

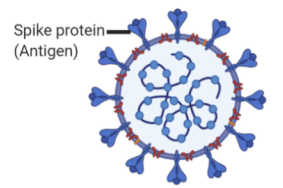
TYPES OF VACCINES

Live Attenuated Vaccine

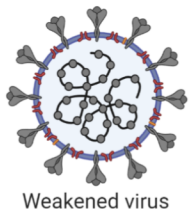
These vaccines contain **live virus** particles that have been **weakened** to keep them from causing disease.

They create a strong immune response

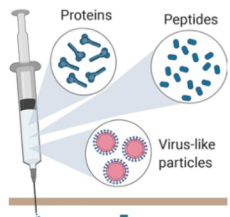
Some attenuated vaccines might not be suitable for people with compromised immune systems



Disease-causing virus



Weakened virus



Antigen is presented to the immune cells on **Antigen Presenting Cells**

Immune Response and Memory

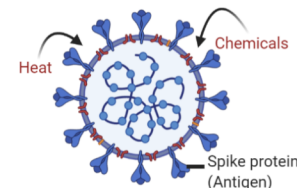
Currently used in:
MMR (Measles/mumps/rubella)
Chickenpox
COVID vaccines in the pipeline:
Codagenix; Indian Immunologicals Ltd

Inactivated Vaccine

These vaccines contain **whole virus particles**, that have been **killed or inactivated** to keep them from causing disease.

They are safer as the virus is already dead

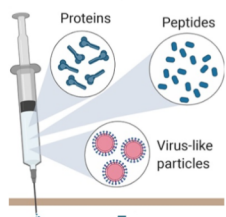
Inactivated vaccines require booster doses as the immunity conferred by these vaccines is weaker than live vaccines



Disease-causing virus



Dead/Killed virus



Antigen is presented to the immune cells on **Antigen Presenting Cells**

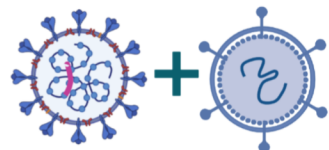
Immune Response and Memory

Currently used in:
Polio
COVID vaccines in the pipeline:
Sinovac; Sinopharma; Bharat Biotech

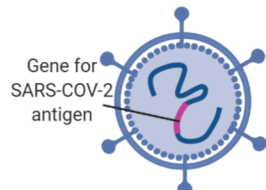
Replicating Viral Vector Vaccine

These vaccines use **low-pathogenic viruses**, which are largely harmless, and alter them into **viral vectors** that will produce some of the same proteins as the disease-causing virus.

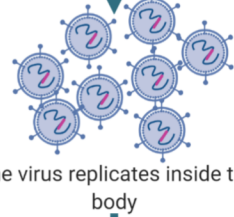
This creates a **strong immune response**, but may not work for people who are already immune to the low pathogenic virus.



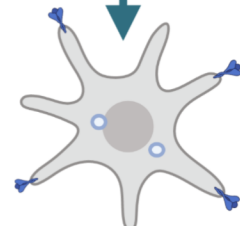
Disease-causing virus Low - pathogenic virus



Viral vector encoding target antigen



The virus replicates inside the body



Antigen is presented to the immune cells on **Antigen Presenting Cells**

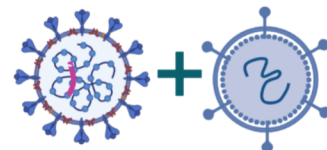
Immune Response and Memory

Currently used in:
Used in veterinary medicine
COVID vaccines in the pipeline:
Themis Bioscience; University of Pittsburgh

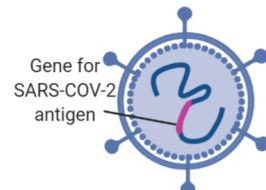
Non-Replicating Viral Vector Vaccine

These vaccines are **similar to replicating viral vector** vaccines except that they **cannot replicate** inside the body as the key viral replication genes is deleted from the low pathogenic vector virus.

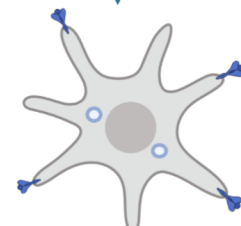
Improved **efficacy and safety**, but require high doses to confer immunity.



