Aakash + BYJU'S NOTES

Human Health and Diseases

Key Takeaways

1. Health
2. Factors affecting health
3. Immunity
   - Innate
   - Acquired
4. Vaccination
   - Types
   - Importance
5. Lymphoid organs
   - Primary lymphoid organs
   - Secondary lymphoid organs

6 **Immunisation**

7 **Bacterial diseases**

- Typhoid
- Pneumonia

8 **Fungal diseases**

- Ringworm

9 **Helminthic diseases**

- Ascariasis
- Filariasis

10 **Protozoan diseases**

- Malaria
- Amoebiasis

11 **Viral diseases**

Common cold

Immunodeficiency 12

13 **HIV/AIDS**

Life cycle

Tumour cell vs normal cell 14

Stages of infection

Modes of transmission

Prevention

15 Tumour & types

Causes of cancer 16

17 Stages of cancer

Treatment of cancer 18

19 Classes of drugs

- Opioids
- Cannabinoids
- Cocaine

Addiction 20

Tobacco addiction

Effects of tobacco

Diseases

Withdrawal symptoms

21

22

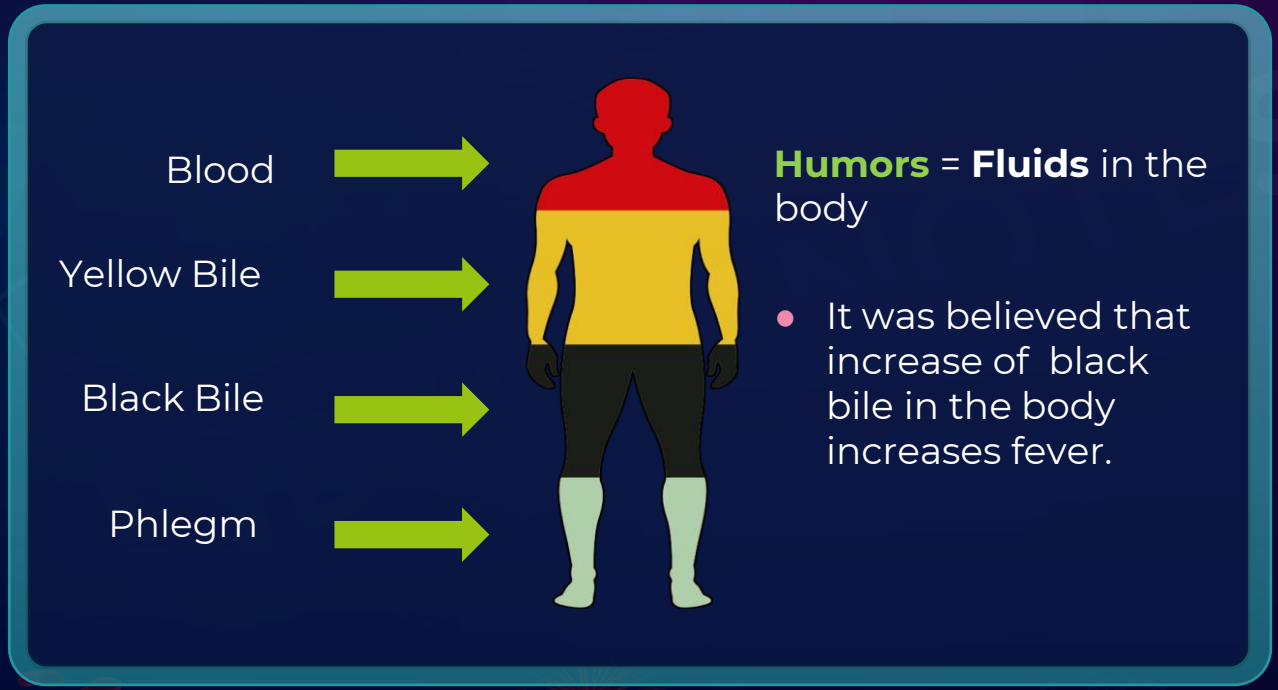
23

Adolescence

Summary

Good Humor Hypothesis

- Health, for a long time, was considered as a state of body and mind where there was a **balance** of certain '**humors**' (liquids).

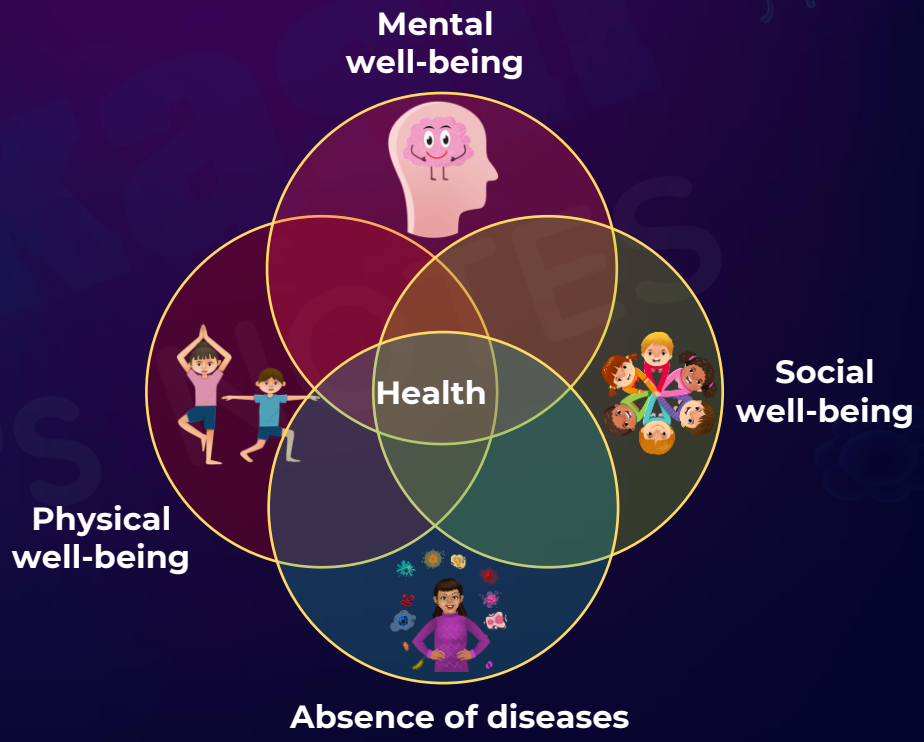


Blood Circulation Hypothesis

- In 16th century, **William Harvey**, an English physician, conducted a series of experiments to understand blood and its circulation.
- He provided many important insights into the **blood circulation system.**
- Research led to the understanding that blood circulation makes sure that the right body temperature is maintained.
- Consequently, **“good humor hypothesis”** of health was disregarded.

Health

- Since then, great works of pioneers and their discoveries have changed the definition of health.
- According to **WHO**, health is the state of complete **physical, mental and social well-being** and not merely the absence of disease and infirmity.

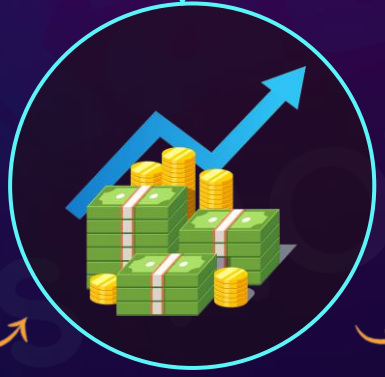


Health

Consequences of good health

High efficiency at work

Low maternal & infant mortality



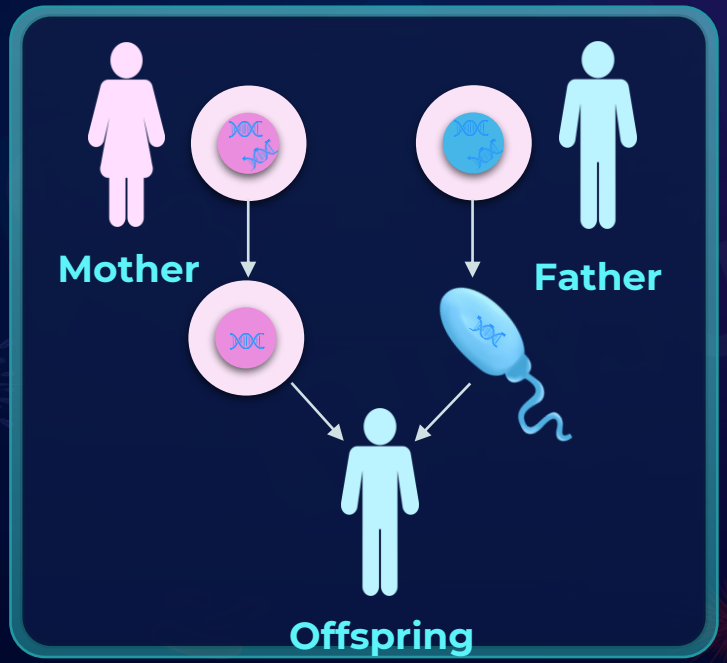
Economic growth

Increased longevity of individuals

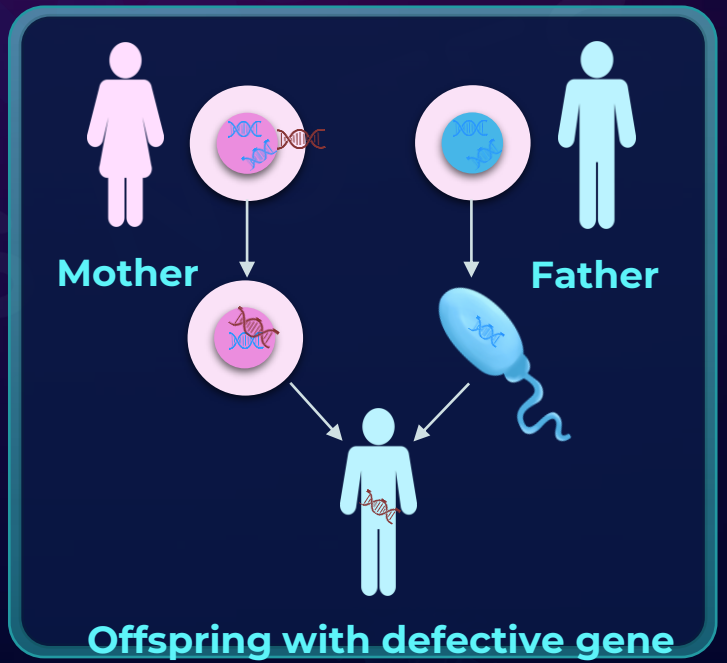
Factors Affecting Health

Genetic factors

- Parents pass on their **traits** through genetic materials to offspring.



- Sometimes, genetic material undergoes some changes due to **mutation** which can be **harmful.**



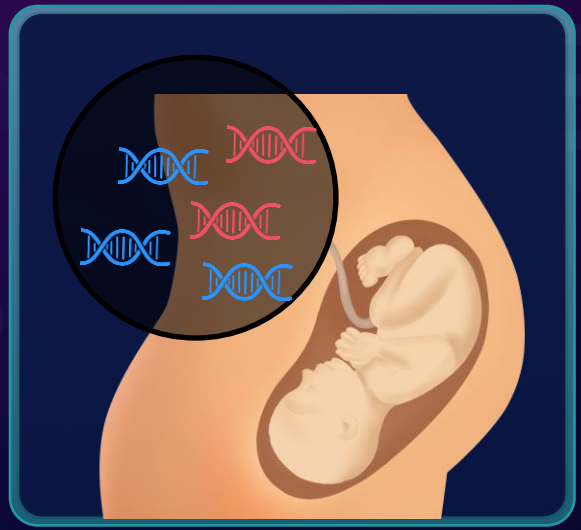
Factors Affecting Health

Genetic factors

- The mutations that are inherited by offspring can lead to **genetic disorders.**

A disease/disorder can be caused in an individual due to a change in the DNA sequence inherited from parents.

Example: Down's syndrome, Sickle-cell anaemia, etc.



Factors Affecting Health

Lifestyle

- Lifestyle includes **food** and **water** we take, **rest** and **exercise** we give to our bodies, **habits** that we have or lack, etc.
- For example, good personal hygiene.
- **Poor hygiene** affects health and can make an individual **sick.**

Factors Affecting Health

Infections

An **infection** is the invasion of an organism's body tissues by disease-causing agents known as pathogens.

Human body has **various mechanisms** to tackle **infectious diseases.**

Pathogen

Pathos

Refers to **'disease'**

Gen

Refers to **'producing'**

Immunity

The ability of the host to fight the disease-causing organisms, conferred by the immune system is called **immunity**. Based on **how it is obtained** it is categorised into two types.

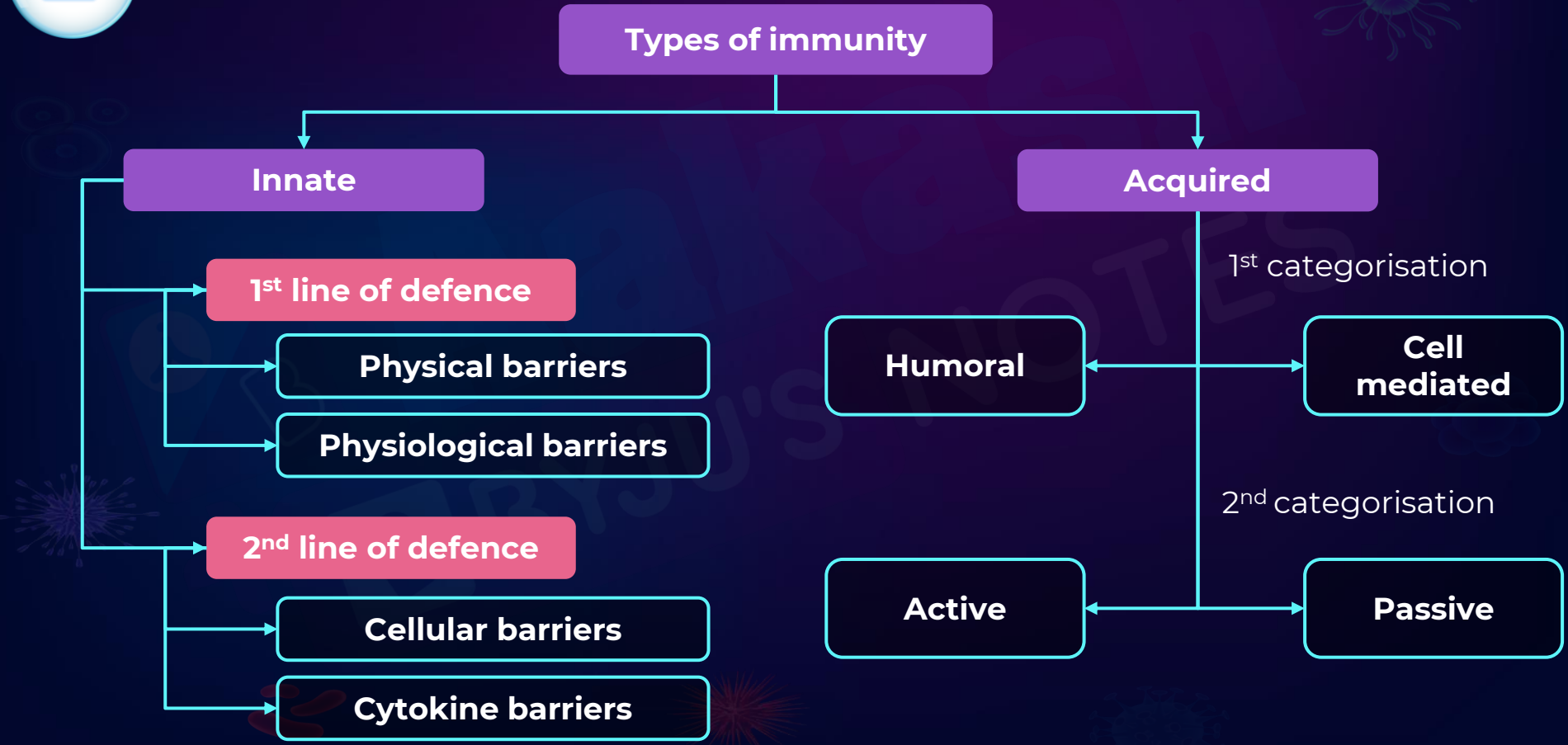
Innate immunity

- It is an ability to fight pathogens which is present **since birth**.
- It is **non-specific** as it fights against all kinds of pathogens.
- It is non-adaptive.

Acquired immunity

- It is an ability to fight pathogens which is developed **over a period.**

Immunity



Innate Immunity

When a pathogen attacks, it faces the **1st line of defence** which comprises of **different barriers.**

Physical barriers

- These provide mechanical defence against microbes.
- These include **skin** and **mucous membrane**.

- Mucus membrane forms the **coating** on the epithelium lining of **respiratory, gastrointestinal** and **urogenital** tracts.
- It traps the microbes.

- Our whole body is covered by skin.
- Skin acts as **shield** and **prevents** pathogens from entering our body.

Physiological barriers

- Physiological barriers provide harsh conditions to microbes such that they cannot survive.
- **Acid in stomach, saliva in mouth** and **tears** kill these microbes.
- Tears and saliva have **lysozyme** enzyme which destroys them.

Innate Immunity

2nd line of defence

Cellular barriers

Human body is **guarded** by many **cells** which fight against pathogens. These cells form the **second line of defence**.

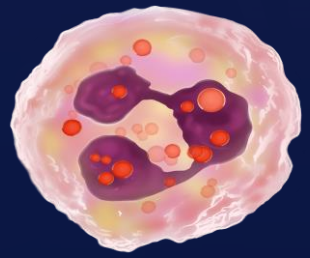
Cytokine barriers

If pathogens are able to **cross** all these barriers and are successful in infecting the cells, then our body uses a special kind of immunity known as **cytokine barrier**.

Innate Immunity

Cellular barriers

- The **first type** of cellular barriers are **neutrophils**.
- They are also called **polymorphonuclear leukocytes** (PMN, PML, or **PMNL**) because of varying shape of their nucleus.



(PMNL) Neutrophils

- Helps in phagocytosis of invading bacteria

Innate Immunity

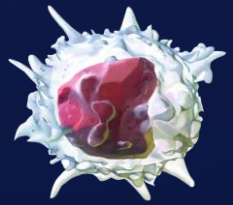
Cellular barriers

- The **second type** of cellular barriers are **monocytes**.
- They can **detect** the region of infection.

Monocytes

- Give rise to macrophages in tissues

- Monocytes transform into **third type** of cells called **macrophages.**
- Macrophages have the ability to **phagocytose** pathogens and **digest** them. These cells can also release **cytokines.**



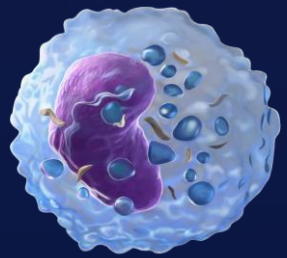
Macrophages

- Phagocytosis of the invading bacteria
- Release cytokines

Innate Immunity

Cellular barriers

- The **fourth type** of cellular barriers are **killer cells**.
- These cells can **release chemicals** which **kill** the bacteria as well as the infected cells.



Natural killer cells

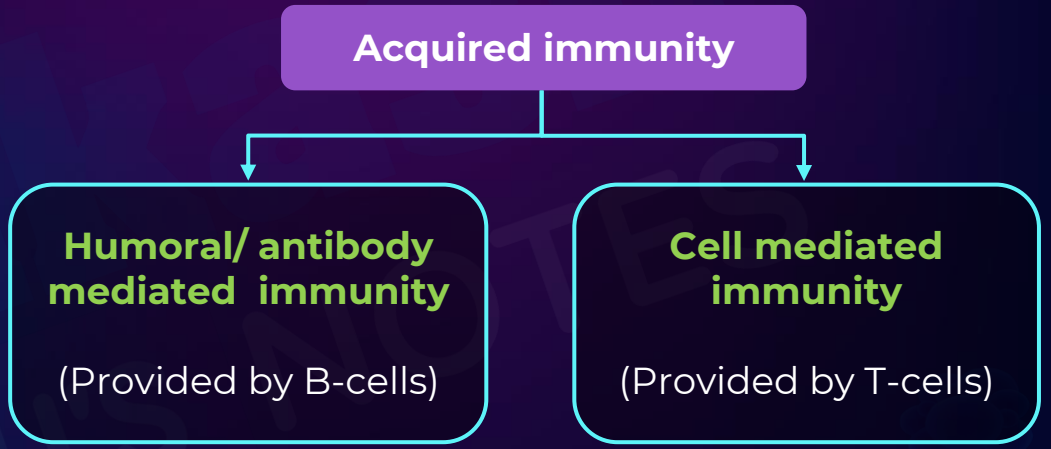
- Kill the invading bacteria

Innate Immunity

- These are certain proteins produced by infected cells, which **protect non-infected cells** from further infection. Example - Interferons produced by virus infected cells.
- **Interferons** stimulate the synthesis of certain proteins that inhibit the production of viral proteins which are required for their replication.

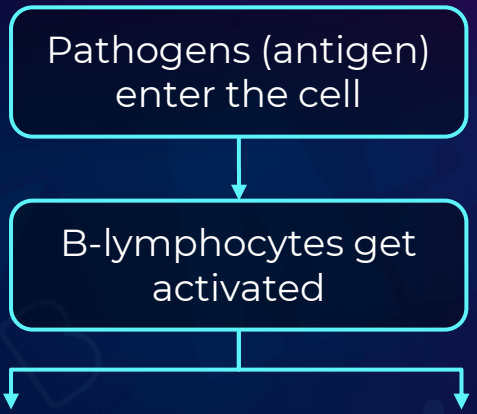
Acquired Immunity

- Pathogen specific
- Initiates primary response on encountering a pathogen for the first time
- **Effector B and T cells** are produced to **counter the infection**
- **Memory B and T cells** are also produced
    - Generate a **secondary**/anamnestic **response**



Acquired Immunity

Humoral immunity



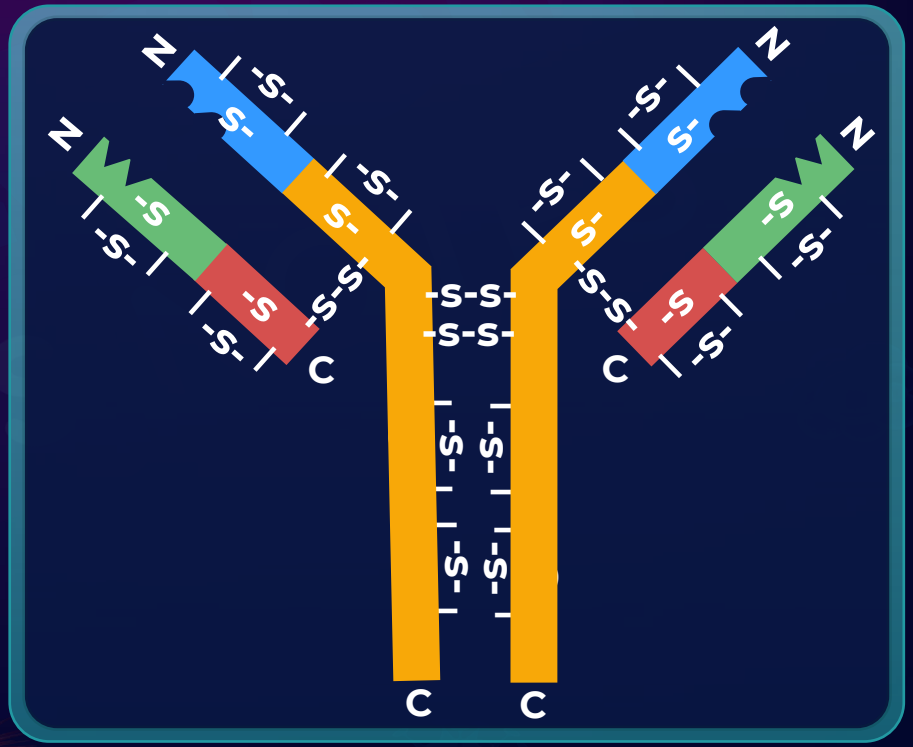
Antigens

- Antigen derived from - **Anti**body + **gen**erating
- Generally, large molecules
- Mostly proteins or polysaccharides on cell walls of bacteria or coats of virus
- Structures like pollen grains, white of an egg, shell fish, dust, blood cells of other organisms , drugs and chemicals can also act as antigens.

