
Science & Technology

50 most important topics

Part III

Science & Technology

50 Important Topics - 2024	
Scheduled Date	**Subject**
01/04/24	Economy
02/04/24	Science & Technology
03/04/24	Environment & D.M.
04/04/24	Science & Technology
05/04/24	Environment & D.M.
06/04/24	----------
07/04/24	----------
08/04/24	Economy
09/04/24	Science & Technology
10/04/24	Economy
11/04/24	English
12/04/24	International Relations
13/04/24	----------
14/04/24	----------
15/04/24	Geography
16/04/24	Polity & Governance
17/04/24	Polity & Governance
18/04/24	Geography
19/04/24	Polity & Governance
20/04/24	Maths
21/04/24	----------
22/04/24	Reasoning
23/04/24	Environment & D.M.
24/04/24	Social Schemes

Sleepy Classes IAS
Awakening Toppers

RAPID REVISION

MOST IMPORTANT TOPICS FOR PRELIMS 2024

CSAT	₹1,500	GS	₹3,500
CSAT + General Studies	₹4,000		

50 HOURS

1500 TOPICS

11th April 2024 – 29th April 2024

Special Inclusions

- 6 FLTs (3 GS+ 3 CSAT)
- Value Additions Material
- Subject Specific MCQS

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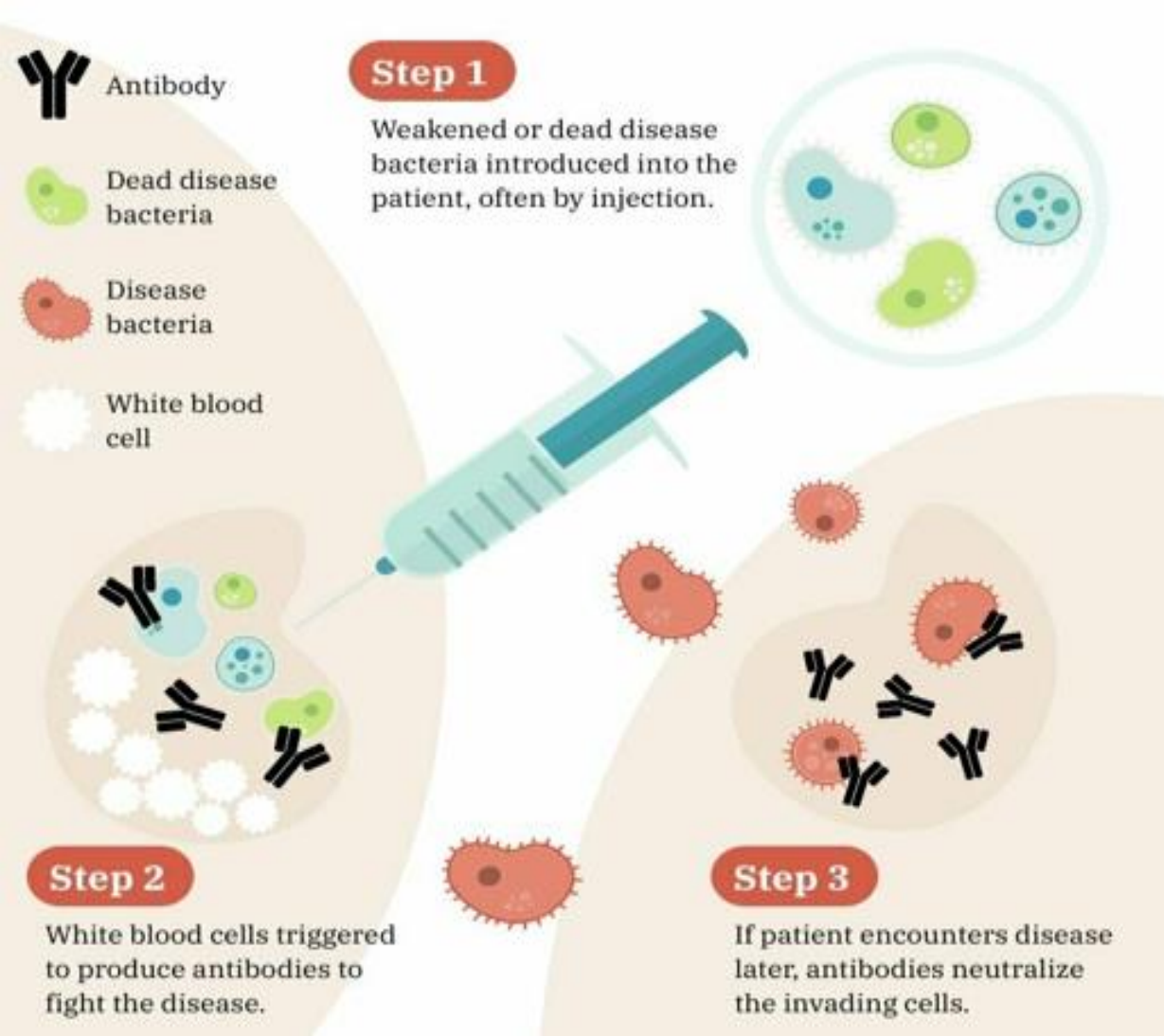
Health and Diseases

Types Of Vaccines

What is a Vaccine

A **vaccine** is a biological preparation that provides **active acquired immunity** to a particular infectious disease.

How do Vaccines Work ?

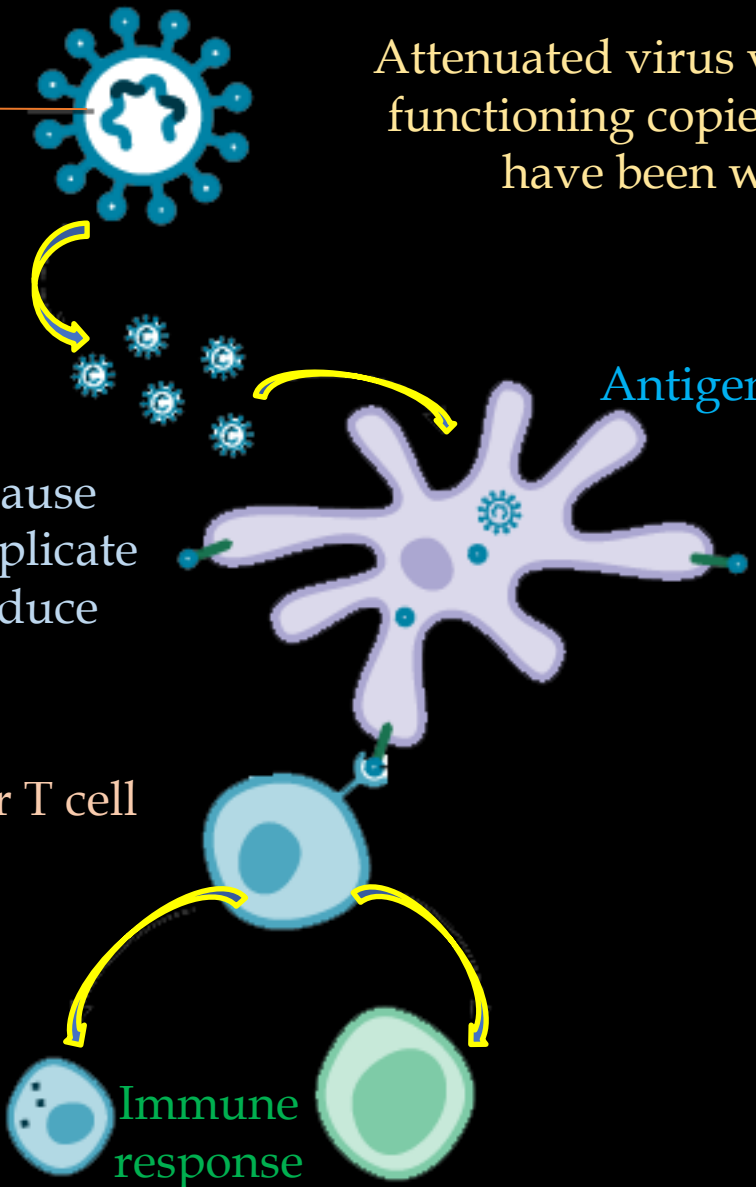


Acquired/Adaptive immunity

Humoral	Cell Mediated
• Antibody mediated response • B Cell • Fast response • Extracellular pathogen	• T cell mediated response • T cell • Slow response • Intracellular pathogen

	DNA & RNA	Live Attenuated	Subunit	Inactivated	Viral vector
					
How it functions	Target the viral proteins by regulating the immunity system	Weakened the viral activity of the actual virus	Subunit vaccine is consisting the piece of virus surface, it target immunity system	Inactivation of whole virus by applied heat or chemicals & use as an inactivated vaccine	The virus used as vector system to deliver viral genes; stimulate the immunity
Advantages	The concept easy to design	The stimulation of the immunity response & robust it	It's well established, more affective, focuses targeted responses	It may safe and easy to develop	The virus-mediated delivery system is more effective
Disadvantages	Not applied before & currently no evidence is available	The concept been used earlier, may be safe by compromised immunity system	The substrate or catalysts are required to stimulate the strong response	Inactivated vaccines cause serious health issues. It may not as effective as a live virus	The selection of appropriate virus safe & host immune response may cause less effective
Existing example	None	Mumps Measles Chickenpox	Hepatitis B HPV Pertussis	Polio	Ebola
Group testing approaches for COVID-19	Moderna (RNA) Inovio (DNA)	Indian Immunologicals Ltd Cadogenix	Adapt Vac Novavax	Sinopharma Sinovac	CanSino Biologics Oxford University & AstraZeneca Johnson & Johnson

Live attenuated Vaccines



Attenuated virus vaccine contain functioning copies of Virus that have been weakened

Virus does not cause disease but still replicate inside body& induce immunity

Five vaccines that are recommended by WHO produced using LAV technology

1. Tuberculosis (BCG),
2. Oral Polio Vaccine,
3. Measles,
4. Rotavirus,
5. Yellow Fever

Live attenuated Vaccines

- Provide **continual antigenic stimulation** giving sufficient time for memory cell production.
- Attenuated pathogens are capable of **replicating within host cells.**

- Can revert to original form & cause disease
- Potential harm to individual with compromised immune system
- Contamination of tissue culture
- Not in pregnancy
- Less safe than inactivated vaccine

COVI-VAC (codenamed CDX-005) is a COVID-19 vaccine developed by Codagenix, Inc.
It is a live attenuated vaccine administered intranasally and requires just one dose. It is currently in Phase 1 clinical trials, involving 48 participants which runs from December 2020 to June 2021.

Inactivated Vaccines

RNA destroyed

Adjuvant

Genetic material of virus has been destroyed

Antigen presenting cells

- Virus can't replicate inside body
- Higher doses needed
- Adjuvant to boost immunity

- Generally induce antibody mediated immunity, not cell mediated immunity

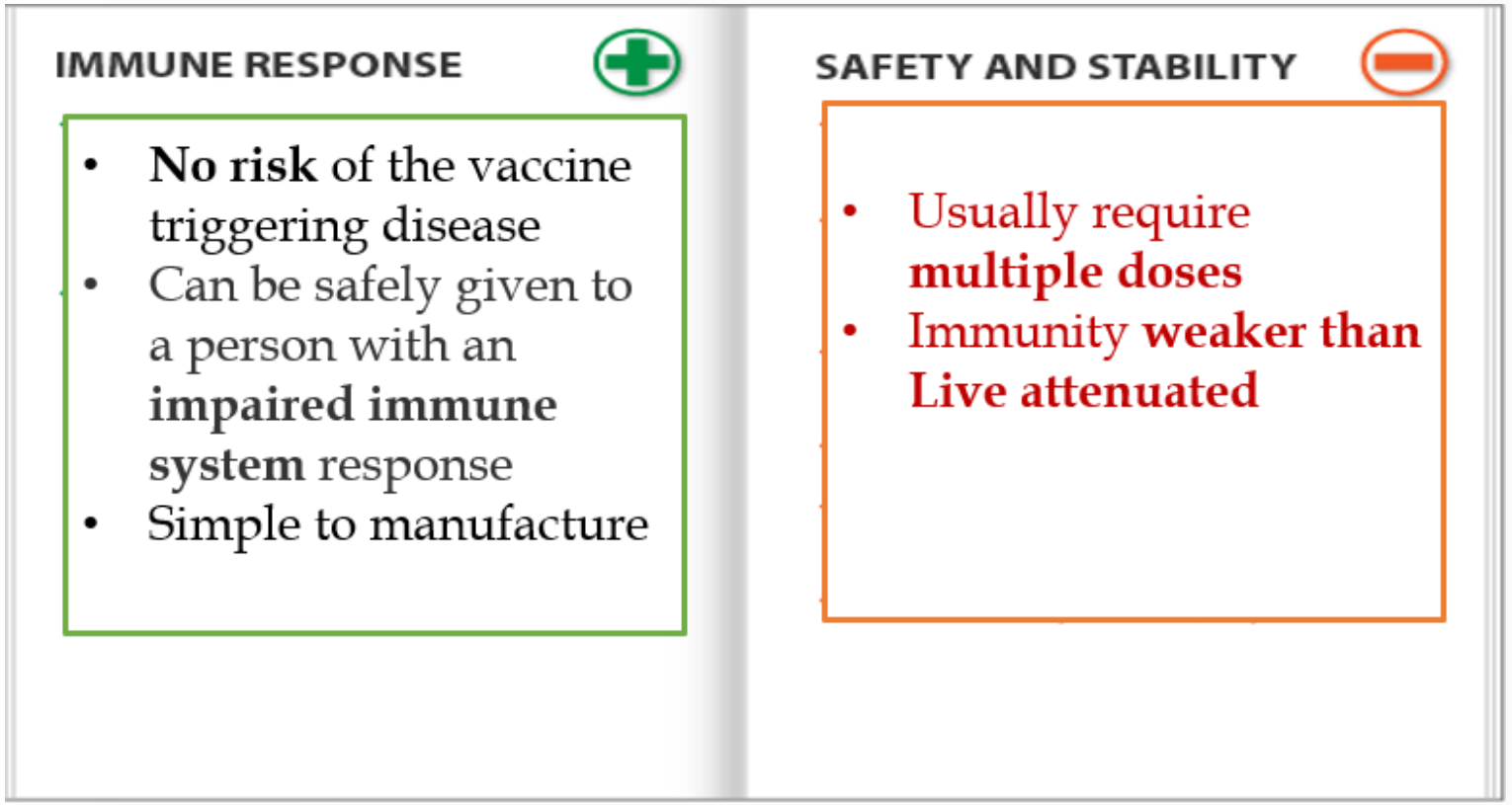
Helper T Cell

Antibody mediated immunity

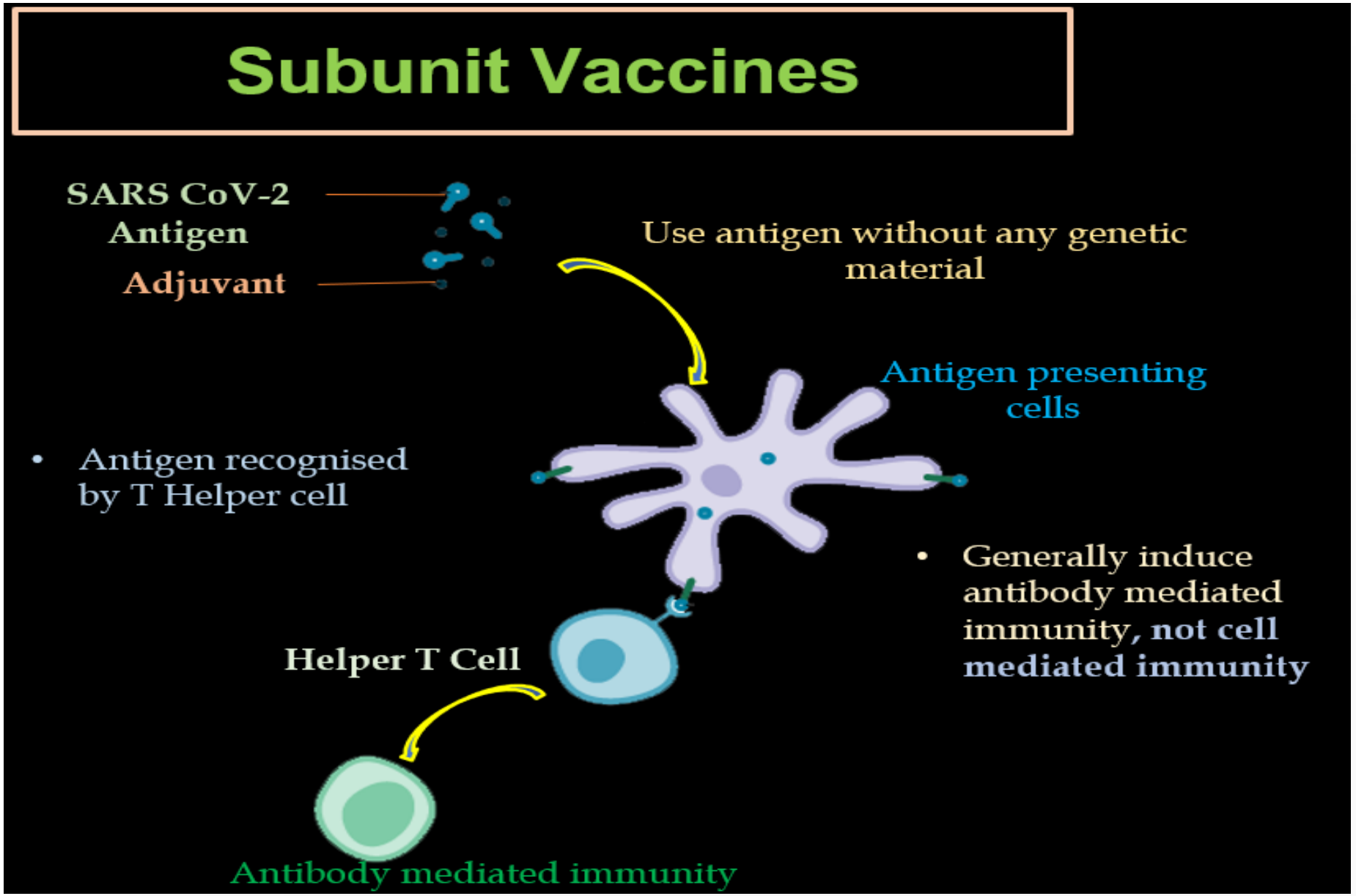
COVAXIN

- Developed by Bharat Biotech, Hyderabad in collaboration with the Indian Council of Medical Research's National Institute of Virology, Pune
- It is an **inactivated vaccine** which is developed by inactivating (**killing**) the live microorganisms that cause the disease.

