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What can harm the body?

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## Modes of Disease Transmission- Summary

### Contact Transmission

- Can be direct, indirect, or by droplets
- Direct contact requires body contact between individuals
- Indirect contact occurs through fomites
- Droplet: occurs when a person coughs, sneezes, or speaks near others

### Vehicle Transmission

- Nonliving carrier of an infectious agent from its reservoir to a susceptible host
- Water
- Air
- Food

### Vector-Borne Transmission

- Vectors: Living organisms that transmit disease to humans
- Most vectors are arthropods: ticks, flies, fleas, lice & mosquitoes

Examples:

Direct contact- Rabies, staphylococcus infections

Indirect contact- Tetanus, common cold

Airborne- chicken pox, TB

Waterborne- Cholera

Foodborne- Hepatitis A, typhoid

Vector transmission- Malaria, yellow fever

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### Function of immune system: Protects the body from pathogens

If pathogen overcomes the defenses of your immune system, it damages the tissues and kills host cells

What causes symptoms of a disease?

Human Body

Immune Protective Response

Bacteria, fungi, virus, toxins attacking the body

HEALTHY IMMUNE SYSTEM

I can bounce back! /

Virus

Bacteria

Mold

Strong immunity

I can't bounce back ... /

Bacteria

Virus

Mold

Weak immunity

It is an image.

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How do pathogens damage the host?

How a Virus Works

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1. The virus enters the cell body releasing RNA.

2. Virus RNA invades the cell nucleus and takes over.

3. Viral RNA uses the host cell to create new RNA and assemble more viral particles.

New viral particles are released, sometimes destroying the cell in the process.

Viruses take over the host cell's genetic and metabolic machinery and cause death of cells

Toxins are poisonous substances produced by microorganisms. They may cause serious effects and sometimes death

Ex: Tetanus toxin

The diagram illustrates the three stages of viral replication: 1. The virus enters the cell body releasing RNA. 2. Virus RNA invades the cell nucleus and takes over. 3. Viral RNA uses the host cell to create new RNA and assemble more viral particles. New viral particles are released, sometimes destroying the cell in the process.

The diagram shows a motor neuron originating from the spinal cord, passing through the neuromuscular junction to a muscle. Red arrows indicate retrograde axonal transport moving up the neuron. A red dashed arrow labeled "Inhibitory interneuron" points back into the spinal cord. The toxin is labeled at the neuromuscular junction.

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Patterns of disease

What is the difference between Endemic, Epidemic and Pandemic?

**ENDEMIC**  
The disease is present in a community at all times but in relatively low frequency.

**EPIDEMIC**  
The sudden, and rapid spread of an infectious disease within a short period of time affecting a large number of people within a region or a group.

**PANDEMIC**  
The phenomenon when an epidemic becomes very widespread and affects a continent, or the entire world.

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Ex: Malaria, cholera

Ex: Nipah, SARS etc

Ex: Covid-19 pandemic

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Treating diseases

## ANTIMICROBIALS

- ANTIBIOTICS/ ANTIBACTERIALS: against bacteria, e.g. drugs for bacterial pneumonia
- ANTIVIRALS: against viruses, e.g. drugs for herpes and HIV
- ANTIPARASITIC AGENTS: against parasites, e.g. drugs for malaria
- ANTIFUNGALS: against fungi, e.g. drugs for yeast infections

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### HOW ANTIBIOTIC RESISTANCE HAPPENS

- Normal bacterium    - Resistant bacterium    - Dead bacterium

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Defense against infectious diseases

## IMMUNITY

**INNATE IMMUNITY:** Physical Barriers, Chemical Barriers, Cellular Defences.

**ADAPTIVE IMMUNITY:** Active Immunity (Natural, Vaccination), Passive Immunity (Maternal, Artificial).

Immunity is the capability of organisms to resist harmful microorganisms

Innate immunity- Innate immunity refers to nonspecific defense mechanisms that come into play immediately or within hours of an antigen's appearance in the body.

Adaptive/aquired immunity: Adaptive immunity refers to antigen-specific immune response.

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**Antigen and antibody**

**ANTIBODY**  
Proteins that recognize and bind to antigens.

**ANTIGEN**

- A protein on a foreign object that stimulates the immune system to produce antibodies.
- A virus, bacteria, toxin, ... that trigger the immune response.