Humoral Immunity

Antibody

- Plasma B cells **release** soluble protein molecules called **antibody.**
- These are also called **immunoglobulins (Ig)** as these are globulin (protein) molecules **helping in immune response.**
- Immunoglobulin is a **Y shaped protein** consisting of **four peptide chains.**
- Since it's a protein, it has **amino end (N terminal) and carboxyl end (C terminal).**
- Each antibody and its clones are specific to a particular antigen.
- There are several antibodies of different specificity referred to as **polyclonal response.**

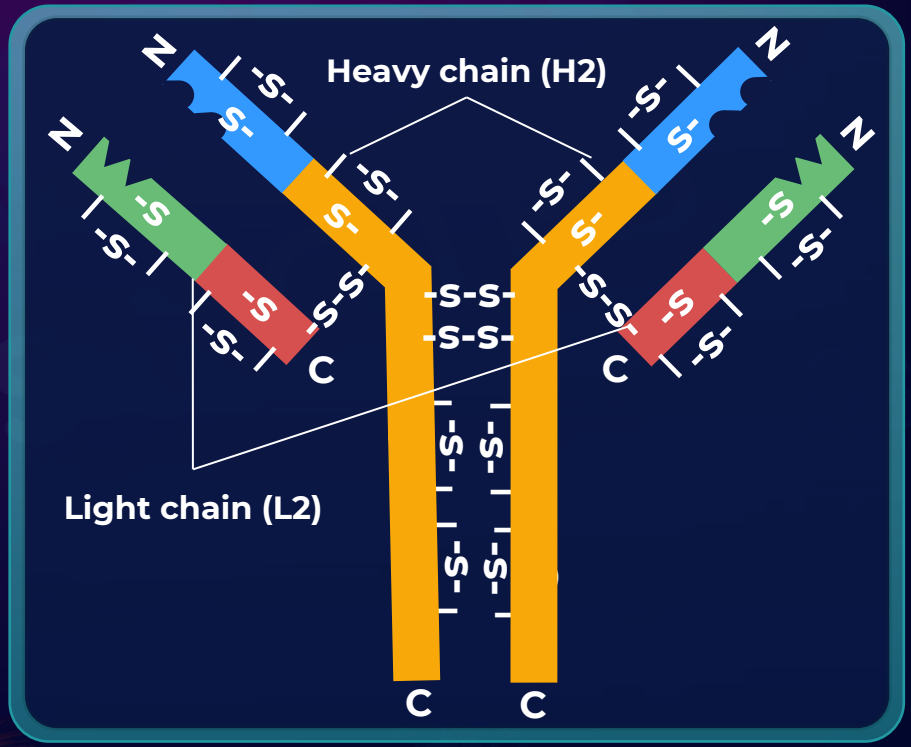


Immunoglobulin (Ig)

Humoral Immunity

Antibody

- Immunoglobulin has **two heavy peptide** chains denoted as **H_2** and **two light peptide** chains denoted as **L_2**.
- Therefore, structurally, an antibody is denoted as **H_2L_2**.
- Heavy peptide chains are connected to each other via **two disulphide bonds.**
- There are total **16 disulphide bonds** in the entire structure.
- The lighter peptide chain is linked to the heavy peptide chain via **single disulphide bond.**

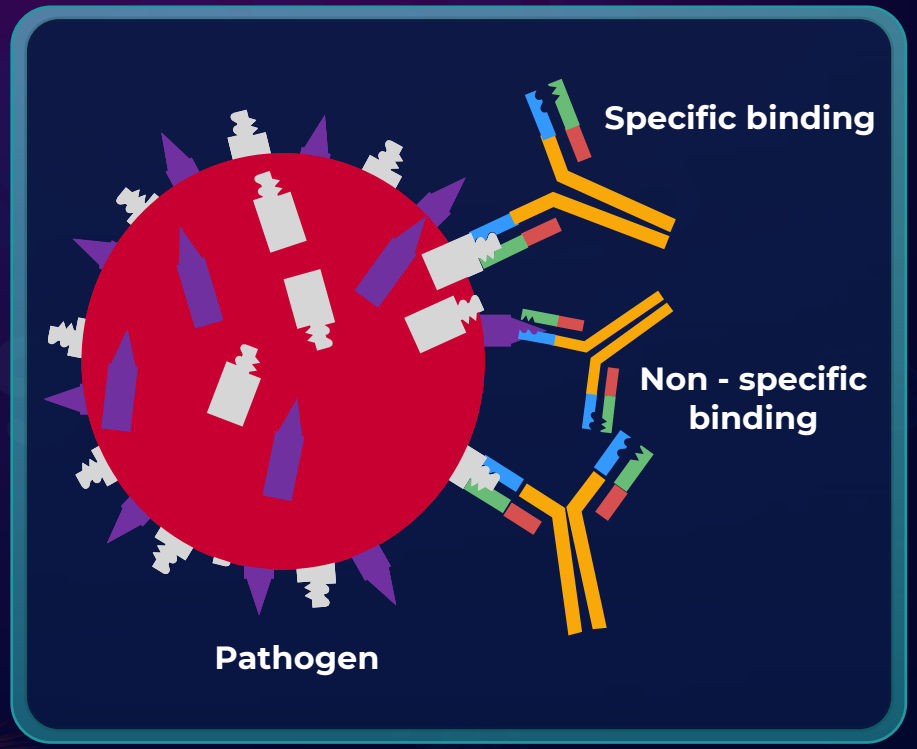


Immunoglobulin (Ig)

Humoral Immunity

Antibody

- Antibody **recognizes and binds** to molecular shapes on antigen called **epitopes.**
- Epitopes whose **shape doesn't complement** with the **antigen binding site** of the antibody **cannot be recognized** by the antibody.
- Antibody **fixes** to the epitope which is **complementary** to the **antigen binding site** of the antibody.
- Antibodies are very **specific** to an antigen.
- Different types of antibodies are IgA, IgG, IgD, IgM and IgE.



Acquired Immunity

Cell-mediated immunity

Bone marrow produces immature lymphocytes

↓

Travel to thymus and differentiate into T-lymphocytes

↓

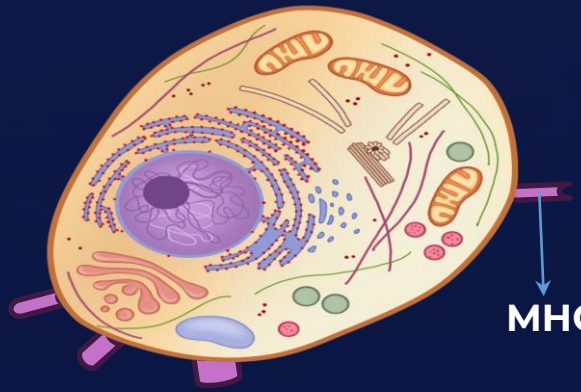
T-lymphocytes migrate to lymphoid tissue and differentiate into one of the four:

- **Helper T-cell** - Stimulate B-cells to produce antibodies and killer T-cells to destroy non-self cells
- **Cytotoxic/Killer T-cell** - Secrete perforins which causes the cells to burst by perforating cell membrane and allowing entry of excess water
- **Suppressor T-cell –** Suppress the function of cytotoxic T-cells and helper cells to protect body's own cells
- **Memory T-cell** - Remain in lymphatic tissue and recognize invading antigens even after several years of first encounter

Mechanism of Detecting Foreign Antigens

Major Histocompatibility Complex

- The **cells present antigens** with the **help of protein complex** called MHC.
- MHC is present on **all cells** of our body.
- T-cells come in contact with the **MHC of cells** and decide whether a given antigen **belongs to the body** or **not.**
- If cell is damaged or attacked by a pathogen, it presents antigen on MHC and **T-cells elicit immune response** against the pathogen.
- MHCs are encoded by several genes located on **chromosome 6**.

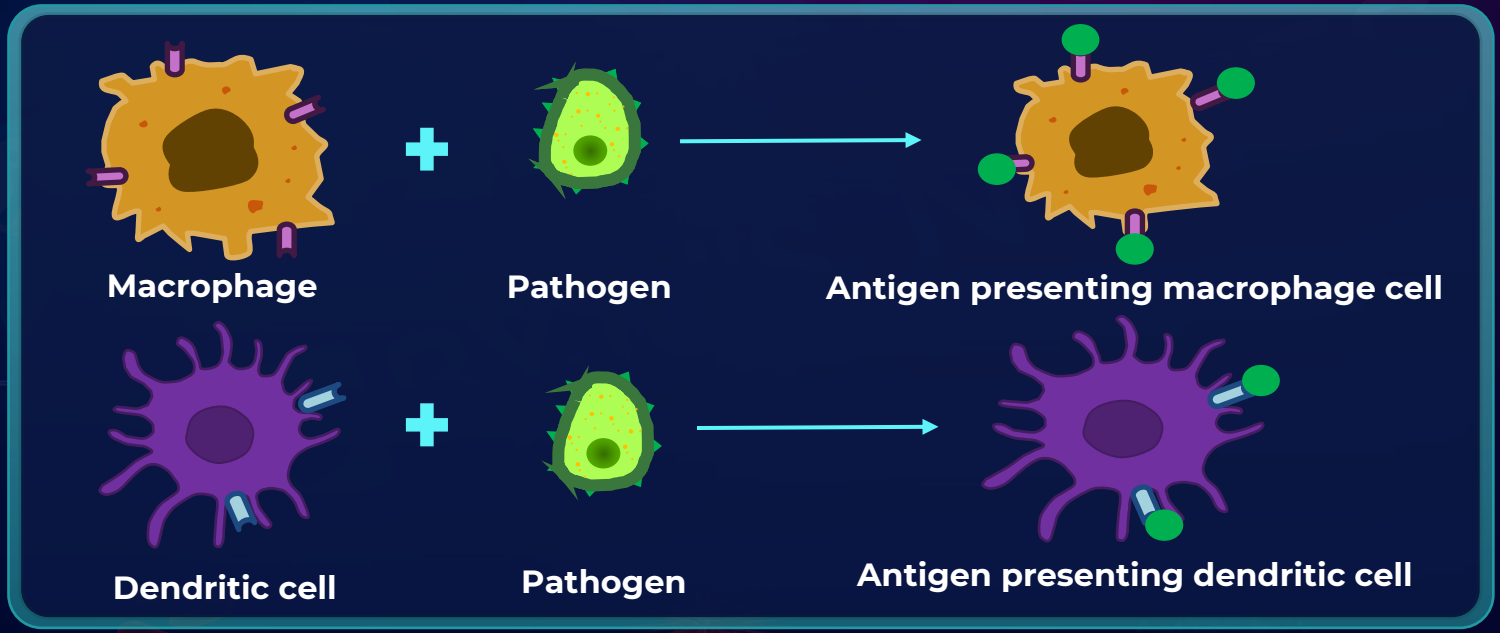


- MHCs are also referred to as **Human Leukocyte Antigen (HLA)**

Mechanism of Detecting Foreign Antigens

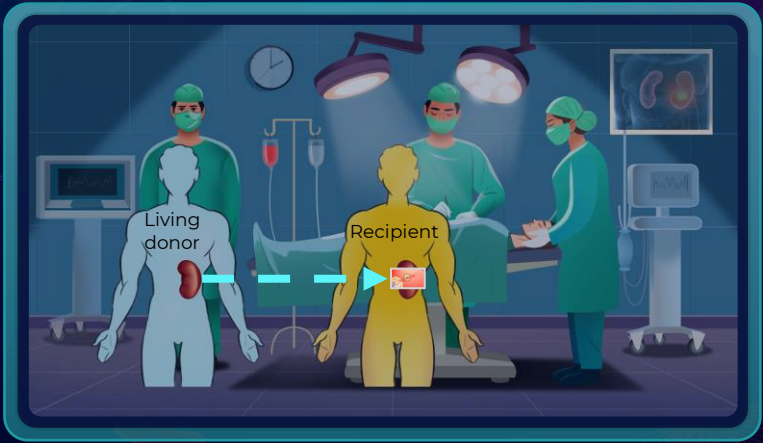
Major Histocompatibility Complex

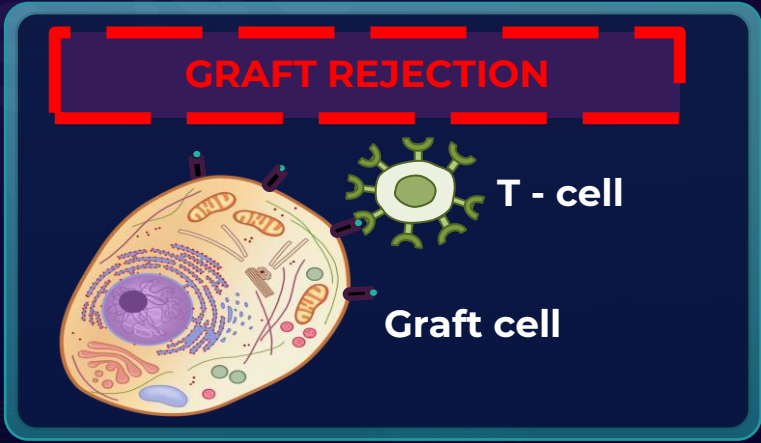
Whenever **macrophages and dendritic cells** encounter **pathogens**, they **present antigen on their surface** with the help of **major histocompatibility complex.**



Organ Transplantation

- Organs like eyes, liver, heart and kidneys need to be **transplanted** in case they fail to function satisfactorily.
- So, the healthy organ from a suitable donor is transplanted into the recipient.
- When the T-cells come close to the cells of the new organ, they **check** whether the **peptide is self or non-self.**
- When the graft (transplanted tissue/organ) has MHC which is **non-self, the T-cells treat it as antigen and reject it by raising immune response.**





Organ Transplantation

- Tissue matching (MHC matches) and blood group matching are essential before undertaking any graft/transplant.
- The body is able to **differentiate 'self' and 'non-self'** and the **cell-mediated immune response** is responsible for the **graft rejection.**
- Even after tissue and **blood group matching**, the patient has to take immunosuppressants all his/her life.
- When a patient takes **immunosuppressants**, his immunity levels become lower.

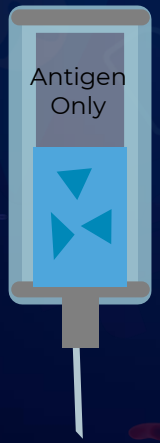
Vaccination

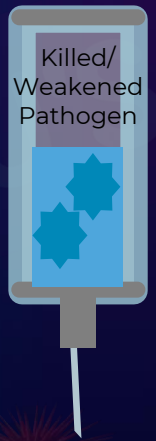
- Vaccination is the administration of vaccine in order to **stimulate the immune system** against the pathogen, thereby developing protection from a disease.
- The principle of vaccination is based on the property of '**memory**' of the immune system.
- They also generate memory T and B-cells that recognise the pathogen quickly on subsequent exposure.
- Vaccines stimulate the production of antibodies and provide immunity against diseases whenever there is an infection in the future.

Vaccines

Types of vaccines

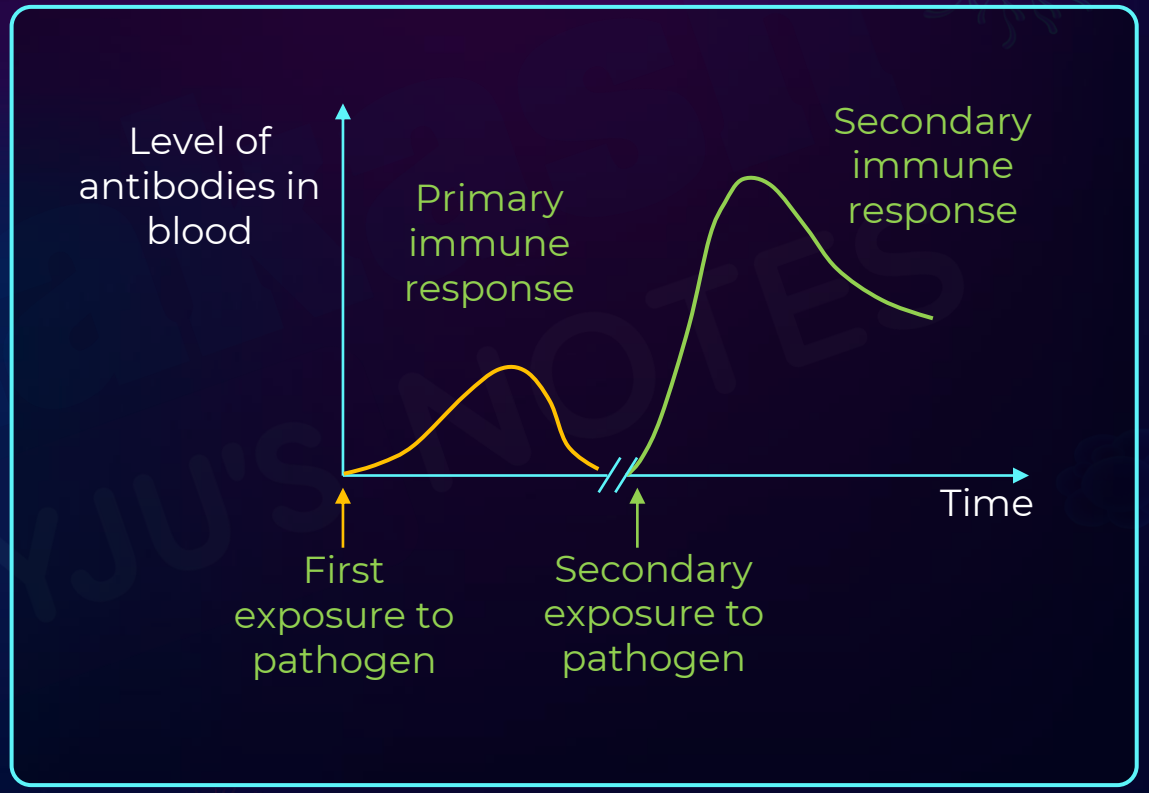
- Antigen only
- Killed/Weakened pathogen
- RNA





Vaccination

- When the body is vaccinated against a pathogen, a **primary immune response** is generated which creates **memory B cells.**
- Memory B cells are then able to mount a defence attack against an actual pathogen – this is the **secondary immune response.**



Graph showing antibody response to pathogens

Importance of Vaccination

- It protects the population and also leads to **herd immunity.**
  - Herd immunity is a form of **protection** from **infectious diseases.**
  - When **sufficient percentage** of a population becomes **immune** to an infection, (through vaccination or previous infections), it **reduces** the **likelihood of infection** in individuals who cannot get vaccinated for medical reasons.
  - When a lot of people in the **population** are **not vaccinated,** the whole **unvaccinated population** is **susceptible** to the disease.
  - In such a scenario, people who cannot be vaccinated due to medical reasons are more likely to get infection and suffer serious disease.

Importance of Vaccination

Myths	Facts
Vaccines cause autism	There's no evidence or link between any vaccine and autism
Vaccines contain dangerous toxins	Some vaccines have very low levels of toxins, which is harmless
Vaccines can infect us with the disease we are trying to prevent	Symptoms appear after vaccination because of our immune system's response against it and not the disease

Adaptive Immunity

Active immunity

- Active immunity comes into play when host is exposed to antigens.
- **Antibodies** are produced.
- **It is slow** but **long lasting.**

1 Natural

- Infectious agents gaining access into body naturally- **natural active immunity**

2 Artificial

- Resistance induced by injecting vaccine- **artificial active immunity**

Adaptive Immunity

Passive immunity

- The **ready-made antibodies** are **administered** into the body of a patient to protect against foreign agents.
- **Passive immunity** is **fast** but **does not last for a long time**.

1 Natural

Ig G antibody through placenta

Ig A antibody through colostrum

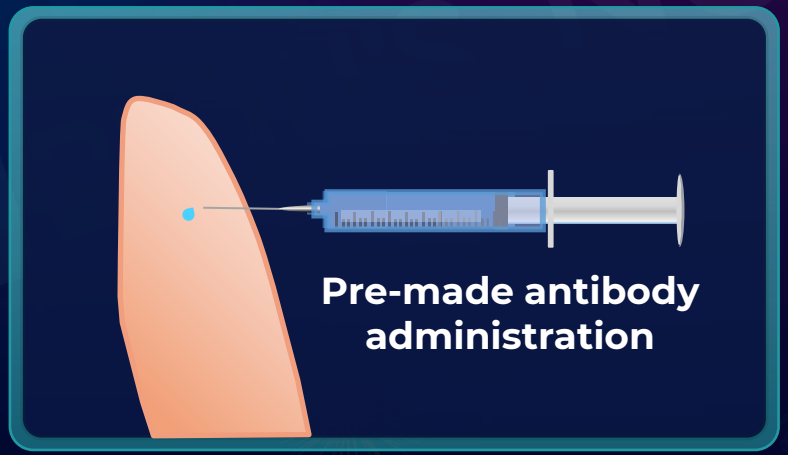
- The foetus receives Ig G antibodies from the mother through the **placenta during pregnancy**.
- The yellowish fluid **colostrum** secreted by mother during the initial days of lactation has **abundant antibodies (Ig A)** to protect the infant.
- These are some examples of natural passive immunity.

Adaptive Immunity

Passive immunity

Artificial

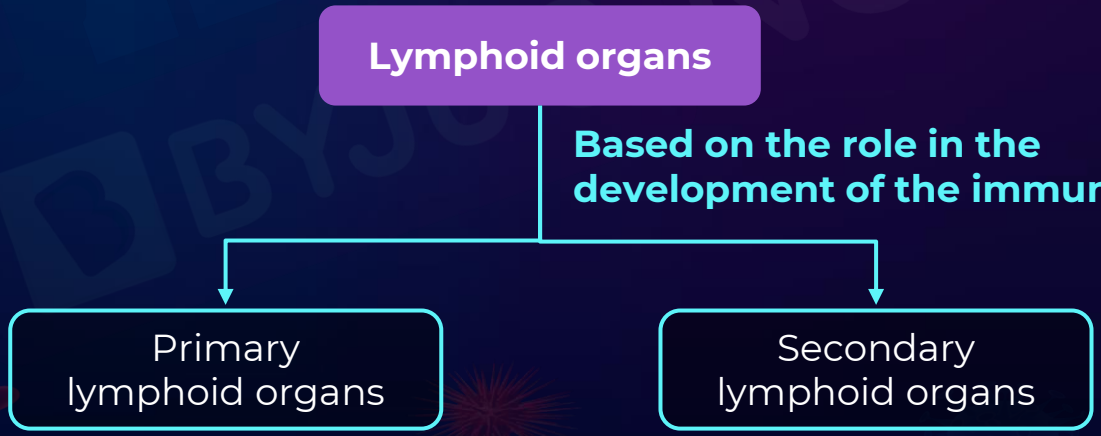
- **Artificial passive immunity** is the resistance **passively transferred by administration of pre-made antibodies** like in the case of anti-venom vaccine.
- In the **process of vaccination**, **a preparation of vaccine containing antibodies** are introduced into the body.



Immune System

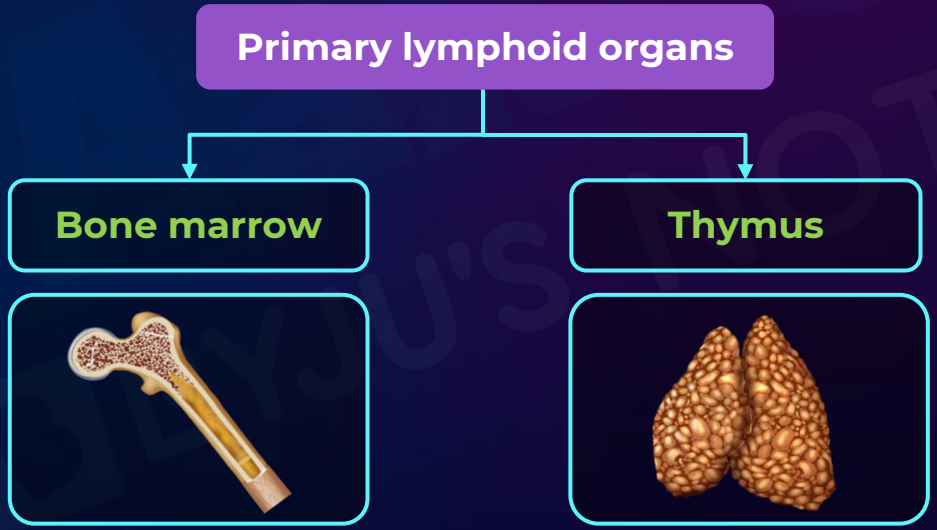
Lymphoid organs

- Organs where **origin** and/or **maturation** and **proliferation** of **lymphocytes occur.**
- **Lymphocyte** is a type of white blood cell that is the part of the immune system.
- **Lymphoid organs** are involved in the immune system.



Primary Lymphoid Organs

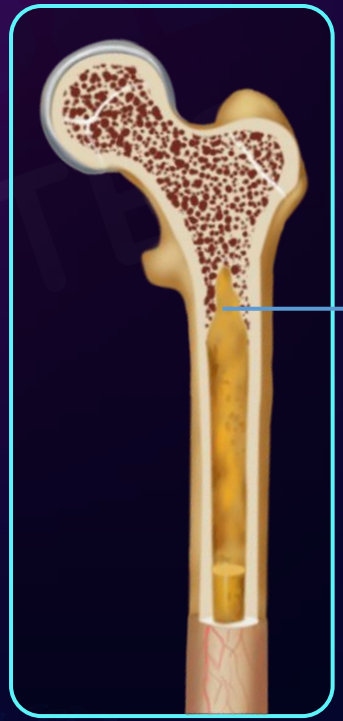
Primary lymphoid organs are the organs where **immature lymphocytes** are **produced** and are **differentiated** into **antigen-sensitive lymphocytes.**



Primary Lymphoid Organs

Bone marrow

- It is the **main** primary lymphoid organ.
- It is the site of **lymphocytes** production and **self renewal.**
- It provides **micro-environments** for the **development** and **maturation** of the **lymphocytes.**
- The cells, molecules, and structures (such as blood vessels) that surround and support other cells and tissues is called micro-environment.
- It is located in most of the bones.
- It is considered equivalent to Avian Bursa of Fabricius.
- **Some lymphocytes migrate** from bone marrow to thymus through blood.



