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ACTIVE IMMUNIZATION

VACCINES AND TOXOIDS

BACTERIAL AND VIRAL

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# DEFINE – IMMUNIZATION

Immunization, also known as vaccination, is the process of administering a vaccine to stimulate the body immune system to bulid immunity against specific diseases.

**The word comes from *immune*, "exempt from disease," and its Latin root, which means "exempt."**

- *"The process of giving a vaccine is called vaccination, although many doctors use the more general term immunization".*

Benefits of immunization :


- Protection against serious and potentially life-threatening diseases.
- Prevention of disease transmission and outbreaks.
- Reduction of disease-related complications and deaths.
- Protection of vulnerable populations, such as young children and older adults.
- Reduction of economic and social burdens associated with disease outbreaks.

# TYPES OF IMMUNIZATION

There are 2 types of immunization, are:

1. Active immunization

2. Passive immunization

## Difference between vaccination and immunization :

# ACTIVE IMMUNIZATION

- Active immunization refers to the process of stimulating the immune system with a specific antigen, typically through vaccination with a suitable immunogen.
- This process promotes an immune response and results in the development of active acquired immunity.
- **Vaccination** can invole the administration of an antigen in various forms, including as a whole, killed organism, or a specific protein or peptide constituent of an organism.
- Vaccines that contain live but weakened organisms include:


1. *Bacille Calmette-Guerin* (BCG-for tuberculosis)
2. Chickenpox (*varicella*)
3. Cholera (certain vaccines given by mouth)
4. Measles-mumps-rubella
5. Typhoid (only the oral vaccine)

# TYPES OF ACTIVE IMMUNIZATION

There are two types of active immunization :

1. Natural active immunization – Eg: Childhood illnesses, infections and viral diseases

2. Artificially active immunization – Eg: Routine vaccination, travel vaccination and cancer vaccines.

## NATURAL ACTIVE IMMUNIZATION :

1. Natural active immunization occurs when a person is exposed to a disease-causing agent, such as a virus or bacteria, and their immune system mounts a response to fight the infection.

2. This process provides long-term immunity against new infections.

3. It leads to antibody production, cell-mediated immunity, and immunological memory.

## ARTIFICIAL ACTIVE IMMUNIZATION : (VACCINES AND TOXOIDS)

It is also known as vaccination process, and it involves vaccine administration, antigen introduction, immune response, immunological memory.

**It provides:**

1. Long-term immunity : Protection against diseases for an extended period.
2. Herd immunity : Community protection when a sufficient percentage of individuals are immunized.
3. Reduced disease risk : Lower risk of contracting and spreading diseases.
4. Safe and controlled : Vaccines are thoroughly tested and monitored for safety and efficacy.

**Artificial active immunization can be induced via two different routes :**

1. **Systemic immunization :** It involves injecting the vaccine subcutaneously or intramuscularly into the deltoid muscle. Eg : Systemic vaccines for measles, mumps, rubella and against *pneumococcus, meningococcus, haemophilus* infection.
2. **Mucosal immunization** : It involves on the mucosal route as the site of choice for immunization either orally or through the nasal associated immune tissue (NALT) such as the oral immunization against polio.

## ADVANTAGES OF ACTIVE IMMUNIZATION

1. The protection offered by active immunization is long lived since it leads to formation of long-lasting memory immune cells.

2. It may be reactivated quickly by a recurrence of the infection or by revaccination.

3. It is less costly in preparation and to administer than passive immunization techniques.

## DRAWBACKS

1. The protective response takes time to establish ranging from few days to weeks which makes it inefficient as a post exposure remedy.

2. Since active immunization is dependent on the individuals immune responses, it may not be suitable for protection of immuno-compromised or immuno-deficient individuals.

*"ACTIVE IMMUNIZATION IS MOSTLY PERFORMED AS A PROPHYLAXIS MEASURE".*

# VACCINES

- A vaccine is a **biological agent** that prevents us from an infectious disease-causing pathogen such as a **virus, bacteria or parasite**. It guides the body on defending itself against the pathogen attack by generating an immune response. Usually, it is administered in our body in liquid form, either **by injection, by oral doses, or by intranasal routes.**
- One type of influenza vaccine is sprayed into the nose.
- More than one vaccine may be given at a time-in one combination vaccine or in separate injections at different injection sites.
- Some vaccines are given routinely. Eg – Tetanus toxoid is given to adults, preferably every 10 years.
- Other vaccines are usually given mainly to specific groups of people. Eg – Yellow fever vaccine is given only to people travelling to certain parts of africa and south america.

# HOW VACCINE WORK ?

- A disease-causing organism can cause two types of responses in our body.

1. The first can be seen as symptoms such as **fever, nausea, vomiting, diarrhoea, rash** etc. which we experience initially.

2. The second is the **immune system's response to the infection**.

- Over time the strength of immune system increases, which in turn reduces the number of infectious agents and slowly the symptoms disappear.