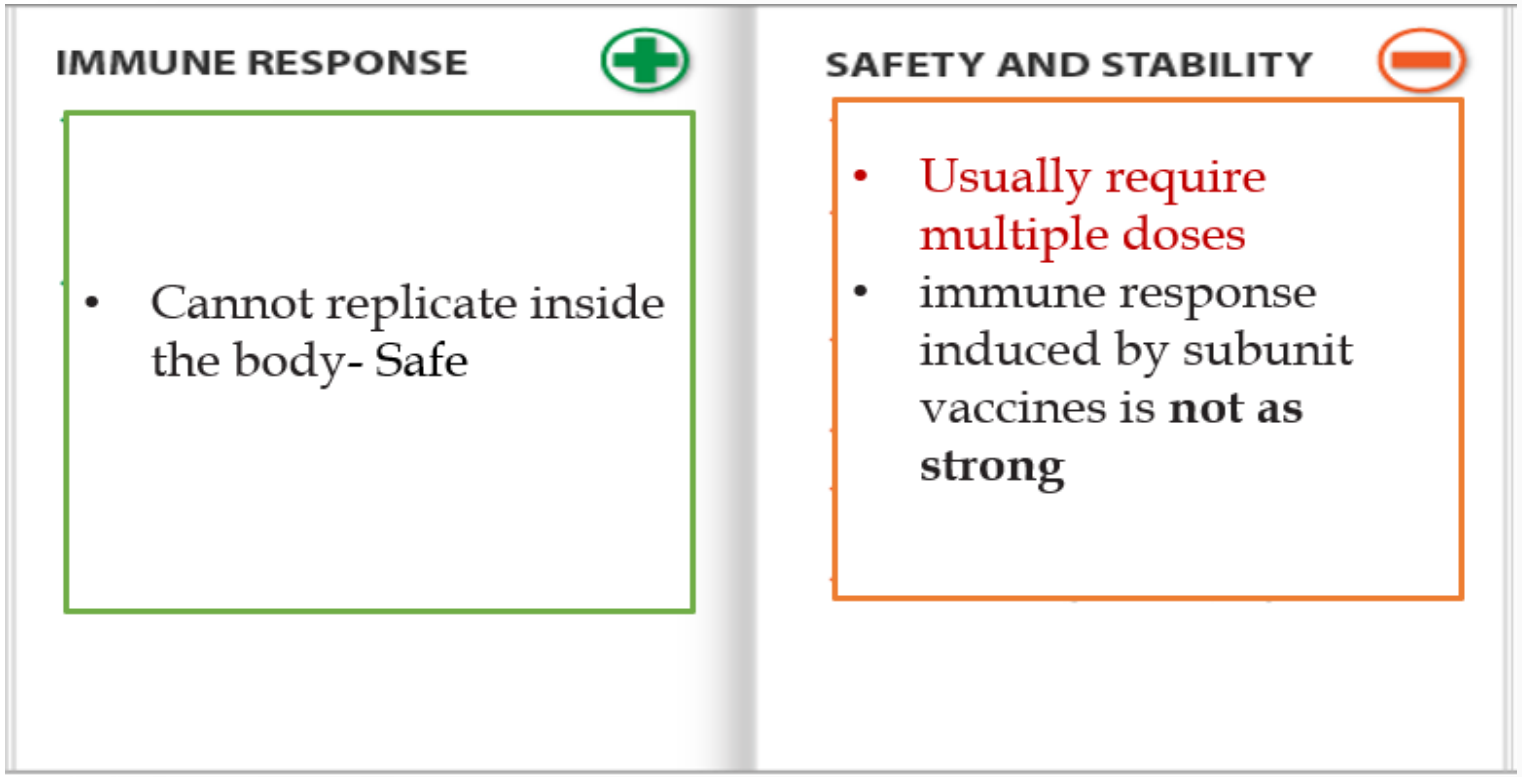
Inactivated Vaccines



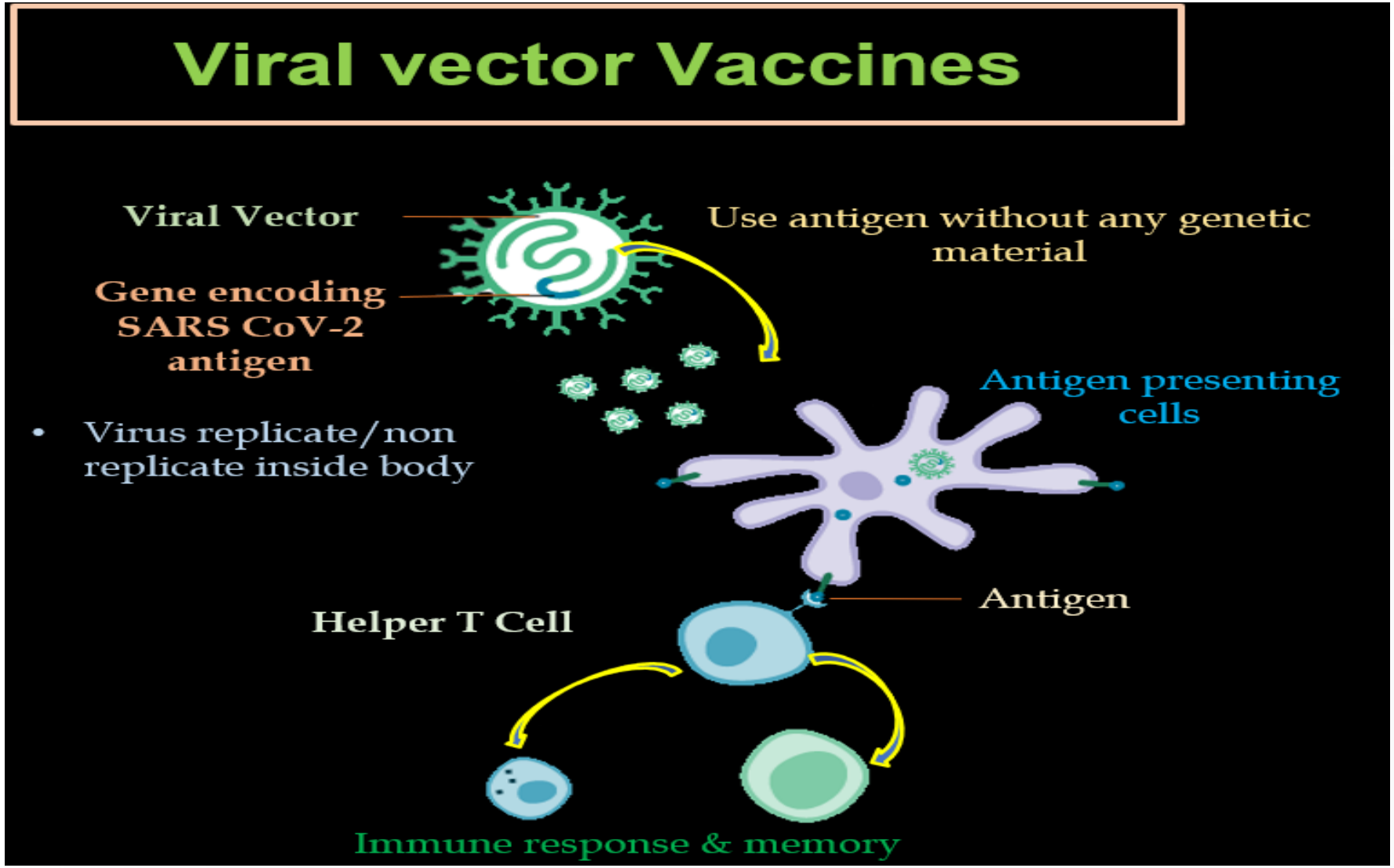
Subunit Vaccines



Subunit Vaccines



Viral vector Vaccines



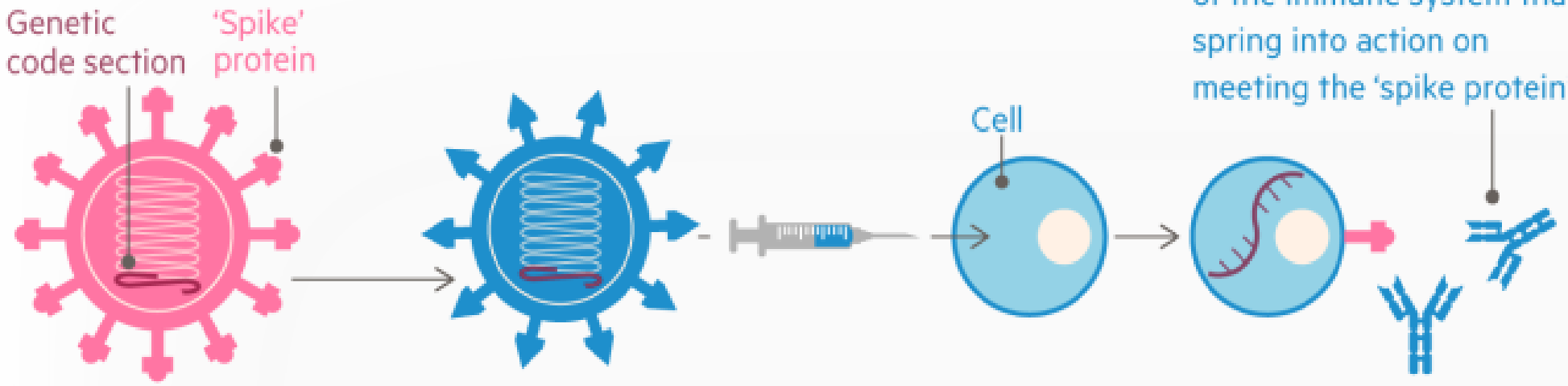
- Virus replicate/non replicate inside body

COVISHIELD

- Developed by the **University of Oxford** in collaboration with Swedish-British drugmaker **AstraZeneca.**
- **Serum Institute of India (SII)** is the manufacturing partner in India.
- It is based on **a weakened version of a common cold virus or the adenovirus** that is found in chimpanzees.

How adenovirus vaccines work

Genetic instructions are given to human cells to make part of the virus



A section of the Covid-19 virus's genome that makes the 'spike protein' is isolated

The code is put into a harmless virus, like the common cold, known as an adenovirus

Once injected, the adenovirus connects to human cells and latches on to proteins on their surface

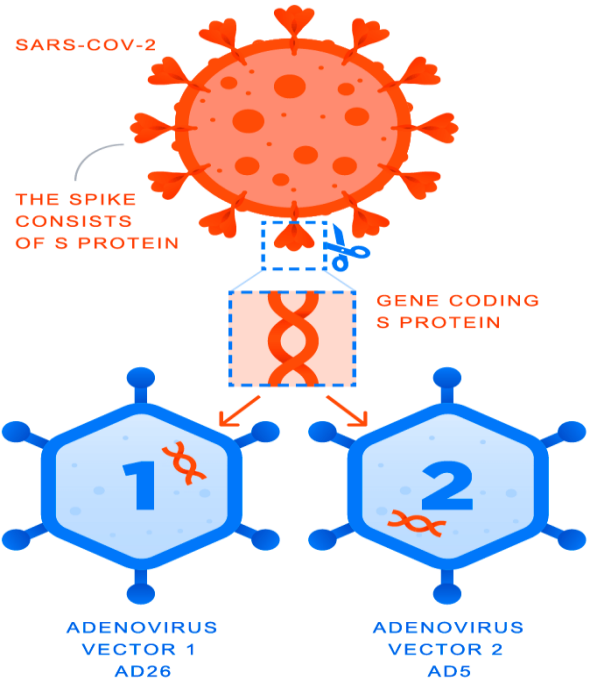
It then enters the cell, which reads the code contained in the genome and makes the Covid-19 'spike protein'

Sources: NHS; FT research

Two-vector vaccine against coronavirus

Vector creation

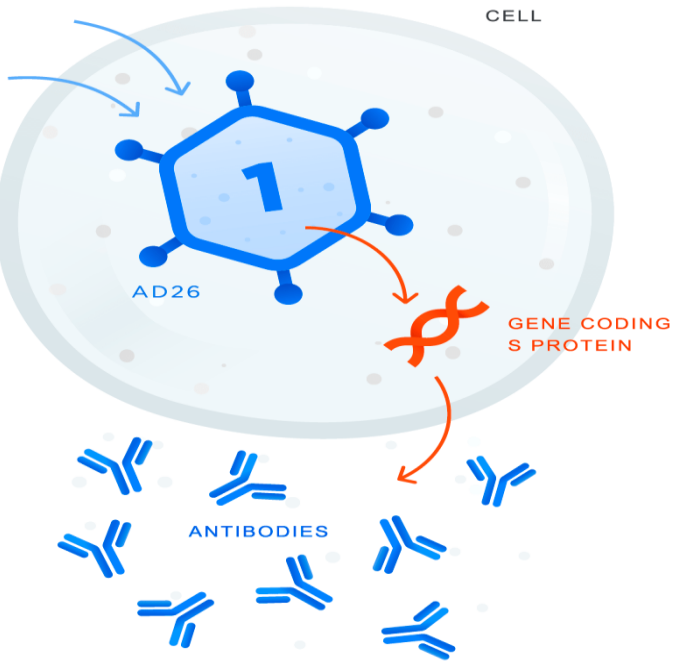
A vector is a virus that lacks a gene responsible for reproduction and is used to transport genetic material from another virus that is being vaccinated against into a cell.
The vector does not pose any hazard to the body. The vaccine is based on an adenoviral vector which normally causes acute respiratory viral infections



A gene coding S protein of SARS-COV-2 spikes is inserted into each vector.
The spikes form the "crown" from which the virus gets its name. The SARS-COV-2 virus uses spikes to get into a cell

First vaccination

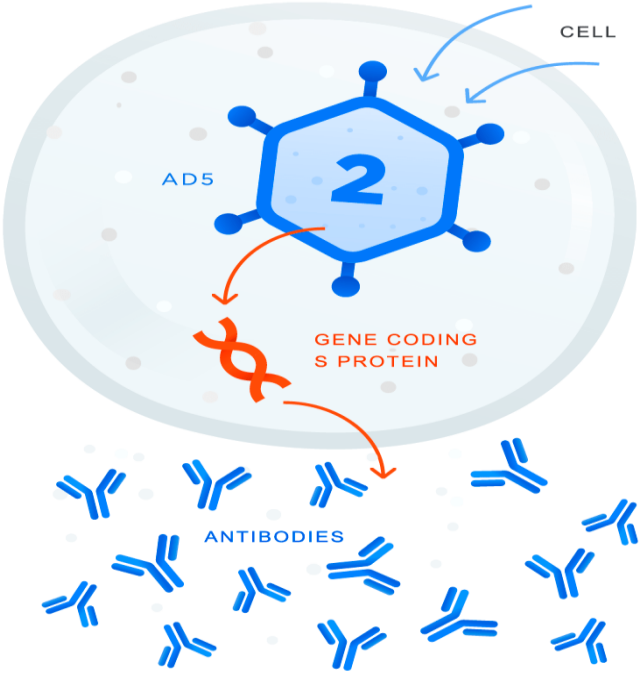
Vector with a gene coding S protein of coronavirus gets into a cell



