digest the pathogen through a process called phagocytosis. By binding to antigens and facilitating either direct destruction or marking pathogens for elimination by immune cells, antibodies play a crucial role in defending the body against infections and diseases.




Antibodies are specific to an antigen. An antibody binds with an antigen which has shape complimentary to the shape of the antibody. That's why a vaccination against T.B is only effective against T.B and not any other disease.



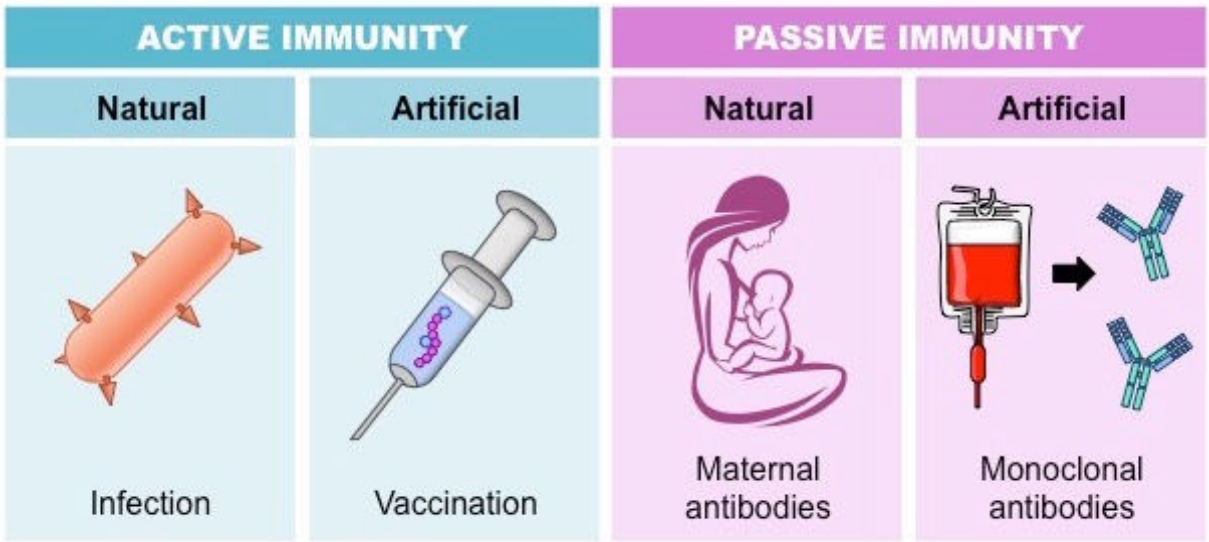
## Explain that active immunity is gained after an infection by a pathogen, or by vaccination

- A pathogen naturally enters into the body or a heat killed dead or weakened live pathogen is entered into the body.
- Some proteins of the pathogen or vaccine are recognized as non-self by the body.
- These antigens bind with complimentary receptors on lymphocytes.
- Number of lymphocytes increase in the body.
- Some cells release antibodies which bind with the pathogen and help destroy them.
- Some lymphocytes continue dividing and keep a memory of this antigen.
- If the same pathogen or antigen enters the body next time, the memory cells quickly recognize them and divide to make more cells which release antibodies. The release of antibodies as a result of entry of an antigen into the body is called immune response.
- There are two types of immune responses.