**Different Antigens**

**Different Antigens**

Antibody paratope is complementary to a specific antigen epitope

Figure 9.7

**INNATE IMMUNE DEFENSES**

**INNATE IMMUNITY**

**Barriers**

- Physical
  - skin
  - hair
  - mucous
- Chemical
  - Acid gastric secretion
  - Lysozyme (tears, saliva)
  - Low pH of Skin
  - Gastric & Duodenal enzymes
  - Antibodies & inhibitors
  - Interferons
  - complement proteins
  - Antimicrobial peptides

**Cells**

**Leukocytes**

- Phagocytose microbes
- Neutrophil
- Macrophage
- Release inflammatory molecules
- Eosinophil
- Mast Cell

**Natural Killer Cells**

Receptor - NK activation signal

Healthy cell

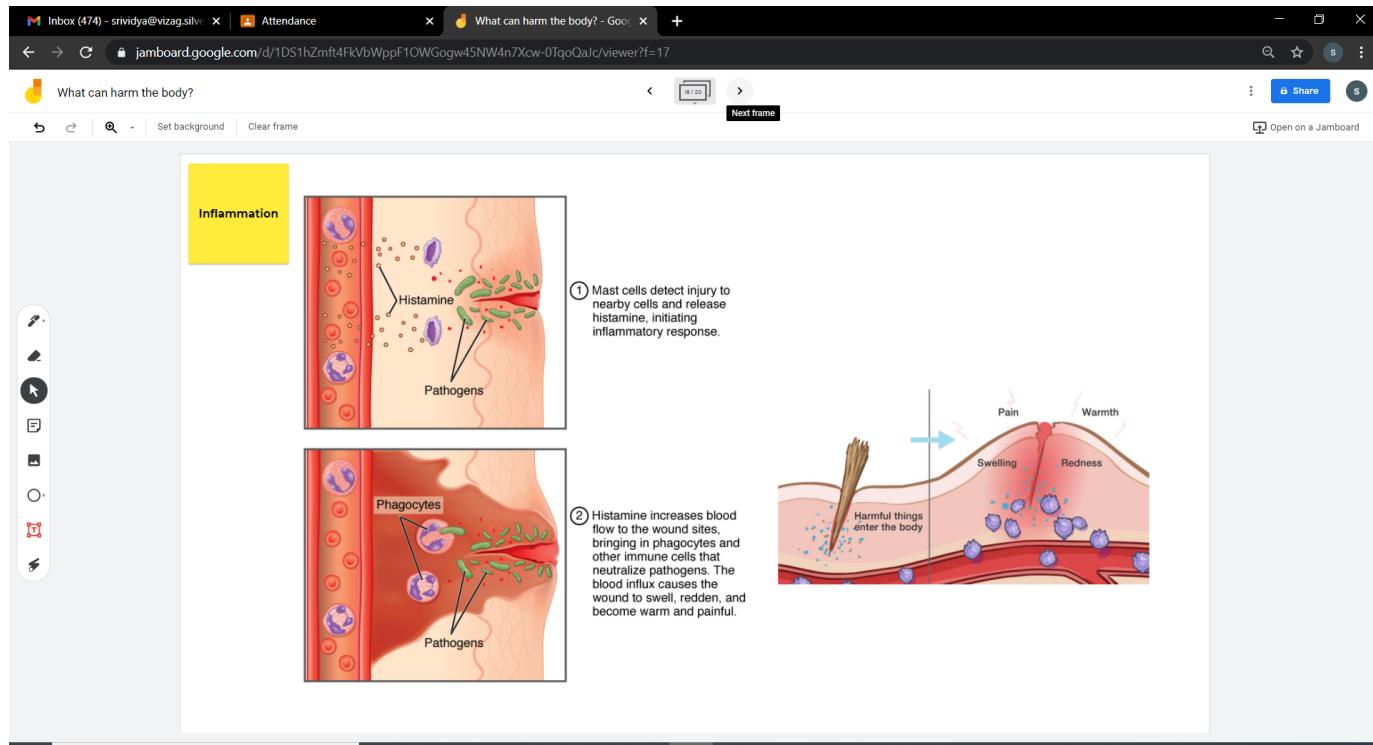
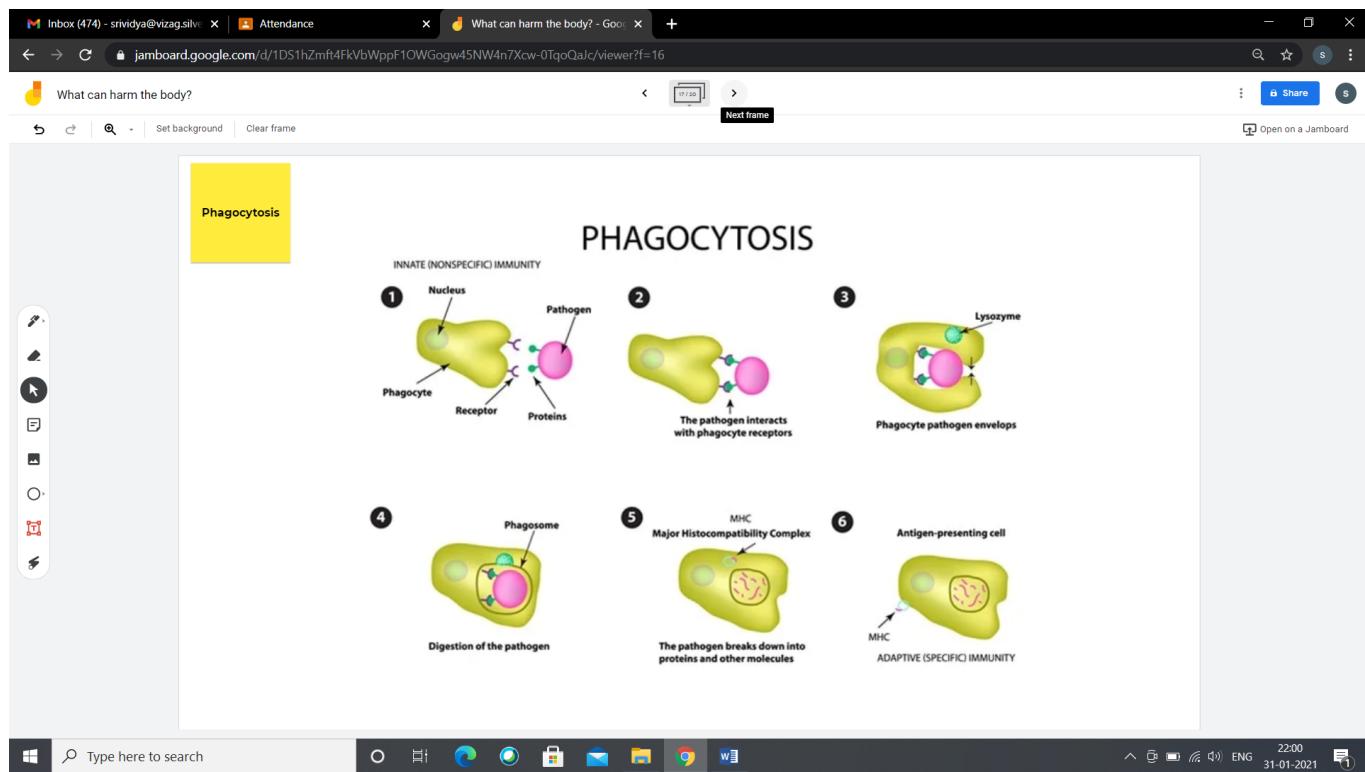
MHC1 - NK inhibitory signal