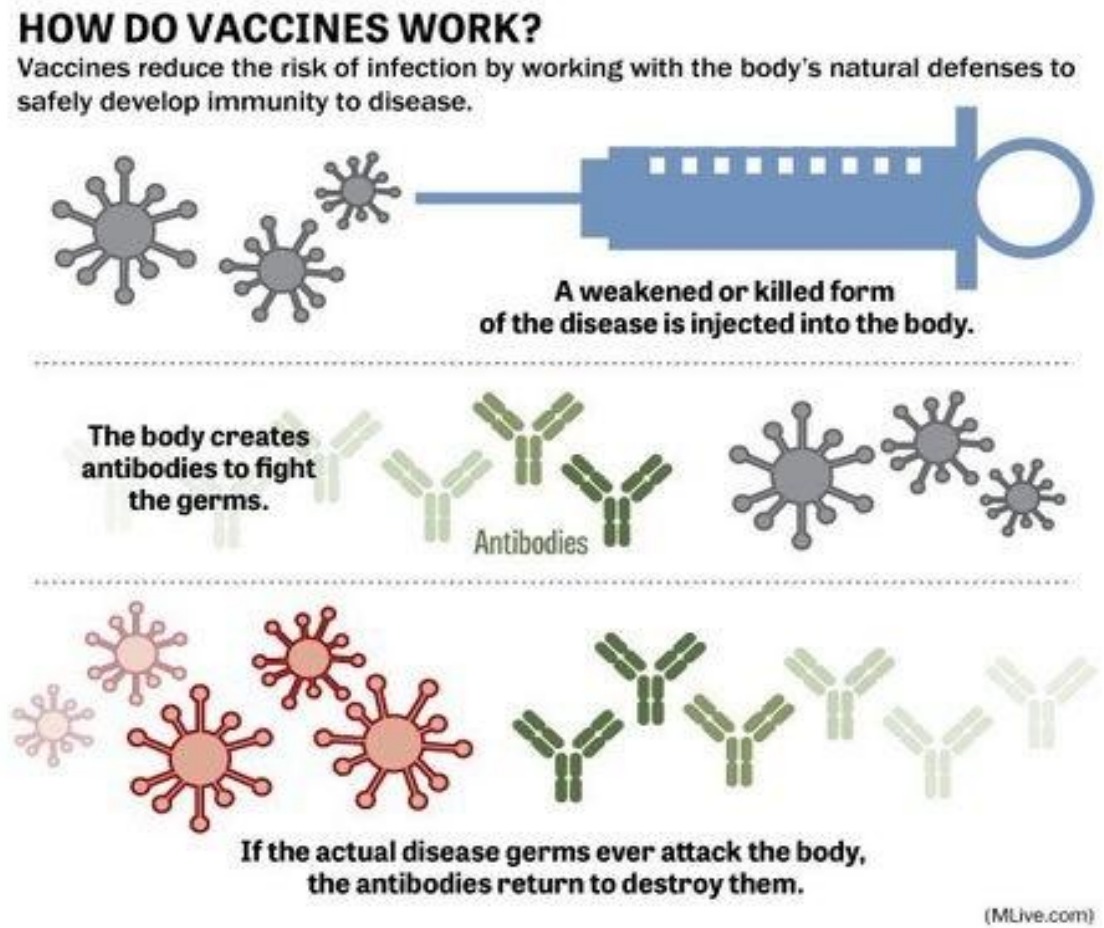
- Vaccines are composed of either the **entire disease-causing microorganism** or some of its components in **non-pathogenic form** which imitate the second type of response without the consequences of the first.

The following steps summarize how a preventive vaccine can protect an individual from infection or disease:

1. The vaccine introduces a small component or a non-harmful form of the pathogen into the body. This is called the foreign **antigen or immunogen**.

2. The body's immune system produces an immune response to the pathogen by generating antibodies, killer cells, or both.

3. A small group of “memory” B-cells and T-cells remain in the body and can quickly initiate a strong immune response, i.e., by producing antibodies, and helping the production of killer T-cells or antibodies, respectively. The next time the real pathogen enters the body, the immune system remembers it and mounts a much larger, quicker response than it would have if the individual had never received the vaccine.



# TYPES OF VACCINES

Vaccines can be synthesized in many ways based on which they are classified:

**1. Live attenuated vaccines**

**2. Inactivated or dead vaccine**

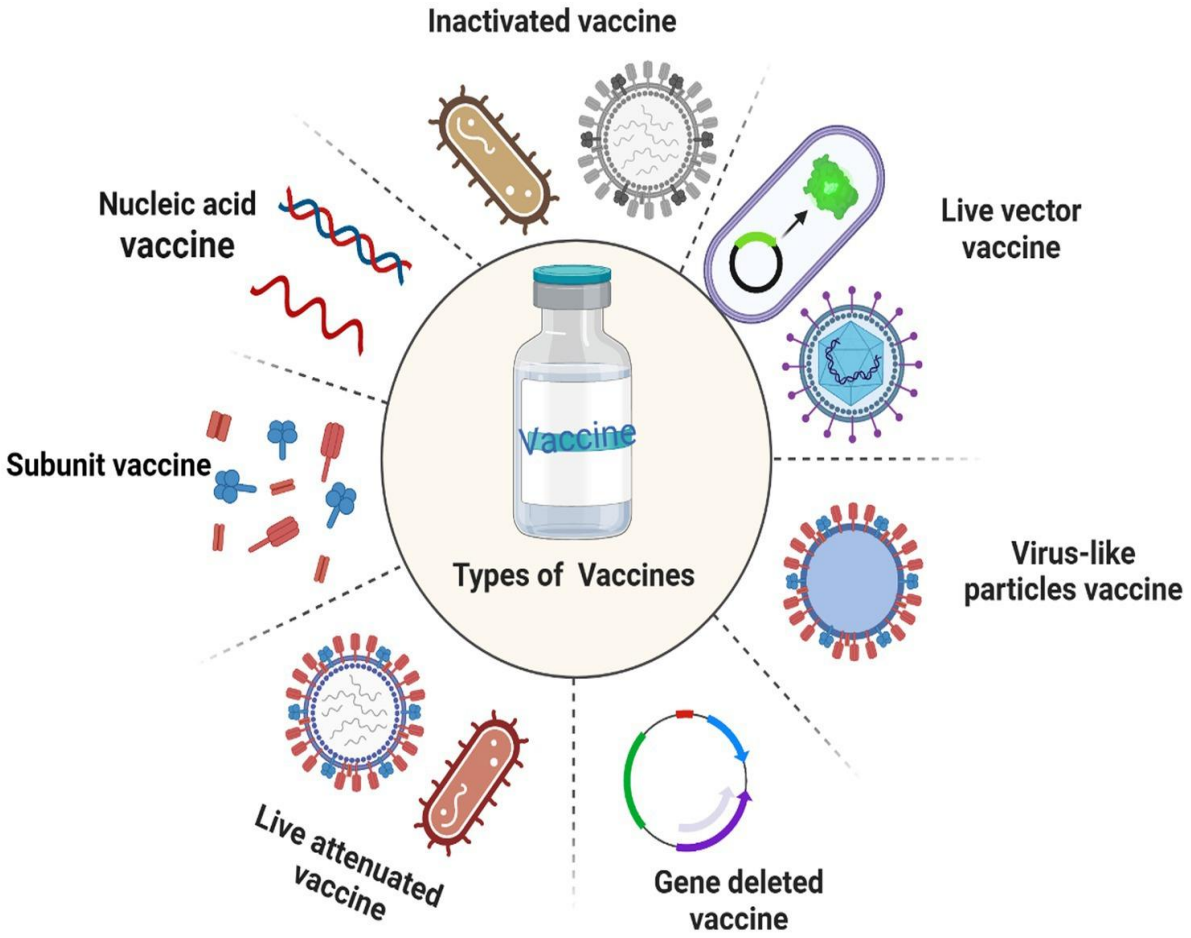
**3. Acellular or subunit vaccine**

i) Toxoid vaccine

ii) Conjugate vaccine

iii) Recombinant vaccine

iv) DNA/ RNA vaccine



## A. LIVE ATTENUATED VACCINE :

Pathogens like virus or bacteria are weakened by genetic manipulations to limit its growth and thus do not cause disease to the host. In some modified versions of live vaccine an organism that is related to the pathogen is used that naturally grows poorly in humans. The weakened pathogen generates a broad immune response in the host similar to that shown by an infected individual with a natural pathogen.