The body synthesizes S protein, in response, the production of immunity begins

Second vaccination

Repeated vaccination takes place in 21 days

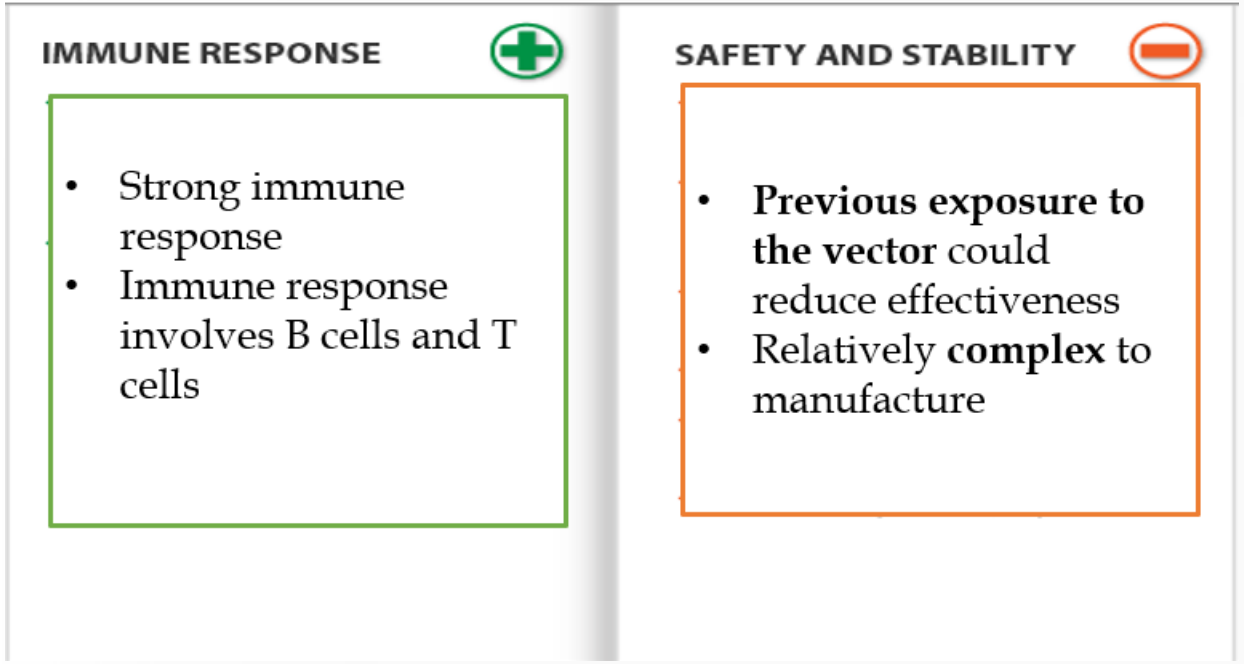


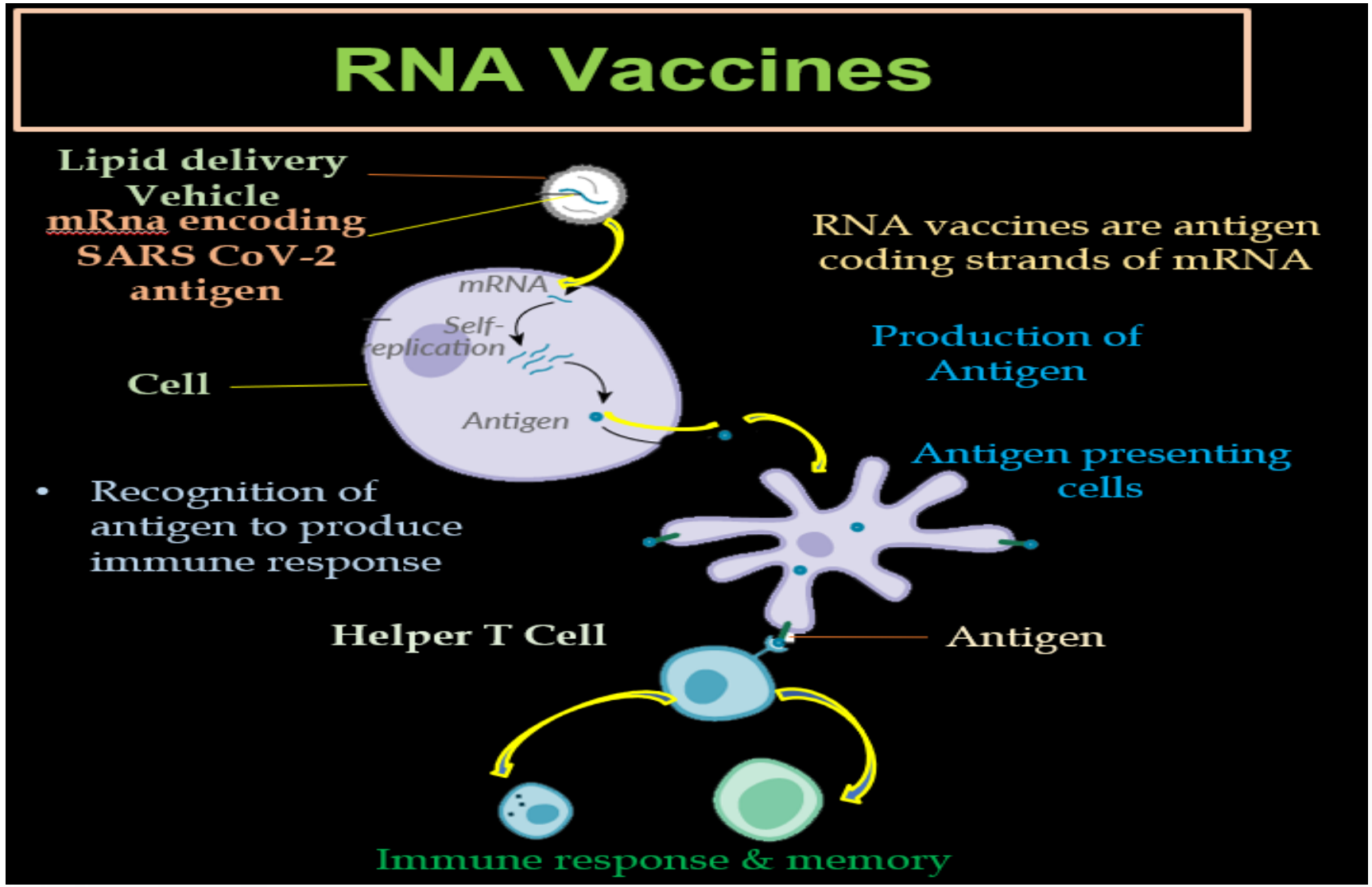
The vaccine based on another adenovirus vector unknown to the body boosts the immune response and provides for long-lasting immunity

The use of two vectors is a unique technology of the Gamaleya Center making the Russian vaccine different from other adenovirus vector-based vaccines being developed globally

Source: Gamaleya Center, RDIF, 2020

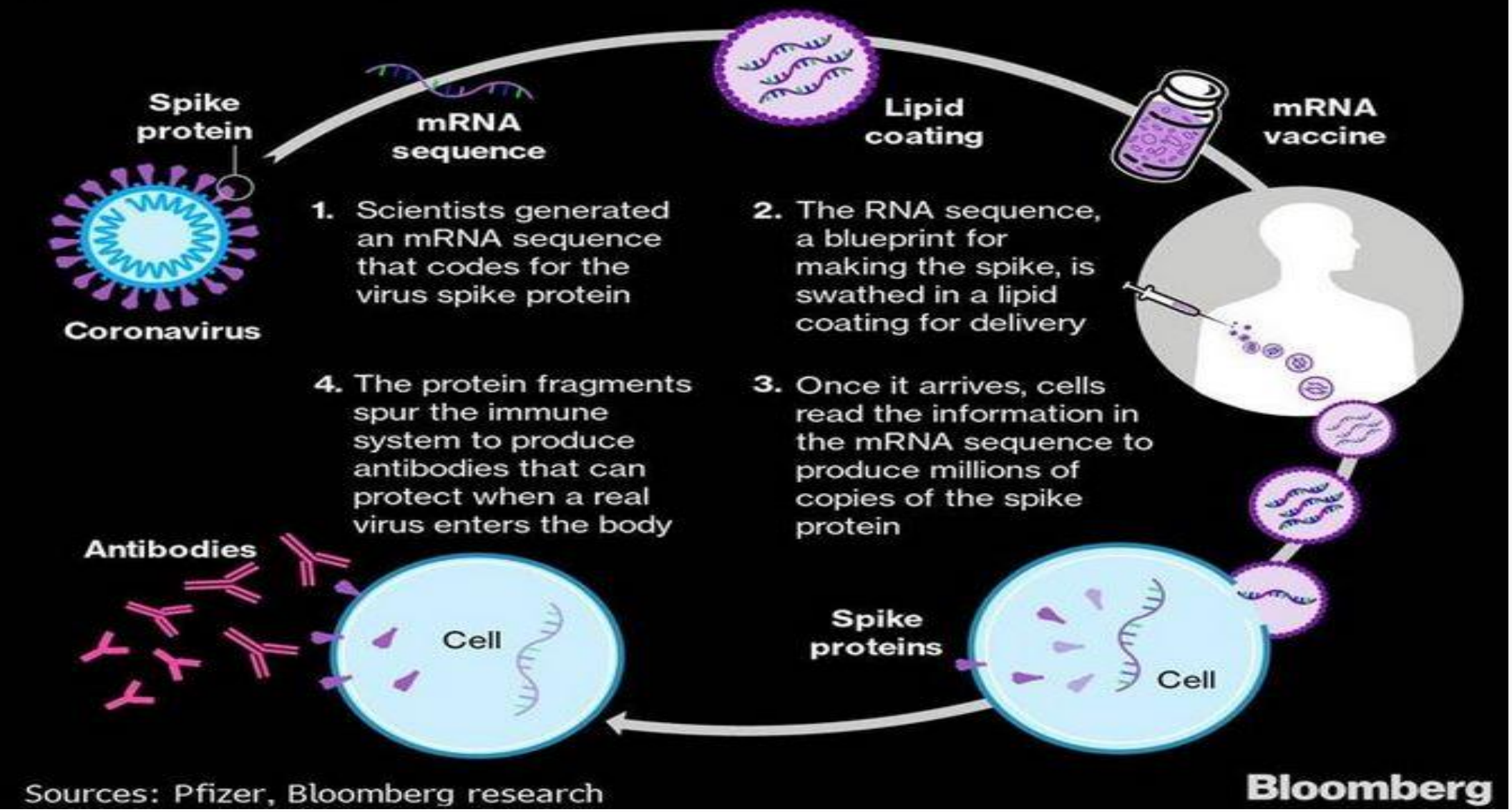
Viral vector Vaccines




RNA Vaccines
Lipid delivery Vehicle
mRna encoding SARS CoV-2 antigen
mRNA
Self-replication
Cell
Antigen
RNA vaccines are antigen coding strands of mRNA
Production of Antigen
Antigen presenting cells
Recognition of antigen to produce immune response
Helper T Cell
Antigen
Immune response & memory

How mRNA Vaccines Work

The vaccine spurs healthy cells to produce viral proteins that stimulate a potent immune response



Sources: Pfizer, Bloomberg research

Bloomberg

RNA/DNA Vaccines

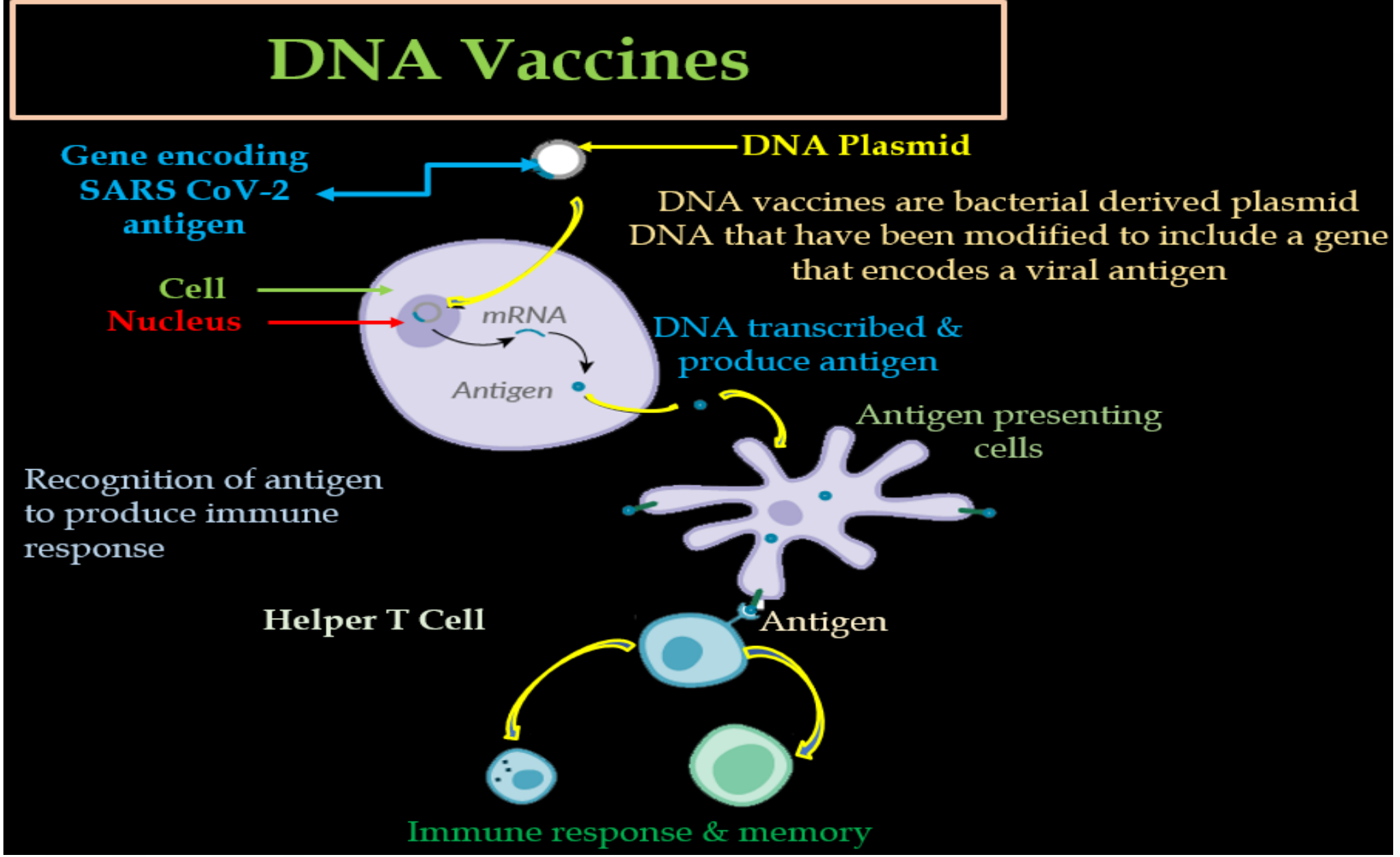
IMMUNE RESPONSE

- Immune response involves B cells and T cells
- **No live components**, so no risk of the vaccine triggering disease
- Relatively **easy to manufacture**

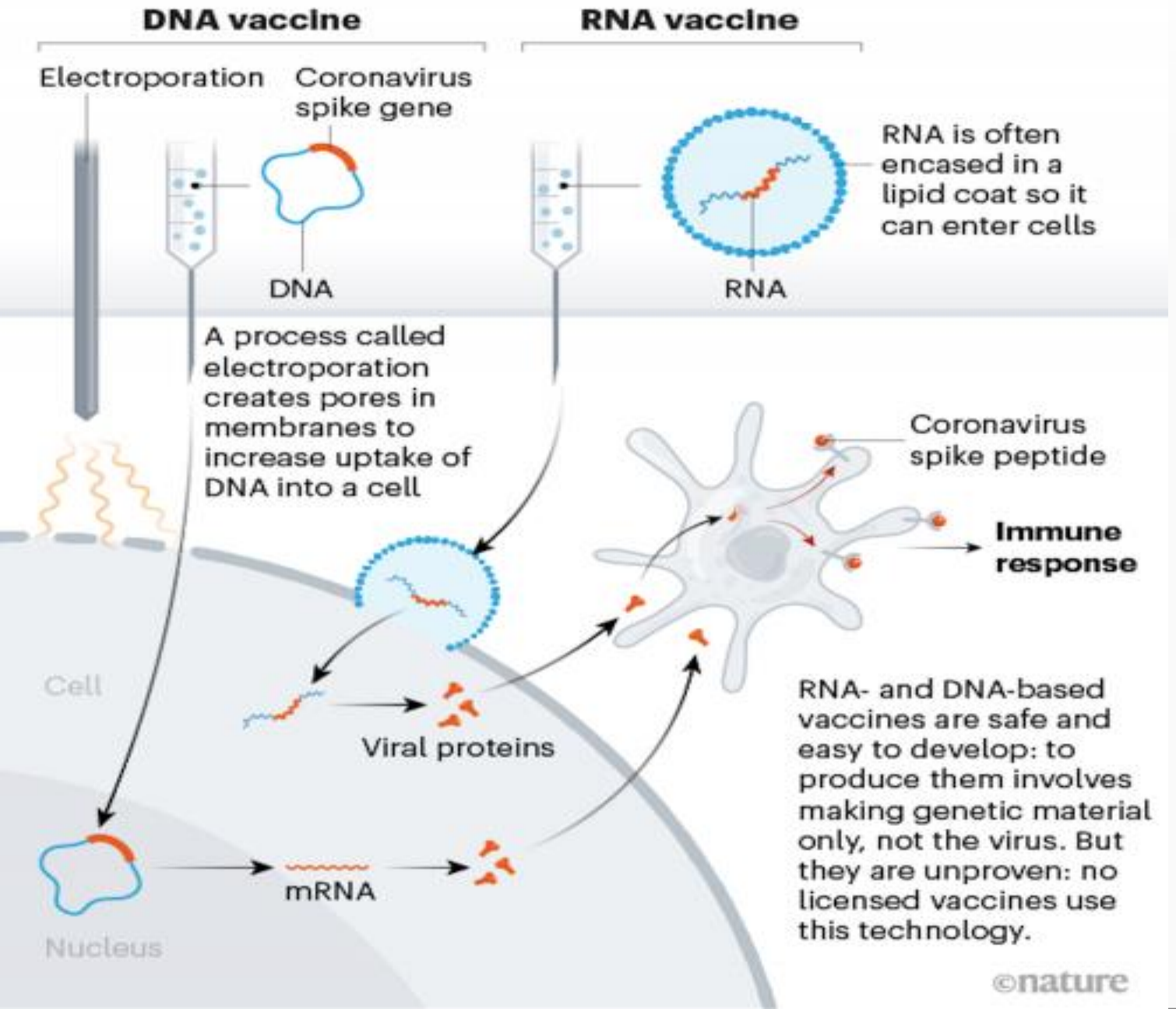
SAFETY AND STABILITY

Some RNA vaccines require **ultra-cold storage**

DNA Vaccines



NUCLEIC-ACID VACCINES

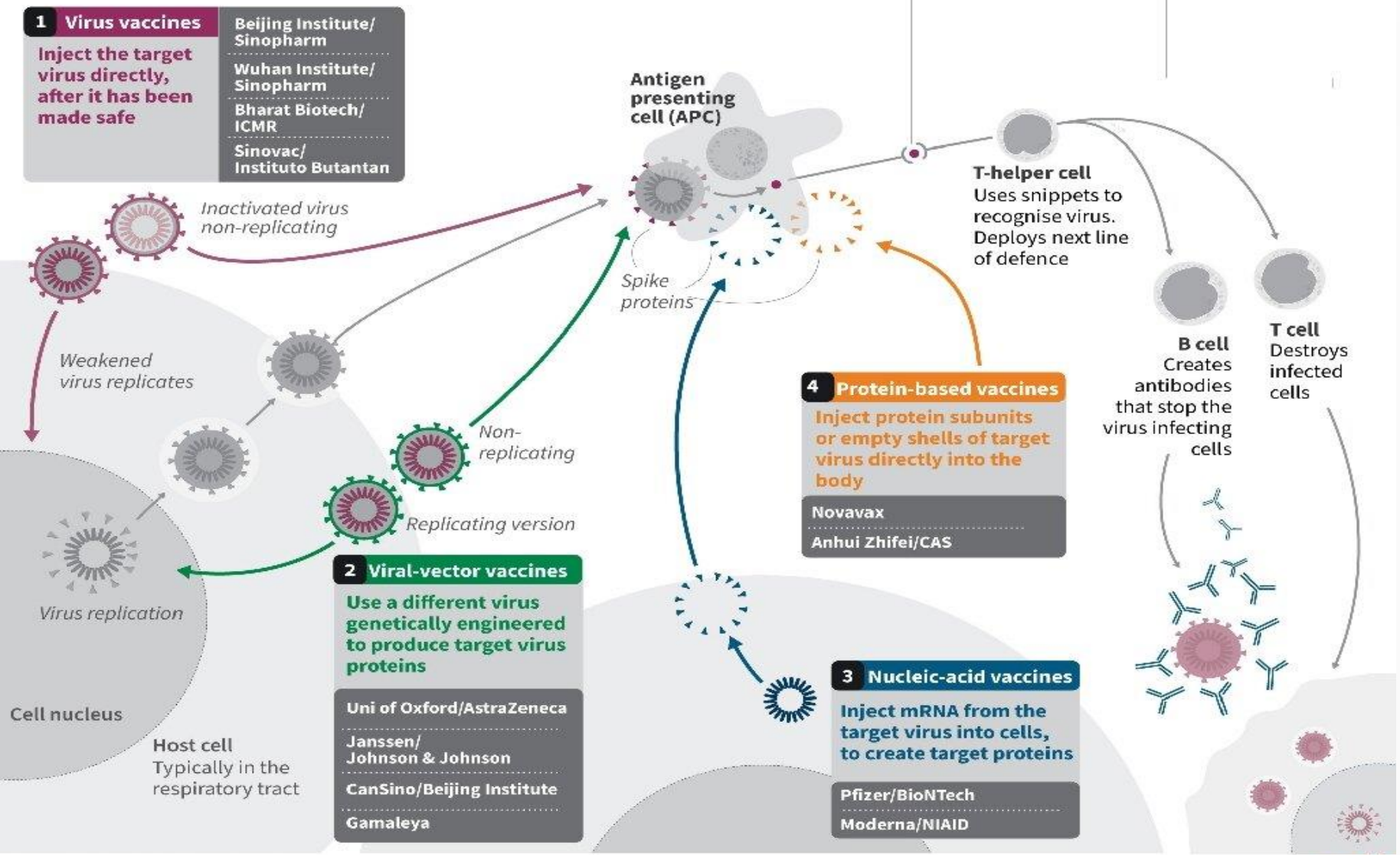


Different routes to a Covid-19 vaccine

Leading contenders in the race to establish effective inoculation against the SARS-CoV-2 virus