Virus-infected cell

**Dendritic Cells**

Antigen

Cytokines



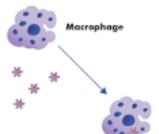
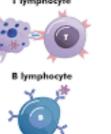
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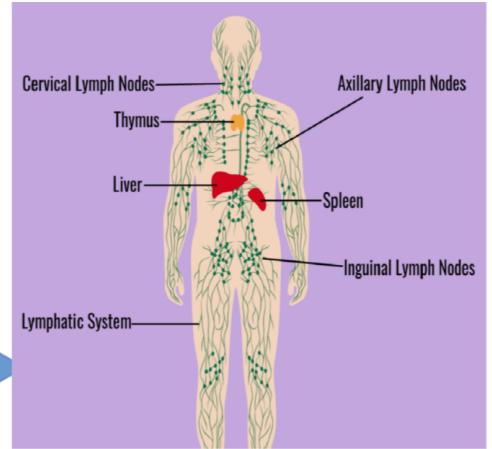
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Acquired/adaptive immunity

Adaptive immunity is the immunity you develop over your lifetime

|   |   |
|---|---|
| Innate Response   | Adaptive Response   |
|  |  |
| HOURS   | DAYS  |

Lymphatic system



Cervical Lymph Nodes, Axillary Lymph Nodes, Thymus, Liver, Spleen, Inguinal Lymph Nodes, Lymphatic System.