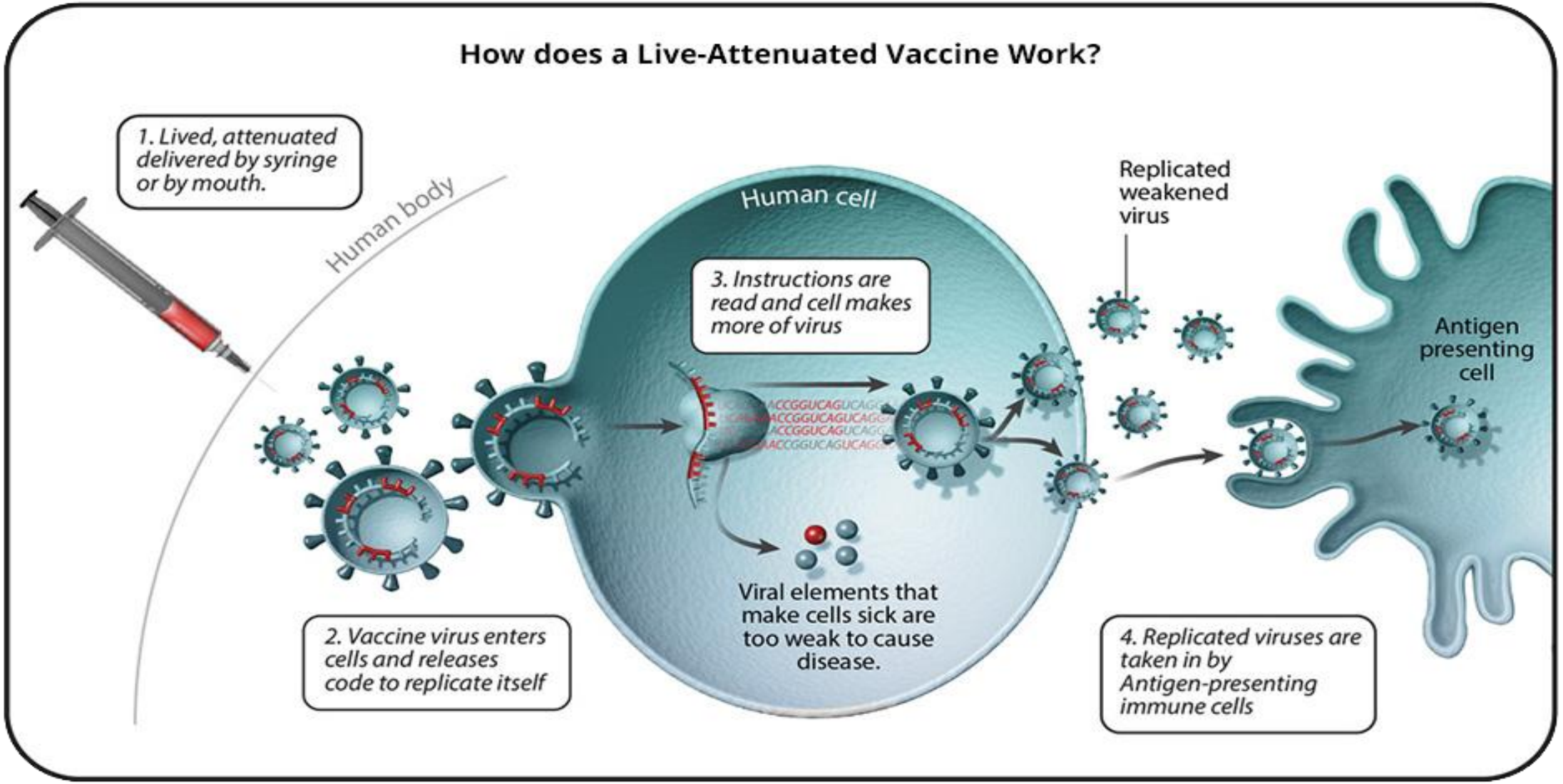
Eg - MRV Vaccine (Measles, Mumps, Rubella, and Varicella), Bacille Calmette-Guerin (BCG) vaccine.

## B. INACTIVATED OR DEAD VACCINE :

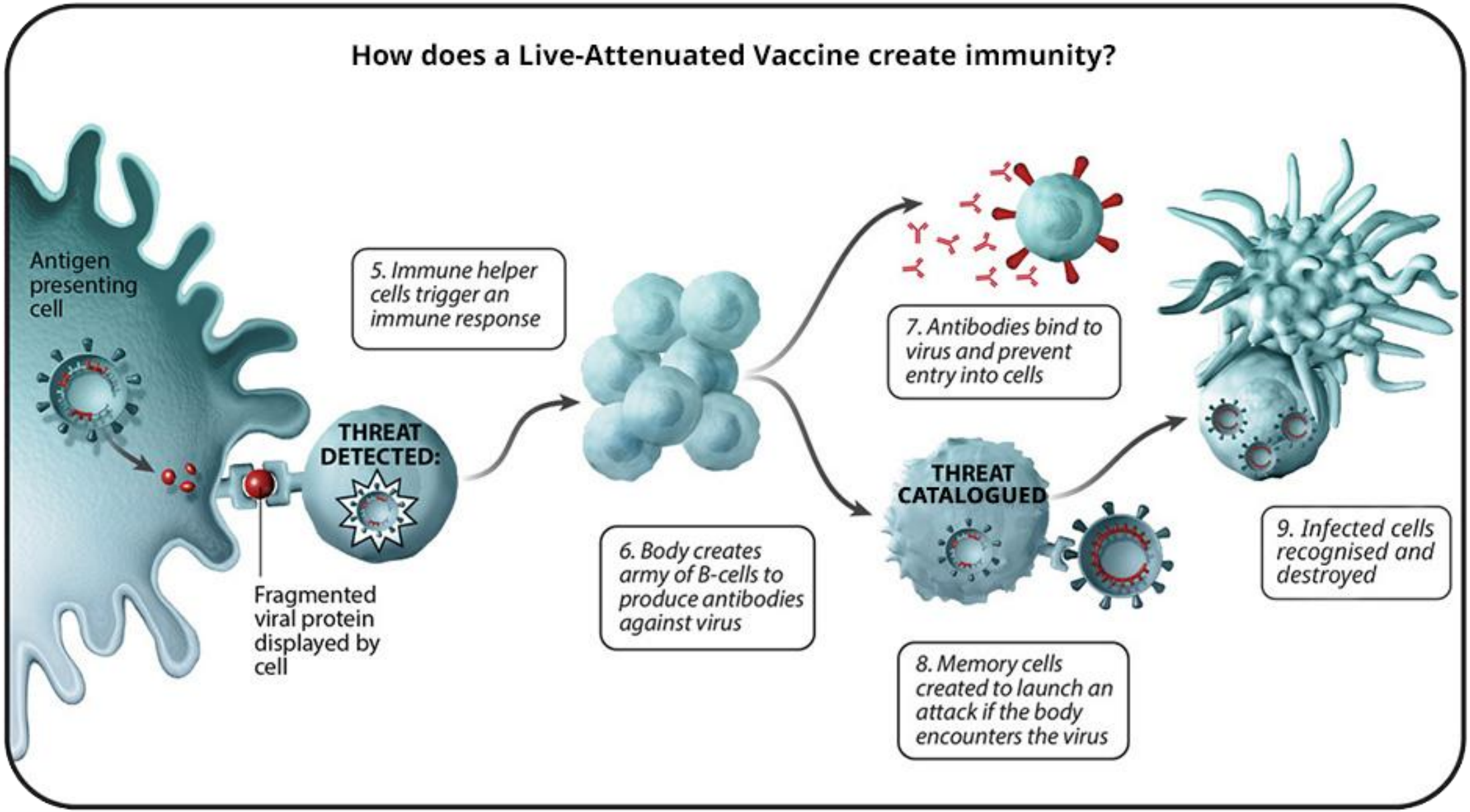
The disease-causing pathogen is killed or inactivated, usually through a thermal (application of high temperature) or chemical (formalin etc.) process. Such vaccines, when administered, elicit a robust immune response that mimics most of the responses seen during an infection.