Disease-causing virus Low - pathogenic virus



Viral vector encoding target antigen



Antigen is presented to the immune cells on **Antigen Presenting Cells**

Immune Response and Memory

Currently used in:
Ebola
COVID vaccines in the pipeline:
University of Oxford and & AstraZeneca

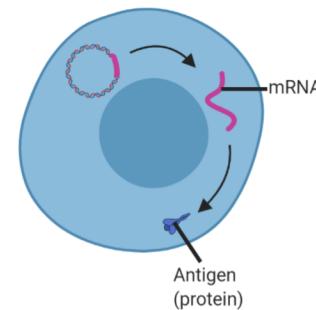
DNA Vaccine

These vaccines use **DNA plasmids** containing a **gene for SARS-CoV-2** along with additional genetic elements that will produce some of the same **antigenic proteins** as the disease-causing virus.

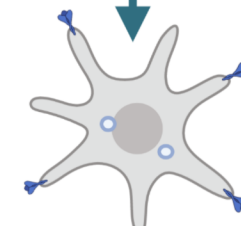
They are easy to develop and produce. There is no risk of infection but there is a possibility that the immune system does not fight against the antigen (tolerance to the antigen).



DNA Plasmid



Antigen (protein)



Antigen is presented to the immune cells on **Antigen Presenting Cells**

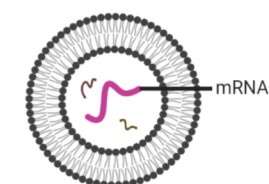
Immune Response and Memory

Currently used in:
No currently available human DNA vaccines
COVID vaccines in the pipeline:
Inovio; Genexine; Zydus Cadila

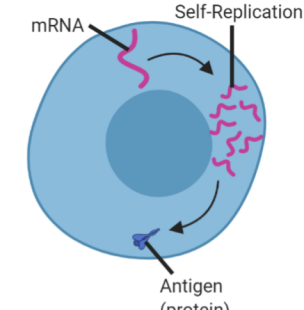
RNA Vaccine

These vaccines use a piece of **messenger RNA (mRNA)** that will produce some of the same **antigenic proteins** as the disease-causing virus.

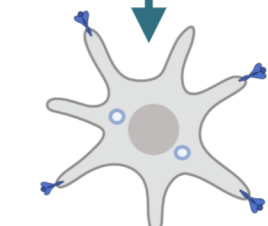
Risk of being integrated to the host genome is averted but, sometimes the RNA molecules may trigger an unintended immune response in the body



Lipid Delivery Vehicle



Antigen (protein)



Antigen is presented to the immune cells on **Antigen Presenting Cells**

Immune Response and Memory

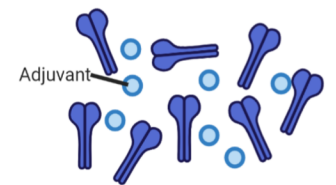
Currently used in:
No currently available human RNA vaccines
COVID vaccines in the pipeline:
Moderna; CureVac; Pfizer; BioNTech; Fosun Pharma

Subunit Vaccine

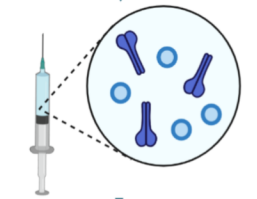
These vaccines use **antigenic protein** from the disease causing virus **without any genetic material**.

They are relatively safer as there is no genetic material and they cannot replicate inside the body. They focus the immune response on the most important part of the virus for protection.

These vaccines require multiple doses for long term immunity. They require adjuvants which are ingredients that help create a stronger immune response.



SARS-CoV-2 antigen and adjuvants

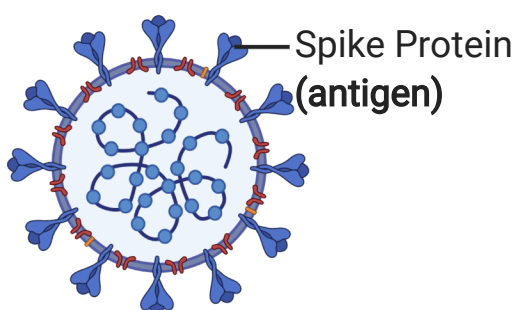


Antigen is presented to the immune cells on **Antigen Presenting Cells**

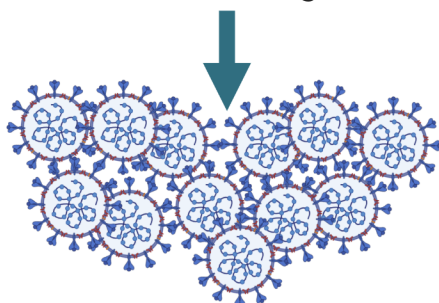
Immune Response and Memory

Currently used in:
HPV (Human Papilloma virus); Pertussis; Hepatitis B
COVID vaccines in the pipeline:
Novavax; AdaptVac