How they work

- Vaccines are all designed to safely trigger the body's natural immune response to SARS-CoV-2
- There are four main approaches towards developing a vaccine against the virus
- All methods rely on APC to initiate the immune response
- APC identifies peptides, snippets of virus protein
- Immune cells will then be enabled to recognise and neutralise the virus



Source: Vaccine pipeline/Nature journal

AFP

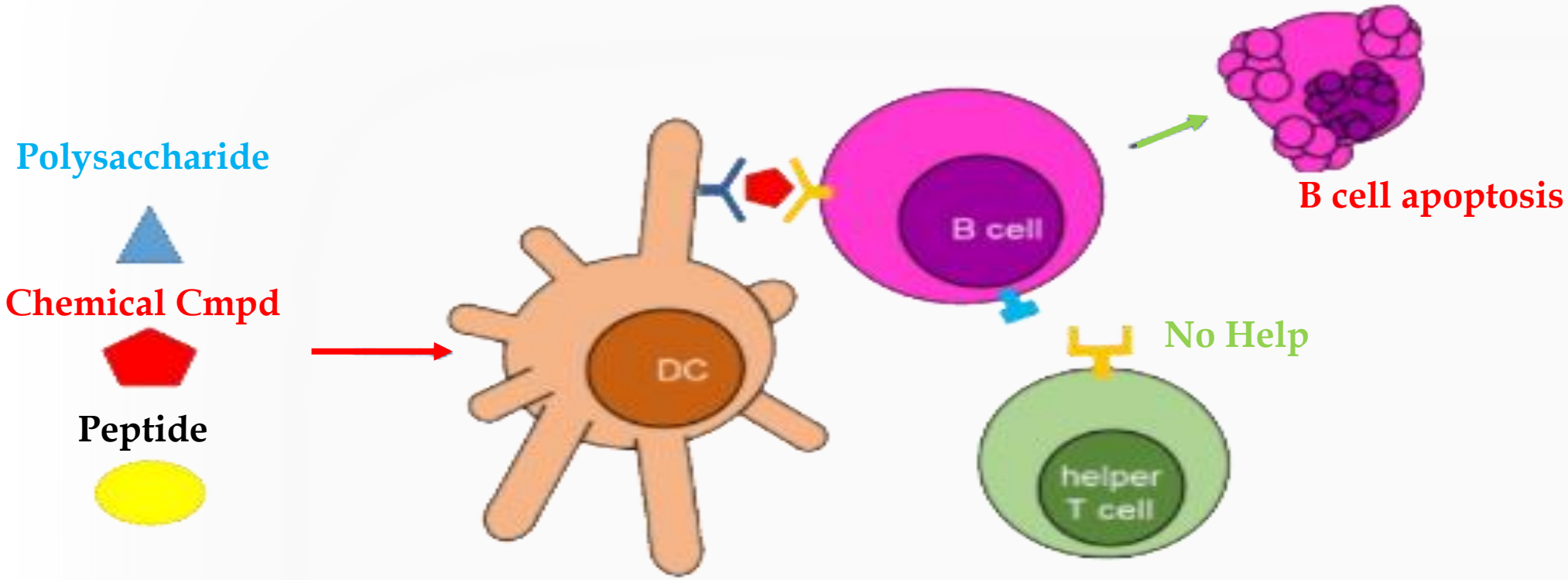
How some of the Covid-19 vaccines compare

Company	Doses	Storage
RNA		
Pfizer (BioNTech)	2	-80 to -60°C (6 months) and 2 to 8°C (for up to 5 days)
Moderna	2	-25 to -15°C (6 months) and 2 to 8°C (for 30 days)
Viral vector		
Oxford-AstraZeneca	2	2 to 8°C (6 months)
Sputnik V (Gamaleya)	2	-18.5°C (liquid form) 2 to 8°C (dry form)
Johnson & Johnson (Janssen)	1	2 to 8°C (3 months)
Inactivated virus		
CoronaVac (Sinovac)	2	2 to 8°C
Sinopharm	2	2 to 8°C
Covaxin (Bharat Biotech)	2	2 to 8°C
Protein-based		
Novavax	2	2 to 8°C

Source: Wellcome Trust, BBC research

BBC

Unconjugated Vaccines



Conjugated Vaccines ?

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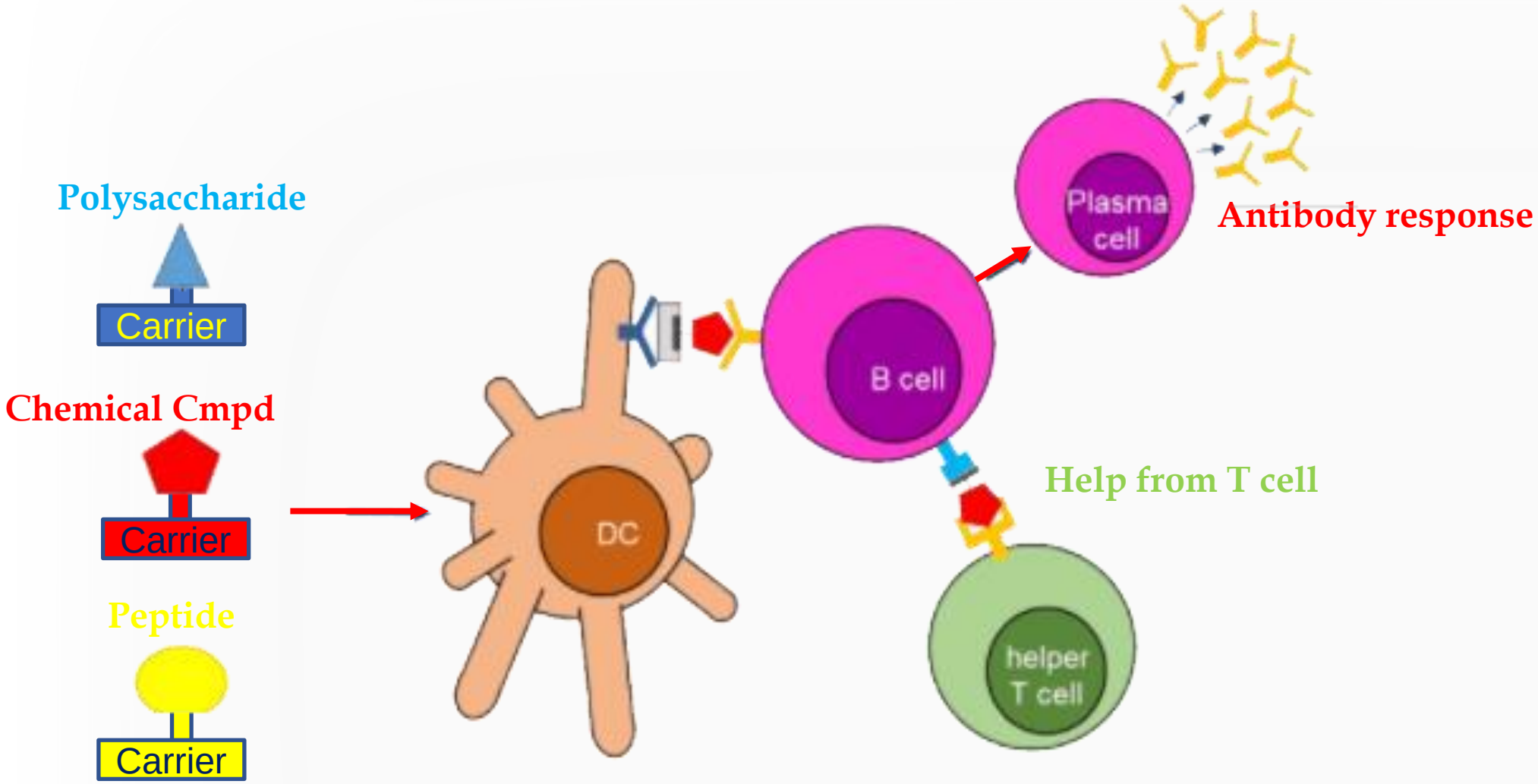
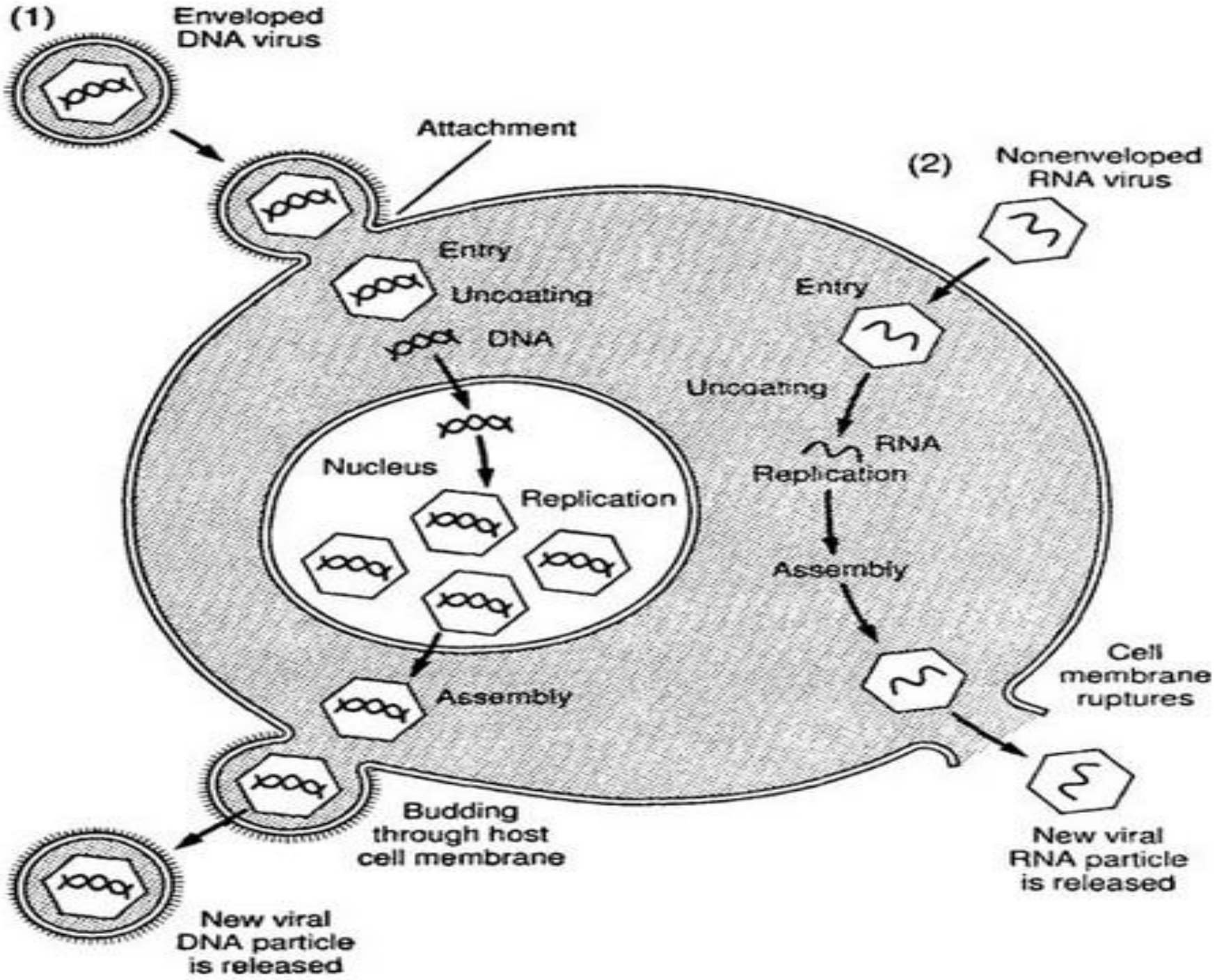
Conjugate vaccines 'marry' or join a specific piece of the germ with a stronger part, typically a carrier protein or antigen, which elicits a very strong immune response that is targeted to key parts of the virus or bacteria

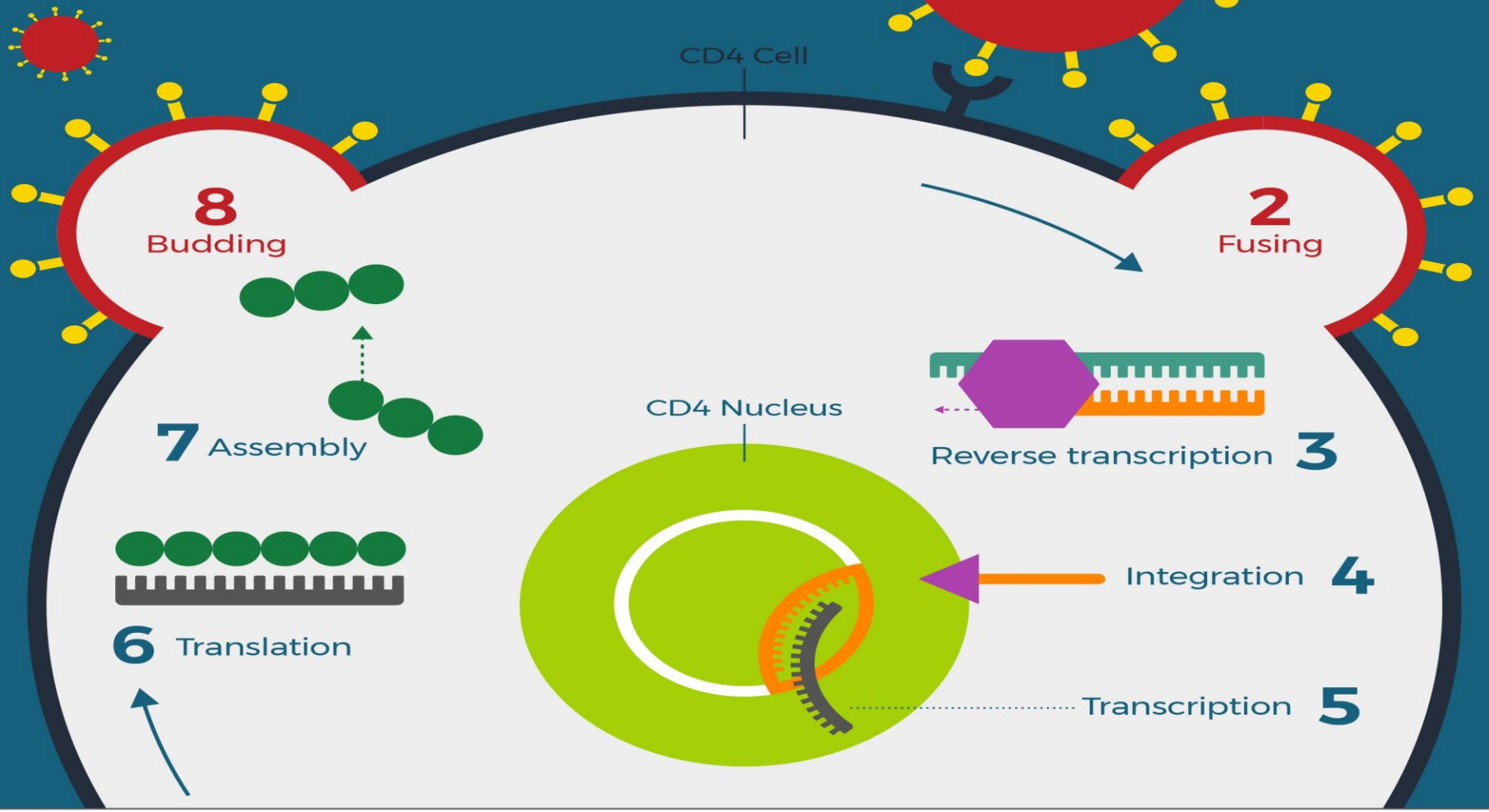
Conjugated Vaccines





The lifecycle of HIV

HIV cannot replicate on its own. It must enter into and use the mechanisms of immune CD4 cells to make copies of itself.