Eg – Typhoid, Influenza, and Hepatitis A vaccine.

# LIVE-ATTENUATED VACCINE WORK ?




Source: https://www.pfizer.com/news/articles/understanding_six_types_of_vaccine_technologies

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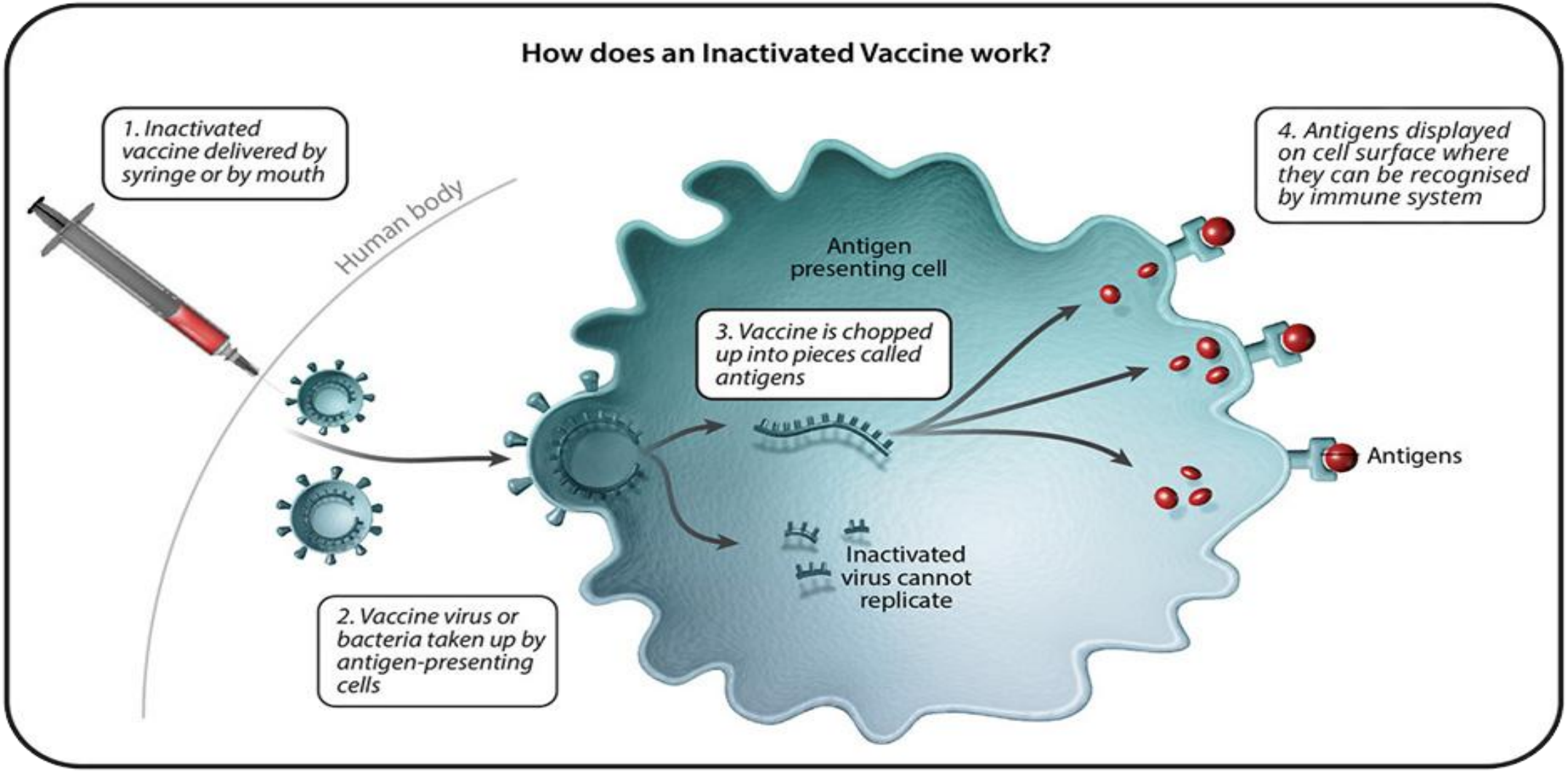
# INACTIVATED VACCINE WORK ?