Bone

Primary Lymphoid Organs

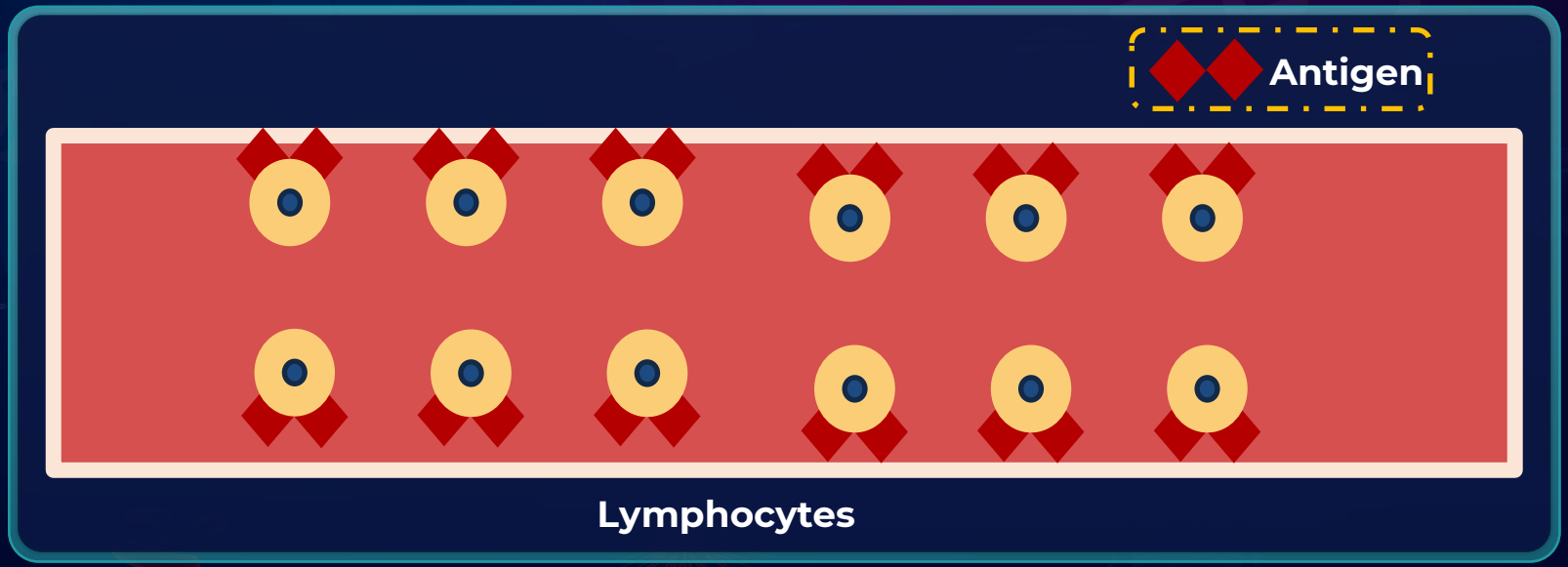
Thymus

- It is a **bilobed** organ.
- It is located near heart, beneath the breastbone.
- It provides **micro-environment** for the **development, maturation** and **selection** of some **lymphocytes.**
- It is very **large in size** at time of birth, **size** starts **reducing** after puberty.
- It is the site where T-lymphocytes mature.

Thymus

Secondary Lymphoid Organs

- **Naïve lymphocytes** move to **secondary lymphoid organs** which is the training ground of these lymphocytes, arriving from primary lymphoid organs.
- Secondary lymphoid organs provide **antigen** to the lymphocytes for the interaction.

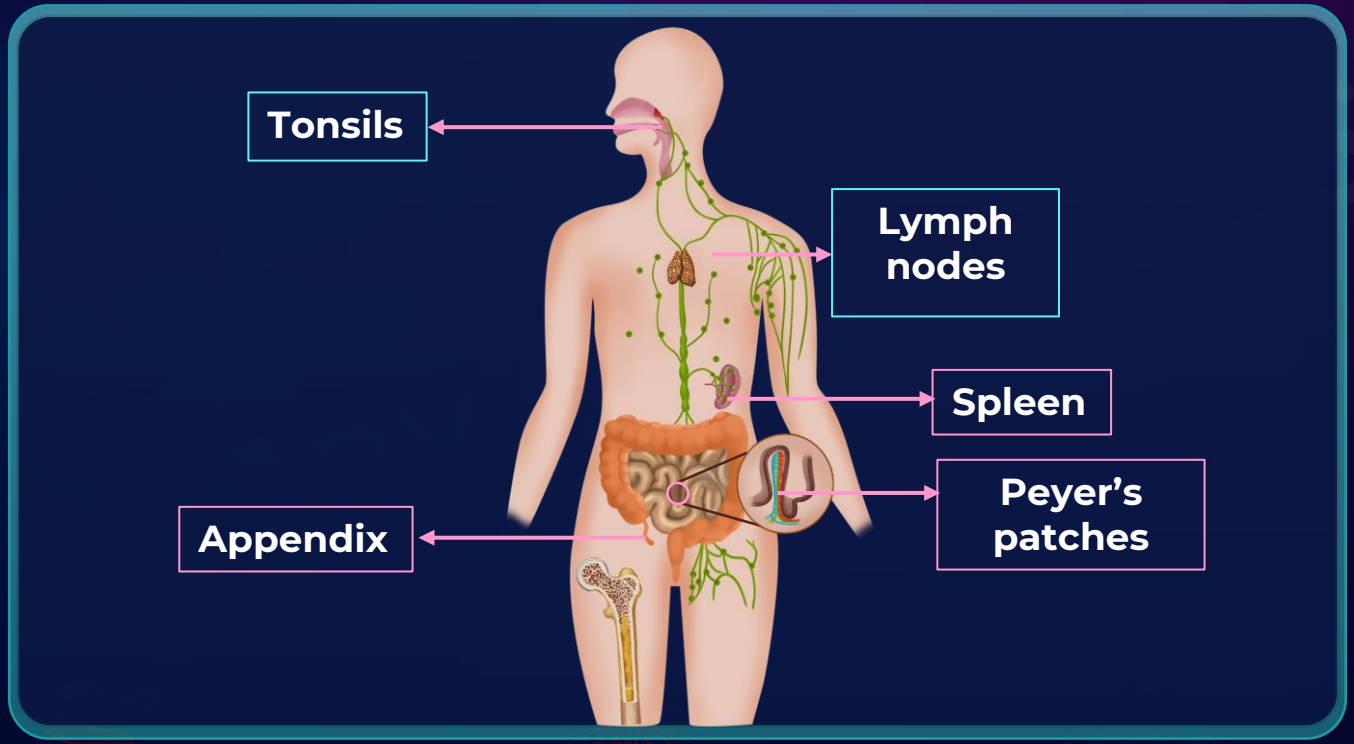


Secondary Lymphoid Organs

- These **lymphocytes** then **proliferate** and increase in number when a pathogen attacks.
- They increase in number to fight against the pathogens.
- **Mature lymphocytes** differentiate into **effector cells** and elicit immune response.
- **Effector lymphocytes** -They identify antigens and **kill the pathogen.**

Secondary Lymphoid Organs

Organs where **mature lymphocytes** interact with the **antigen** and then **proliferate** to become **effector cells.**



Secondary Lymphoid Organs

Tonsils

- These are **two round** lumps.
- **Location** - Either side of **back throat**
- They provide **1st line of defense** against **ingested** or **inhaled pathogens (**They are the first ones to attack the pathogen).

Spleen

- It is a large **bean shaped** organ.
- **Location - High, left** side of **abdominal cavity.**
- It contains **lymphocytes** and **phagocytes** (cell-eating cells).
- **It acts** as **filter** of **blood** and traps blood-borne microorganisms.
- It is a large reservoir of **erythrocytes (RBC).**
- It is commonly referred to **as graveyard of RBCs.**

Secondary Lymphoid Organs

Appendix

- It is a **finger** like structure.
- It is located at the **junction** of small intestine and large intestine.
- The **function** of appendix is **unclear**.

Peyer's patches

- **They are patch** like structures.
- They are located in the **mucosal layer** of **small intestine,** usually in the ileum area.
- They **trap microorganism** which enter through **digested, absorbed food.**
- Trapped antigen **stimulates** and **activates the lymphocytes** present there.

Secondary Lymphoid Organs

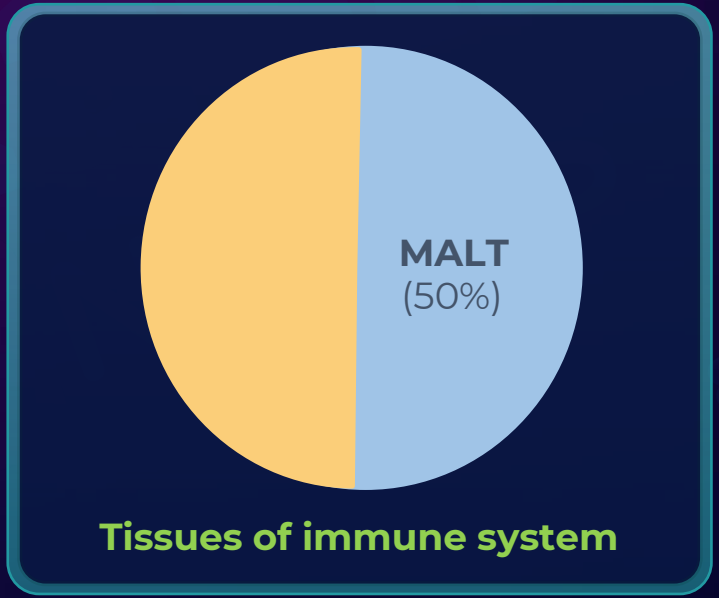
Lymph nodes

- They are **small, solid** node like structures.
- **Location** - Various points along the lymphatic system.
- **Traps microorganism** which enter **lymph** and **tissue fluid.**
- Trapped antigen then **stimulates** and **activates lymphocytes** present there
- Lymph nodes have a huge, extensive network in the entire body which constitutes an entire system called **lymphatic system**.

Immune Tissue

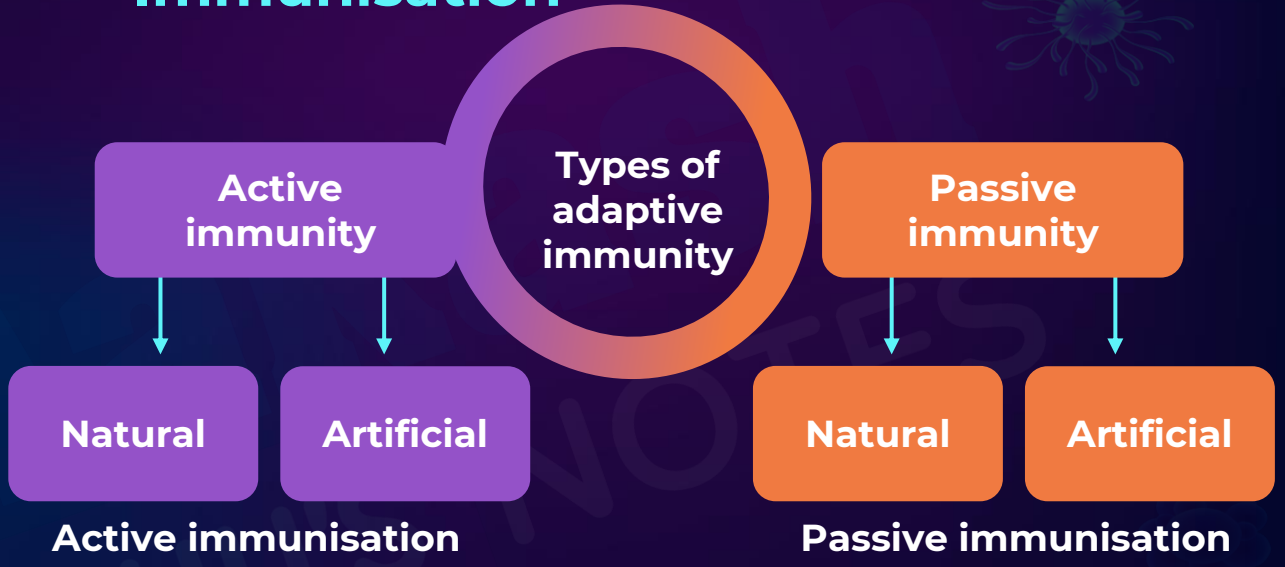
Mucosa associated lymphoid tissue

- Mucosa-associated lymphoid tissue (MALT) specializes in mucosal defense and is present on the body's **mucosal** surfaces.
- It constitutes **50%** of lymphoid tissue in human body.
- Location - Lining of major tracts
  - Respiratory tract
  - Digestive tract
  - Urogenital tract



Immunisation

It is a process by which an individual's immune system becomes equipped with antibodies against a pathogen.



Active immunisation

- Exposure to an antigen triggers the immune system to produce antibodies in the **host body**.
- Certain vaccines belong to this category.

Passive immunisation

- Preformed antibodies are injected into the body to provide a quick immune response.
- Vaccines made from toxins belong to this category.

Passive Immunisation

- It is needed when a person has insufficient time to produce antibodies against a high risk of infection.
- For example, a **bite** from a **venomous snake** introduces deadly toxins inside the victim.
    - This can have dangerous effects and can be fatal in some cases.

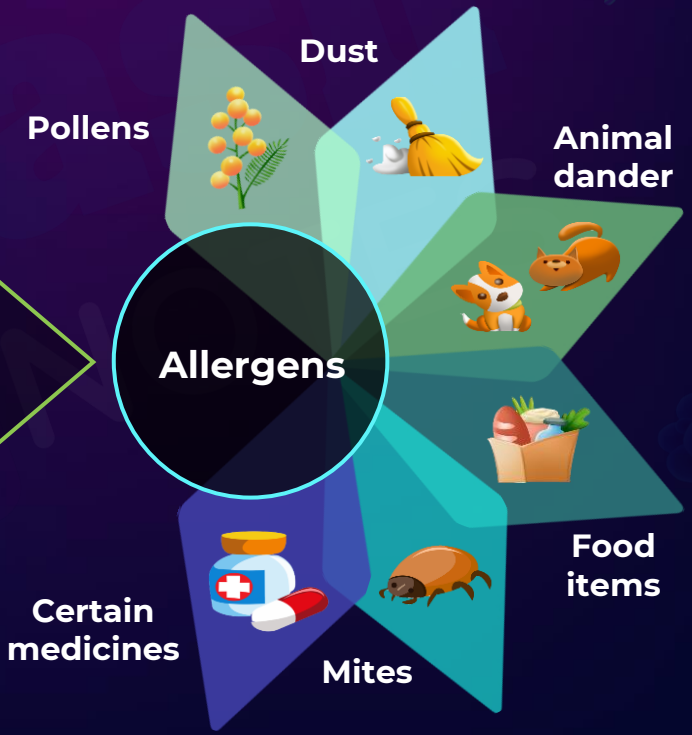
Passive Immunisation

- In such cases, an injection with **preformed antibodies** against the snake venom is given to the patient. These antibodies **neutralize** the venom and reduce its effects.
- These antibodies are usually **generated** in **horse** or **rabbits**, collected and kept ready for emergency use.

Allergy

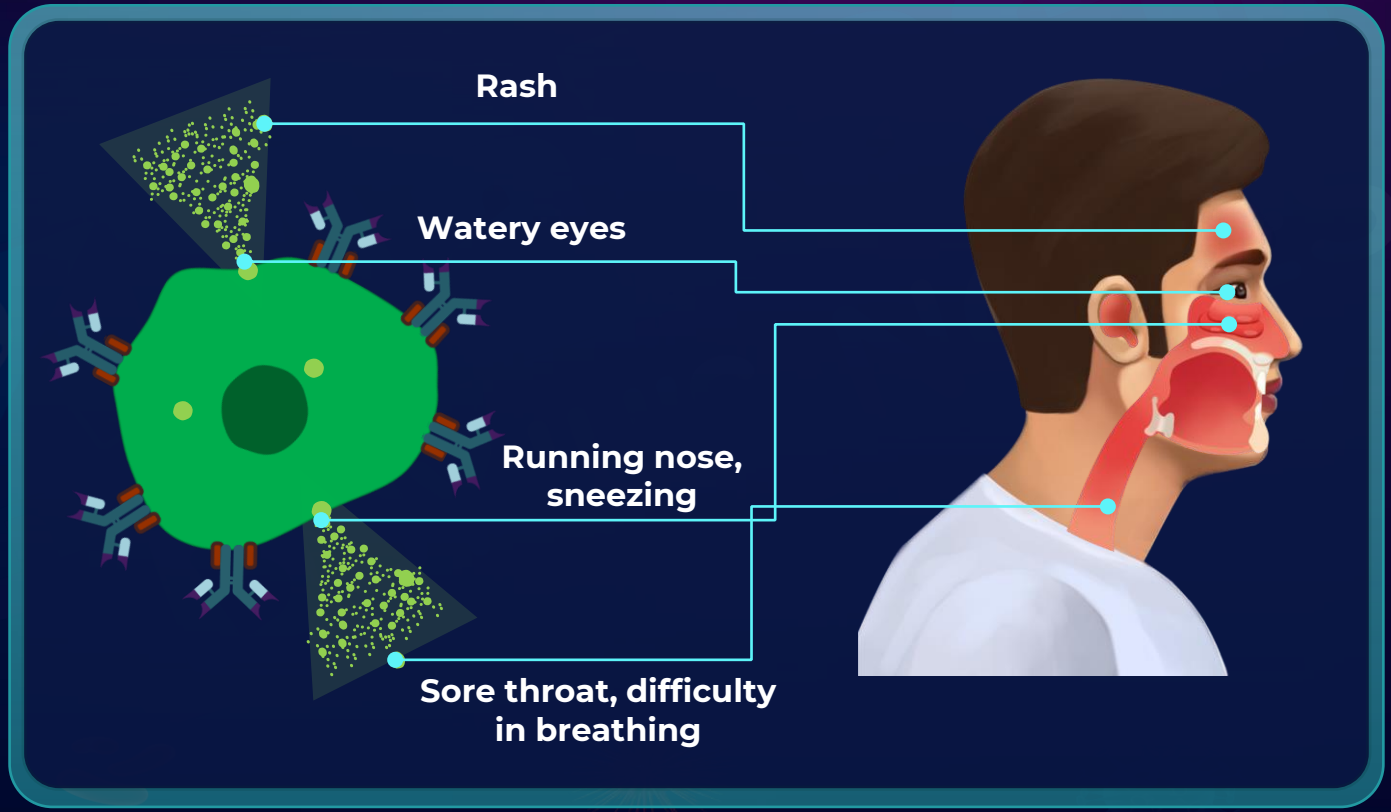
The **exaggerated response** of the immune system to **certain antigens** present in the environment is called **allergy**.

Substances which trigger such exaggerated response



Allergy

Symptoms



Allergy

Diagnosis

- Patient is exposed to or **injected with** very small doses of **possible allergens,** and the reactions are studied.

Treatment

- The use of drugs like **antihistamine, adrenaline** and **steroids** quickly reduce the symptoms of allergy.
- These drugs **decrease inflammation** or act against the histamines.

Autoimmune Diseases

- In an autoimmune disease, the immune system **mistakes** part of the body like joints or skin as foreign and starts **attacking** them (**self-cells**).
- Example: **Rheumatoid arthritis**
  - It is **inflammation** of joints.
  - It **worsens** with age.
  - Its symptoms are **joint pain** and **stiffness.**

Diseases

- Condition where functioning of one or more organs of body is adversely affected.
- It presents with different signs and symptoms.

Types of diseases

Non-infectious diseases

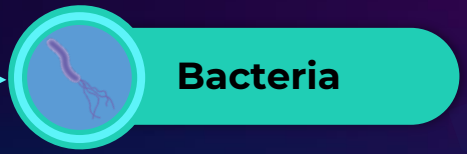
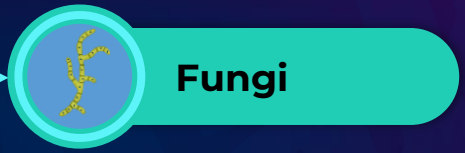
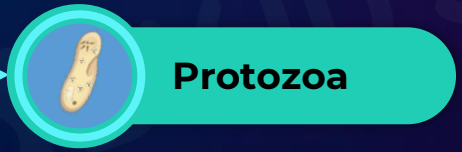
- Do **not spread**
- Also known as **non-communicable or non-contagious diseases e.g.:**
  - Cancer
  - Diabetes
  - Genetic disorders
  - Allergy
  - Autoimmune diseases, etc..

Infectious diseases

- **Spread** from one person to another
- Also known as **communicable or contagious diseases**
- Caused by **pathogens**

Disease

Pathogens

- Bacteria 
- Fungi 
- Virus 
- Protozoa 
- Helminths 

Bacterial Diseases

Typhoid

Tuberculosis

Pneumonia

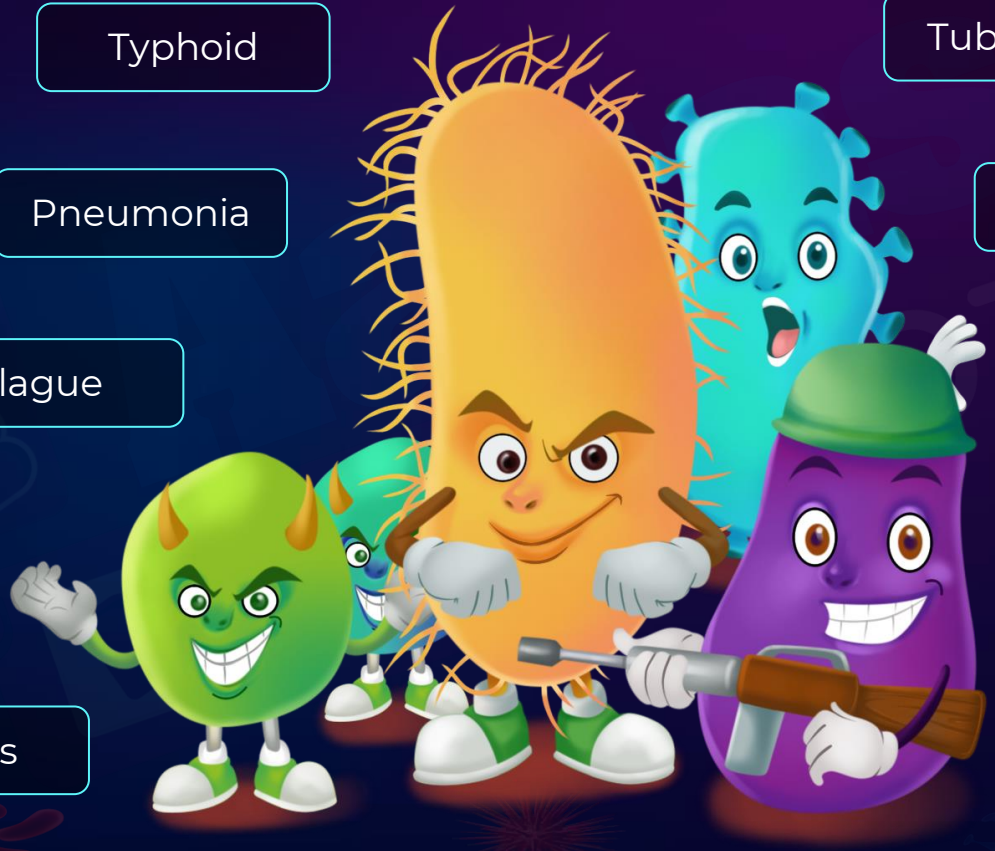
Cholera

Plague

Diphtheria

Dysentery

Tetanus



Typhoid

Causative agent - *Salmonella typhi*

Mode of transmission

- ***Salmonella*** can be transmitted through **contaminated food and water.**
- Insects like flies can be carriers for the *Salmonella*.
- Flies sitting on human faeces can pick up these bacteria.
    - When the same fly sits on food, it transmits bacteria to food, thereby acting as a carrier
- Migrates to different organs through blood

Symptoms

- Sustained fever (39-40^{O}C)
- Weakness
- Stomach pain
- Constipation
- Headache
- Loss of appetite
- Intestinal perforation or death may occur in severe cases

Test

- Widal test

Pneumonia

Causative agent - Bacteria like *Streptococcus pneumonia, Haemophilus influenzae*

Mode of transmission

- By **inhalation of droplets**/aerosols released by an **infected person**
- By **sharing** glasses and utensils with infected person
- Hospitalised patients and people with **weak immune system** are affected by pneumonia more often.