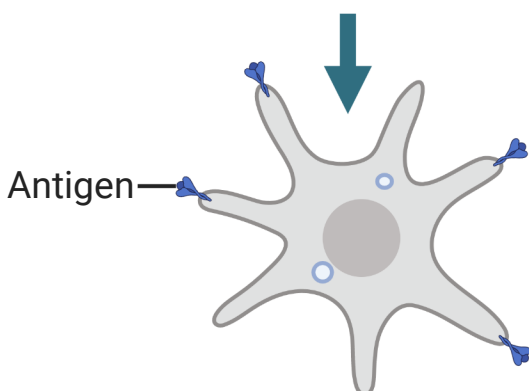
IMMUNE RESPONSE



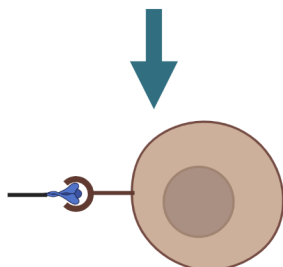
Disease-causing virus



Virus enters body replicates inside the cells



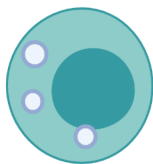
Antigen-presenting cells take antigens from the infecting viruses and present them to immune cells.



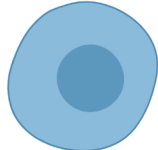
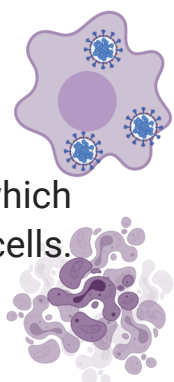
This teaches "helper" CD4+ T-cells to recognize the antigen

CELL-MEDIATED IMMUNITY

ANTIBODY-MEDIATED IMMUNITY



Cytotoxic or "killer" CD8+ T-cells produce and release cytotoxins, which kill infected cells.



B-cells produce antibodies, which can neutralize virus



GLOSSARY

Antibody - Y-shaped protein produced mainly by immune cells that is used by the immune system to neutralize pathogens such as virus and bacteria.

Antigen - A toxin or other foreign substance which induces an immune response in the body, especially the production of antibodies.

Antigen presenting cells - Large group of various cells that trigger the cellular immune response by processing an antigen and exposing it in a form recognizable by T cells in the process known as antigen presentation.

B cell - Is a type of immune cell that produces antibodies to enable antibody mediated immune response.

Booster dose - It is an extra administration of a vaccine after an earlier (prime) dose and intended to increase immunity against that antigen back to protective levels, after memory against that antigen has declined through time.

Cytotoxic or Killer CD4-T cell - Is an immune cell that kill cells that are infected (particularly with viruses), or cells that are damaged in other ways.

DNA Plasmid - A small, extrachromosomal DNA molecule within a cell that is physically separated from chromosomal DNA and can replicate independently. Plasmids used experimentally for the purpose of research are called vectors

Genome - Complete set of genetic information in an organism.

Helper CD4 T-Cells - A type of immune cell that stimulates killer T cells, macrophages, and B cells to make immune responses.

Immune system - Complex network of cells and proteins that defends the body against infection.

Messenger RNA or mRNA - Molecules in the cell that carries codes from DNA in the nucleus to the cell machinery responsible for protein synthesis (cytoplasm) within a cell.

Pathogens - Microorganisms that cause a disease eg bacteria, virus.

Peptides - A short chain of amino acids (basic units of protein)

Tolerance to the Antigen - Tolerance is the prevention of an immune response against a particular antigen.

Viral Vectors - Tailored virus for the delivery of the infective viral gene.

Weakened virus - Retained Immunogenicity (ability of an antigen, to provoke an immune response in the body) but no pathogenicity (the property of causing disease).