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Polio

Recently **vaccine-derived poliovirus (VDPV) was detected** in the environmental surveillance of sewage samples from **Kolkata**

- The genetic sequencing is done at ICMR-National Institute of Virology, Mumbai, and this was discussed with the World Health Organisation (WHO). It can **occur in any country where oral polio vaccine (OPV) is given**
- A VDPV is a strain of **the weakened poliovirus** that was initially included in OPV and that has changed over time and behaves more like the wild or naturally occurring virus

Polio

Strains of wild poliovirus

- Of the three strains of **wild poliovirus (type 1, type 2 and type 3),** wild poliovirus **type 2 was eradicated in 1999** and no case of wild poliovirus type 3 has been found since the last reported case in Nigeria in November 2012. Both strains have officially been certified as globally eradicated.
- As on 2020, wild poliovirus **type 1 affects two countries — Pakistan and Afghanistan — according to the WHO**

Transmission

Throat-saliva , sneeze,cough(Rare)

Intestine-fecal-oral route (Water,food)-Transmission

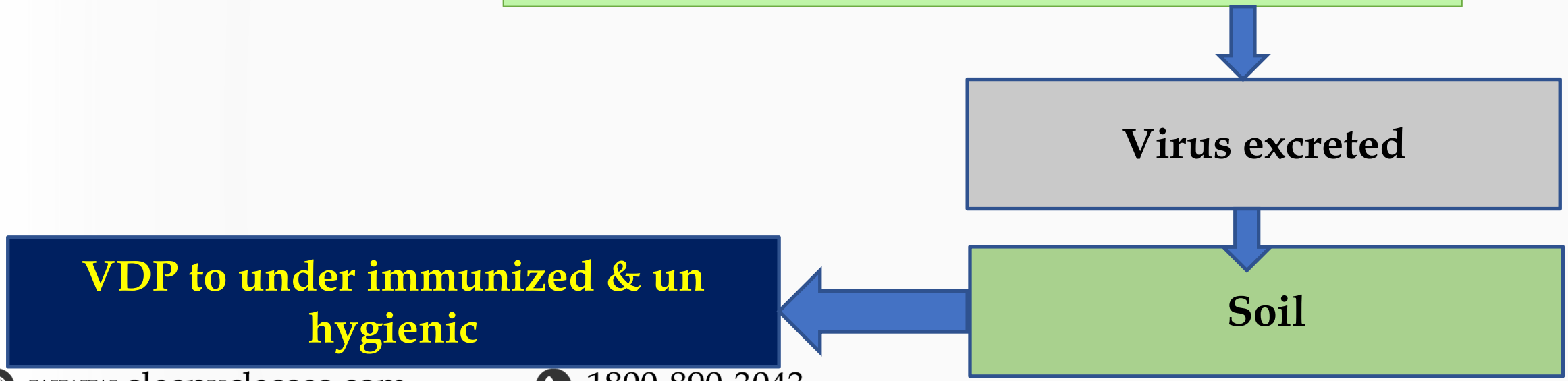
Minor illness	• Headache, nausea, vomiting etc
1% cases	• Flaccid paralysis

Can it affect adult

- Yes but vary rare
- Intestinal immunity weaken over time-reinfection-polio virus through excretion-contribute wild polio virus without developing polio.
- More hygienic

Vaccine derived polio

- OPV-weakened vaccine virus
- R@ replicate in intestine



Injectable inactivated polio vaccine

- Virus inactivated by Formalin
- Protect from all type of poliovirus strains

Antimicrobial resistance

Context-Over half of the almost 10,000 hospital patients surveyed recently were **given antibiotics to prevent infection, rather than to treat it**, amidst growing concerns about the rise in resistance to antibiotics

Key points

- Health Ministry released the results of a survey conducted by the **National Centre for Disease Control**, mapping the patients treated on one to five days each at 20 tertiary care institutes across 15 States and two Union Territories between November 2021 and April 2022.
- The vast majority of patients surveyed – **94% – were given antibiotics** before the confirmation of a definitive medical diagnosis of the precise cause of infection.
- Out of 11,588 admissions and 9,652 eligible patients, **72% were prescribed antibiotics**. Of these, **only 45%** were prescribed antibiotics for therapeutic indications, meant to **treat infection or disease**. **The remaining 55% were prescribed the drugs for prophylactic indications,** meant to prevent the occurrence or spread of an infection.

Antimicrobial resistance

- Only **6% were prescribed antibiotics after a confirmed diagnosis** of the specific bacteria causing their illness, called **definitive therapy**.
- The **remaining 94% were on empirical therapy**, based on the doctor's clinical experience in assessing the likely cause of an illness

Antimicrobial resistance

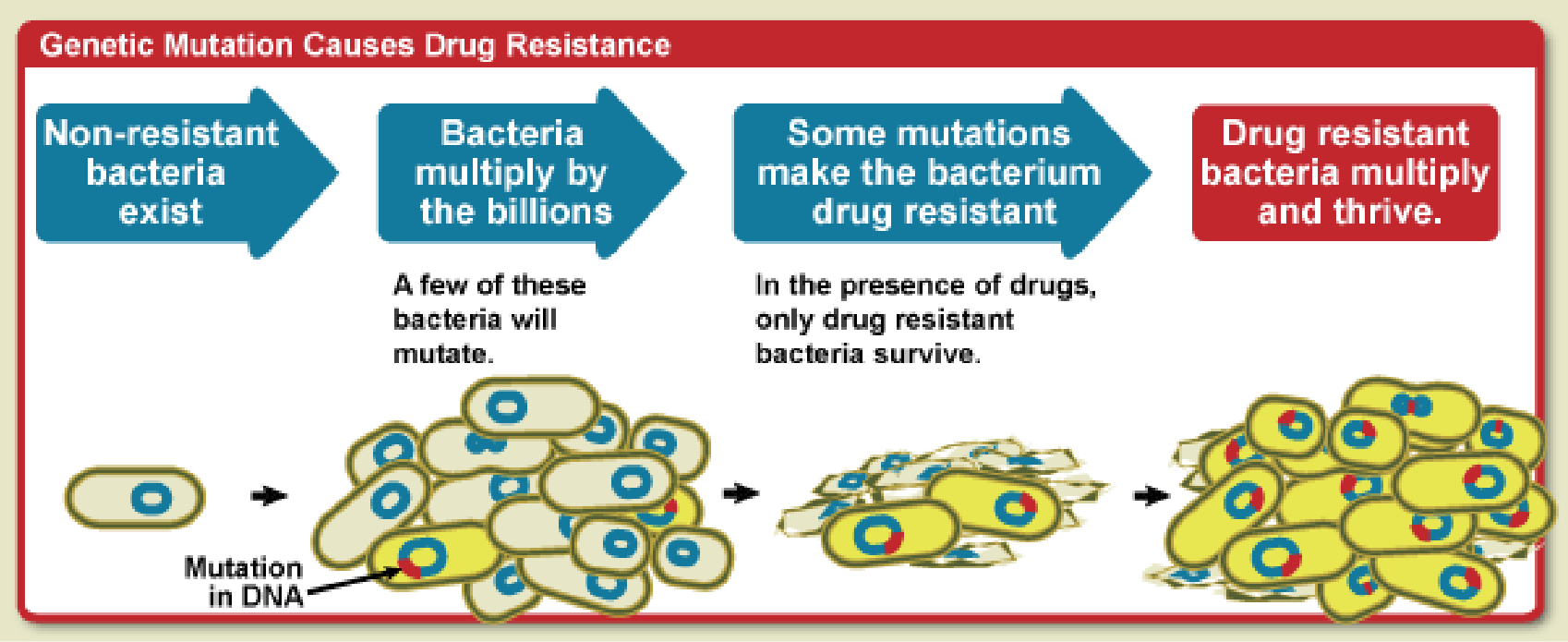
Antimicrobial resistance

- Microbes, such as **bacteria, viruses, fungi, and parasites**, are living organisms that evolve over time. Their primary function is to reproduce, thrive, and spread quickly and efficiently. Therefore, microbes **adapt to their environments and change in ways that ensure their survival.**
- If something stops their ability to grow, such as an antimicrobial, genetic changes can occur that enable the microbe to survive. There are several ways this happens.

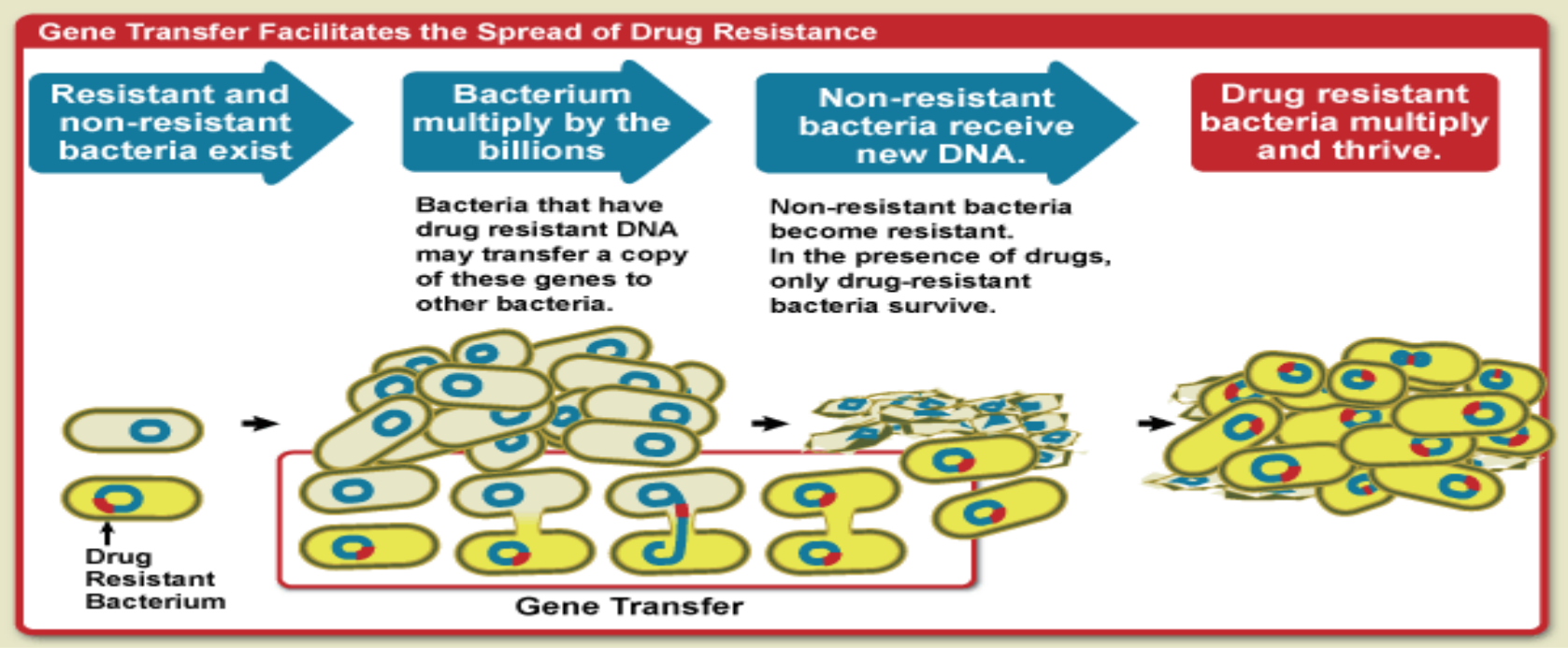
Antimicrobial resistance

Causes

- Genetic mutation



Causes
Gene transfer



Inappropriate Use

- Selection of resistant microorganisms is exacerbated by inappropriate use of antimicrobials. Sometimes **healthcare providers will prescribe antimicrobials inappropriately**, wishing to placate an insistent patient who has a viral infection or an as-yet undiagnosed condition.

Inadequate Diagnostics

- More often, healthcare providers must use incomplete or **imperfect information to diagnose an infection** and thus prescribe an antimicrobial just-in-case or **prescribe a broad-spectrum antimicrobial when a specific antibiotic might be better.** These situations contribute to selective pressure and accelerate antimicrobial resistance.

Hospital Use

- Critically **ill patients are more susceptible to infections** and, thus, often require the aid of antimicrobials. However, the **heavier use of antimicrobials in these patients can worsen the problem by selecting for antimicrobial-resistant microorganisms**. The extensive use of antimicrobials and close contact among sick patients creates a fertile environment for the spread of antimicrobial-resistant germs.

Agricultural Use

- Scientists also believe that the practice of **adding antibiotics to agricultural feed promotes drug resistance.** More than half of the antibiotics produced in the United States are used for agricultural purposes.[1, 2] However, there is still much debate about whether drug-resistant microbes in animals pose a significant public health burden.

Coordinated global action to address AMR

One Health approach

- AMR is a complex problem that requires both sector-specific actions in the human health, food production, animal and environmental sectors, and a coordinated approach across these sectors.

Global action Plan on AMR

- To address AMR globally, countries adopted the Global Action Plan (GAP) on AMR during the 2015 **World Health Assembly** and committed to the development and implementation of multisectoral national action plans with a One Health approach to tackle AMR.

Quadripartite Joint Secretariat on Antimicrobial Resistance

- To coordinate the One Health global response to AMR, WHO works closely with the Food and Agriculture Organization of the United Nations (FAO), the UN Environment Programme (UNEP) and the World Organisation for Animal Health (WOAH). The 4 organizations (FAO, UNEP, WHO and WOAH) are known as the Quadripartite.

World AMR Awareness Week (WAAW)

- World AMR Awareness Week (WAAW) is a global campaign to raise awareness, understanding and best practices with the public, One Health stakeholders, and other policymakers. One of **WHO'**s official health campaigns since 2015, WAAW is celebrated from 18 to 24 November every year.

Access, Watch and Reserve (AWaRE) classification

- AWaRe is the WHO classification of antibiotics introduced by WHO as part of the 2017 Model List of Essential Medicines. In the AWaRe classification, there are three categories of antibiotics:

1. **Access antibiotics** that have a narrow spectrum of activity and a good safety profile in terms of side-effects.
2. **Watch antibiotics** that are **broader-spectrum antibiotics** and are recommended as first-choice options for patients with more severe clinical presentations or for infections where the causative pathogens are more likely to be resistant to Access antibiotics.
3. **Reserve antibiotics** that are **last-choice antibiotics** used to treat multidrugresistant infections. This classification can be used to give an indirect indication of the appropriateness of antibiotic use.

- The World Health Organization (WHO) has defined a target that **at least 60% of global antibiotic consumption at the national level should be from the Access group**.

Antimicrobial resistance

Tracking antibiotic use

- The NCDC (National centre for disease control) is the nodal agency for India's national programme on AMR containment, of which one of the key components is the surveillance of antibiotic usage.
- To achieve this goal, it has established the **National Antibiotic Consumption Network (NAC-NET)** through which network sites compile data on antibiotic consumption in their respective health facilities and send it to NCDC.
- According to NCDC, a **major contributing factor to antibiotic resistance is the overuse of antibiotics** by humans, with approximately half or more hospitals using antibiotics inappropriately.

Operation AMRITH (Antimicrobial Resistance Intervention for Total Health.**)**

- Launched by **Kerala government** to tackle anti-microbial resistance.
- It aims to conduct unexpected inspections at retail pharmacies to detect over-the-counter sales of antibiotics, without prescription.

Guidelines on Management of Monkeypox Disease

Recently Ministry of Health has released "Guidelines on Management of Monkeypox Disease".

Guidelines

- A person suspected to have the **Monkeypox must have a history of travel to the affected countries in the last 21 days**, an unexplained rash and one of the other symptoms.
- **Integrated Disease Surveillance Programme (IDSP)** – a network that tracks infectious diseases in the country – has been asked to **remain alert** about the cases.
- **International travellers** to countries reporting cases of monkeypox have been **advised to not come in close contact with sick persons** and dead or live wild animals. They have also been asked not to consume the meat of wild animals or use creams, lotions or powder made of it.
- The **airport health authorities** have been asked to **familiarize themselves with symptoms of monkeypox** and conduct strict thermal screening and history of travel.

Guidelines on Management of Monkeypox Disease

Monkeypox disease

- The monkeypox virus is an orthopoxvirus**, which is a genus of viruses that also includes the** variola virus, which causes smallpox, and vaccinia virus, which was used in the **smallpox vaccine**. **Monkeypox causes symptoms similar to smallpox, although they are less severe.**
- While vaccination **eradicated smallpox worldwide in 1980,** monkeypox continues to occur in a swathe of countries in Central and West Africa, and has on occasion showed up elsewhere.
- Monkey Pox infection was **first discovered in 1958** following two outbreaks of a pox-like disease in colonies of monkeys kept for research — which led to the name 'monkeypox'.

Guidelines on Management of Monkeypox Disease

Transmission

- Monkeypox is a zoonosis, that is, a disease that **is transmitted from infected animals to humans.**
- According to the WHO, **cases occur close to tropical rainforests inhabited by animals that carry the virus.**
- Monkeypox virus infection has been **detected in squirrels, Gambian poached rats, dormice, and some species of monkeys.**
- **Human-to-human transmission is, however, limited** — the longest documented chain of transmission is six generations, meaning the last person to be infected in this chain was six links away from the original sick person, the WHO says. "**It is important to emphasise that monkeypox does not spread easily between people and the overall risk to the general public is very low**,"
- Transmission, when it occurs, can be through contact with **bodily fluids, lesions on the skin or on internal mucosal surfaces**, such as in the mouth or throat, respiratory droplets and contaminated objects, the WHO says.

Guidelines on Management of Monkeypox Disease

- Vaccinia vaccine used during the smallpox eradication programme was also protective against monkeypox.

Spain to begin monkeypox vaccination of close contacts

Reuters / Updated: Jun 10, 2022, 10:54 IST

TIMESPOINTS SHARE AA

ARTICLES

Spain to begin monkeypox vaccination of close contacts

Myntra's End Of Reason sale gets

Around 200 of Bavarian Nordic's Imvanex vaccine arrived in Spain on Monday and the government is waiting to buy more under an EU vaccine purchasing scheme.

Specs 2030

Context-Recently 74th World Health Assembly, 2021 has embarked on an initiative called **"Specs 2030"** to provide integrated and **people-centered eye care.**

- According to the **WHO**, at least 2.2 billion people function with compromised eyesight and at least a billion of these were preventable with access to eye care. Around 90% of those with vision **impairment or blindness live in low- and middle-income countries.**
- In India, where over 100 million people may not have access to eye care and glasses, it is imperative to take corrective measures

Specs 2030

- WHO SPECS 2030 envisions a world in which **everyone who needs a refractive error intervention** has access to **quality, affordable and people-centred refractive error services.**
- The initiative calls for coordinated global action amongst all stakeholders across 5 strategic pillars, in line with the letters of SPECS, to address the key challenges to improving refractive error coverage.