  1. Primary immune response.

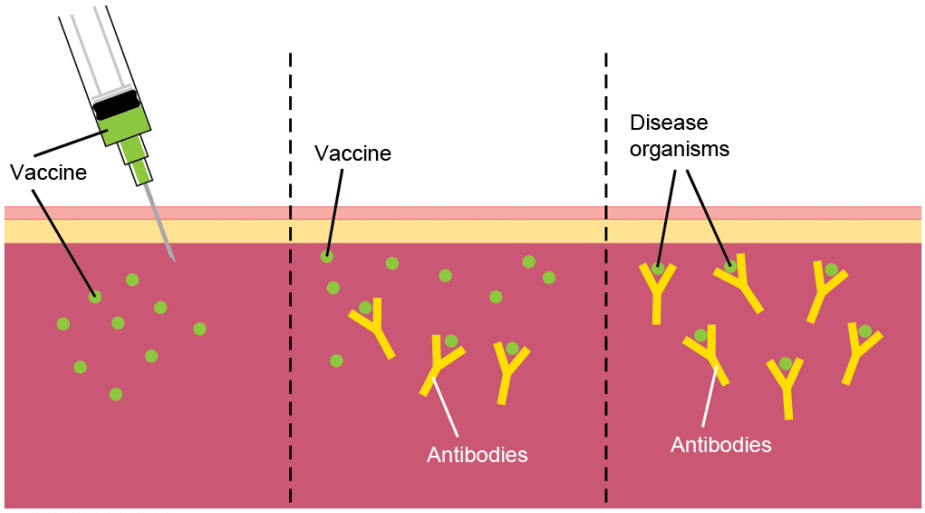
  2. Secondary immune response.

- The immunity provided by the body in which body's own lymphocytes release antibodies against an antigen is known as an active immunity.
- The active immunity is produced in the body in response to the entry of a pathogen in case of Natural active immunity or in response to vaccination which is Artificial active immunity.



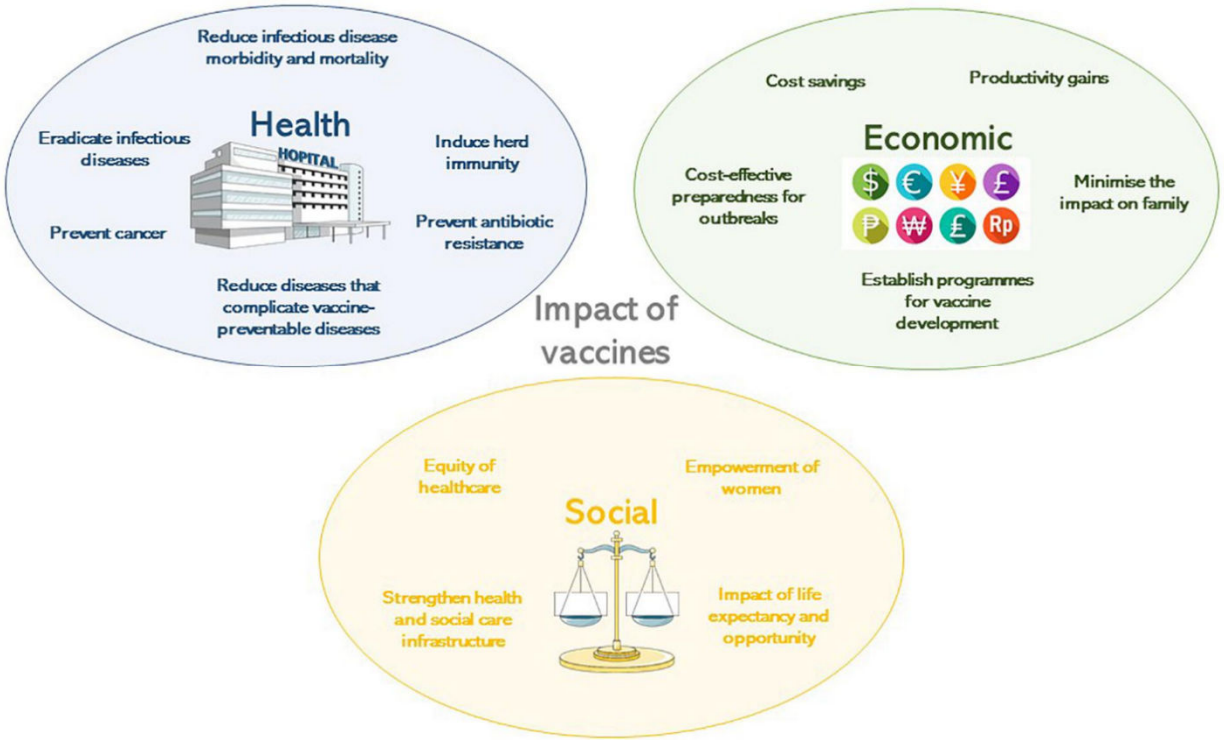
**Outline the process of vaccination:**
**(a) weakened pathogens or their antigens are given.**
**(b) the antigens stimulate an immune response by lymphocytes which produce antibodies.**
**(c) memory cells are produced that give long-term immunity.**