Symptoms

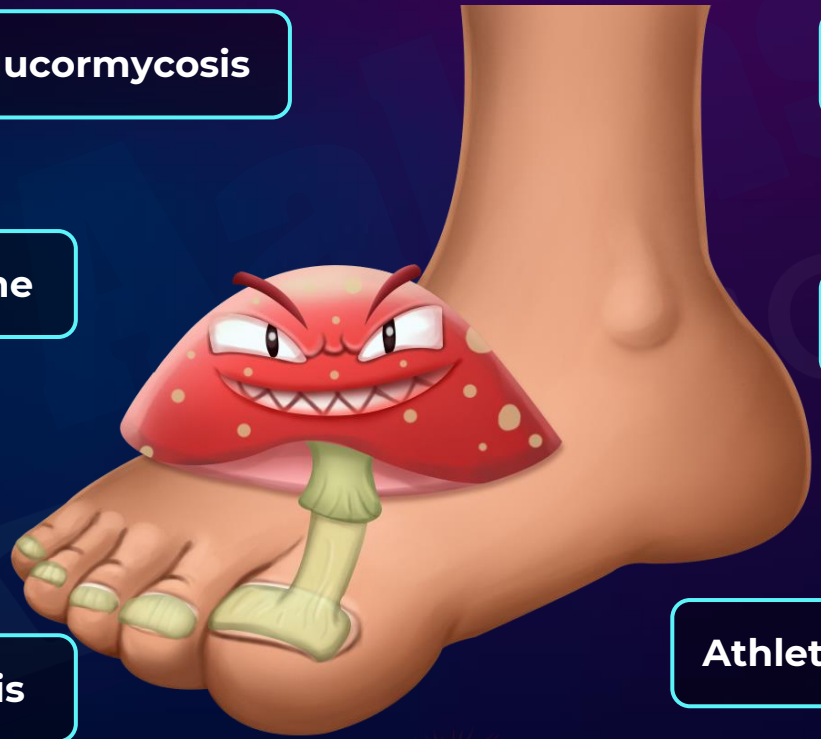
- **Alveoli** of the lungs are infected and get **filled with fluid** leading to **respiratory problems**
- Fever
- Chills
- Cough
- Headache
- Lips and nails may turn grey to bluish in severe cases

Fungal Diseases

Mucormycosis

Ringworm

Fungal acne



Aspergillosis

Candidiasis

Athlete’s foot

Ringworm

- Mycelia of pathogenic fungi grown on epidermis of the skin
- Diagnosed by **scraping the lesion and observing** under the microscope

Transmission:

- Through direct contact with an infected person or pet
- By sharing of combs, bath towels, nail cutters etc. with infected person

Treatment:

- **Topical creams**, **antifungal soaps and shampoos**
- **Oral antifungal drugs** are also given in severe cases

Causative genera

- It is caused by three genera of fungi -
  - ***Microsporum***
  - ***Trichophyton***
  - ***Epidermophyton***

Symptoms

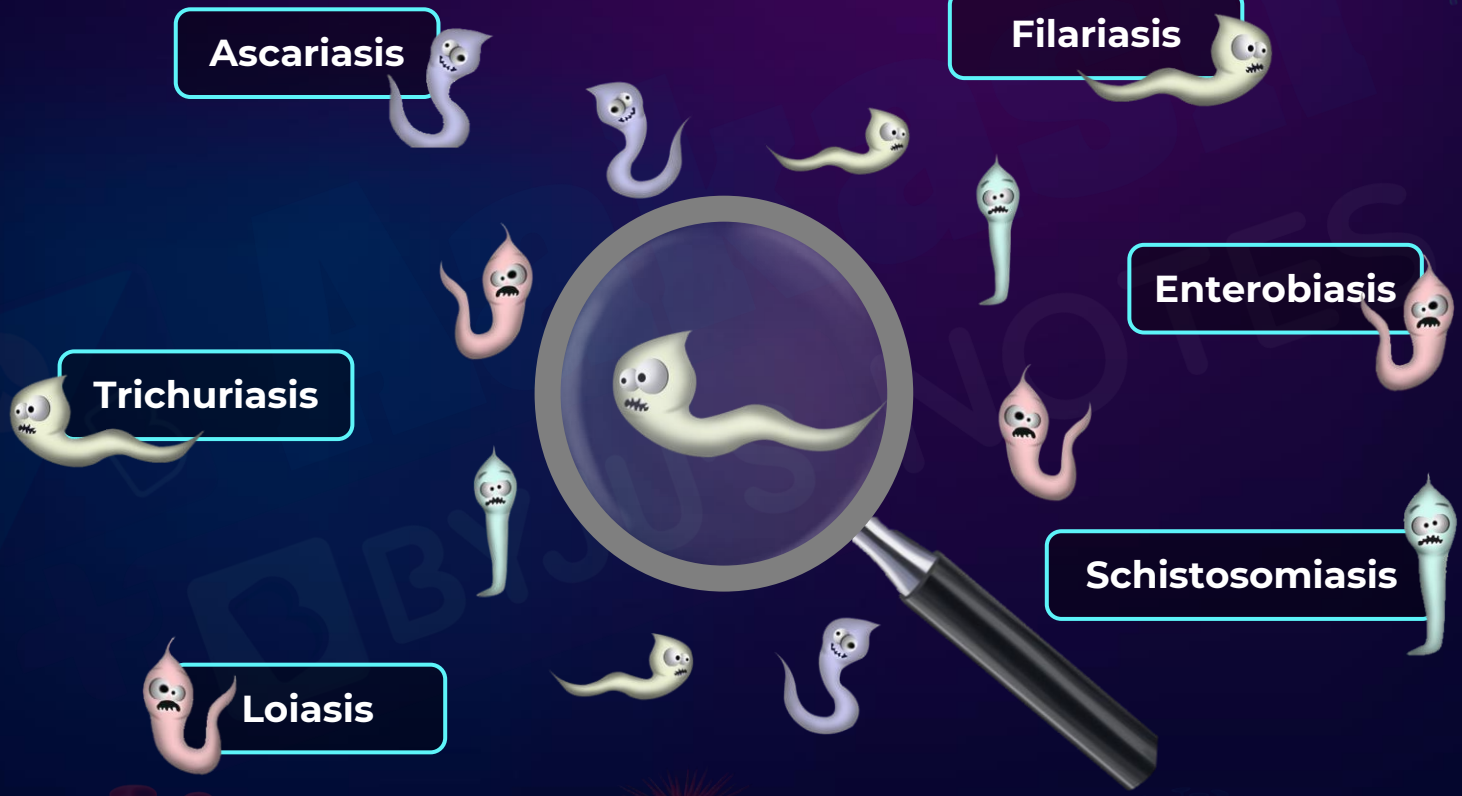
- Fungi specially infect areas like **neck, armpit, trunk, groin, scalp** and **under the nails**
- Circular, red, flaky, itchy and burning rash
- Appearance of **dry, scaly lesions** on various parts of the body such as skin, nails and scalp

Ringworm

Variations

- **Tinea pedis**
  - Also called **Athlete's foot**
  - Commonly seen in **sportsmen who wear tight shoes**
  - Appears as **red flaky rash between the toes**
- **Tinea cruris**
  - Leads to pain in **groin** and **perineum**
- **Tinea barbae**
  - Affects **bearded areas of the face** and **neck**

Helminthic Diseases



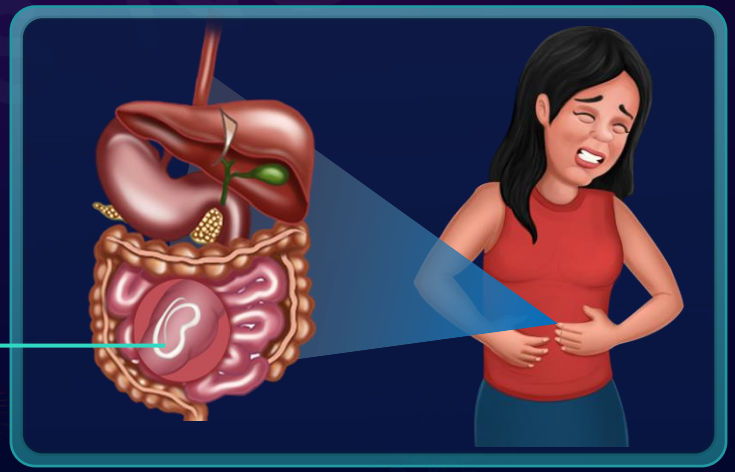
Ascariasis

- *Ascaris* (roundworm) is a parasitic nematode which infects small intestines.
- It is also known as **intestinal worm.**
- This disease is found in tropical countries with poor hygiene and sanitations.
- The worms **live and mature in the small intestine.**
- They grow to an extent that they block the intestinal passage.

Causative organism

Ascaris lumbricoides

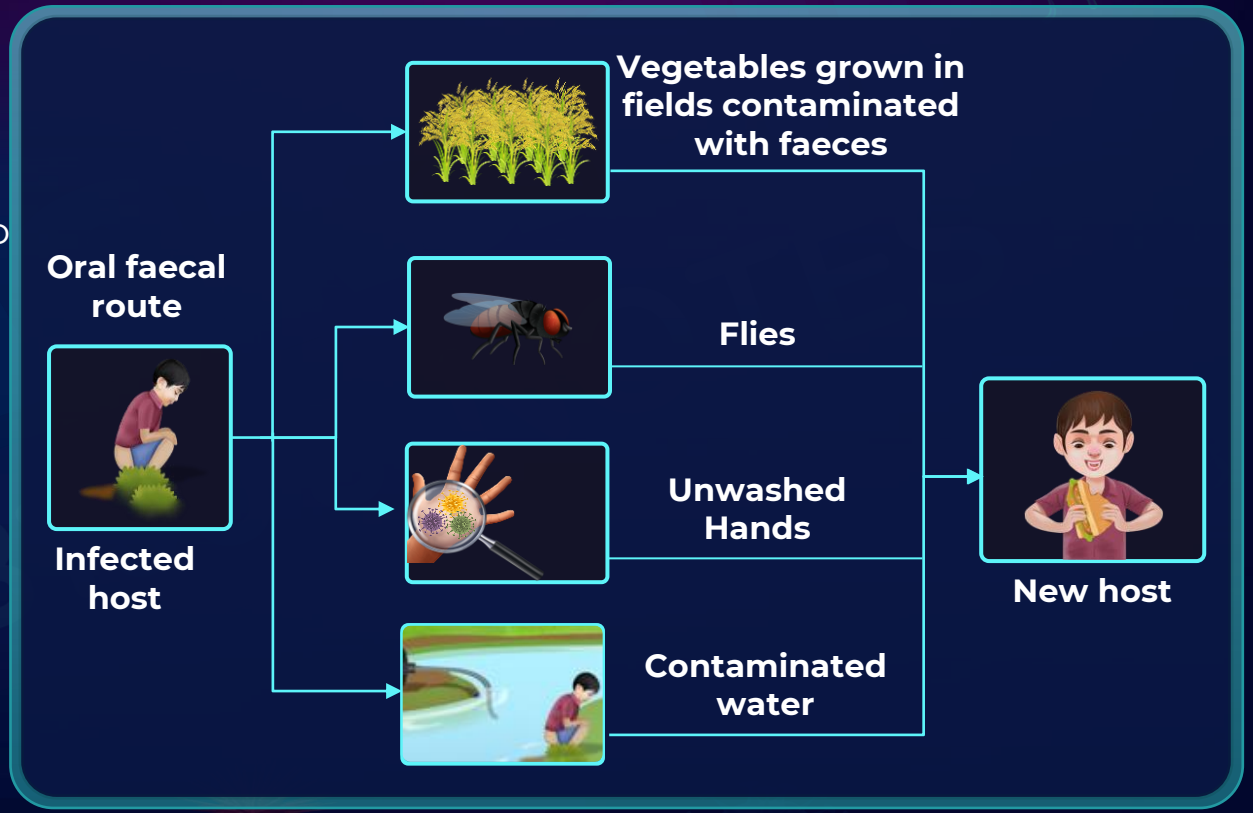
Ascaris



Ascariasis

Transmission

- Infected human's **faeces containing *Ascaris* eggs** can get **mixed with the soil** due to poor sanitary facilities.
- Unwashed fruits or vegetables that are grown in contaminated soil can **transmit the ascariasis eggs when healthy humans consume them.**

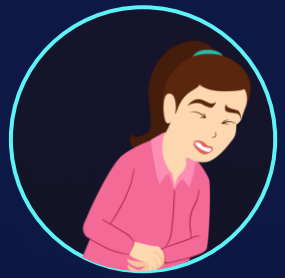


Ascariasis

Treatment

- **Anti-helminthic drugs** like Albendazole and Mebendazole are given to **kill worms**
- In severe case, worms block intestinal passage. They are **surgically removed.**
- Ascariasis can be prevented by practicing proper hygiene and sanitation.

Symptoms



Abdominal and muscle pain

Presence of worms and eggs in feces

Abnormal weight loss

Anaemia

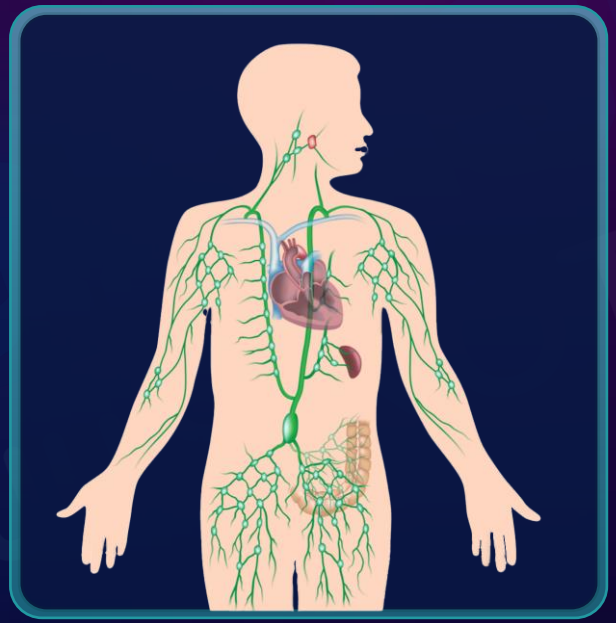
Fever

Blockage of intestinal passage

Filariasis

Causative organism

Wuchereria bancrofti and *Wuchereria malayi*



Lymphatic system

The parasitic worms live in the **lymphatic system (lymph nodes/lymphatic vessels).**

Also called **Elephantiasis**, due to its resemblance to leg of an elephant

Filariasis

Transmission

- Through the **bite of female mosquito vectors.** E.g.: Culex mosquito

Symptoms

- Slowly developing chronic infection and inflammation of organs
- Swelling of legs, scrotum and other parts
- Usually affect the lymphatic vessels

Treatment

- **Anti-helminthic** drugs are given to kill the worms.
- They reduce the density of early stage (microfilariae) in blood stream.
- Thus, they help prevent spread of parasites to mosquitoes.
- In severe cases, where worms block the intestines, worms are **surgically** removed.

Protozoan Diseases

There are many protozoan pathogens that **only infect humans and can be deadly.**

Babesiosis

Malaria

Amoebiasis

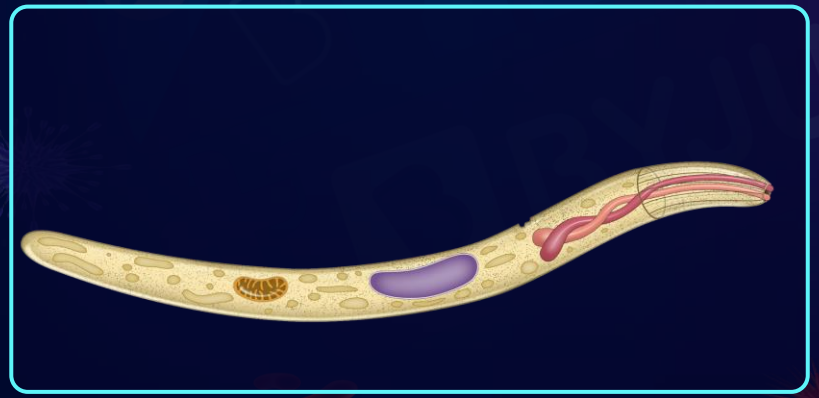
Leishmaniasis

Cryptosporidiosis

Trypanosomiasis

Malaria

Causative organism
Plasmodium



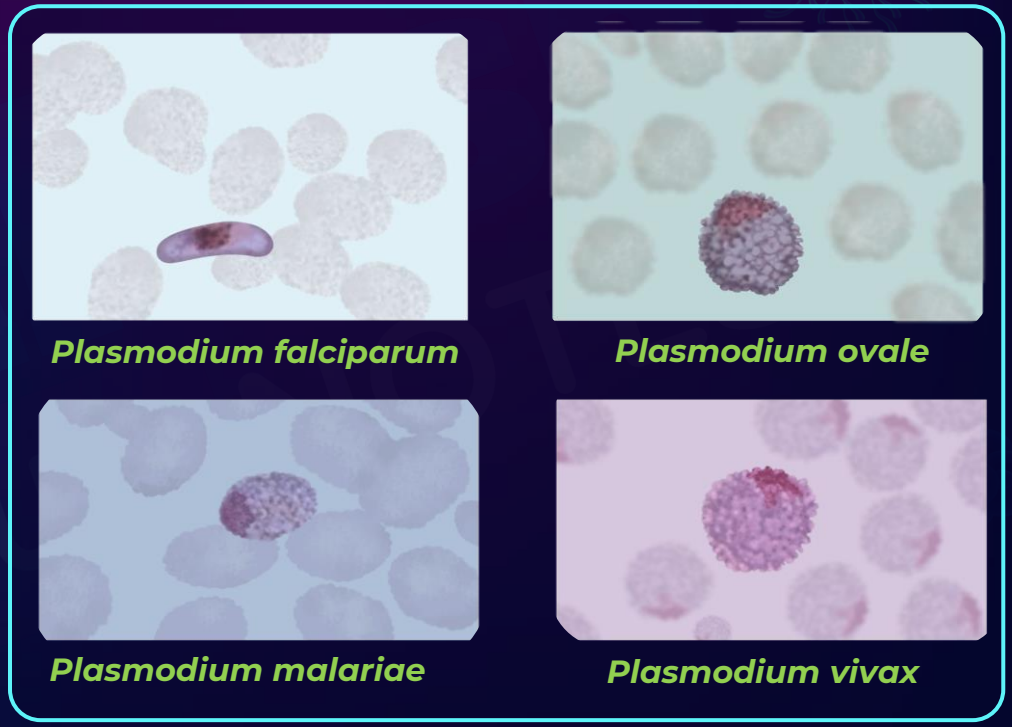
Female *Anopheles* mosquito

- Plasmodium is transmitted through the bite of female ***Anopheles mosquito.***

Malaria

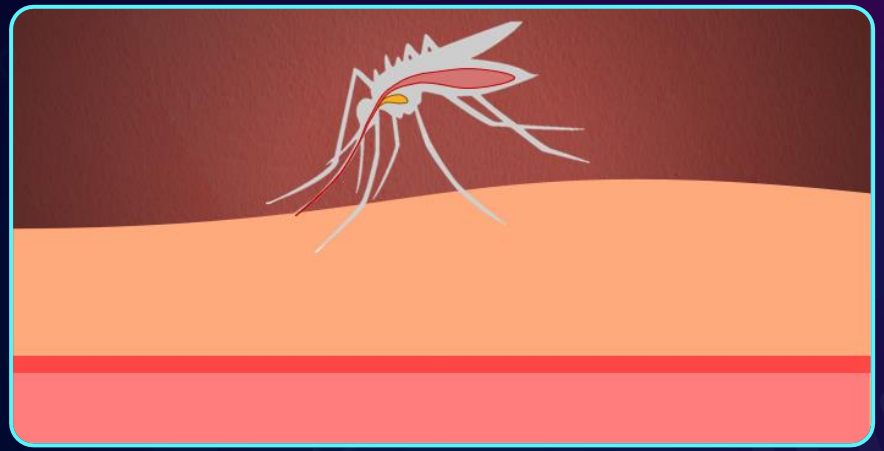
Plasmodium are of 4 types:

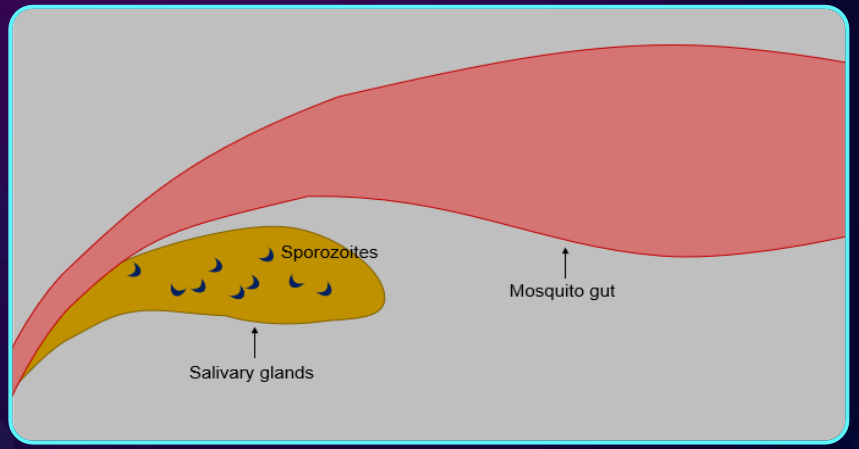
- *Plasmodium vivax* - Common
- *Plasmodium ovale* - Rare
- *Plasmodium falciparum* - Most dangerous, can be fatal
- *Plasmodium malariae*



- It involves **two hosts - human and mosquito.**

Lifecycle of Plasmodium

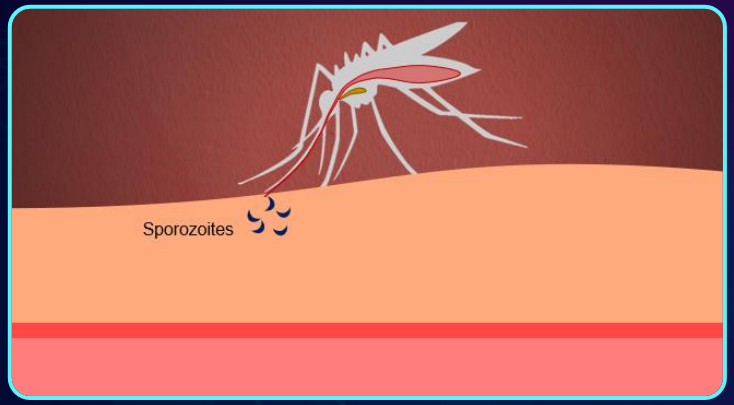




- **Infected mosquito** sits on human host to suck blood.