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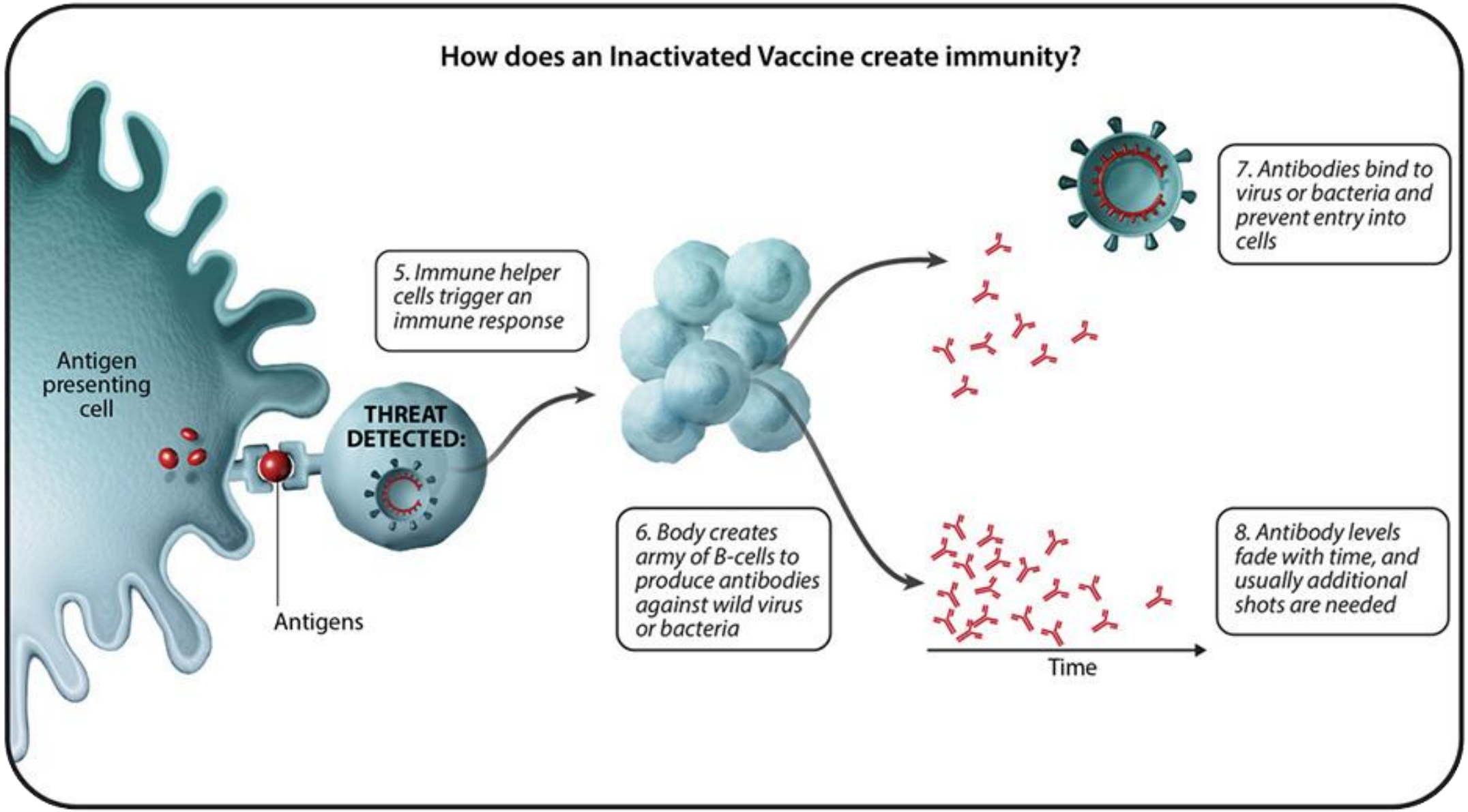


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## C. ACELLULAR OR SUBUNIT VACCINE :

Acellular means not containing the whole cells. Acellular vaccines do not contain the whole bacteria or viruses. Instead, they contain polysaccharides or proteins from the surface of the bacteria or virus. These polysaccharides or proteins are the parts that our immune system recognizes as ‘foreign’ and evoke immune response against them.