Specs 2030

Typbar vaccine

Context- A phase-3 trial in children aged between nine months and 12 years carried out in Malawi, Africa, which is a typhoid fever-endemic setting, has shown that **efficacy of the Hyderabad-based Bharat Biotech's conjugate typhoid toxoid vaccine — Typbar — lasts for at least four years.**

Children were vaccinated with a single dose of the vaccine during the period February to September 2018.

Typhoid

- Typhoid fever is a life-threatening infection caused by the bacterium ***Salmonella* Typhi.**
- It is usually spread through **contaminated food or water**. Once *Salmonella* Typhi bacteria are ingested, they multiply and spread into the bloodstream.

Typbar vaccine

Symptoms

- *Salmonella* Typhi **lives only in humans**. Persons with typhoid fever carry the bacteria in their bloodstream and intestinal tract.
- Symptoms include prolonged high fever, fatigue, headache, nausea, abdominal pain, and constipation or diarrhoea. Some patients may have a rash.

Typbar vaccine

Treatment

- Typhoid fever can be treated with **antibiotics.** Antimicrobial resistance is common with likelihood of more complicated and expensive treatment options required in the most affected regions.
- Even when the symptoms go away, people may still be carrying typhoid bacteria, meaning they can spread it to others, through shedding of bacteria in their faeces.

Prevention

- Typhoid fever is common in places with poor sanitation and a lack of safe drinking water. Access to safe water and adequate sanitation, hygiene among food handlers and typhoid vaccination are all effective in preventing typhoid fever.
- Typhoid conjugate vaccine also helps to prevent typhoid
-

First vaccine for chikungunya

Context- Recently **world's first vaccine for chikungunya** was approved by the Food and Drug Administration (FDA) in the U.S.

- The vaccine has been developed by European vaccine manufacturer Valneva and will be available under the **brand Ixchiq**, and has been approved for administration in people who are 18 years or older, and are at increased risk of exposure to the virus.

What is the vaccine composition?

- Ixchiq is administered as a single dose by injection into the muscle.
- It contains a **live, weakened version** of the chikungunya virus and may cause symptoms in the vaccine recipient similar to those experienced by people who have the disease.

First vaccine for chikungunya

Chikungunya

- It is characterised by severe joint pain and impaired mobility, and comes with fever.
- It is a **viral infection (CHIKV) transmitted** primarily by the **Aedes aegypti and Aedes albopictus** mosquitoes and has been described as an emerging global health threat.
- These mosquitoes bite primarily during daylight hours.
- Chikungunya is **prevalent in Africa, Asia, and the Americas;** but sporadic outbreaks have been reported in other regions.
- Since 2004, outbreaks of CHIKV have become more frequent and widespread, partly due to viral adaptations allowing the virus to be spread **more easily by the Aedes albopictus mosquitoes.**
- Chikungunya is often **misdiagnosed as dengue or zika**, as symptoms can seem similar.
- As of now, there is **no cure, only symptomatic relief, with analgesics** to help with the pain, antipyretics for the fever, rest, and adequate fluids

First vaccine for chikungunya

- Prevention includes **mosquito control activities,** primarily falling under public health outreach and routine civic maintenance.
- Individuals are also advised to use medicated mosquito nets and ensure that there is no water stagnation in any containers at home, in order to prevent the breeding of mosquitoes.

HPV vaccine protects against cervical cancer

- A new research, funded by Cancer Research UK, **has found** that the **human papillomavirus (HPV) vaccine**, which protects against cervical cancer in women, reduced the **risk of developing the cancer by 62 per cent in women between the ages of 14 and 16**.

HPV vaccine protects against cervical cancer

Cancer

- Cancer is a disease in which some of the body's cells grow uncontrollably and spread to other parts of the body.

Cervical cancer

- is the uncontrolled growth of **abnormal cells in the lining of the cervix**. The cervix is part of the **female reproductive system**
- The various strains of the **Human papillomavirus (HPV)** play a role in causing most cervical cancer.
- When exposed to HPV, the **body's immune system** typically prevents the virus from doing harm. In a small percentage of people, however, the **virus survives for years**, contributing to the process that causes some cervical cells to become cancer cells.

HPV vaccine protects against cervical cancer

Human papillomavirus (HPV)

- HPV is a type of virus, of which there are more than 100 types.
- The National Cancer Institute (NCI) notes that **more than 40 types of HPV are spread through direct sexual contact.**
- Out of these 40, two cause genital warts, while about a dozen of HPV cause different types of cancer including **cervical, anal, oropharyngeal, penile, vulvar and vaginal.**
- Significantly, almost all cervical cancers are caused by HPV and the **vaccine protects against two of the cancer-causing strains, which are HPV 16 and 18.**
- Once infected, most people do not develop any symptoms, thereby are not aware that they have the virus.

HPV vaccine protects against cervical cancer

Types

- **Quadrivalent vaccine** (Gardasil), which protects against **four types of HPV (HPV 16, 18, 6 and 11). The** latter two strains cause genital warts
- **Bivalent vaccine** (Cervarix), which protects against HPV 16 and 18 only
- The third type is a **non valent vaccine** (Gardasil 9), which protects against **nine strains of HPV.**

HPV vaccine protects against cervical cancer

India

- In India, **bivalent and quadrivalent HPV vaccines** were licensed in 2008 and a **non valent vaccine** was licensed in 2018.
- A paper published in the Asian Pacific Journal of Cancer Prevention notes that in India, the **primary obstacle to HPV vaccination is financial**.
- It also says that while India is home to 16-17 per cent of the world's population, **globally 27 per cent of total cervical cancer cases are from here.**
- Further, in India about **77 percent cases of cervical cancer are caused by HPV 16 and 18.**

Anticancer mRNA vaccine

- Recently, the results of a trial of **messenger Ribonucleic Acid (mRNA-4157/V940)** vaccine made by **Moderna and MSD** (Merck & Co.) when taken along with an immunotherapy **drug Keytruda** has shown promising results **against advanced melanoma, a kind of skin cancer**.

About

- It is a **personalised cancer vaccine**, meaning it is **manufactured specifically for each patient.**
- Researchers collected tissue samples from patients' tumours and healthy tissue to create the vaccine.
- In order to create the vaccine, the **samples were examined to decode their genetic sequence** and isolate mutant proteins linked exclusively to the cancer.
- The vaccine showed a **44% reduction in the risk of dying of cancer** or having the cancer progress.

Anticancer mRNA vaccine

Mechanism

- It allows the body's immune system to **seek and destroy cancerous cells.**
- The personalised cancer vaccine works in concert with Keytruda, to **disable a protein called Programmed Death 1 (PD-1),** that helps **tumors to evade the immune system.**
- When injected into a patient, the patient's cells act as a manufacturing plant, producing perfect copies of the mutations for the **immune system to recognise and destroy.**
- Having been **exposed to the mutations without the virus, the body learns to fight off the infection**

SUPERCOMPUTER

Supercomputer

- any of a class of **extremely powerful computers**. **,** opening up a new horizon of opportunities.
- Performance measured in **FLOPS** (floating point operations per second).
- Great **speed and great memory** are the two prerequisites of a super computer.
- The performance is generally evaluated in **petaflops (1 followed by 15 zeros).**
- Memory is averaged around **250000 times of the normal computer** we use on a daily basis.

SUPERCOMPUTER

Unit	Flops	Example	Decade(s)
Hundred FLOPS	10^2	Eniac	1940
KFLOPS (kilo flops)	10^3	IBM 704	1950
MFLOPS (mega flops)	10^6	CDC 6600	1960
GFLOPS (giga flops)	10^9	Cray-2	1980
TFLOPS (teraflops)	10^{12}	ASCI Red	1990
PFLOPS (petaflops)	10^{15}	Jaguar	2010
EFLOPS (exa flops)	10^{18}	under development	2020

SUPERCOMPUTER

Here are the 10 fastest supercomputers in the world :

1. **Frontier**, the new number 1, is built by Hewlett Packard Enterprise (HPE) and housed at the Oak Ridge National Laboratory (ORNL) in Tennessee, **USA.**
2. **Fugaku**, which previously held the top spot, is installed at the Riken Center for Computational Science in Kobe, **Japan**. It is three times faster than the next supercomputer in the top 10.
3. **LUMI** is another HPE system and the new number 3, crunching the numbers in **Finland**.
4. **Summit**, an IBM-built supercomputer, is also at ORNL in Tennessee. Summit is used to tackle climate change, predict extreme weather and understand the genetic factors that influence opioid addiction
5. Another US entry is **Sierra**, a system installed at the Lawrence Livermore National Laboratory in California, which is used for testing and maintaining the reliability of nuclear weapons.
6. China's highest entry is the **Sunway TaihuLight**, a system developed by the National Research Center of Parallel Computer Engineering and Technology and installed in Wuxi, Jiangsu.

Supercomputers Installed & Commissioned in India as a part of NSM		
Name	**Speed**	**Location**
PARAM Shivay	833 TF	IIT BHU Varanasi
PARAM Shakti	1.66 PF	IIT Kharagpur
PARAM Brahma	797 TF	IISER Pune
PARAM Sanganak	1.66 PF	IIT Kanpur
PARAM Seva	833 TF	IIT-H
PARAM Yukti	833 TF	JNCASR
PARAM Smriti	833 TF	NABI Mohali
PARAM Utkarsh	833 TF	C-DAC B
PARAM Sidhi	5.26 PF	National AI Facility CDAC-Pune
PARAM Pravega	3.3 PF	IISC
PARAM Ganga	1.66 PF	IIT Roorkee

AIRAWAT

The AI Supercomputer 'AIRAWAT', installed at C-DAC, Pune has been ranked 75th in the world.

- The system is installed under National Program on AI by Government of India.
- C-DAC has implemented **AI Research Analytics and Knowledge Dissemination Platform (AIRAWAT)** of 200 AI Petaflops **at Centre for Development of Advanced Computing (C-DAC), Pune** under the initiative of Ministry of Electronics and IT, Government of India.
- It puts India on top of AI Supercomputing nations worldwide. The system is installed under the National Program on AI by the Government of India.
- C-DAC has designed and commissioned the converged HPC-AI dense GPU infrastructure integrated with the existing PARAM SIDDHI AI system to make the cumulative compute capacity of 410 AI PF (13.17 PF DP). Currently, the system is operational under the aegis of National PARAM Supercomputing Facility (NPSF, C-DAC) at Pune.

AIRAWAT

National Program on AI

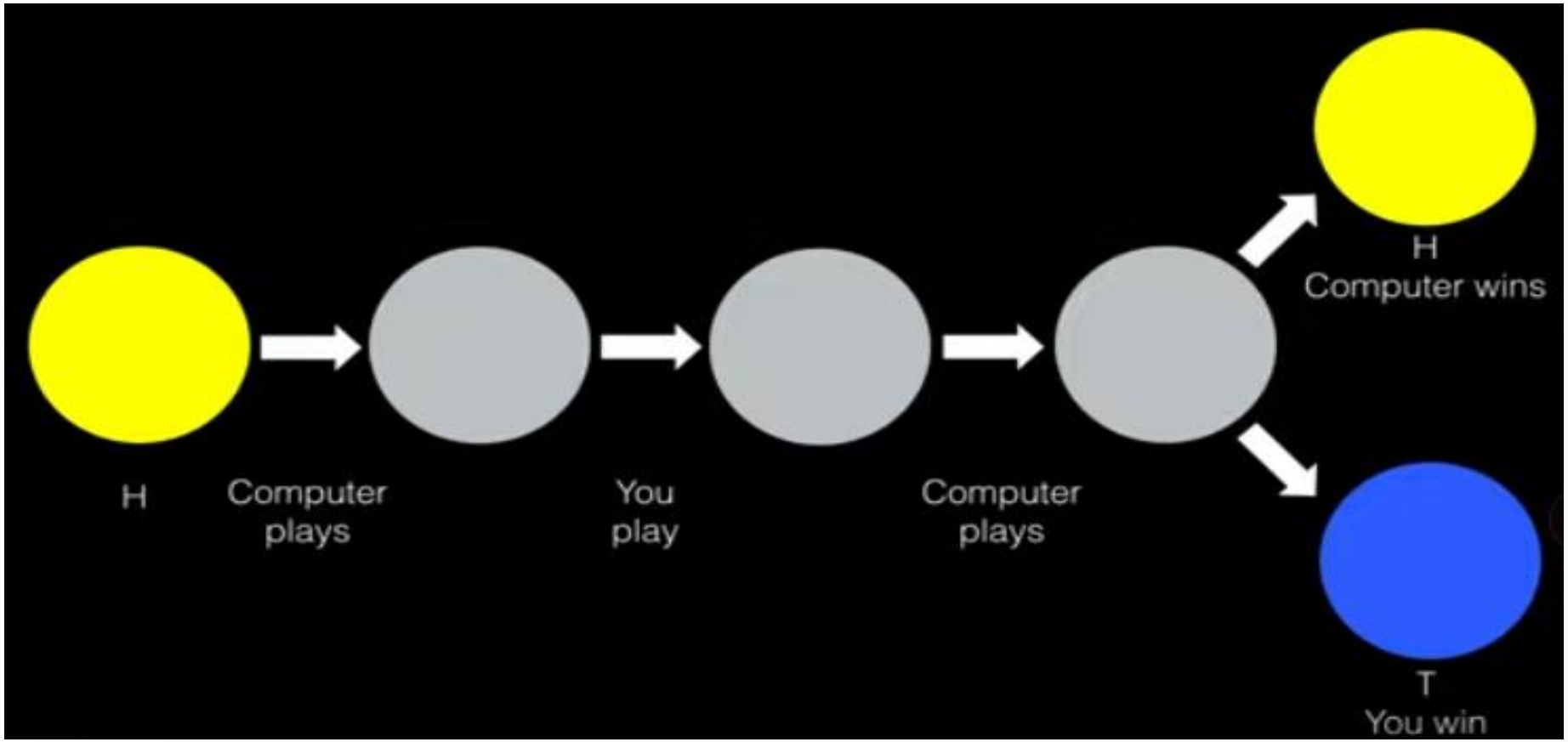
- It is an umbrella programme by the MeitY for leveraging transformative technologies to foster inclusion, innovation, and adoption for social impact in AI.

QUANTUM COMPUTING

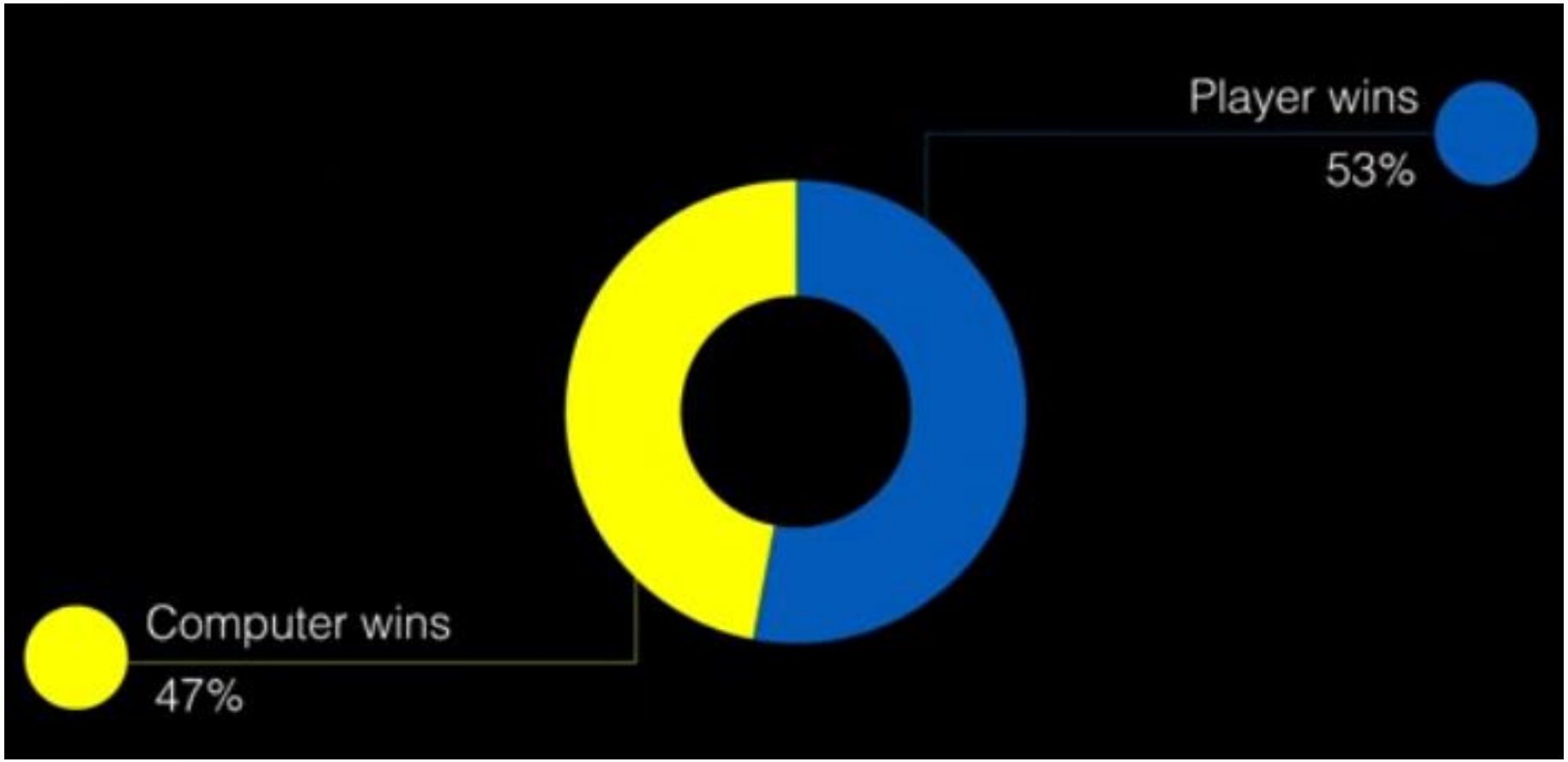
QUBIT

- Quantum computing relies on quantum bits, or "qubits", which can also represent a 0 or a 1.
- Qubits can also achieve a mixed state, called a "**superposition**" where they are both 1 and 0 at the same time.