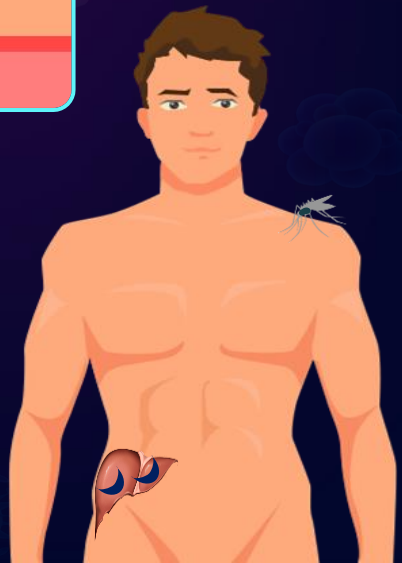
- Malarial parasite *Plasmodium* are found in the salivary glands of mosquito as **sporozoites.**

Lifecycle of Plasmodium



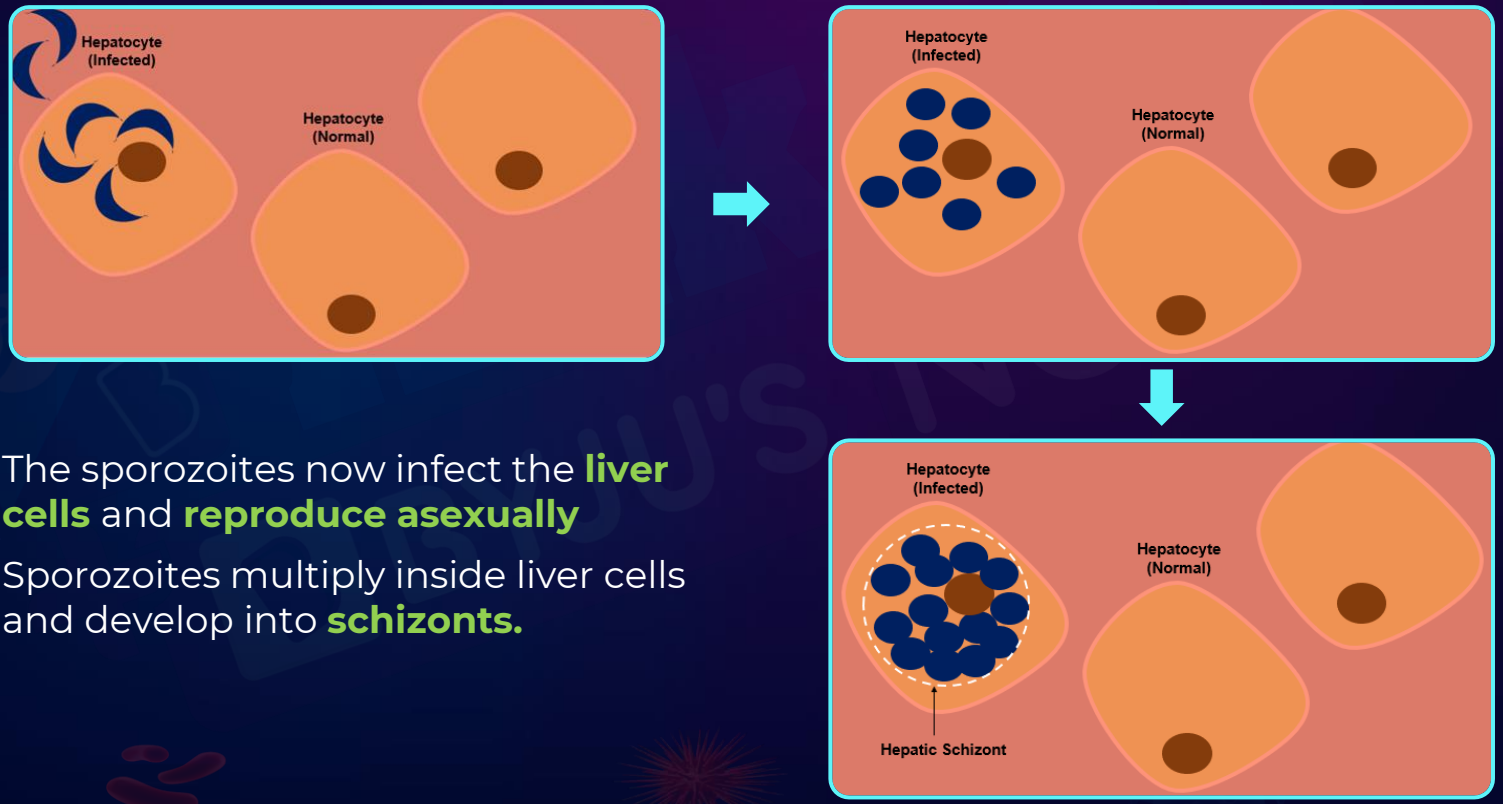
- Mosquito **injects *Plasmodium* sporozoites** into the human body

- Injected **sporozoites reach bloodstream**



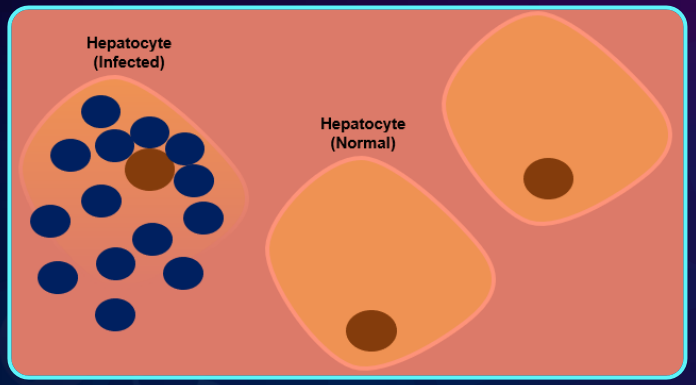
- From the bloodstream, **sporozoites travel to the liver.**

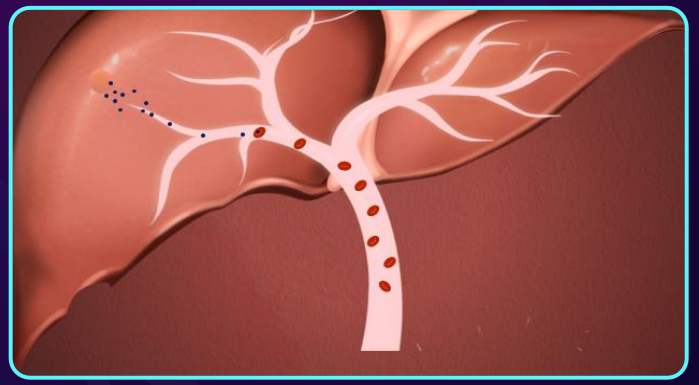
Lifecycle of Plasmodium



- The sporozoites now infect the **liver cells** and **reproduce asexually**
- Sporozoites multiply inside liver cells and develop into **schizonts.**

Lifecycle of Plasmodium

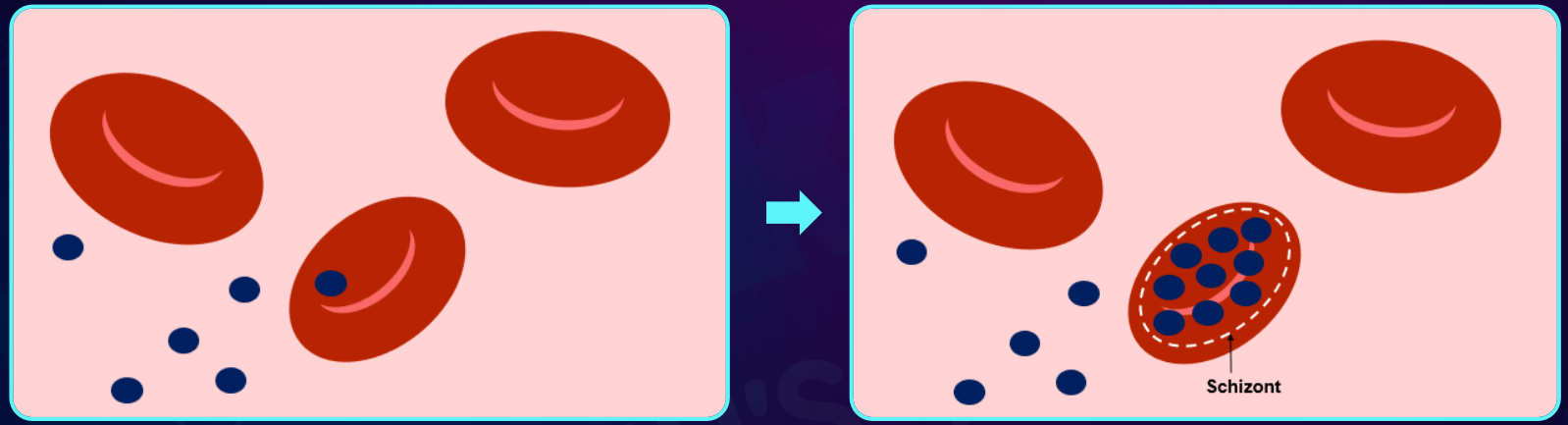




- Each sporozoite **multiplies** to form **schizonts** that matures to form ~ 40,000 **merozoites.**
- Liver cells rupture over a period of several weeks to release **merozoites**

- Merozoites released from liver **re-enter the** bloodstream.
- At this stage, merozoites are also called **cryptozoites.**

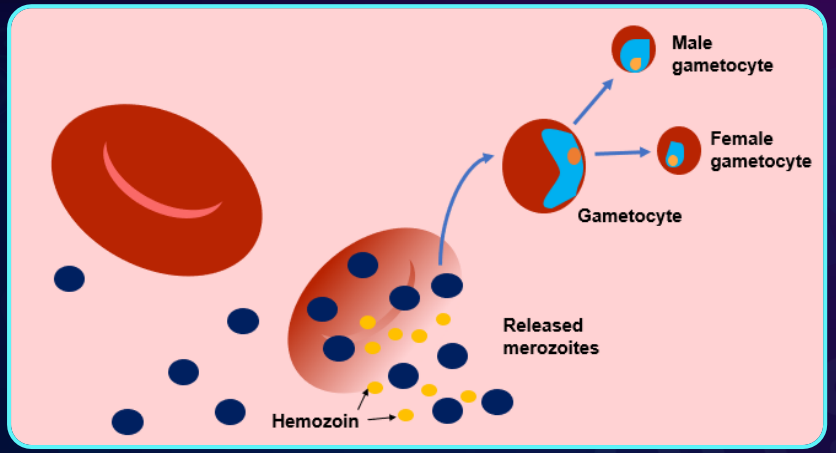
Lifecycle of Plasmodium

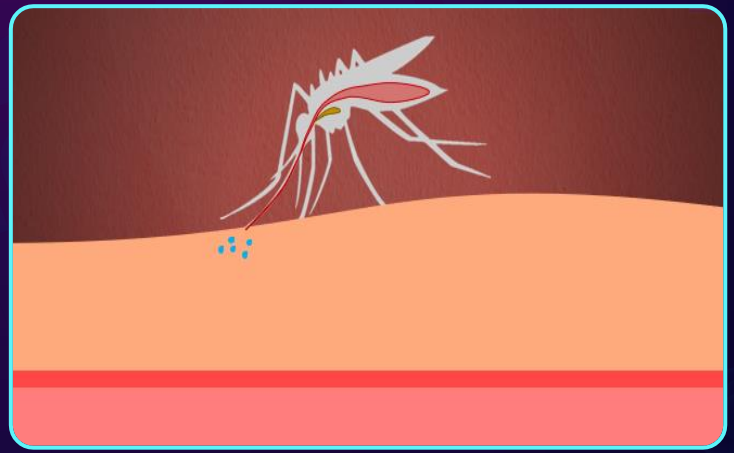


- The merozoites infect the **RBCs and reproduce** asexually.
- The released parasites then infect other **new RBCs.**

- The **merozoites** mature **and multiply** to form blood-stage schizonts.

Lifecycle of Plasmodium



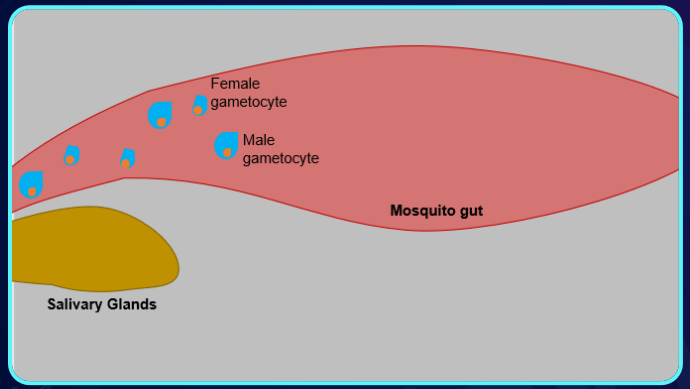


- The **merozoites develop sexually into gametocytes** in the RBCs.
- The rupture of RBCs is associated with release of a toxic substance, **haemozoin**, which is responsible for **the chill and high fever** recurring every three to four days.

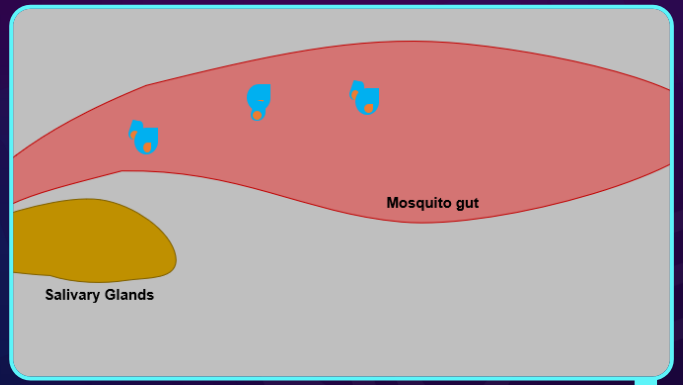
- When a female Anopheles mosquito bites an infected person, these parasites enter the mosquito's body and undergo further development, the **mosquito takes in the *Plasmodium* gametocytes along with the blood.**

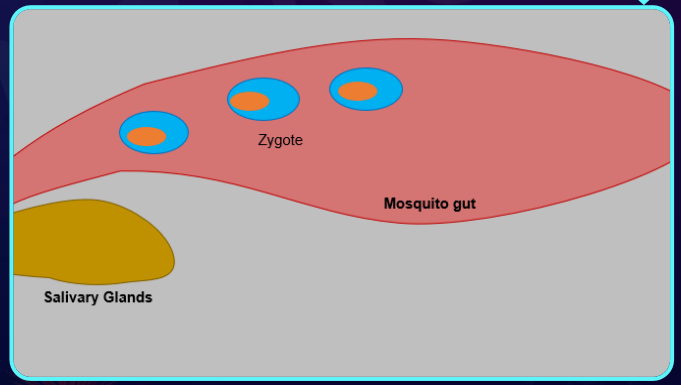
Lifecycle of Plasmodium

- These **gametocytes** enter the mosquito gut.



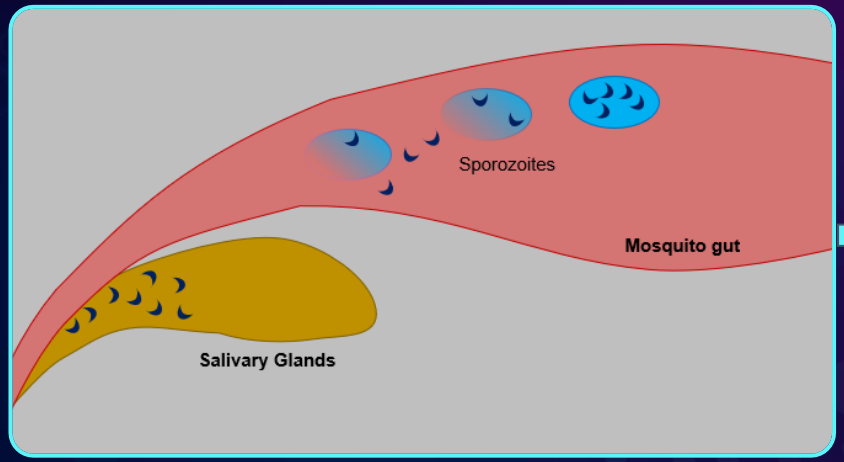
- These zygotes develop and mature in the mosquito gut to finally form **sporozoites.**

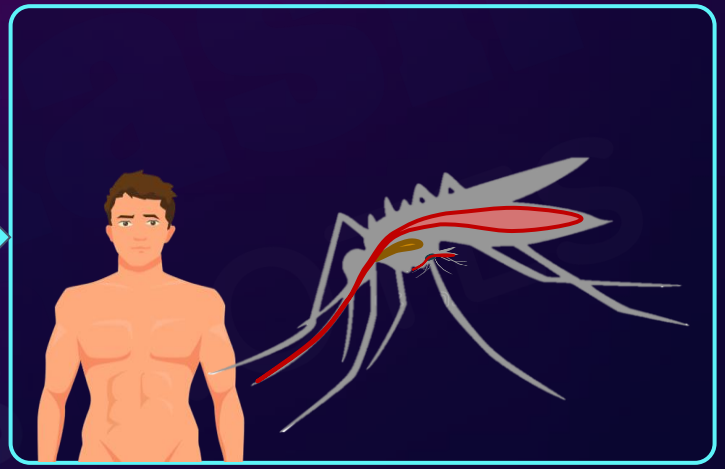




- Then the male and the female gametocytes **fuse** to form zygotes i.e., they reproduce sexually.

Lifecycle of Plasmodium

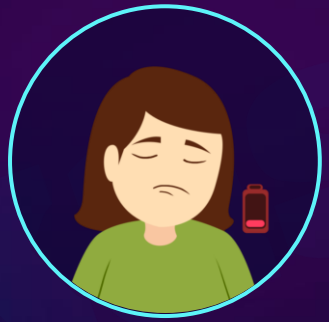




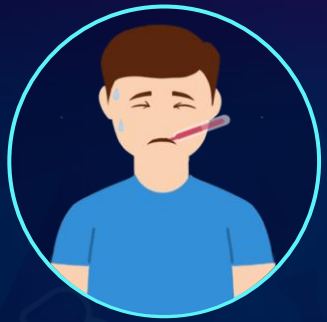
- The **sporozoites** formed then enter the **salivary glands** of the **mosquito**.
- Then these sporozoites are injected into the human body during the next blood meal i.e., when the mosquito bites another human being.
- Same mosquito **injects the sporozoites into uninfected human** and the cycle continues.

Malaria

Headache



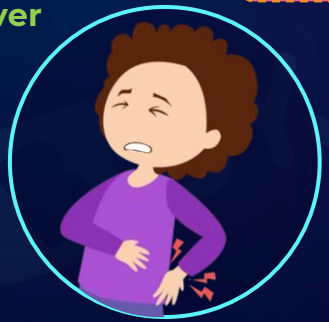
Fatigue



Fever

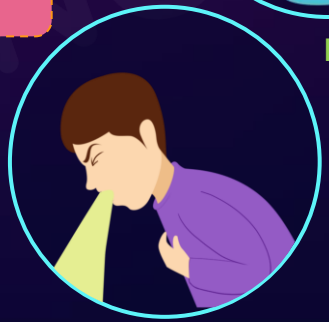
Symptoms

Nausea



Muscle ache

Chills

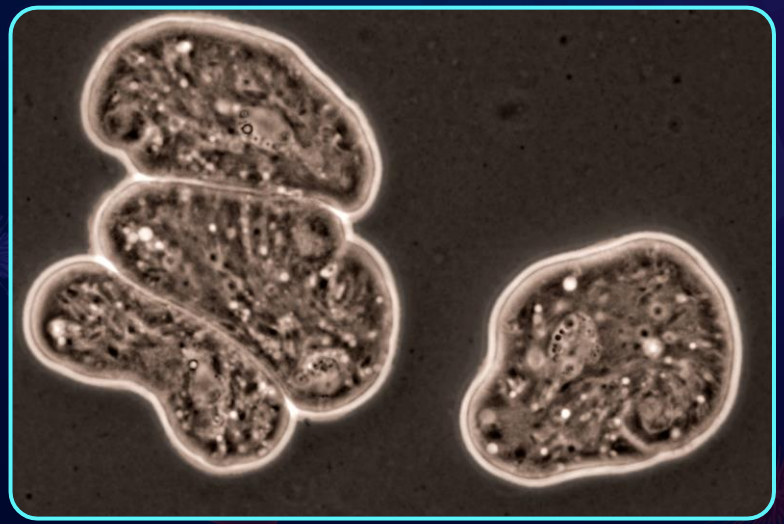


Vomiting

Amoebiasis

- Amoebiasis is caused by a protozoan.

Causative organism
Entamoeba histolytica



Transmission

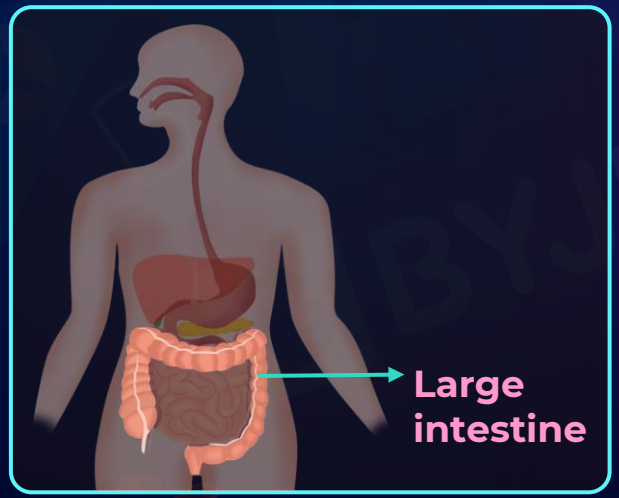
- House flies act as **mechanical carriers** (transfer parasites from faeces to food and water).

- Drinking **contaminated water and food** infects the person.

Amoebiasis

Effect

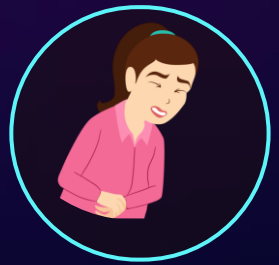
- ***Entamoeba histolytica*** is a protozoan parasite in the **large intestine** of human which causes **amoebiasis** (amoebic dysentery).



Symptoms

Fatigue

Loose stools with blood and mucus



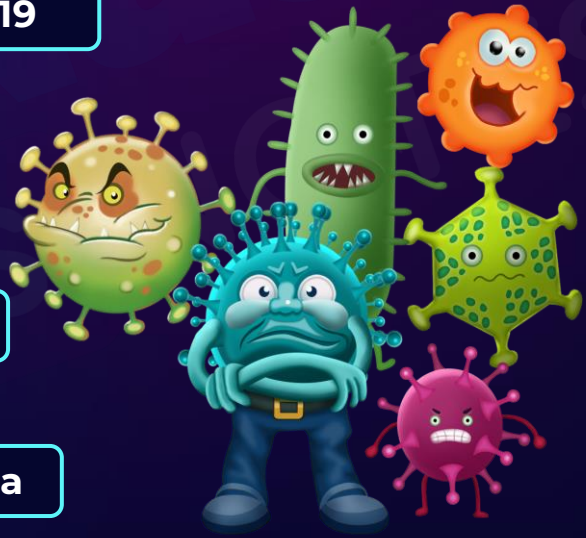
Stomach ache

Constipation

Viral Diseases

- Many viruses causes various diseases - Mild to severe.

- People sneezing and coughing without covering the mouth leads to spread of droplets that carry viruses.



Common Cold

Causative organism

- Rhinovirus affects **nasal and respiratory tract** (not the lungs).
- Common cold virus **cannot be treated with any medications.**

Rhinovirus

Transmission

- Aerosols from an **infected person**
- Contact with **infected surfaces** like mouse, keyboard, pen books, cups etc

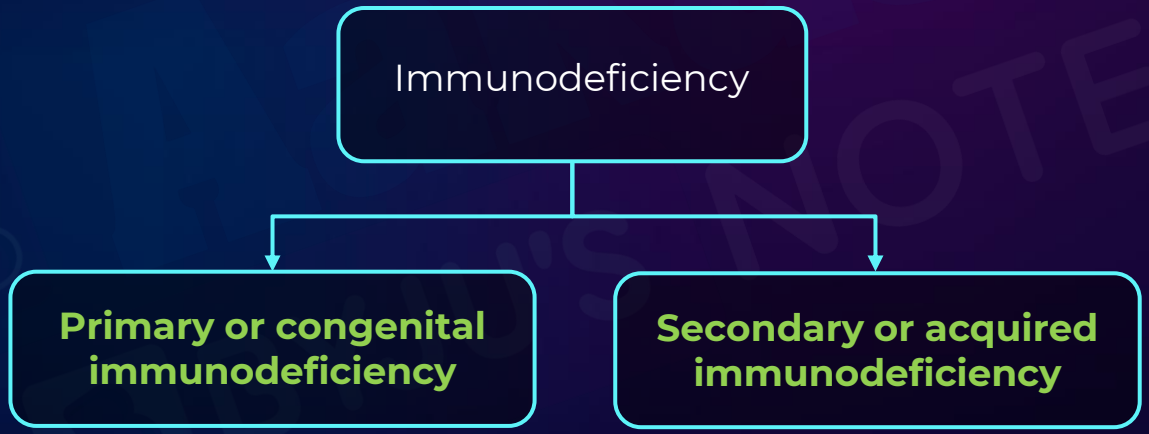
Symptoms

- Cough
- Sore throat
- Headache
- Fatigue
- Nasal congestion and runny nose
- Hoarseness in voice

Immunodeficiency

Inability of the immune system to fight against infectious diseases

Types

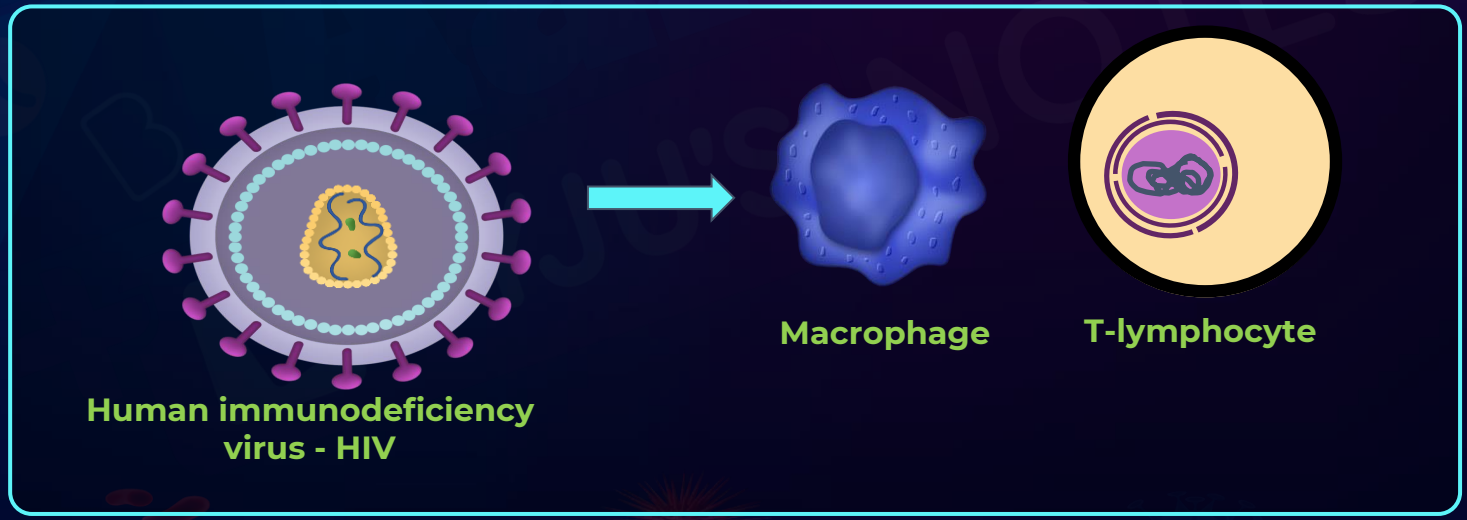


- Congenital and is caused by genetic factors
- Example - **SCID (Severe combined immunodeficiency)**

- Acquired and caused due to external factors
- Example – **HIV/AIDS**

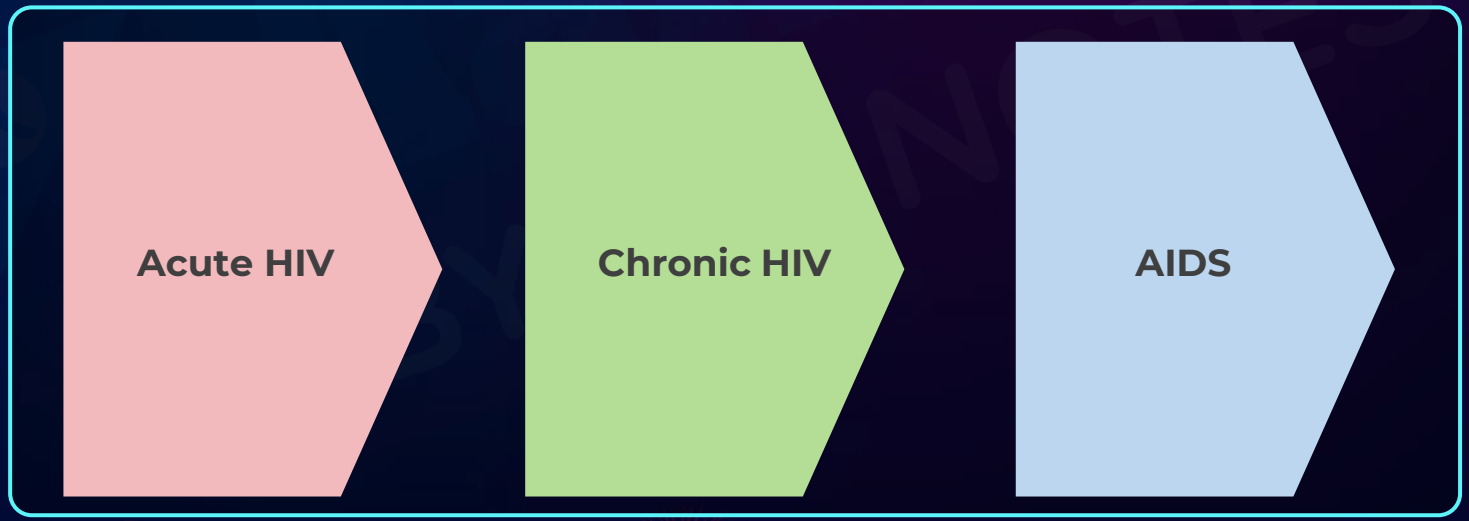
HIV/AIDS

- AIDS or acquired human immunodeficiency syndrome is caused by the infection of human immunodeficiency virus.
- **HIV** is a virus that infects the **macrophages** and **T lymphocytes** (since it affects and damages the immune cells), thus it **leads to immunodeficiency.**
- HIV causes **AIDS.**
- All individuals with AIDS are **HIV positive.**
- However, **all HIV positive individuals do not have AIDS.**



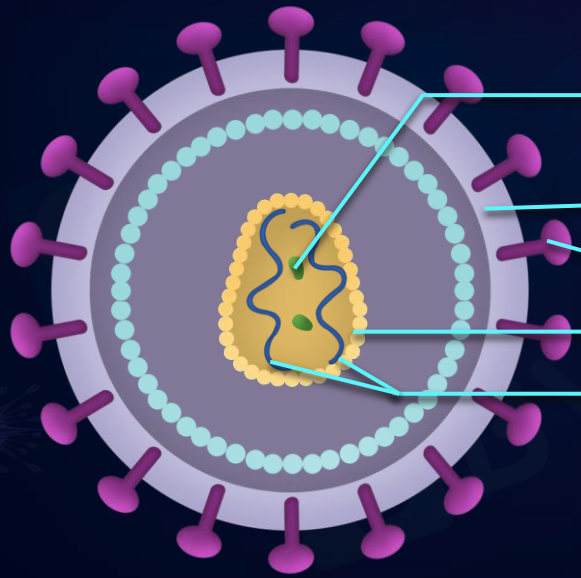
HIV/AIDS

- Initial HIV infection itself does not cause AIDS.
- HIV progresses in three different stages – **acute, chronic and AIDS.**
- Thus, **AIDS** is the **ultimate stage** of HIV infection.
- So, a patient who is HIV positive **might be** in **any of the 3 stages,** not essentially AIDS.