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The Lymphatic System



- Tonsils:**
  - Simplest lymphoid organ
  - function: traps and destroys bacteria
- Thymus:**
  - most active during childhood
  - function: maturation of t-lymphocytes
  - helps fight against infected or cancerous cells
- Lymph Nodes:**
  - principle lymphoid organ
  - function: filter lymph
  - 500-700 in the body
  - Critical for immune response
- Spleen:**
  - Largest lymphatic organ
  - recycles RBCs
  - stores WBCs
  - acts as a filter for blood

Functions:  
Get rid of waste and toxins by the transportation of lymph fluid.

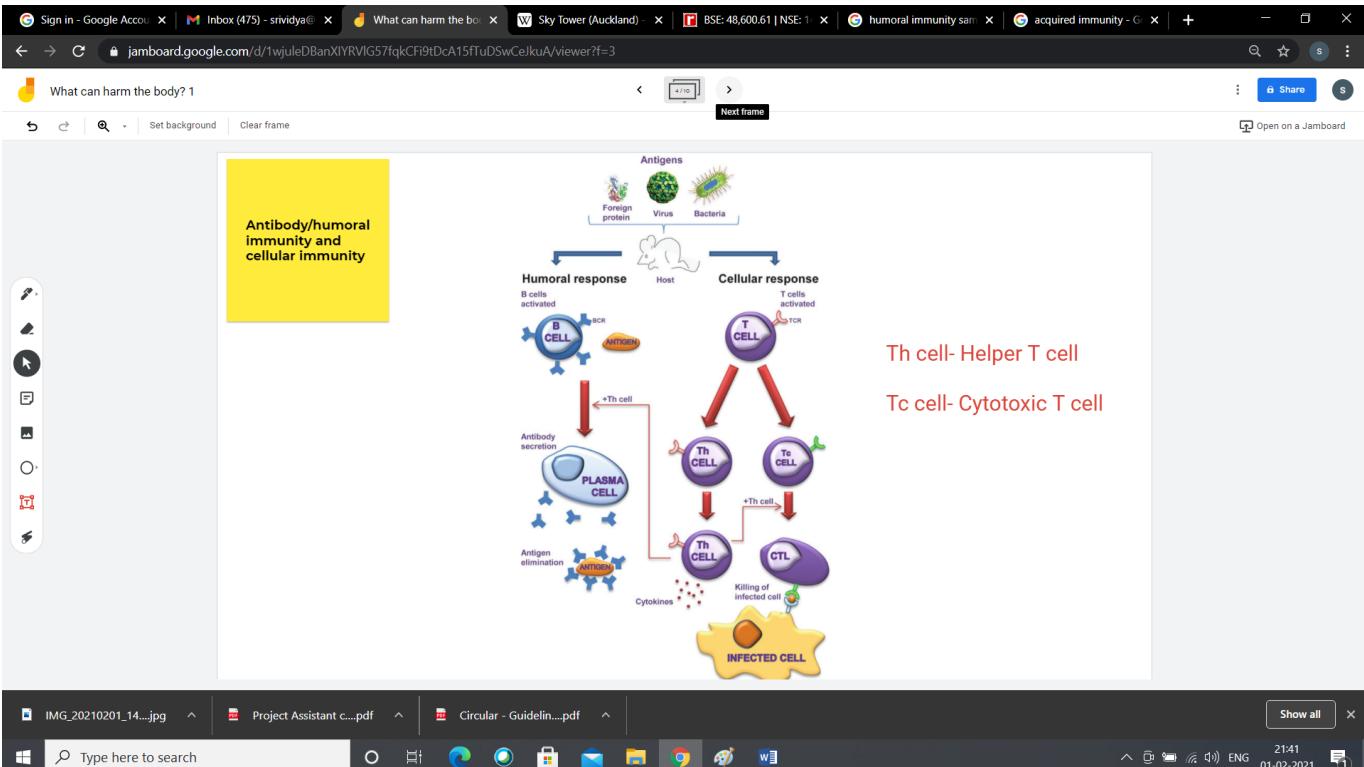
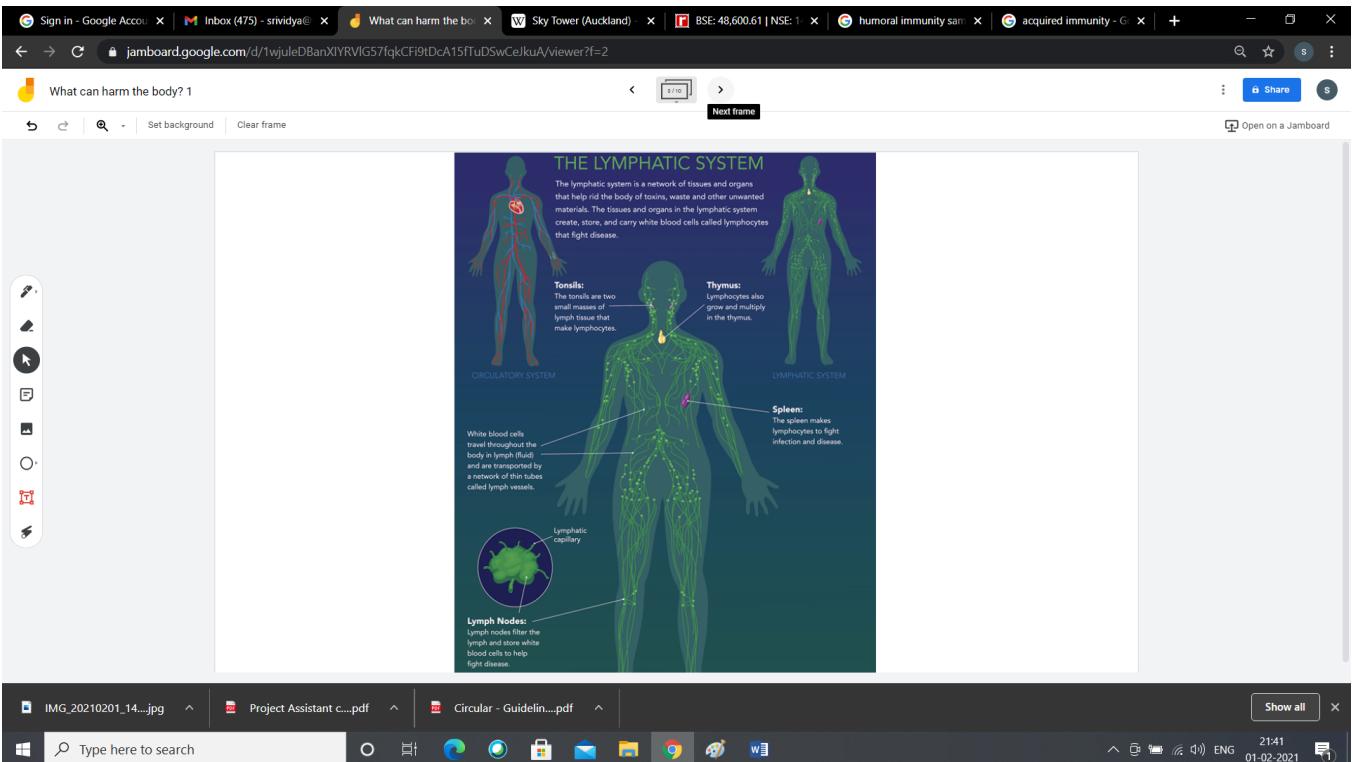
Lymph fluid contains WBCs that fight infections