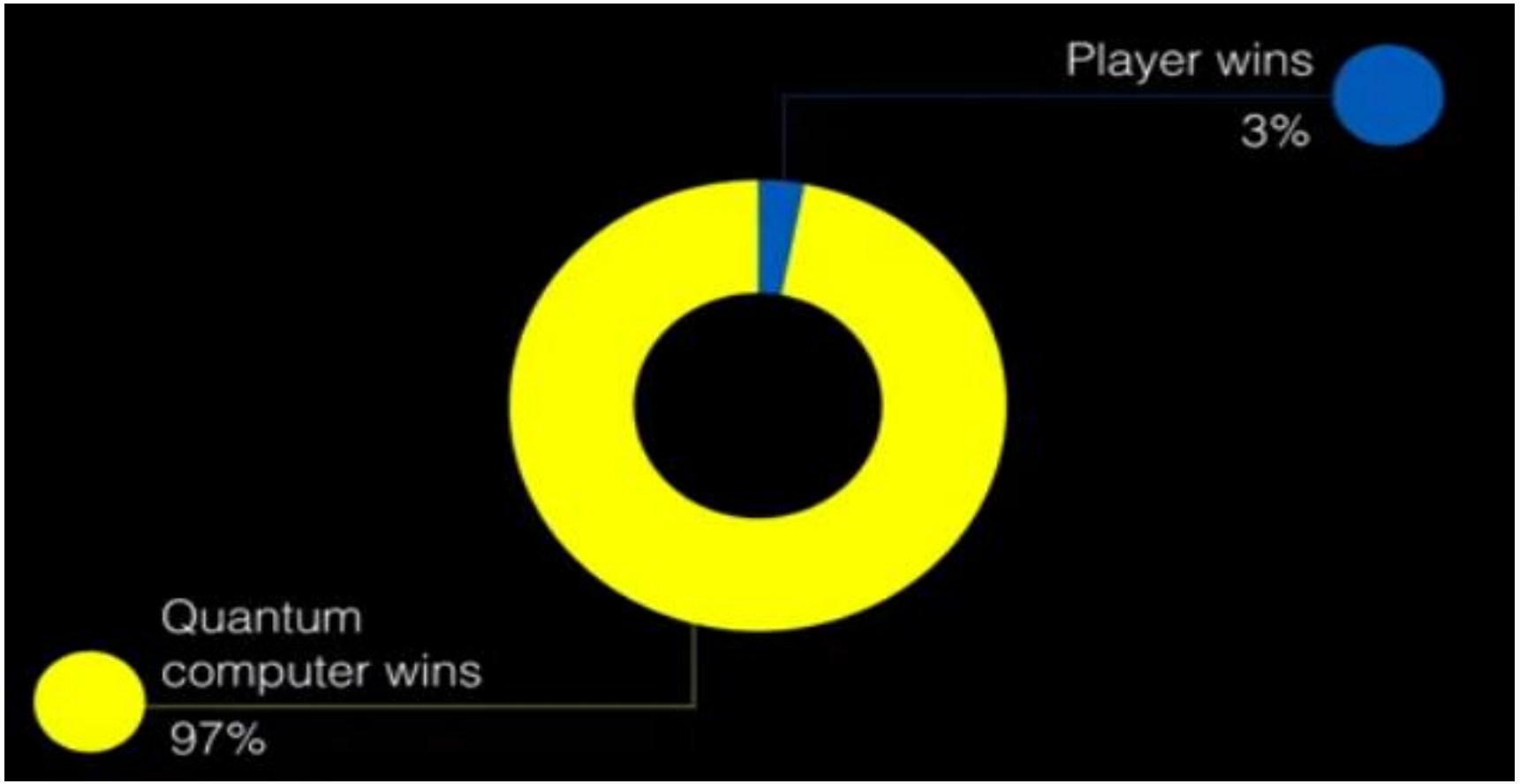
Quantum computing



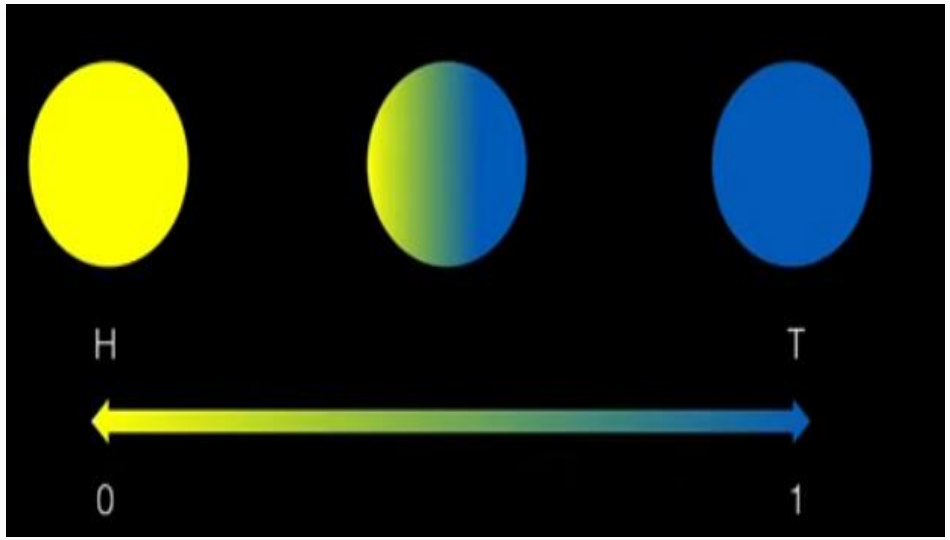
Quantum computing



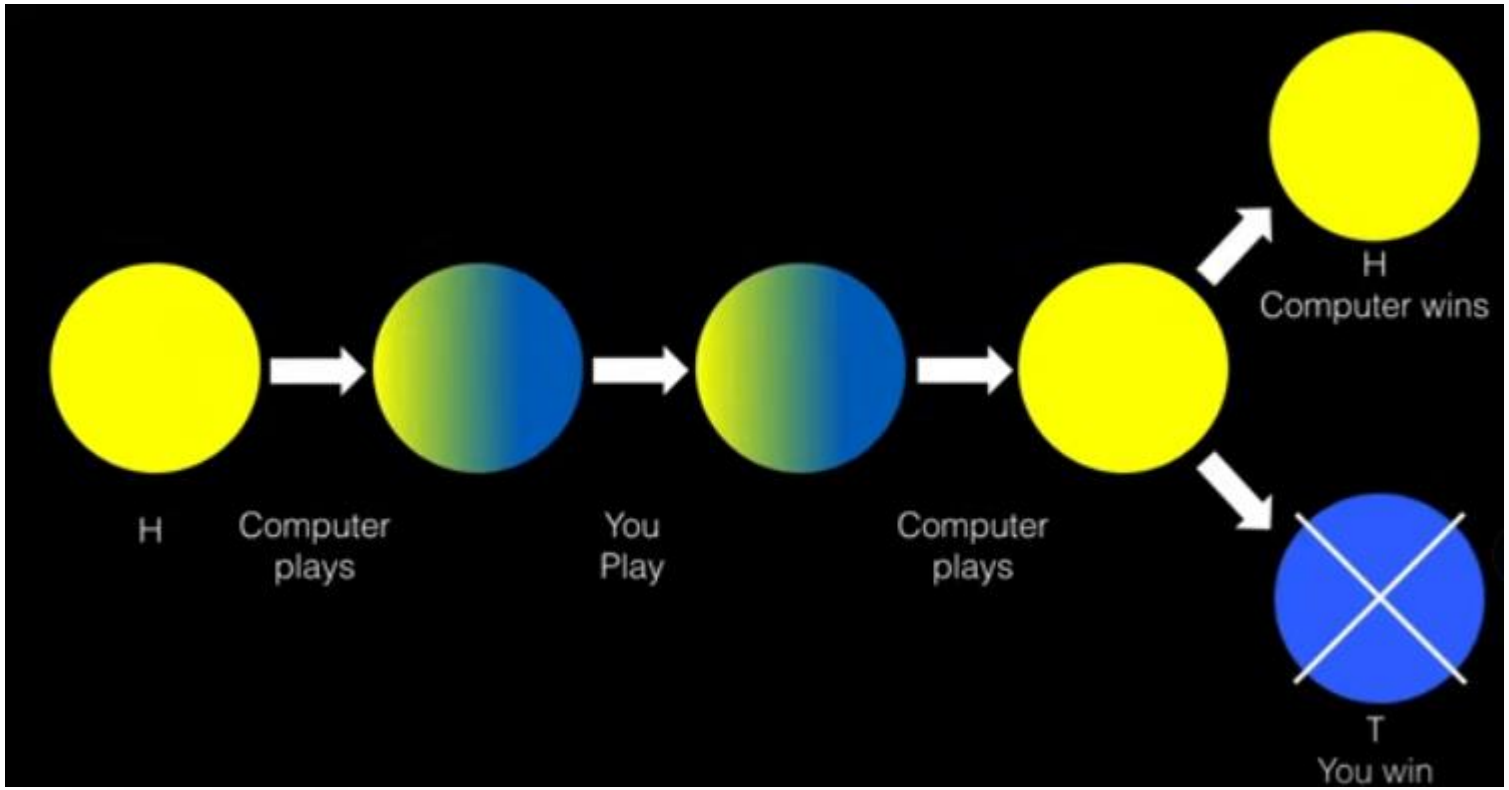
Quantum computing



Quantum computing



Quantum computing



Quantum Supremacy

- It's the point at which a **quantum computer can complete a mathematical calculation that is beyond the reach of even the most powerful supercomputer.**
- Recently, **Sycamore** (Google's quantum computer)took **200 seconds to perform a calculation that the world's fastest supercomputer would have taken 10,000 years** to accomplish.

Quantum satellite

- Recently, China's quantum satellite, **Micius** enables first totally secure long-range messages

Micius

- world's **first quantum-enabled satellite**, launched by China in 2016.
- It is also known as the Quantum Experiments at Space Scale (QUESS)which is Chinese research project in the field of quantum physics.
- This breakthrough was achieved by Micius using **Quantum Key Distribution (QKD)**

Quantum satellite

Quantum Key Distribution (QKD)

- Technique that allows for **secure distribution of keys to be used for encrypting and decrypting messages.**
- Whereas in QKD **achieves security through the laws of quantum physics** i.e. **superposition and entanglement.**

Superposition

❑means that each qubit can represent both a **1 and a 0 at the same time**.

quantum satellite

Quantum entanglement

- Subatomic particles become inextricably linked or “entangled” in such a way that **any change in one disturbs the other** even if both are at opposite ends of the universe.
- Quantum Satellite serves as **source of pairs of entangled photons**, twinned light particles whose **properties remain intertwined no matter how far apart they are.**
- This means any attempt at hacking entangled particles would be impossible.

3D Printing

- **3D printing or additive manufacturing** uses computer-aided designing to make prototypes or working models of objects by laying down successive layers of materials such as plastic, resin, thermoplastic, metal, fibre or ceramic.
- The **model to be printed is first developed by the computer,** which then gives instructions to the 3D printer.

3D Printing

Significance

- **Companies can make specific products for projects where there are very specific demands** such as lightweight equipment, etc.
- One of the key applications for such products is in the medical and allied sector.
- The **USA remains the global leader in 3D printing,** with **more than 35% market share.**
- In **Asia,** about **50% of its market is cornered by China,** followed by **Japan** at 30%, and **South Korea** at 10%.

3D Printing

Challenges

- **Lack of Standards: No global qualifications and certification norms.**
- **Risk of Job Losses**
- **High cost**
- **largest consumer of 3D printing is the automotive industry Put more pressure after BS VI**

3D Printing

India's first 3D printed house

- It was built by IIT-Madras startup Tvasta was inaugurated on the campus.
- The house, which has a built-up area of 600 square feet, has a bedroom, a hall and a kitchen.
- The entire house was designed using software and printed using concrete 3D printing technology.
- Using this technology, a new house can be built in five days against four or five months in conventional mode.

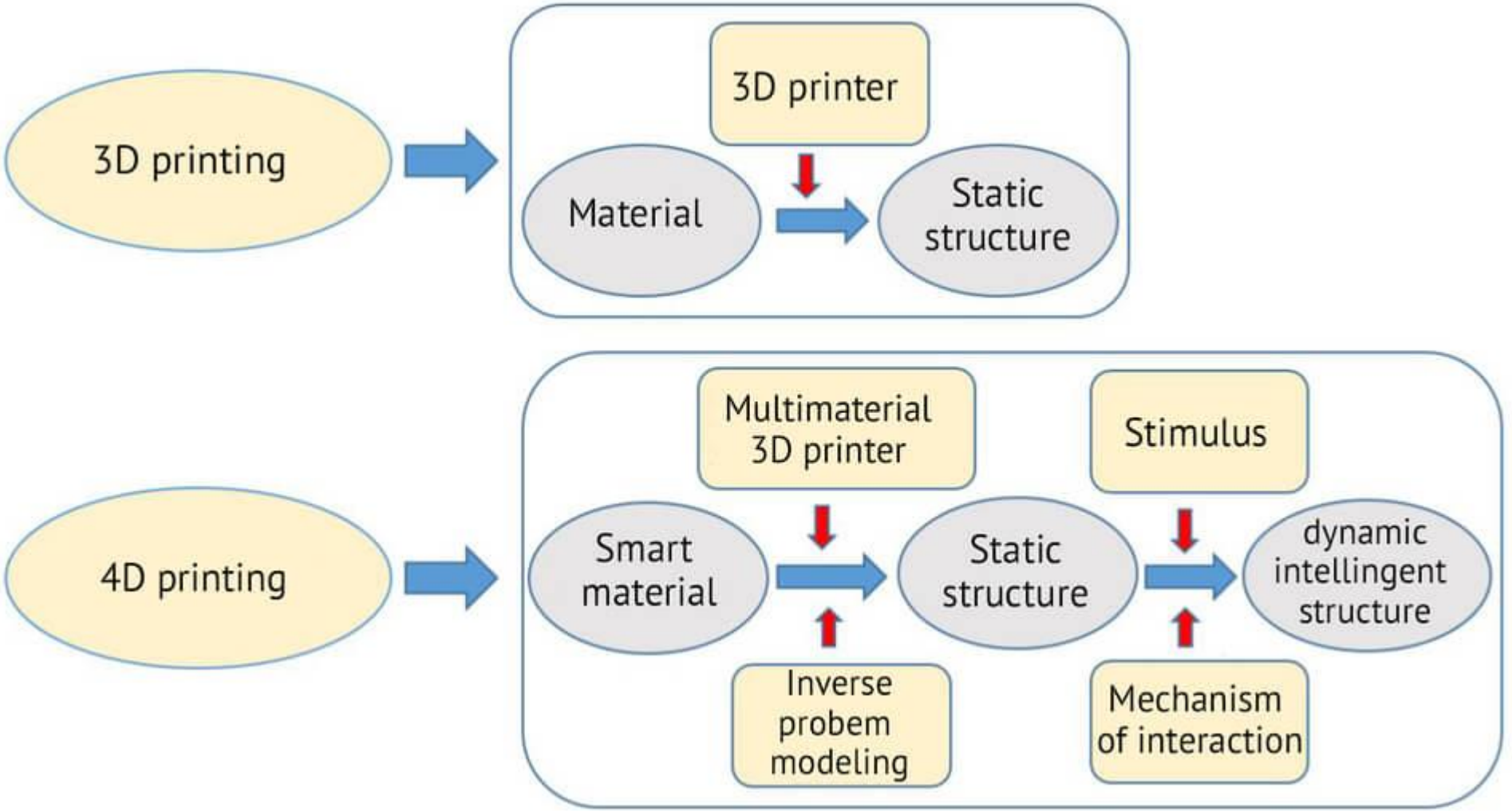
4D Printing

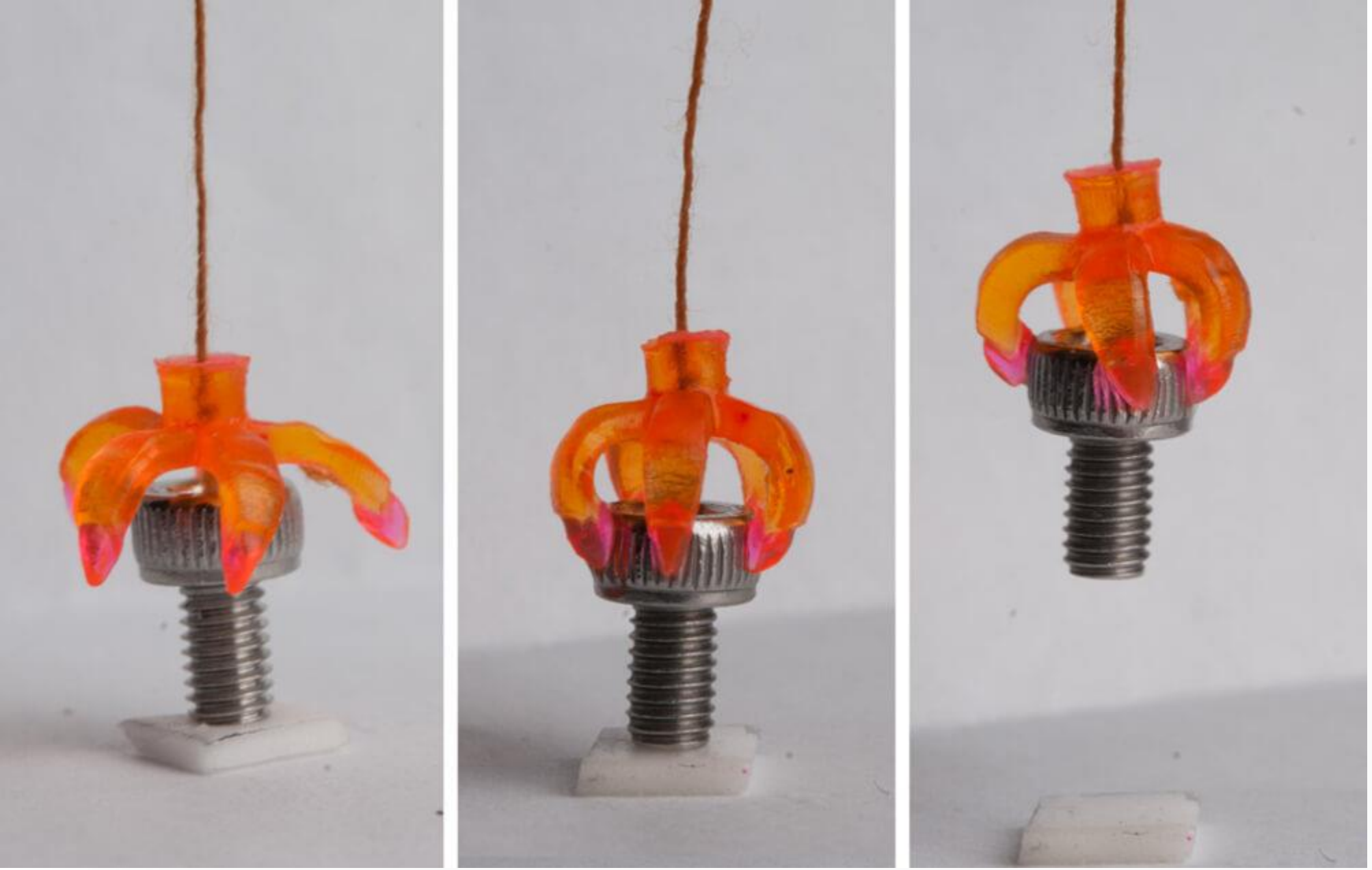
4D printing is the process through which **a 3D printed object transforms itself into another structure** over the influence of external energy input as **temperature, light or other environmental stimuli.**