Human Immunodeficiency Virus

Structure



Reverse transcriptase (present within the capsid**)**

Viral envelope (outermost layer**)**

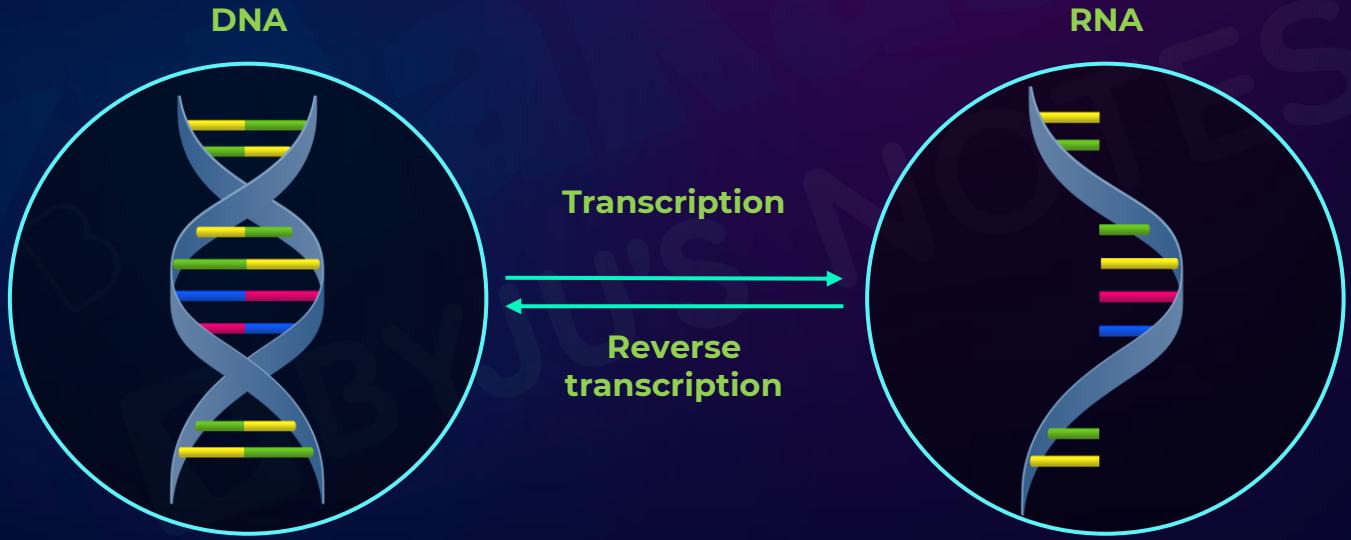
Glycoprotein (spike - like structure, embedded in envelop**)**

Capsid (made up of protein, present within the envelop **)**

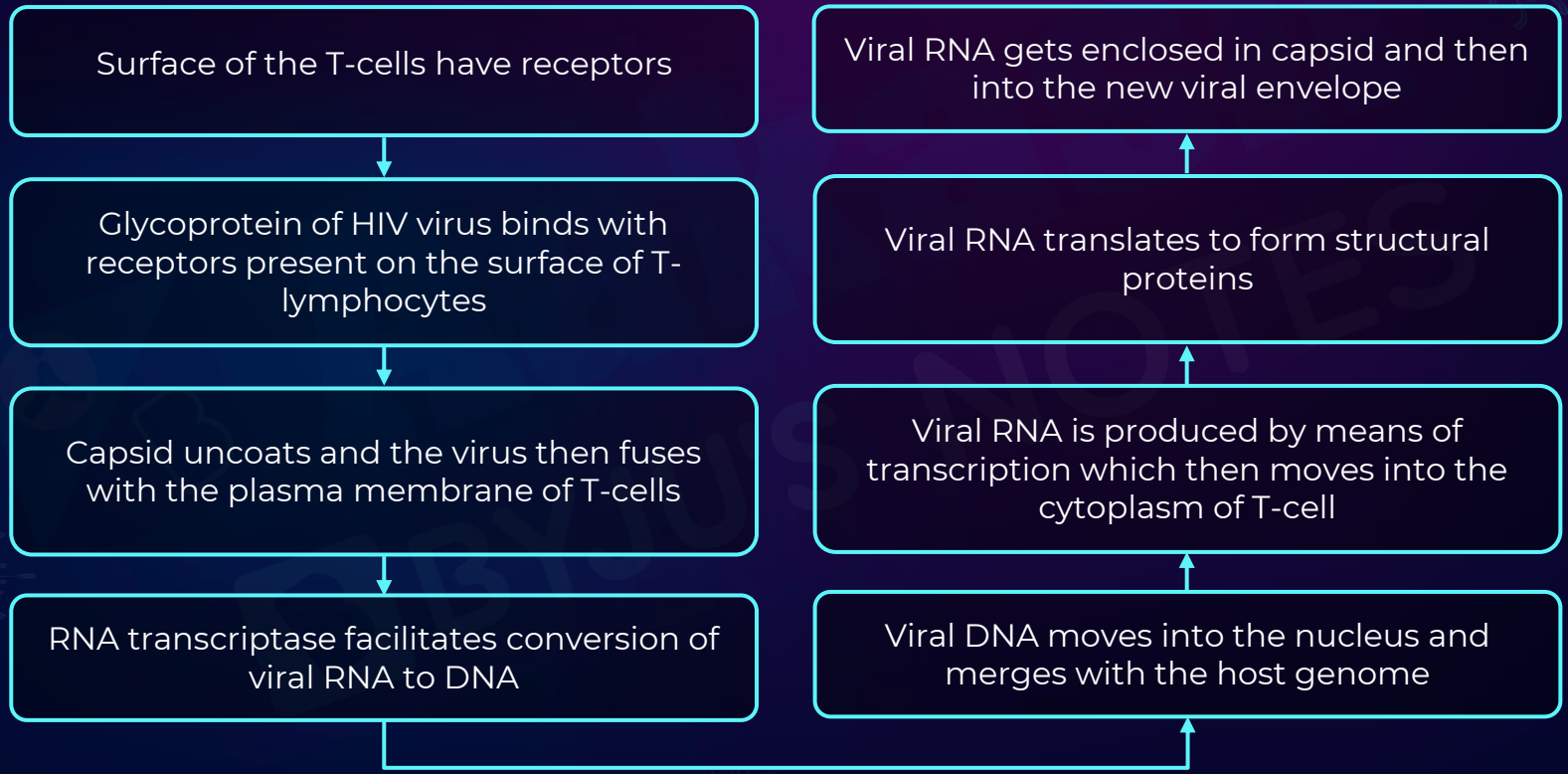
ssRNA (HIV is a type of retrovirus as it contains two single stranded RNA**)**

Reverse Transcriptase – Function

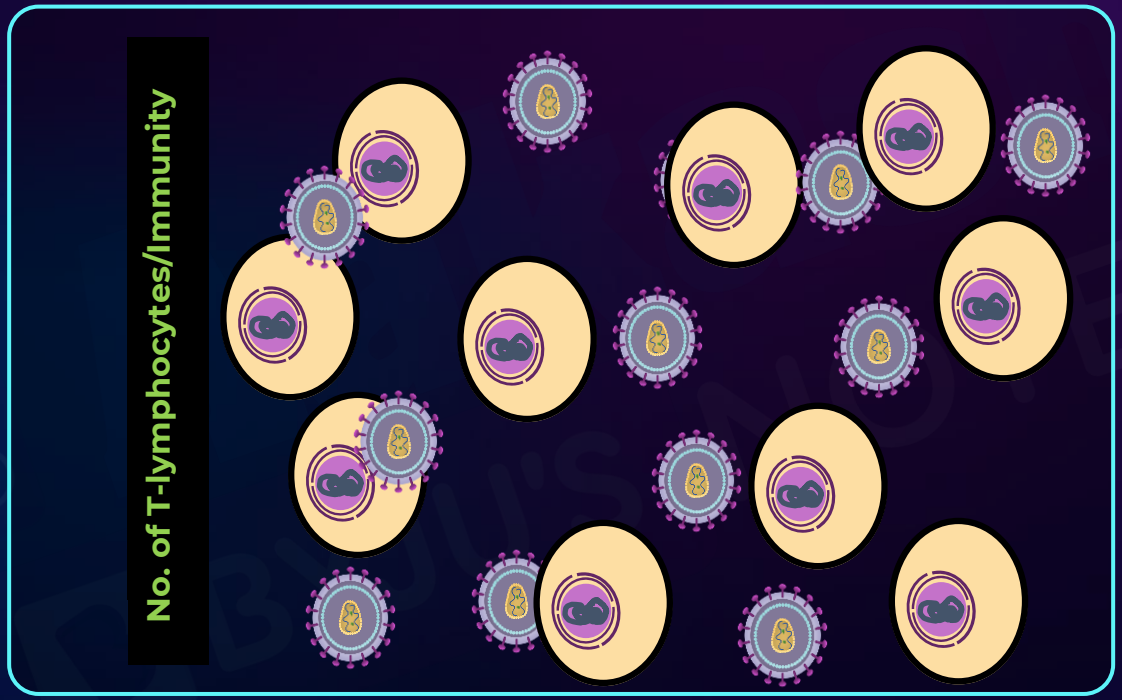
- The process of **formation of DNA from RNA** is called **reverse transcription**.
- The enzyme **reverse transcriptase** is used in this process.
- This helps in the formation of **viral DNA** within the host cell.



Human Immunodeficiency Virus - Life Cycle



Human Immunodeficiency Virus – Life cycle



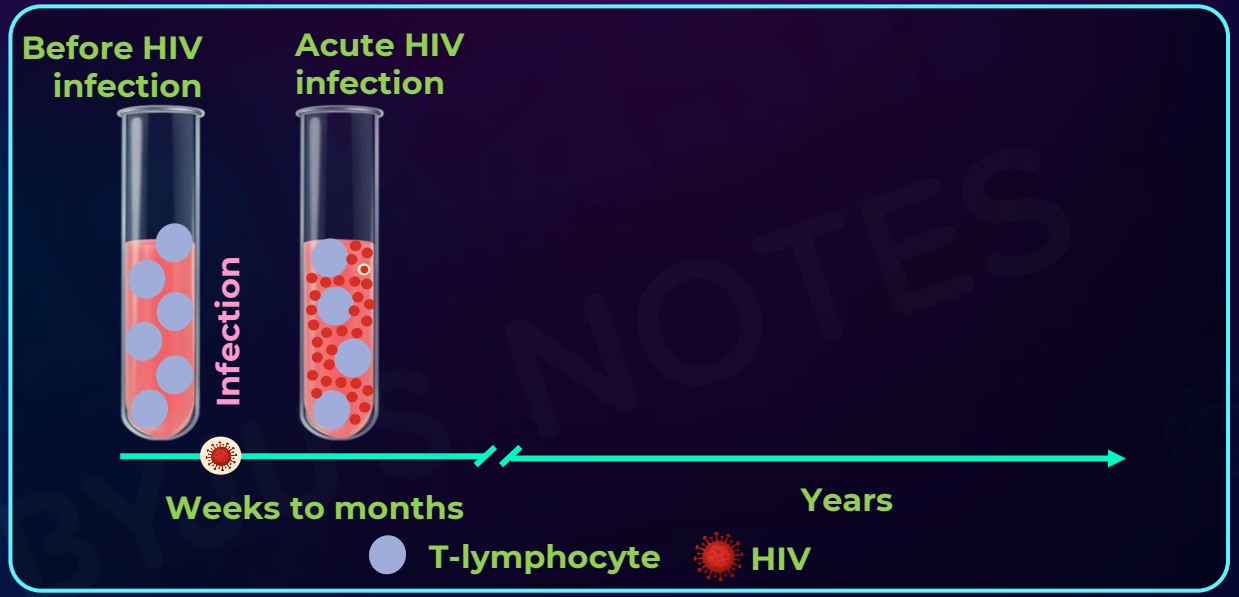
- After the new viruses are formed, they attack and **kill** the **T-lymphocytes.**
- As a result, **T-lymphocyte count drops** in the blood, thus weakening the immunity.

Secondary Lymphoid Organs

Acute HIV

- **Initial stage**
- **T lymphocyte** count decreases
- Occurs **after first few weeks of infection**
- Develop **flu like symptoms**

HIV progression



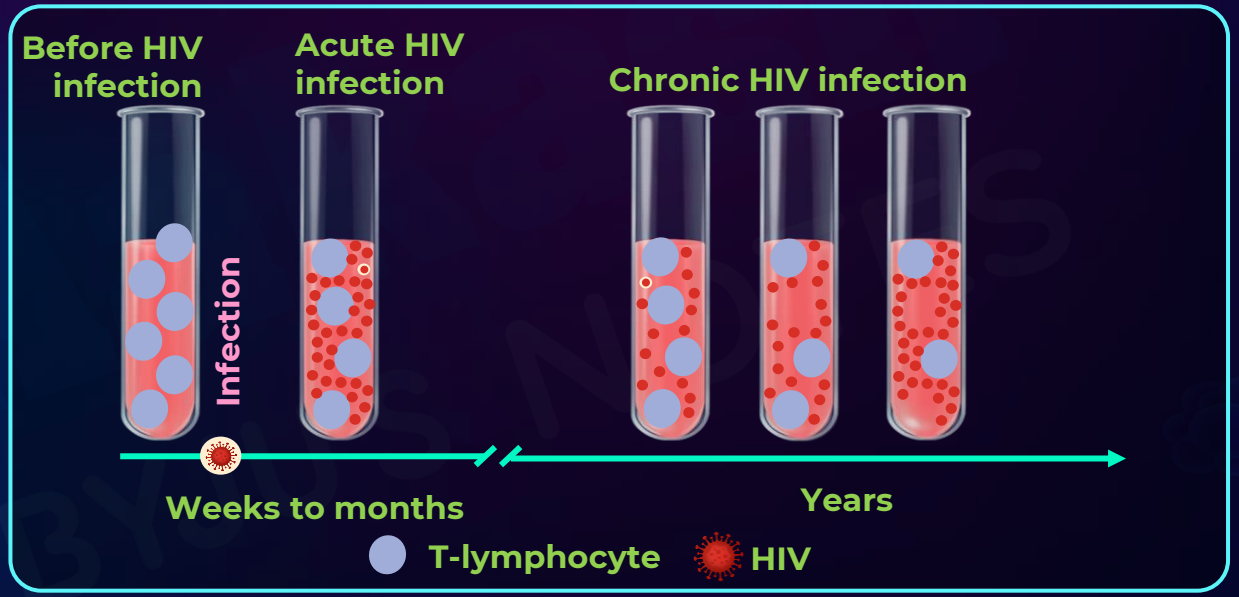
- During this phase, the HIV multiplies rapidly and spreads throughout the body, destroying some lymphocytes.
- HIV level in blood is very high in this stage, thus increasing the chances of transmission.

HIV/AIDS – Stages of Infection

Chronic HIV

- **Asymptomatic** stage
- Lasts for **several years,** ~ 10 years

HIV progression



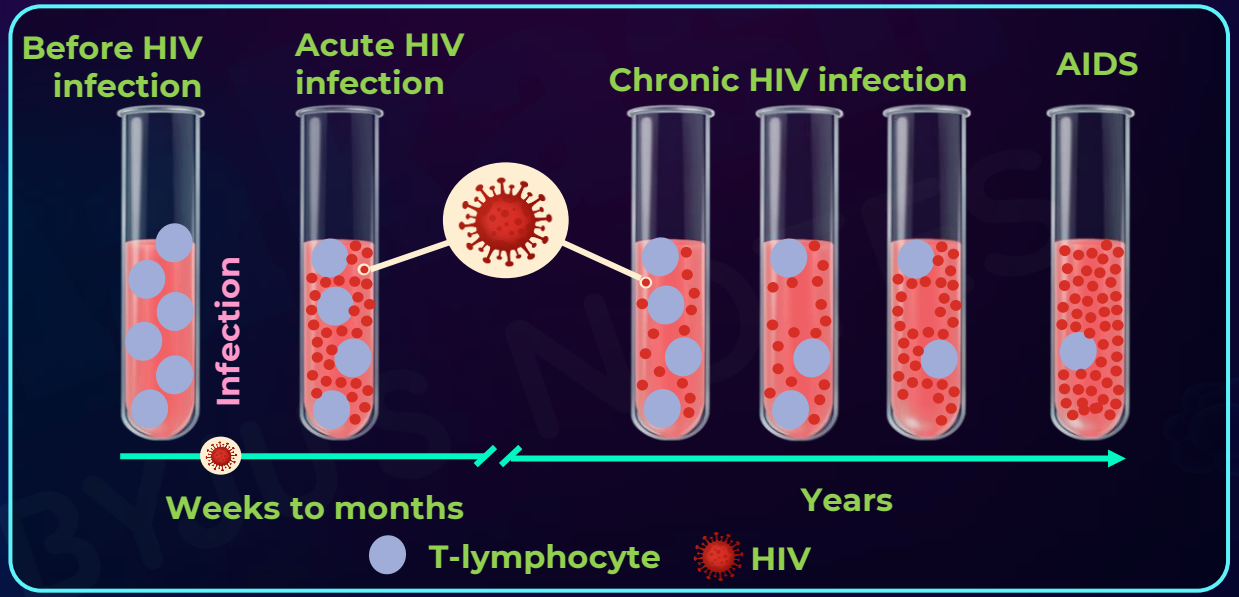
- During this stage, the **HIV** continues to **multiply** in the blood, but at a very **low rate.**
- The HIV levels overall drop considerably.
- However, over time, levels of **T-lymphocytes drop** too.

HIV/AIDS – Stages of Infection

AIDS

- The last stage is **Acquired immunodeficiency syndrome.**
- The body is prone to several **infections** due to **weak immune system.**
- **(AIDS-defining illnesses** are seen.**)**

HIV progression



- The **last stage** of HIV infection is **AIDS** (acquired immunodeficiency syndrome).
- In this stage, the **immune system is the weakest**. Thus, it is prone to several infections.
- Some of these infections are even fatal.
- These infections are called **opportunistic** infection or AIDS defining illnesses.

HIV/AIDS – Stages of Infection

AIDS – defining illness (common diseases that people suffering from AIDS become susceptible to)

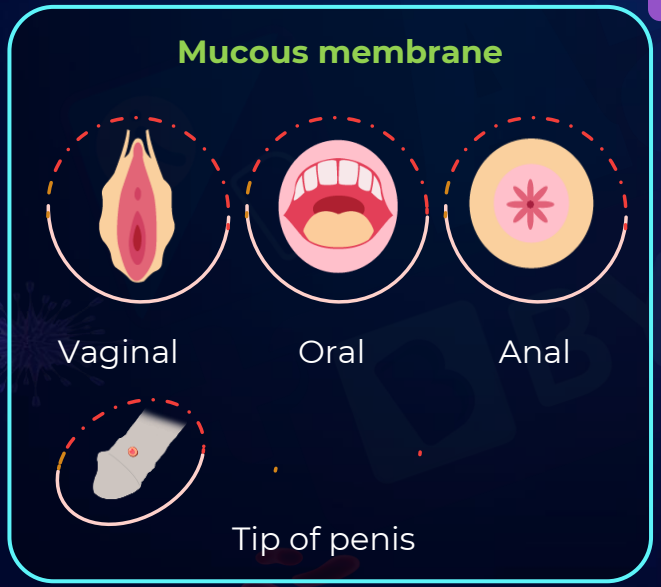
- **Candidiasis : Fungal** infection
- ***Mycobacterium avium* complex : Bacterial** infection
- **Toxoplasmosis: Parasitic** infection (***Toxoplasma***)

HIV – Modes of Transmission

Infectious fluids

HIV can **spread through** different **body fluids** from the infected people.
E.g. - blood, semen, rectal fluid, pre-seminal fluid, breast milk and vaginal fluid.

Susceptible areas

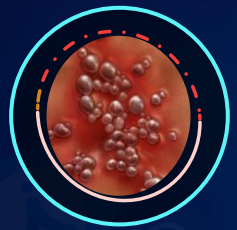


- These **fluids** have to come in contact with specific susceptible areas in the body to transmit HIV.
- The **mucous membranes** of **mouth**, **anus** and **sex organs** are the susceptible areas of transmission.
- This kind of transmission through body fluids, is common with **breast milk** and also through sexual fluids during sex.

HIV – Modes of Transmission

Susceptible areas

Injuries



Sores

Open cuts

- HIV can get in through **open cuts** either through sex organs or any other part of the body.
- Sometimes it may be transmitted through **sores** in mouth or genitals too.

Direct into blood

- HIV can also be transmitted when **infected objects come in direct contact with blood.**

HIV – Modes of Transmission

There are the different ways with which a person can contact HIV disease.

- **Blood transfusion** - Blood transfused from a person infected with HIV.
- **Pregnancy** - The infected mother can transmit the virus through placenta to the baby, and even through mother's milk after the birth of baby.
- **Non-sterile instruments** - Needles or syringes used by an HIV patient will have some blood on it, which when reused by a non-infected person will result in transmission.
- **Unprotected sex** - Sex without condom is way to come in contact with the vaginal fluid, semen or pre-seminal fluid.

Non-sterile instruments

Blood transfusion

Unprotected sex

Pregnancy

HIV – Modes of Transmission

How HIV is NOT transmitted?

Sharing food

Insect bite

Touching

Sharing pool

HIV - Treatment & Diagnosis

Treatment

- **Antiretroviral drugs** - Partially effective, cannot prevent death but can prolong the life
  - **Zidovudine or Azidothymidine (AZT)** - First and still the drug of choice
- Other drugs with similar action as AZT are all nucleoside analogs, similar to the naturally occurring nucleosides in RNA and DNA
  - Block conversion of retroviral RNA into DNA
  - Examples - Dideoxyinosine (**DDI**), dideoxycytidine (**DDC**), stavudine (**D4T**)
- **Zidovudine** and **Nevirapine** are given to **HIV positive pregnant women** to ensure that their children do not carry the infection.