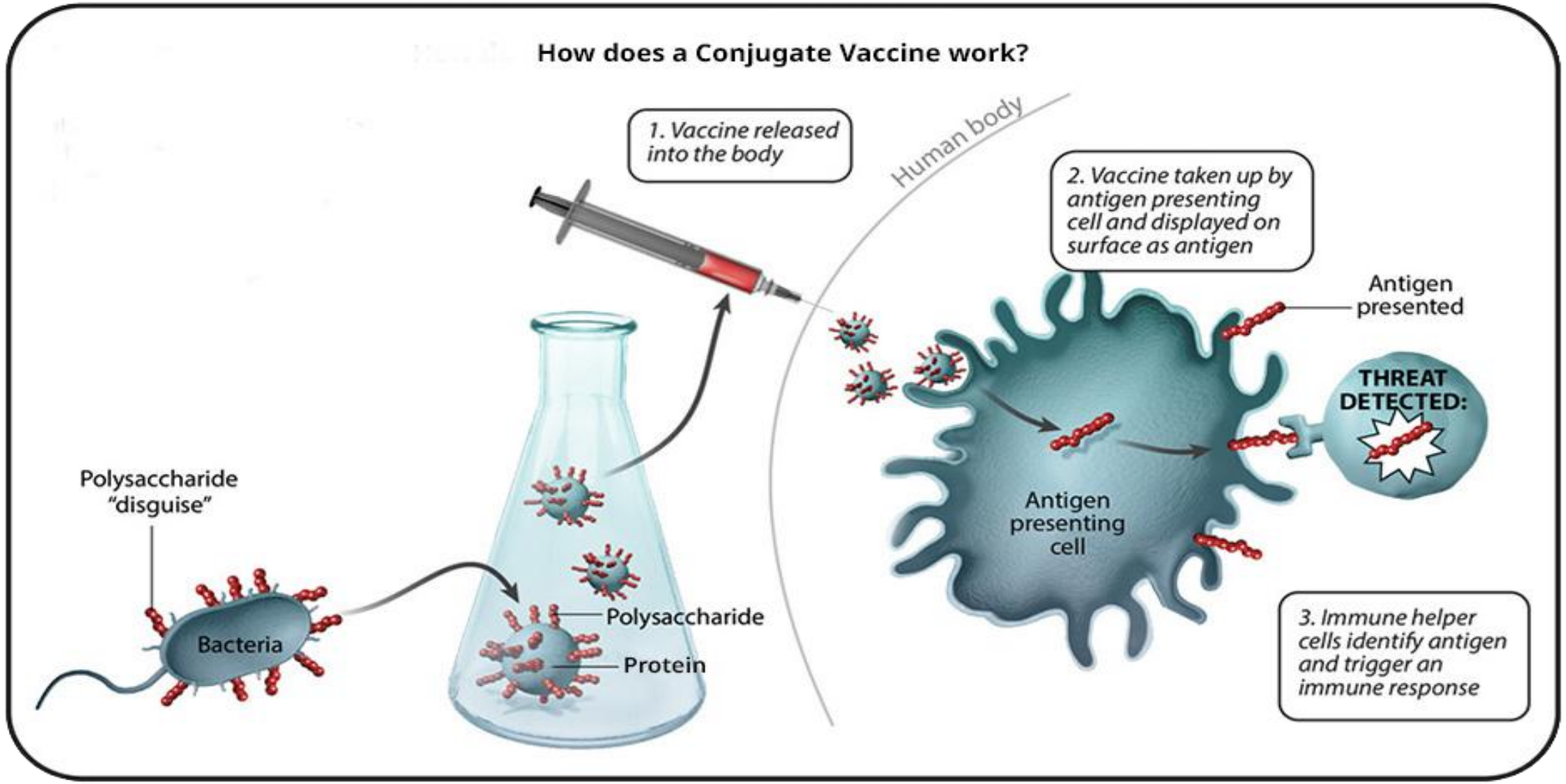
**There are many types of a cellular vaccines:**

**1.Toxoid Vaccine**: Some pathogenic bacteria release toxins or poisonous proteins when they attack the body. Some vaccines are made by inactivating these toxins chemically and called ‘toxoids’, because they look like toxins but not poisonous. They trigger a strong immune response.

Eg – Diphtheria, Tetanus, and Pertusis vaccine.

**2. Conjugate vaccine :** Earlier polysaccharide vaccines were made using sugar molecules present on the surface of the bacteria but it was found to be less effective in babies and young children. Researchers discovered that these vaccines can work better if the bacterial polysaccharide molecules are chemically linked or conjugated to a carrier protein. Addition of other proteins confers the immunological attributes of the carrier to the antigen and thus induces a stronger immune response effective enough for younger children also. Eg - Haemophilus influenza type b (Hib) conjugate vaccine