4D Printing

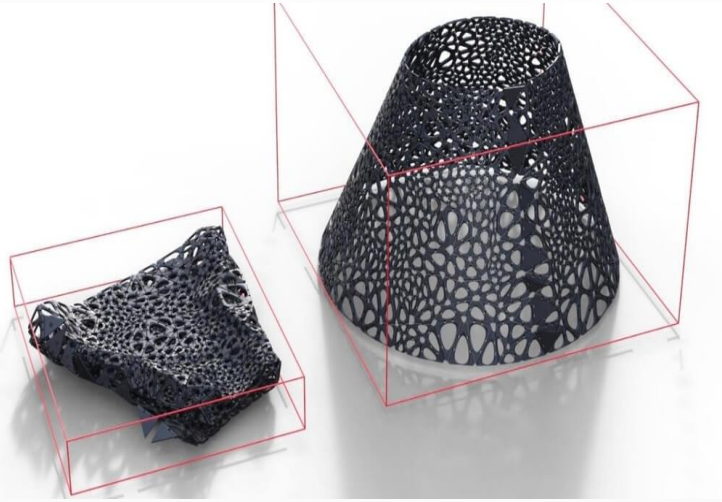
3D Printing Vs 4D Printing

- 3D Printing is about repeating a 2D structure, layer by layer in a print path, from the bottom to the top, layer by layer until a 3D volume is created. **4D Printing is referred to as 3D printing transforming over time**. Thus, a fourth dimension is added: time. So, the **big breakthrough about 4D Printing over 3D Printing technology is its ability to change shape over time**.
- A 4D printed object is printed just like any 3D printed shape. The difference is that the **4D Printing technology uses programmable and advanced materials** that perform a different functionality by adding **hot water, light or heat**. That's why a non-living object can change its 3D shape and behavior over time.


3D printing
3D printer
Material
Static structure
4D printing
Multimaterial 3D printer
Stimulus
Smart material
Static structure
dynamic intellingent structure
Inverse probem modeling
Mechanism of interaction



4D Printing



Potential Advantages of 4D Printing

Size changing

- Since the 4D printed objects can **change shape, can shrink and unfold**, objects that are too large to fit a printer can be compressed for 3D printing into their secondary form.
- 4D printing could allow to just print a **flat board that will curl up into a chair** by just adding water or light to it.

New materials= new properties

- Shapememory polymer will resemble tailorable shapes is very important for the health industry. For instance, we could make **devices that will change shape are release medicine** when the patient gets fewer.

Self-repair piping system

- **Pipes that could possibly heal themselves automatically** if they crack or break, due to their ability to change in response to the environment's change.

4D Printing

Fashion

- One of the ideas is that **clothing could change accordingly to the weather or the activity**. For instance, **shoes could change their shape when you start running** to provide you with better comfort and amortization.

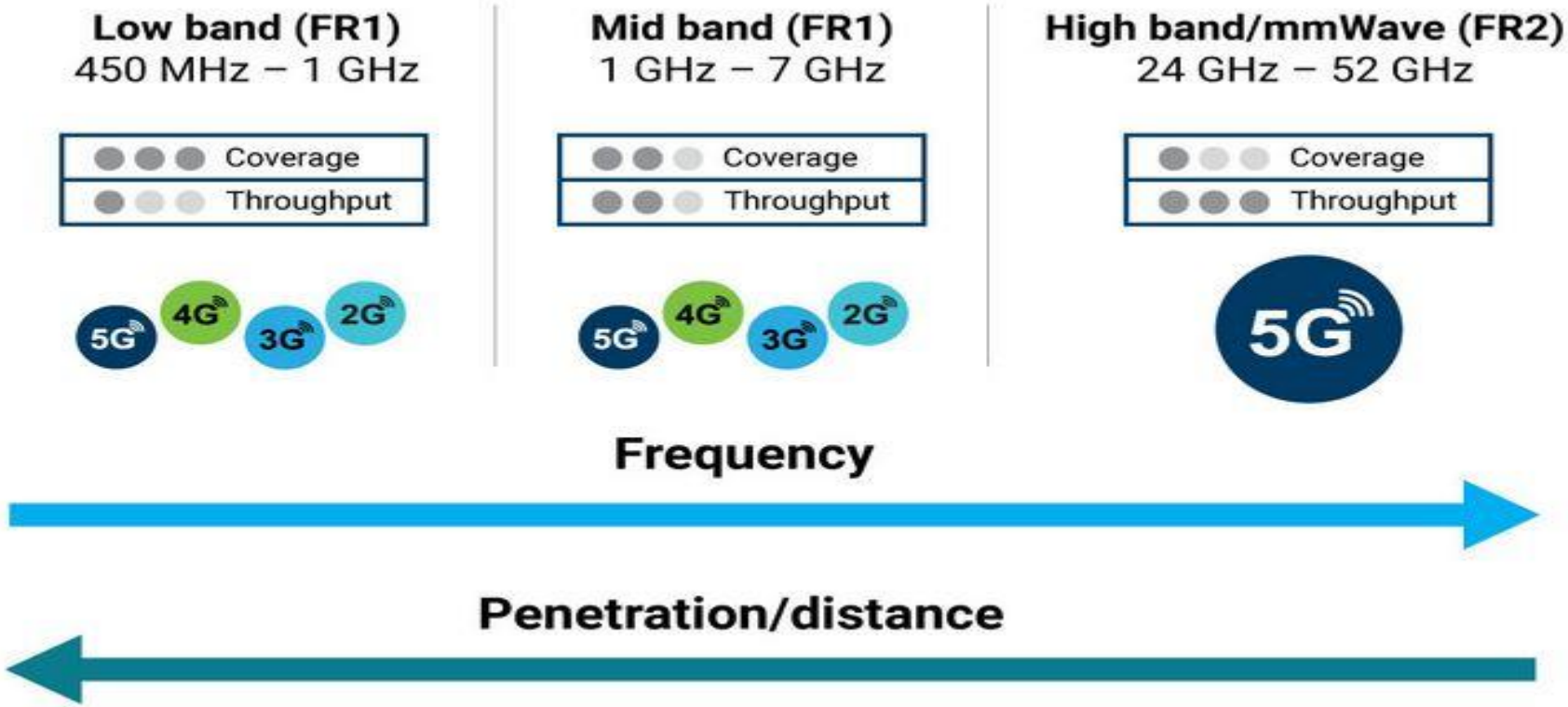
INTERNET

5G is the latest upgrade in the **long-term evolution** (LTE) mobile broadband networks.

Bands in 5G

- **Low band spectrum:**
- **Mid-band spectrum:**
- **High-band spectrum:**

Low band spectrum	• Great promise in terms of **coverage and speed of internet** • Maximum **speed is limited** to 100 Mbps • Main use- **commercial cell phones**
Mid-band spectrum	• **Higher speeds** compared to the low band • **Limitations in terms of coverage** area and penetration of signals • **Use-industries and specialized factory** units for building captive networks
High-band spectrum	• **Highest speed** of all the three bands • **Extremely limited coverage** and signal penetration strength. • Use-IoT


Low band (FR1)
450 MHz – 1 GHz
Coverage
Throughput
5G
4G
3G
2G
Mid band (FR1)
1 GHz – 7 GHz
Coverage
Throughput
5G
4G
3G
2G
High band/mmWave (FR2)
24 GHz – 52 GHz
Coverage
Throughput
5G
Frequency
Penetration/distance

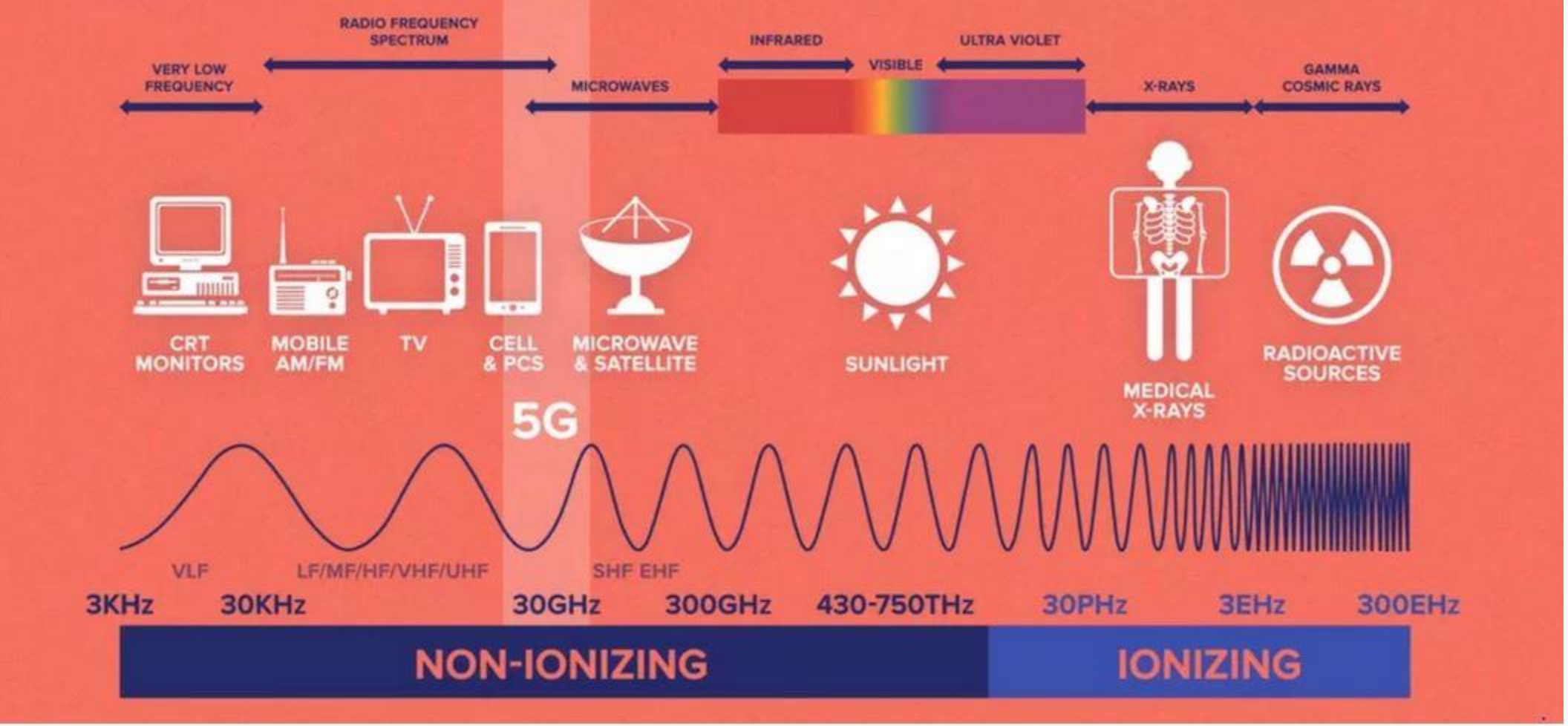
INTERNET

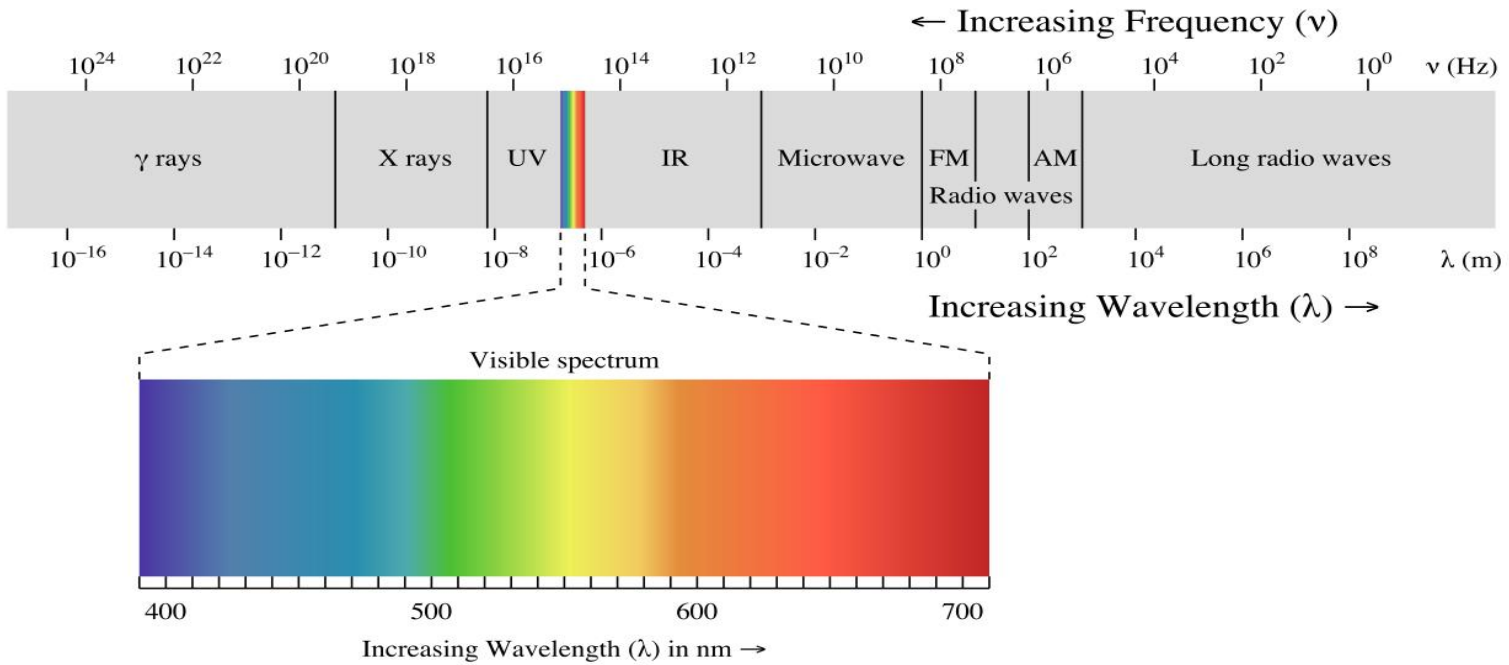
- Millimeter wave spectrum is the band of spectrum **between 30 GHz and 300 GHz**.
- Wedged between **microwave and infrared waves**, this **spectrum can be used for high-speed wireless communications**

INTERNET

Millimeter wave spectrum

- The 5G networks will operate in the **millimeter wave spectrum** (30-300 GHz) which have the **advantage of sending large amounts of data** at very high speeds because the **frequency is so high,** it experiences little interference from surrounding signals.




← Increasing Frequency (ν)
10^{24} 10^{22} 10^{20} 10^{18} 10^{16} 10^{14} 10^{12} 10^{10} 10^{8} 10^{6} 10^{4} 10^{2} 10^{0} ν (Hz)
γ rays
X rays
UV
IR
Microwave
FM
Radio waves
AM
Long radio waves
10^{-16} 10^{-14} 10^{-12} 10^{-10} 10^{-8} 10^{-6} 10^{-4} 10^{-2} 10^{0} 10^{2} 10^{4} 10^{6} 10^{8} λ (m)
Increasing Wavelength (λ) →
Visible spectrum
400
500
600
700
Increasing Wavelength (λ) in nm →

Indian Patents Act, 1970.

- As per **Section 84**, **any person**, regardless of whether he is the holder of the license of that Patent, can make a request to the Controller for grant of compulsory license on **expiry of three years**, when any of the following conditions is fulfilled –

1. The **reasonable requirements of the public** with respect to the patented invention have not been satisfied
2. The patented invention is **not available to the public at a reasonably affordable price**
3. The patented invention is **not worked in the territory of India**.

Indian Patents Act, 1970.

Further, compulsory licenses **can also be issued suo motu by the Controller under section 92,** pursuant to a **notification issued by the Central Government** if there is either a "national emergency" or "extreme urgency" or in cases of "public non-commercial use".

- Even after a compulsory license is granted to a third party, the **patent owner still has rights over the patent**, including a right to be **paid for copies of the products made** under the compulsory license

Indian Patents Act, 1970.

Termination of Compulsory License

- The compulsory license granted under section 84 may be revoked **by the controller by an application filed by the patentee or by the beneficiary of the patent rights**, along with evidence proof that the **circumstance during which the compulsory license was granted have ceased to exist**.
- For example The license was **granted to Natco Pharma Ltd. for the drug Nexavar,** patented by M/S Bayer Corporation

Indian Patents Act, 1970.

Evergreening

- **Section 3(d) of the Indian Patent Act 1970 (as amended in 2005) does not allow patent to be granted to inventions** involving new forms of a known substance **unless it differs significantly in properties with regard to efficacy.**
- So, Indian Patent Act does not allow evergreening of patents.