Diagnosis

- **Enzyme Linked Immunosorbent Essay** (ELISA) is the widely used test
- **Western blotting** is used for confirmation of ELISA positive cases

HIV – Prevention

- The first step towards prevention of HIV infection is educating and creating **awareness** amongst people.
- In India, **NACO (National AIDS Control Organisation)** is a governmental organisation that provides leadership to HIV/AIDS control programme.
- It has approved **“Teach AIDS”** curriculum to be used in India.
- It monitors **blood bank licensing** and **blood donation** activities.
- It **controls/monitors** the **testing** and **reporting** of infection transmitted through blood transfusion.

HIV – Prevention

World Health Organisation

- WHO has come up with several methods to prevent the transmission of HIV:
  - Free distribution of **condoms**
  - Ensures usage of **disposable needles** in hospitals
  - Conducting camps for regular check-ups in **HIV prone population**
  - Making **blood safe** from **HIV**

Tumour Cell vs Normal Cell

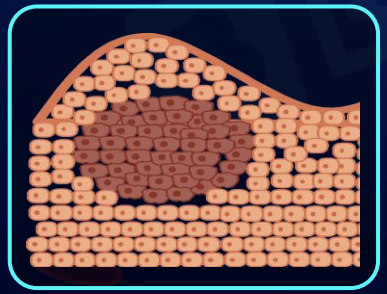
Normal cell	Tumour cell
Cell division is definite and regulated	Cell division is indefinite and unregulated
Contact inhibition present - Cell growth gets arrested when two or more cells come in contact	Contact inhibition fails leading to unregulated growth.
Growth factors bring about controlled cell differentiation	Cell proliferation is uncontrolled
Absence of normal angiogenesis amidst cells dividing normally	Extensive angiogenesis (blood vessels formation) is seen in regions of tumour

Tumour

Types of tumours

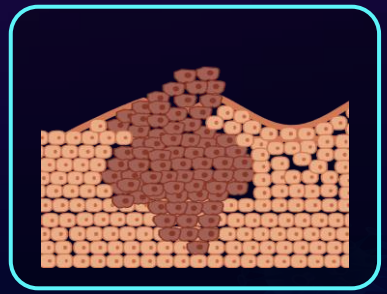
Benign tumor

- **Localised** at particular location
- **Does not spread** to other body parts
- **Not as harmful** as malignant tumour
- Causes **limited** damage to body



Malignant tumour

- **Grows quickly** and **spreads** to other body parts
- Are mass of proliferating cells called **neoplastic** or tumour cells
- Process by which cancer cells spread to other body parts is called **metastasis**
- Cancer cells metastasise when they get into bloodstream or the lymph nodes and form secondary tumours across various sites in the body.



Causes of Cancer

Physical agents

Ionising radiations (higher energy radiation) like **X-rays** and **gamma rays** and non-ionising radiations (lower energy radiations) like **UV** cause DNA damage leading to **neoplastic transformation** (abnormal growth of mass of tissue).

Chemical agents

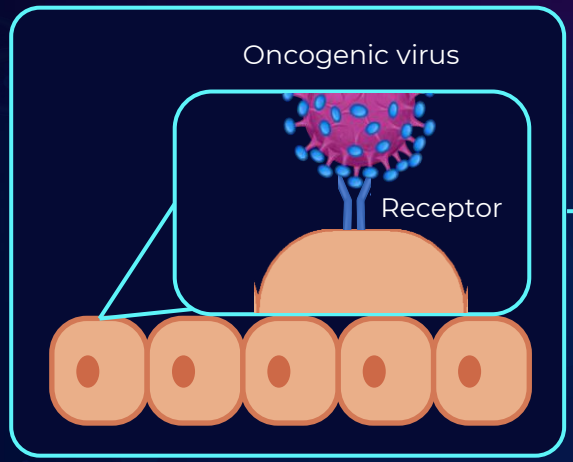
Chemical carcinogens present in **tobacco smoke** have been identified as a major cause of lung cancer.

Biological agents

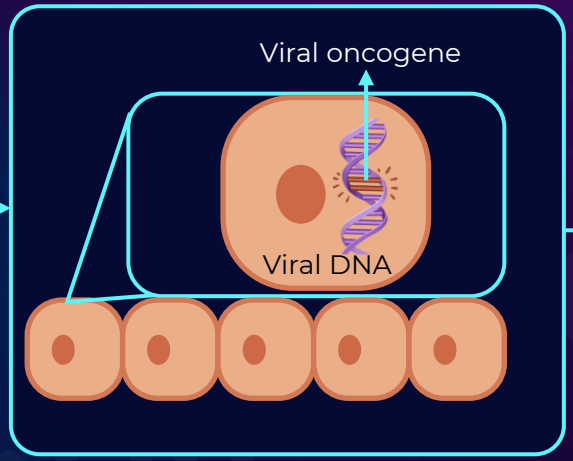
- **Cellular or Proto-oncogene** is a gene involved in cellular metabolism.
- **Mutations** (changes) in a proto-oncogene may cause it to become an **oncogene,** which can cause the growth of cancer cells.

Causes of Cancer

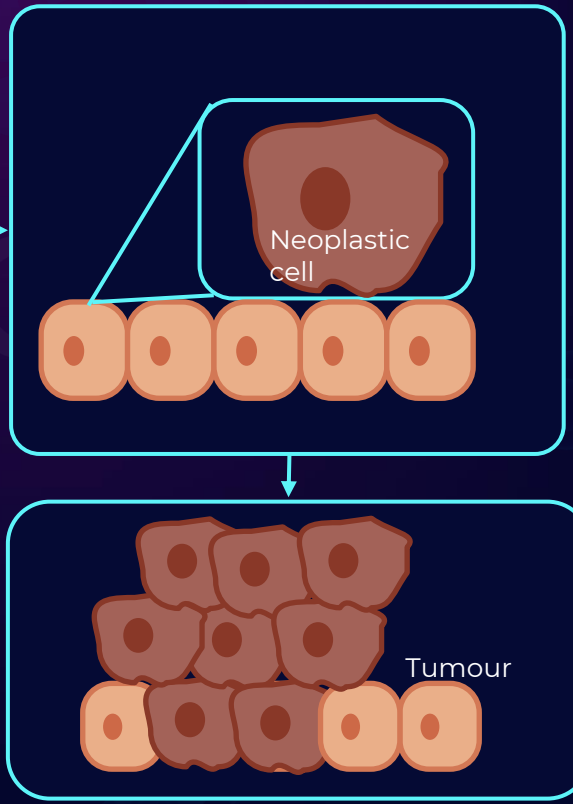
Biological agents



Cancer causing virus is called **oncogenic virus**. These viruses bind to specific receptors present in the cells in our body.

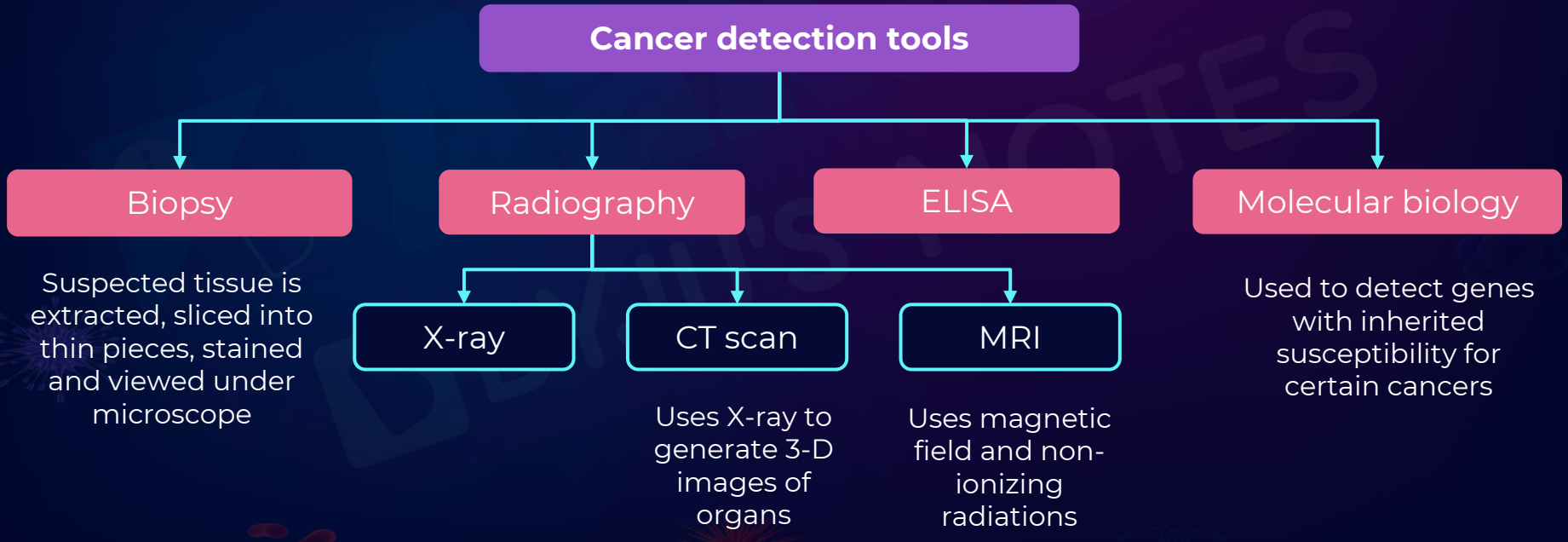


These viruses transfer their DNA to the host cell nucleus where the **viral oncogene** becomes part of the host DNA and hence the cell becomes **neoplastic**.



Detection of Cancer

- Diagnosis of cancer cannot be done just on the basis of symptoms as they may resemble symptoms of many other diseases.
- Hence, we use other tools for confirmation.



Stages of Cancer

- **Benign tumour**
- **Confined** to the place where it started
- Often curable

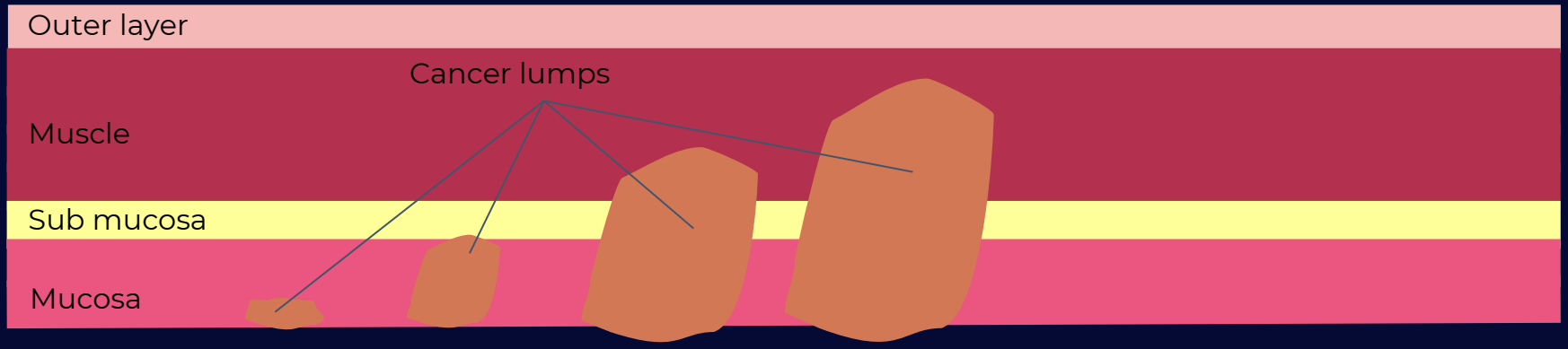
Stage 0

- **Early-stage cancer**
- **Contained** within the organ
- **Not spread** to lymph nodes and other parts of the body

Stage 1

- **Later stages of cancer**
- Grow deep into the tissue
- May have spread to lymph nodes but usually not other parts of the body

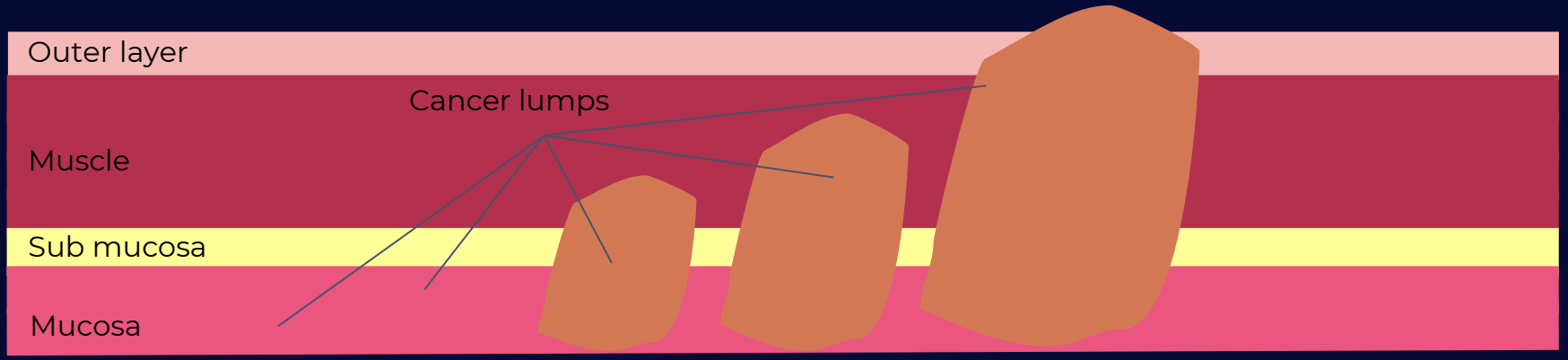
Stage 2 Stage 3



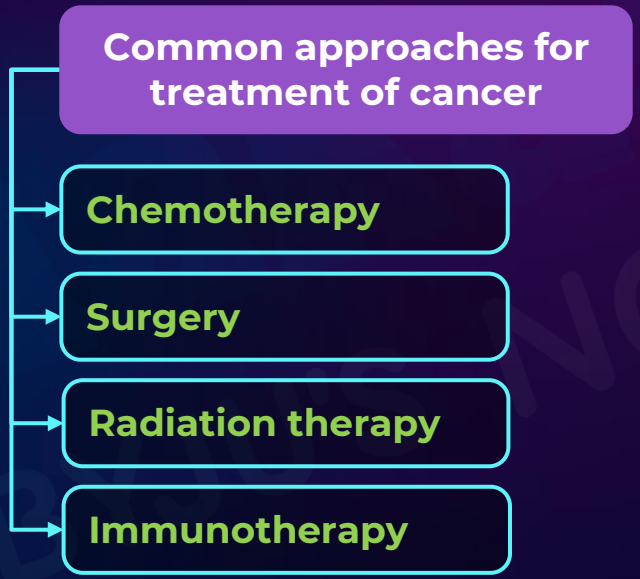
Stages of Cancer

- **Advanced cancer**
- Grows deep into the tissue
- **Spreads** to lymph nodes and other parts of the body (**metastasis**)

Stage 0 | Stage 1 | Stage 2 Stage 3 | Stage 4



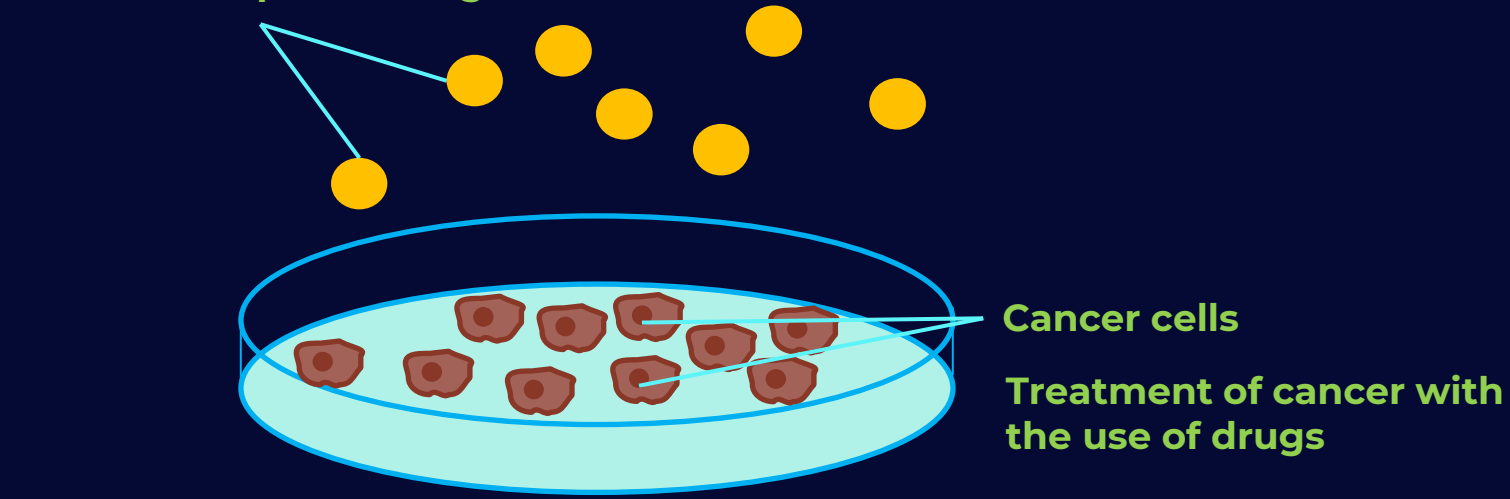
Treatment of Cancer



Treatment of Cancer

Chemotherapy

- Chemotherapeutic drugs are used to :-
  - **kill cancer cells**
  - stop the spread
  - slow their growth
- The drugs are administered by :-
  - mouth
  - in shots (injection using syringe)
  - Intravenously (in veins)
- **Side effects** of drugs are :-
  - Hair loss
  - Anaemia
  - Tiredness, etc



Treatment of Cancer

Surgery

- Localised cancerous masses are **removed** through **surgical procedure**.
- This process is **highly effective** for benign tumours as they are localised.

Radiation therapy

- The affected body part is **exposed** to **radiations like X-rays**, **protons** or other types of energy to kill the cancer cells.

Immunotherapy

- Immune system is not able to detect and destroy the tumour cells.
- So, the patients are administered with biological response modifiers (glycoproteins) such as **α-interferons** which **activate** their immune system and help in **destroying** the tumour.

Types of Cancer Based on the Site of Origin

Carcinomas	Sarcomas	Leukemias	Lymphoma
These are cancerous tumours of **epithelial tissues**.	These are cancerous tumours of **connective tissues** such as blood vessels, muscles, bones, etc.	These are cancer of the **blood cells**.	These are cancer of the **lymphatic systems** such as **spleen, lymph nodes, thymus glands,** etc.

Classes of Drugs

Habitual administration of drugs either obtained from illegal or legal sources that are administered for creating pleasurable effects and harms one's health is called **drug abuse**.

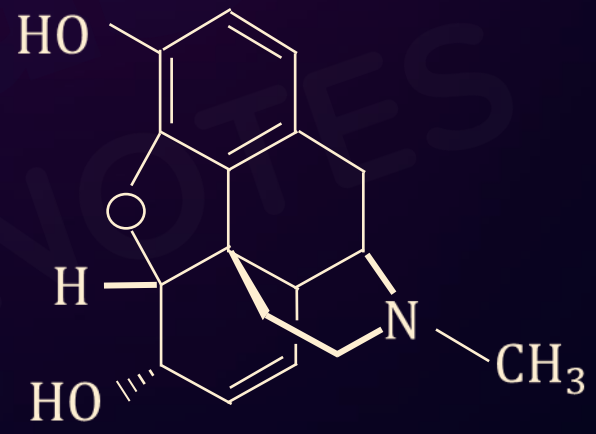
Generally, the abusive drugs belong to following classes.

1. Opioids
2. Cannabinoids
3. Coca alkaloids

Most of these are obtained from flowering plants and some from fungi. Morphine belongs to the class of drugs called **opioids**.

Opioids

- Opioids are extracted from latex (whitish milk) of poppy plant - ***Papaver somniferum.***
- Opioids and its derivatives act on the **central nervous system** and **gastrointestinal tract** in humans.
- Opioids attach to **proteins called opioid receptors on nerve cells in the brain, spinal cord, gut**, and other parts of the body.
- Opioid derivative, **morphine undergoes acetylation** to produce another derivative **heroin**.
- Opioids are administered by either injecting or snorting.



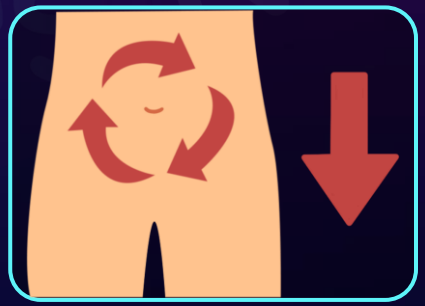
Structure of morphine

Opioids Effects

- After opioid administration, the common effects seen by people are:
  - Physiological
  - Psychological
  - Physical

Vomiting

Constipation



Slowdown in body function

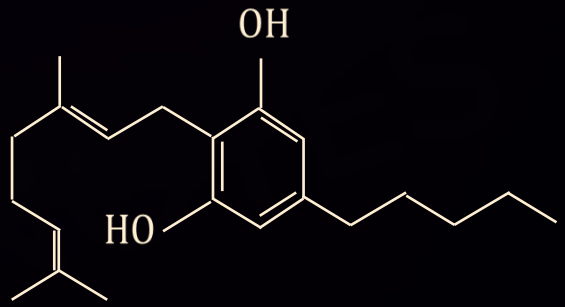
Euphoria

Cannabinoids

- Cannabinoids are class of drugs obtained from the inflorescence of plant ***Cannabis sativa.***

Types of cannabis

- **Marijuana** - leaves
- **Hashish** - cannabis extract
- **Charas (Resin)** - whole plant



Structure of cannabinoid molecule

- **Cannabinoids** (Ganja/Charas/Hashish) are **administered** by inhalation or oral ingestion.

Coca Alkaloids/Cocaine

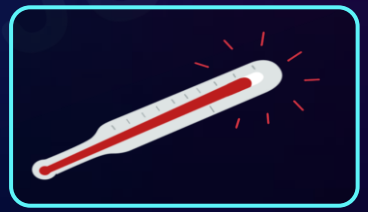
- Coca alkaloids are also called as cocaine.
- They are obtained from ***Erythroxylum coca,*** native to **South America.**
- They are commonly called as **coke** or **crack.**
- They are administered by **snorting.**

Euphoria

Paranoia

Energetic

Hallucinations



Increased body temperatures

Increased heart beat

Did you know

- Hallucinations are caused by other plants as well such as:

Atropa belladonna

Datura

Morning glory

Fly agaric

- Several such plants have been used for hundreds of years in:
  - Rituals and religious ceremonies
  - Folk medicines

Drugs with History of Abuse

Barbiturates
(Class of sedative hypnotics)

- At low dose:
- Relieve tension and anxiety
- Induce sleep

Slight overdose can cause death or coma

Benzodiazepines
(Class of tranquilisers)

At prescribed doses, aids in treating:

- Anxiety
- Alcohol withdrawal
- Insomnia
- Anaesthetic
- Seizure control

Overdose along with alcohol can be lethal

Drugs with History of Abuse

Amphetamines

- Treats attention deficit hyperactivity disorder (ADHD)
- Narcolepsy
- Were used as antidepressants

- Overdose causes physical and physiological disorders

Lysergic acid diethylamide (LSD)

- Hallucinogen
- Treat mental illness (anxiety, psychosomatic diseases)
- Used as antidepressants

- Overdose leads to psychosis
- Lacks accepted safety under medical supervision

Addiction

It is the habitual, physiological and psychological dependence on a substance (tobacco, alcohol, drugs) which is beyond control of the body.

Tobacco Addiction

Tobacco

- It is obtained from the leaves of plant ***Nicotiana tabacum.***
- It is being consumed for about **400** years.
- Tobacco contains a **poisonous alkaloid called nictoine** that is a major component of tobacco, cigarettes and is **responsible** for addiction to these.

Modes of tobacco use

Smoking

- Inhaling tobacco smoke from cigars, cigarettes, bidis, pipes and hookah.

Chewing

- Tobacco in powdered form can be chewed with *paan*.
- It is also placed between the lip and the gum for a period of time then spat out.