When vaccine enters into the body tissue antigens bind with receptors on B cells or T cells. Activated T cells activate B cells. B cells undergo cell division by mitosis and increase number of B cells in the body. Some B cell mature into plasma cells which release antibodies. The antibodies level increases in the body and is known as immune response. Some B cell remain as memory cells. They keep dividing and retain memory of the entry of the pathogen into the body the first time. If the same pathogen or antigen enters the body the second time, these memory cells recognize the antigen and rapidly divide to make more plasma cells which release more antibodies



## Explain the role of vaccination in controlling the spread of transmissible diseases.

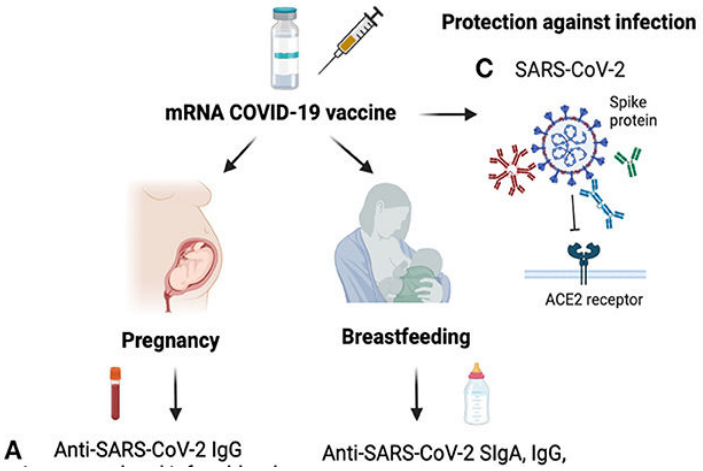
Vaccination plays a crucial role in controlling the spread of transmissible diseases by stimulating the immune system to recognize and combat specific pathogens. It helps prevent illness in vaccinated individuals and contributes to reducing the overall transmission of the disease. This collective immunity is particularly important for protecting vulnerable populations who may be unable to receive vaccines. Vaccination played a pivotal role in the successful eradication of smallpox. Through widespread immunization campaigns, millions of people worldwide were vaccinated against the smallpox virus. As a result, the transmission chain was broken, and the last natural case of smallpox occurred in 1977. Vaccination not only protected individuals from the disease but also contributed to interrupting its spread, ultimately leading to the global eradication of smallpox in 1980. This success highlights the power of vaccination in controlling and eliminating highly contagious diseases.



**Explain that passive immunity is a short-term defence against a pathogen by antibodies acquired from another individual, limited to: across the placenta and in breast milk.**

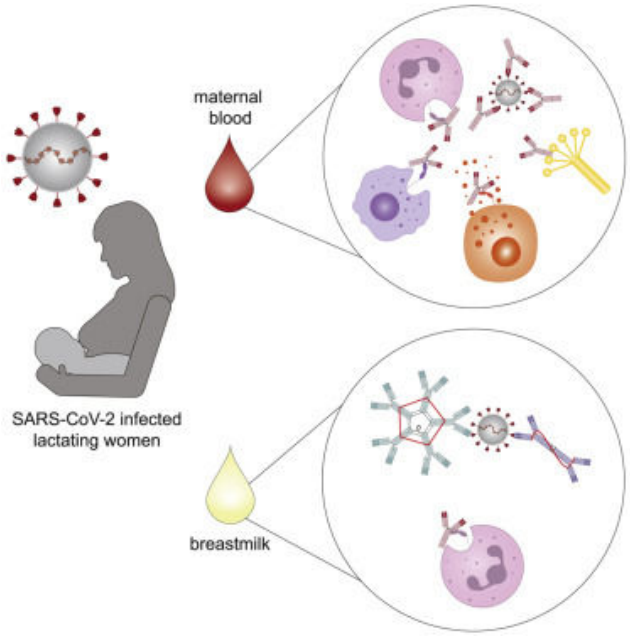
**Explain the importance of breast-feeding for the development of passive immunity in infants.**

If mother is vaccinated or she recovers from some infectious disease, antibodies are produced in her body. These antibodies are carried to the placenta. Where these antibodies cross the placenta and enter into the body of the developing baby. These antibodies protect the baby from the same diseases the mother has been vaccinated or she has recovered from a disease. These antibodies are also passed to the baby through breast feed.