Lymphocytes are white blood cells that are also one of the body's main types of immune cells.

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**Humoral Immunity** VS **Cell mediated Immunity**

The diagram illustrates the two main types of adaptive immunity:

- HUMORAL:** Involves antibodies produced by plasma cells. It targets extracellular pathogens. Key components include B cells, T<sub>H</sub> cells, and T<sub>B</sub> cells.
- CELL-MEDIATED:** Involves T<sub>C</sub> cells that defend against infected cells, cancers, and transplant tissues. Key components include T<sub>H</sub> cells, T<sub>C</sub> cells, and memory cells.

Both pathways lead to memory cells for future responses.

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**Acquired Immunity**

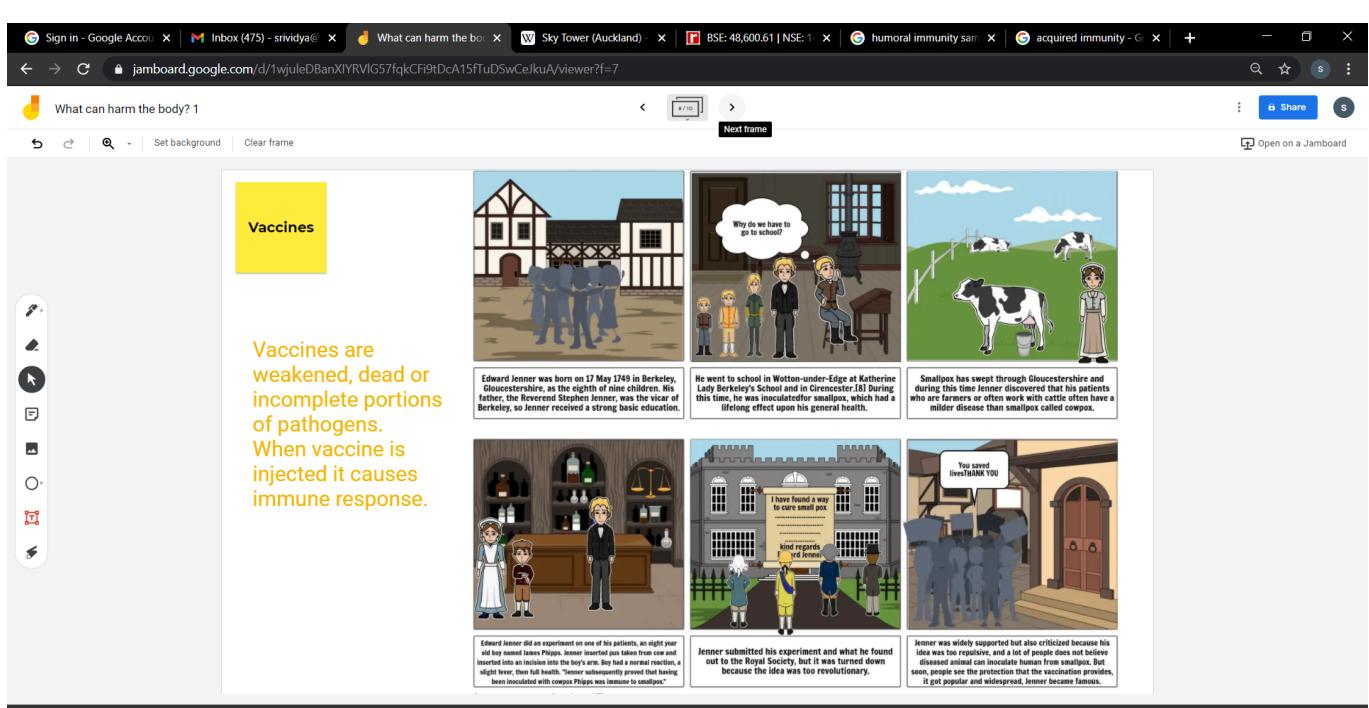
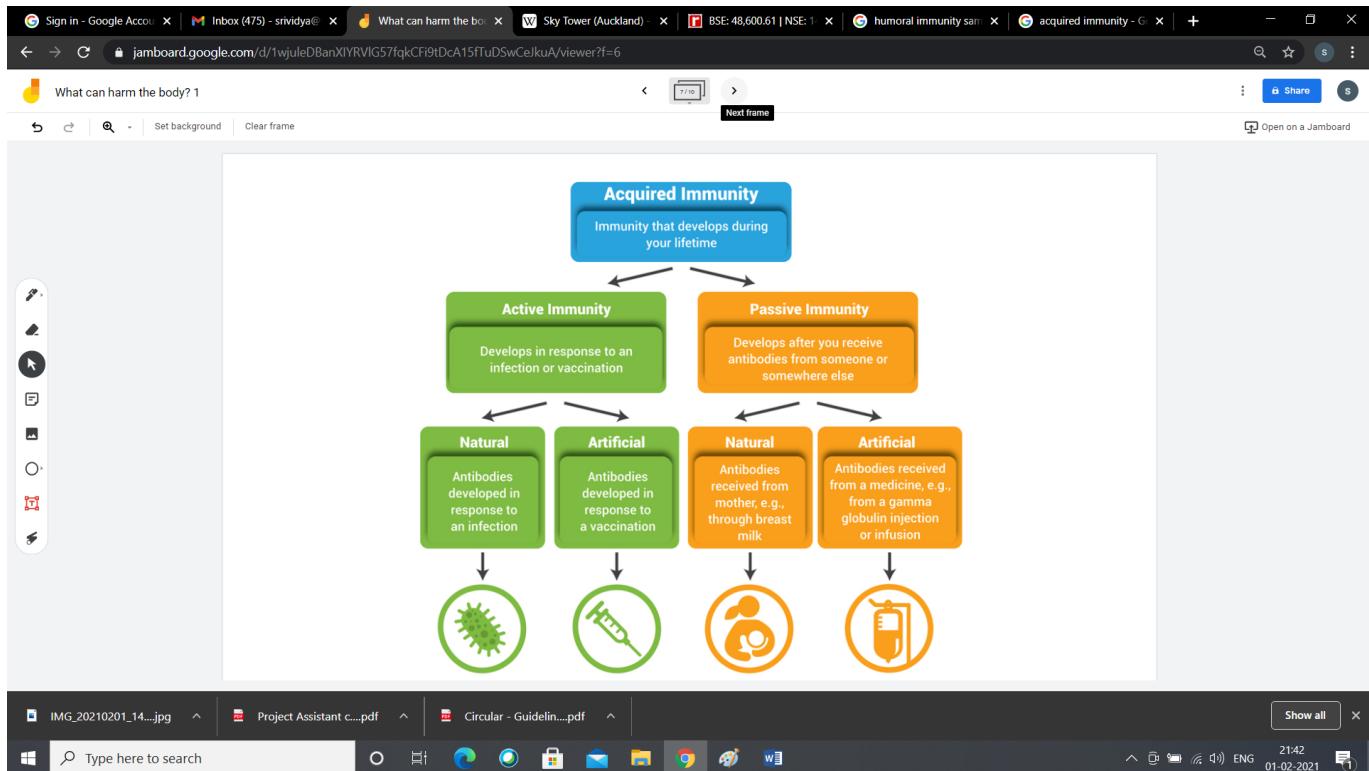
Acquired immunity is divided into:

- Active immunity:** Produced by the immune system. It can be **Natural** (immune response to a pathogen) or **Artificial** (vaccines).
- Passive immunity:** No role of immune system. It can be **Natural** (colostrum, foetus receiving antibodies via placenta) or **Artificial** (ATS, ADS).

**HINDI**

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Sarah Nelmes, a milkmaid infected with cowpox.

James Phipps is inoculated with cowpox pus from Nelmes.

Phipps falls ill with a mild case of cowpox.

Scabs are collected from a smallpox patient.

Phipps is inoculated with the scabs of smallpox.

Phipps is unaffected. Protection is complete.

A diagram illustrating the historical process of vaccination. It shows a sequence of six stages: 1. A milkmaid (Sarah Nelmes) is infected with cowpox while milking a cow. 2. Cowpox pus is taken from her. 3. James Phipps is inoculated with the cowpox pus. 4. Phipps falls ill with a mild case of cowpox. 5. Scabs are collected from a smallpox patient. 6. Phipps is inoculated with the scabs of smallpox. The final stage shows Phipps unaffected, indicating successful protection against smallpox.

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## HOW VACCINES WORK

A weak or dead form of the disease germ is introduced > This sparks your immune response to develop antibodies that remember the germ > The antibodies fight off the germ if it invades again

A weakened form of the disease germ is injected into the body.

The body makes antibodies to fight these invaders.

If the actual disease germs ever attack the body, the antibodies will return to destroy them.

The diagram illustrates the mechanism of vaccination. It shows a sequence of three steps: 1. A weakened form of the disease germ is injected into the body. 2. The body's immune system responds by developing antibodies that remember the germ. 3. If the actual disease germs ever attack the body, the antibodies will return to destroy them, providing protection.

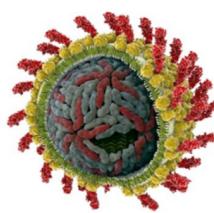
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## What is a virus?

- A microscopic infectious agent
- Prolific and found in almost all life forms
- Can only replicate inside the living cells of organisms
- The study of viruses is called virology
- Viruses infect host cells to reproduce
- Viruses can learn to adapt to immune responses
- Viruses are much more difficult to treat than bacteria



Hepatitis C: Cut away molecular model

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## What is the structure of a virus?