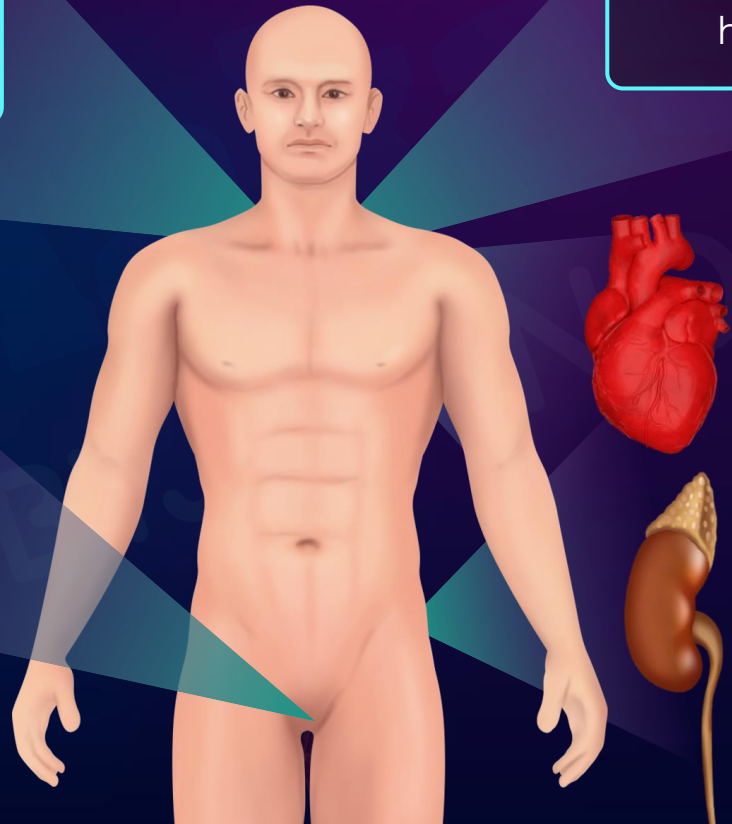
Snuffing

- When powdered tobacco is taken through nose, it is called snuffing.

Effects of Tobacco

Increased blood pressure

Increased risk of heart disease



Increased heart rate

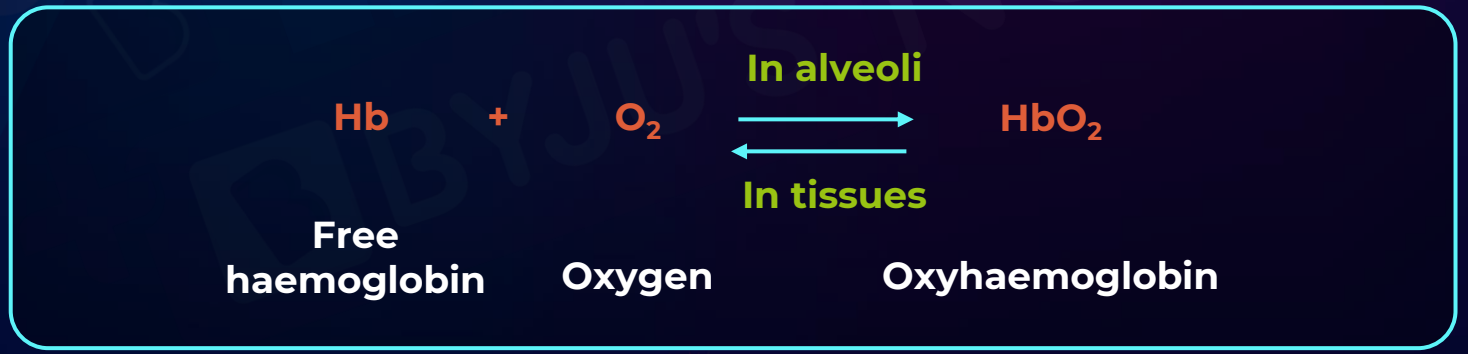
Sterility in men

Stimulates adrenal gland to release adrenaline and noradrenaline

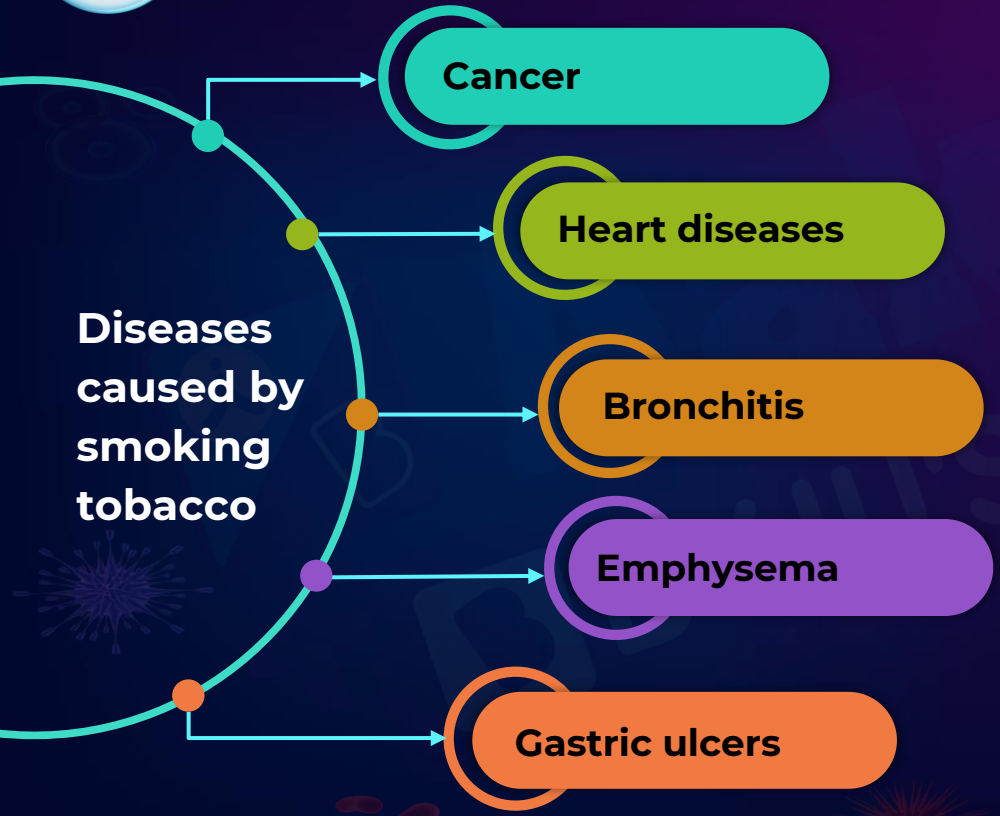
Withdrawal Syndrome

Carbon monoxide

- Carboxyhaemoglobin compound does not readily dissociate unlike **oxyhaemoglobin** (formed when oxygen combines with haemoglobin) or carbaminohaemoglobin (formed when carbon dioxide combines with haemoglobin).
- Thus, haemoglobin molecules are **not available** for the transport of oxygen, and this **leads to oxygen deficiency** in the tissues.



Diseases Caused by Smoking Tobacco



Adolescence

- Adolescents are individuals within the average age group of **12-18** years who are transitioning from childhood to adulthood.
- Apart from major physical changes due to attainment of **sexual maturity**, adolescents also undergo **cognitive, social** and **emotional changes** as they gradually mature into adults.

Adolescence

Common Effects of Drugs and Alcohol Abuse

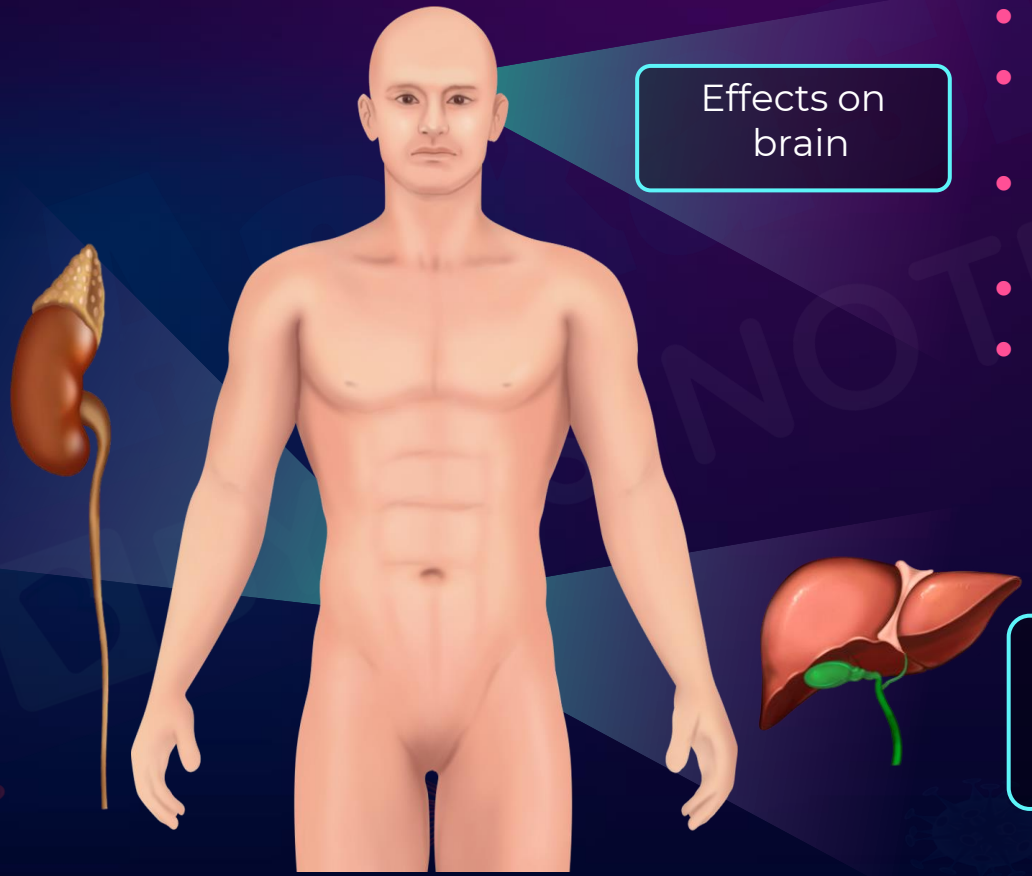
Continuous use of these leads to over dependence on them.

Diseases Caused by Alcohol

Effects on brain

- Decreases sleep
- Person loses judgement
- Coordination of muscles is lost
- Slurring of speech
- Loss of consciousness

Increased urine output (Diuresis)



Liver disorders like cirrhosis

Misuse of drugs

Drugs are **not harmful**, however when taken for a purpose other than medicinal use or in amounts/frequency that impairs one's physical, physiological or psychological functions, it constitutes **drug abuse**, which is **harmful.**

Doping

- Drugs are misused by certain sportspersons.
- They **misuse** narcotics, steroids, diuretics and hormones to **improve** their **performance.**
- This is called doping.

Side Effects of Doping

In females

- Masculinisaton
- Excessive hair growth
- Increased aggressiveness
- Enlargement of the clitoris
- Mood swings
- Abnormal menstrual cycle
- Depression
- Deepening of voice

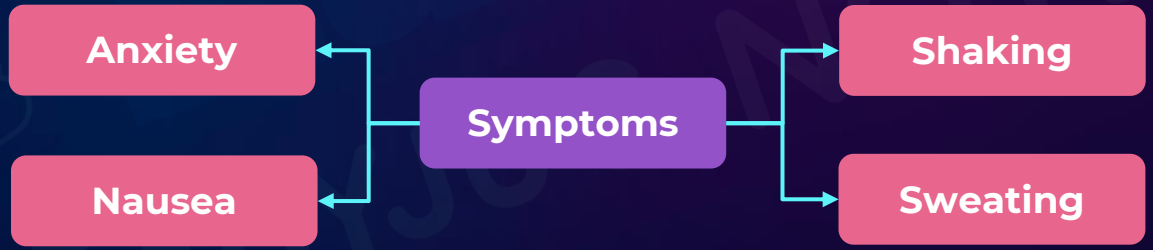
Side Effects of Doping

In males

- Acne
- Increased aggressiveness
- Mood swings
- Depression
- Reduction of size of the testicles
- Decreased sperm production
- Potential for liver dysfunction
- Gynaecomastia(breast enlargement)
- Premature baldness
- Prostate enlargement

Withdrawal Syndrome

The body tends to experience withdrawal if the consumption of drugs/alcohol is suddenly stopped which makes it even more difficult for the person to stop using these.



Withdrawal Syndrome

- It is difficult to overcome withdrawal syndrome and go completely clean.
- Thus, prevention is better.
- Preventing kids from diverting to alcohol or drugs should be a high priority.

How to avoid getting diverted to drugs?

↓

Avoid undue peer pressure

Every child is unique in their own terms. Encouraging children for better academic performance is good; however comparing them to their peers, scolding them for not scoring well, should be avoided by the parents and teachers.

Withdrawal Syndrome

How to avoid getting diverted to drugs?

Education and counselling

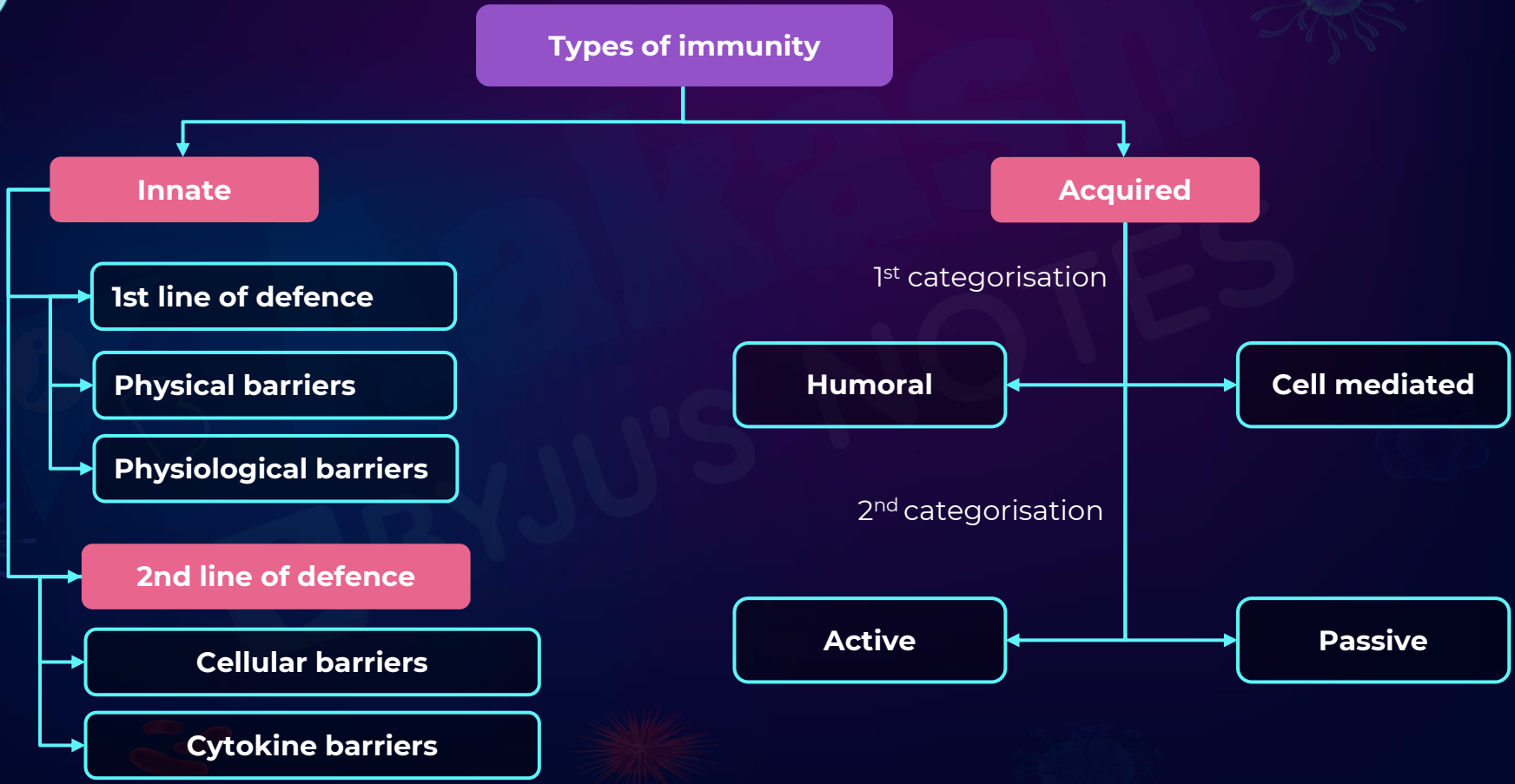
Counselling the child regarding stresses in their life and how to overcome them is important.

Seeking help from parents and peers

The child should be comfortable enough to share his/her problems with his/her parents and friends and find appropriate solutions to the problem.

Seeking professional guidance in case of psychological disorders

Summary



Summary

Types of Adaptive immunity

Active

Natural

- Infectious agents gaining access into body activates natural immunity

Artificial

- Resistance induced by injecting vaccine is artificial immunity

Passive

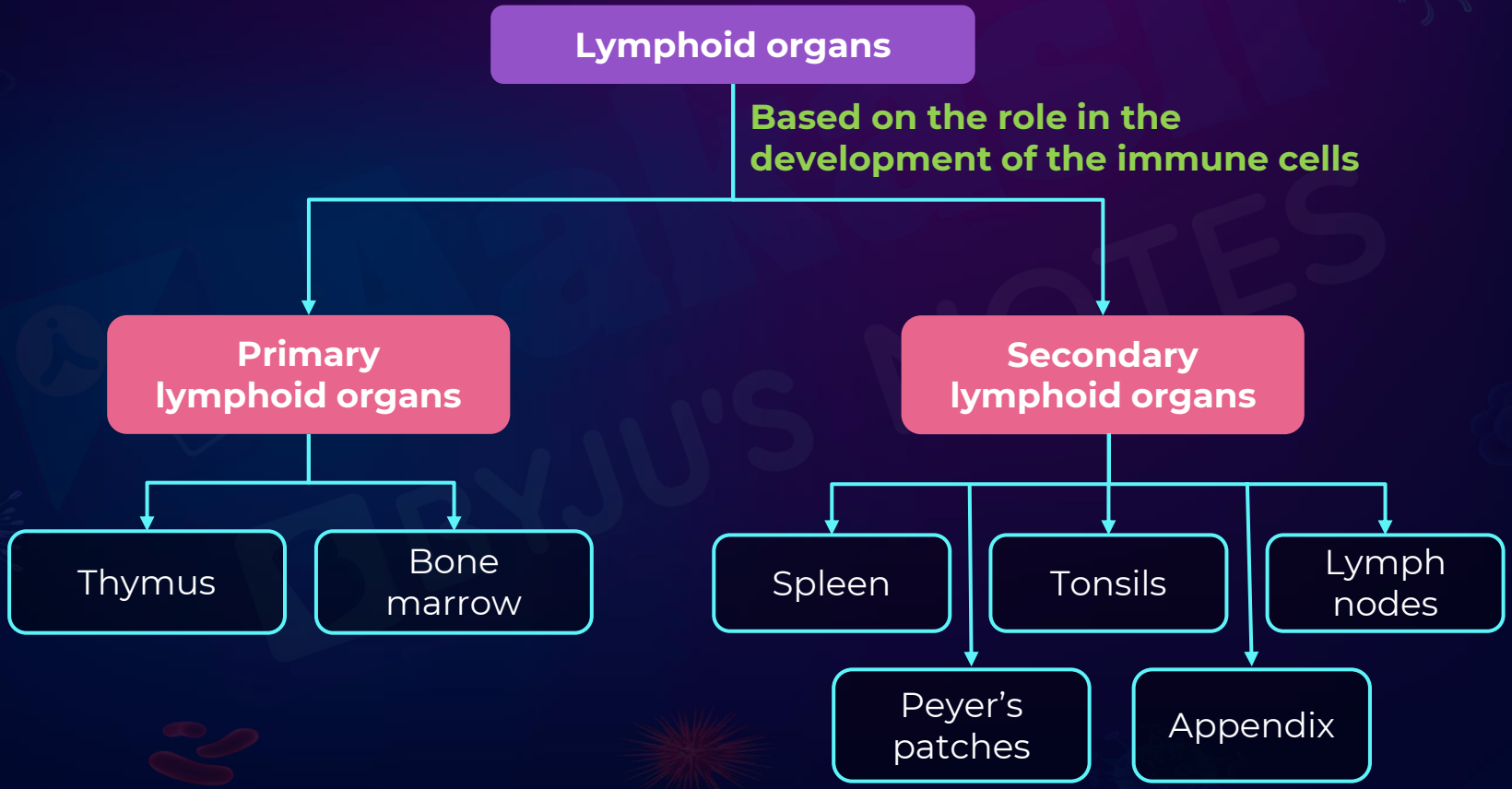
Natural

- Receiving readymade antibodies naturally from mother
- E.g. - IgG through placenta and IgA through colostrum

Artificial

- Artificial administration of readymade antibodies
- E.g. - Anti-venom injections

Summary



Summary

Humoral immunity

Pathogens (antigen) enter the cell

B-lymphocytes get activated

Some B-cells differentiate into **plasma cells** to secrete **antibodies** against pathogen

Undifferentiated B-cells become **memory cells** to **protect against future attacks**

Cell-mediated immunity

Bone marrow produces immature lymphocytes

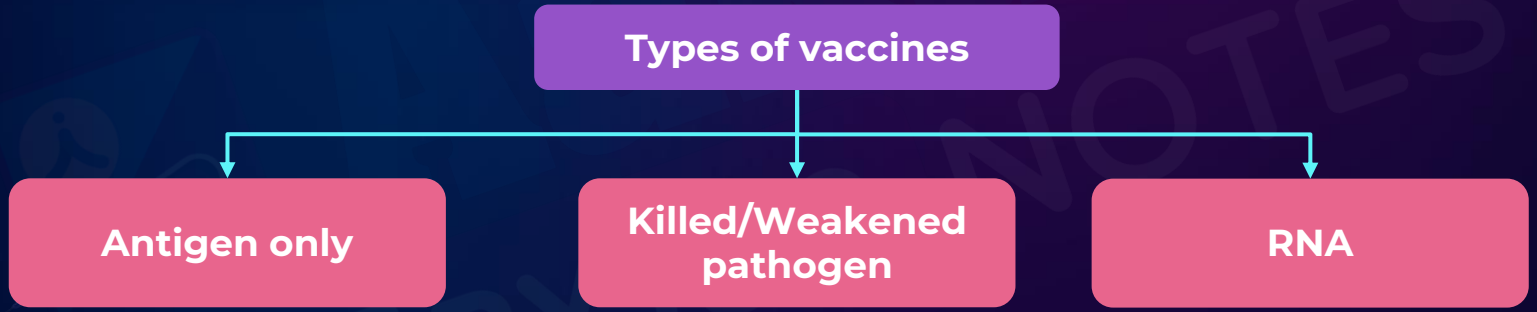
Travel to thymus and differentiate into T-lymphocytes

T-lymphocytes migrate to lymphoid tissue and differentiate into one of the four:

- **Helper T-cell**
- **Cytotoxic/ Killer T-cell**
- **Suppressor T-cell**
- **Memory T-cell**

Summary

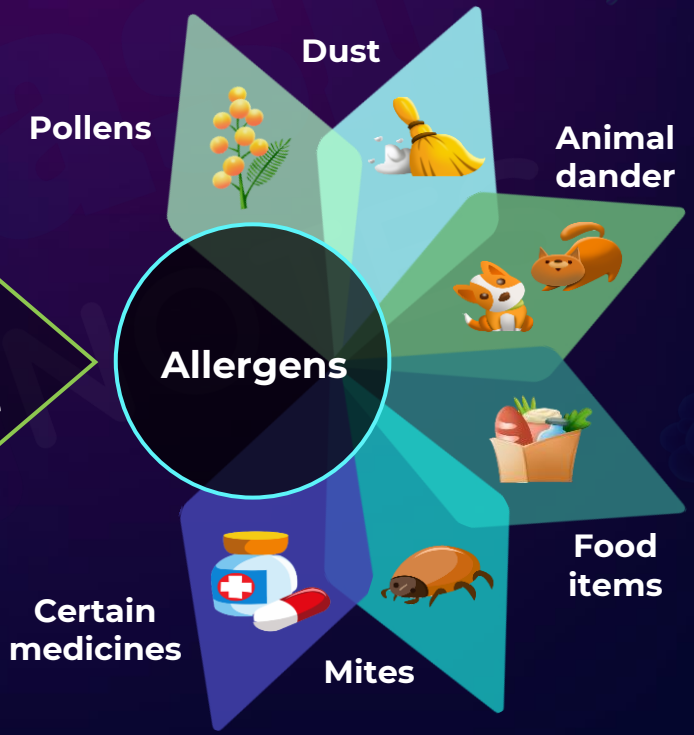
Vaccination is the administration of vaccine to **stimulate the immune system** against the pathogen, thereby developing protection from a disease.



Summary

The **exaggerated response** of the immune system to **certain antigens** present in the environment is called **allergy**.

Substances which trigger such exaggerated response



Summary

Bacterial diseases

Typhoid	Pneumonia
Salmonella typhi	*Streptococcus pneumoniae*

Viral diseases

Common cold	Acquired Immunodeficiency Syndrome
Rhinovirus	Human Immunodeficiency Virus

Summary

Helminthic diseases	Fungal diseases	Protozoan diseases
Filariasis *Wuchereria bancrofti* and *Wuchereria malayi*	**Ringworms** *Microsporum, Trichophyton, Epidermophyton*	**Malaria** *Plasmodium*
Ascariasis *Ascaris lumbricoides*		**Amoebiasis** *Entamoeba histolytica*

Summary

Viral diseases

Polio	**Rabies**	**Dengue fever**
Poliovirus	Lyssavirus, Rhabdovirus	Flavi-ribovirus
Flu		**Smallpox**
Influenza virus		Variola virus
Chickenpox	**Chikungunya**	**Rubella**
Varicella zoster	Chikungunya virus	Rubella virus
Mumps	**Measles**	**Hepatitis**
Paramyxovirus	Rubeola virus	Hepatitis virus