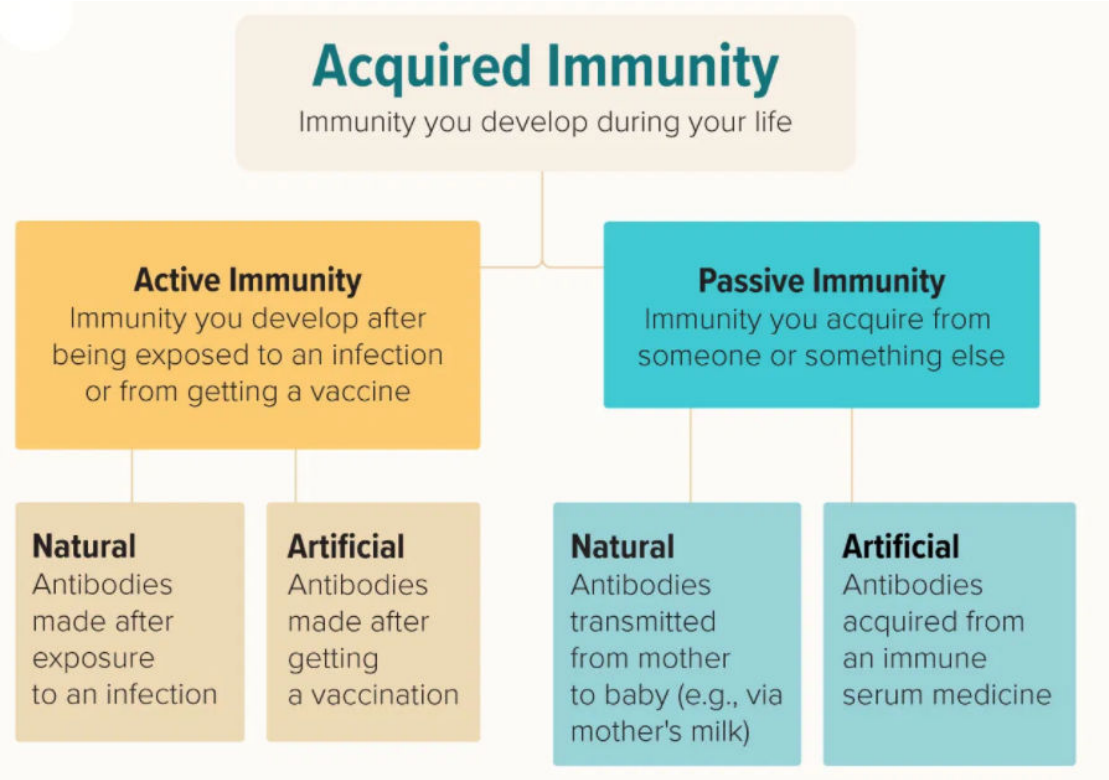

Breastfeeding plays a crucial role in fostering passive immunity in infants by delivering vital antibodies and immune factors present in the mother's milk. The initial milk produced, colostrum, is particularly abundant in these immune components.

These antibodies offer defense for the infant's gastrointestinal and respiratory systems, providing a shield against various infections. This transfer of passive immunity is especially significant during the early months of life when the infant's own immune system is still maturing. Beyond nourishment, breastfeeding enhances the infant's ability to combat infections, contributing to a healthier beginning in life.



## State that memory cells are not produced in passive immunity.

In passive immunity antibodies from mother are passed to the baby through placenta or through breast milk. The infant is protected from the infectious diseases that the mother has been vaccinated or she has recovered from. The protection in the mother to the diseases is long term. The immunity provided to the mother is an active immunity involving memory cells whereas the immunity provided to the baby from antibodies passed from mother to the baby is a passive immunity. So it does not produce any memory cells. Due to this the infant will have short term immunity.



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