## How does a virus attach to host cell?

### What Are Viruses Made Of?

**Nucleic Acid**  
DNA or RNA  
But not both

**Capsid** – a protein coat surrounding the nucleic acid.

**Envelope** – membrane like structure outside the capsid in some viruses

Examples:  
Influenza  
Chickenpox  
Herpes-simplex  
HIV

**Human Immunodeficiency Virus (HIV) Anatomy**

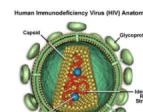


Figure 1

**Bacteriophage Structure**

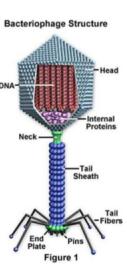
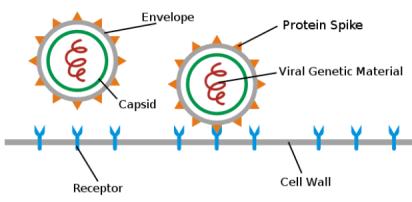


Figure 1



Envelope  
Capsid  
Protein Spike  
Viral Genetic Material  
Receptor  
Cell Wall

Some viruses infect more than one species

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## Lytic and Lysogenic cycles

### LYTIC AND LYSOGENIC CYCLES

The diagram illustrates two strategies of viral reproduction:

- Lytic Cycle:** Phage attaches to a host cell and injects its DNA. The phage DNA circularizes, and the cell enters either a lytic or lysogenic cycle. If lytic, the cell lyses, releasing phages. If lysogenic, the phage DNA integrates into the host genome, and the infected cell divides to produce infected daughter cells. Occasionally, prophage is excised and begins a lytic cycle.
- Lysogenic Cycle:** Phage DNA integrates into the host genome. The infected cell divides to produce infected daughter cells. Occasionally, prophage is excised and begins a lytic cycle.
- Combination:** Phages are assembled, leading to either the lytic cycle or the lysogenic cycle.

MANY VIRUSES REPRODUCE USING A COMBINATION OF THESE TWO STRATEGIES

BOGO BIOLOGY

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## AIDS and the immune system

### HIV and AIDS

**AIDS (Acquired Immune Deficiency Syndrome)** was apparently a new **emerging** disease when it first appeared in the human population.

- AIDS was **first detected** in Los Angeles, USA in **1981**.
- By **1983** the pathogen causing the disease (shown right) had been identified as a **virus** that selectively infects **helper T cells**.
- The virus, which causes a collapse of the immune system, was given the name **Human Immunodeficiency Virus (HIV)**.
- As yet, there is no cure for AIDS. The disease is now a global pandemic.

The Human Immunodeficiency Virus (HIV)

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How is HIV spread

## HIV 101

Without treatment, HIV (human immunodeficiency virus) can make a person very sick and even cause death. Learning the basics about HIV can keep you healthy and prevent transmission.

**HIV Can Be Transmitted By**

- Sexual Contact
- Sharing Needles to Inject Drugs
- Mother to Baby during pregnancy, birth, or breastfeeding

**HIV Is NOT Transmitted By**

- Air or Water
- Saliva, Sweat, Tears, or Closed-Mouth Kissing
- Insects or Pets
- Sharing Toilets, Food, or Drinks

Symptoms: Swollen lymph nodes, loss of appetite, weight loss, fever, rashes etc.

AIDS weakens the body's immune system and the body cannot fight off other infectious diseases or certain forms of cancer.

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Viroids and prions

## Viroids & Prions

**Viroids**

- Infectious RNA molecules
  - Plant diseases (interfere with metabolism)
- Transmitted like viruses

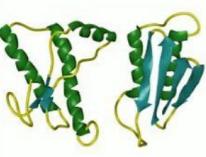
**Prions**

- Infectious protein molecules
- Animal/human diseases
  - Insomnia, mad cow disease

Biologyconcepts

DISEASES CAUSED BY VIROIDS

- Viroids causes over 20 different plant diseases of which the most studied are
  - POTATO SPINDLE-TUBER DISEASE
  - CHRYSANTHEMUM STUNT DISEASE



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Coronavirus

Coronavirus (SARS-CoV-2)

COVID-19

MicrobeOnline

Spike Glycoprotein (S)

RNA and N protein

Envelope

Hemagglutinin-esterase dimer (HE)

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Coronaviruses

large group of viruses

envelope

Genetic material

protein spikes

crown = "corona"

different types

number of human diseases

respiratory      gastrointestinal

common cold      pneumonia

generally mild disease

some cause severe disease

SARS - COV      China - 2003

MERS - COV      Saudi Arabia - 2012

2019 N - COV      China - 2019

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