# CONJUGATE VACCINE WORK ?

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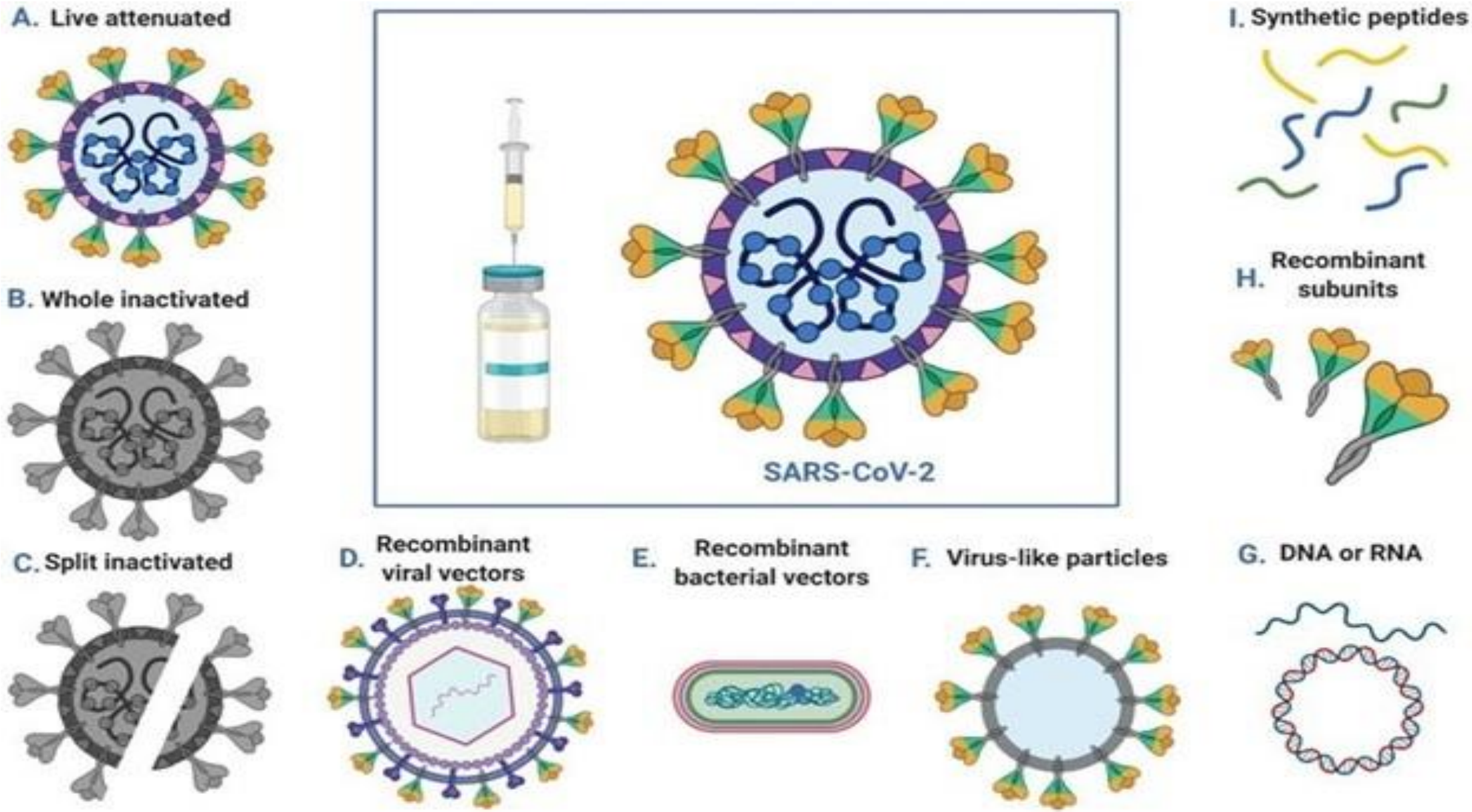
**3. Recombinant Vaccine**: A small piece of the DNA is taken from the disease-causing bacterium or virus. The particular gene is incorporated into plasmid or a carrier vehicle which enables production of large quantities of well-defined proteins, which are then used as vaccines.

Eg – Hepatitis B and HPV ( Human papillomavirus vaccine )

**4.DNA/RNA Vaccine**: Genetic material, either DNA or RNA, from the pathogenic bacteria or virus is introduced into the human cells and then the cell machinery is employed to produce the protein encoded by the inserted gene(s) of the pathogen. Our body's immune system detects such protein as a foreign agent and produces an immune response against the whole pathogen. At present, different types of nucleic-acid vaccines are in developmental, pre-clinical and clinical evaluation phases.

Eg - HIV vaccine




Source: http://www.biomat-trans.com/EN/10.3877/cma.j.issn.2096-112X.2021.01.005

# TOXOIDS VACCINE

- Toxoid vaccines use toxoids (as antigens) to induce an immune response in protecting against diseases caused by toxins secreted by specific bacteria.
- By using toxoids, the body is able to form an immune response to the original toxin (maintained immunogenicity), but since the toxoid is a weakened form of the toxin, it cannot lead to any toxicity or toxin-induced disease.
- Compared to other vaccines, toxoid vaccines are more stable and less susceptible to damage caused by temperature, humidity, or light.
- During the immune response mounted by the body in response to exposure to toxoids, Th2 (CD4+) and B-cells become activated which produce immunoglobulins against the immunogenetic part of the toxoid (which is the same as it is in the toxin), allowing for protection against the actual toxin should exposure ever occur.
- Usually, toxoid vaccines are given as part of a course of multiple doses throughout childhood and adulthood for maximum protection, and booster shots can be given if you are traveling to a high-risk country for example.

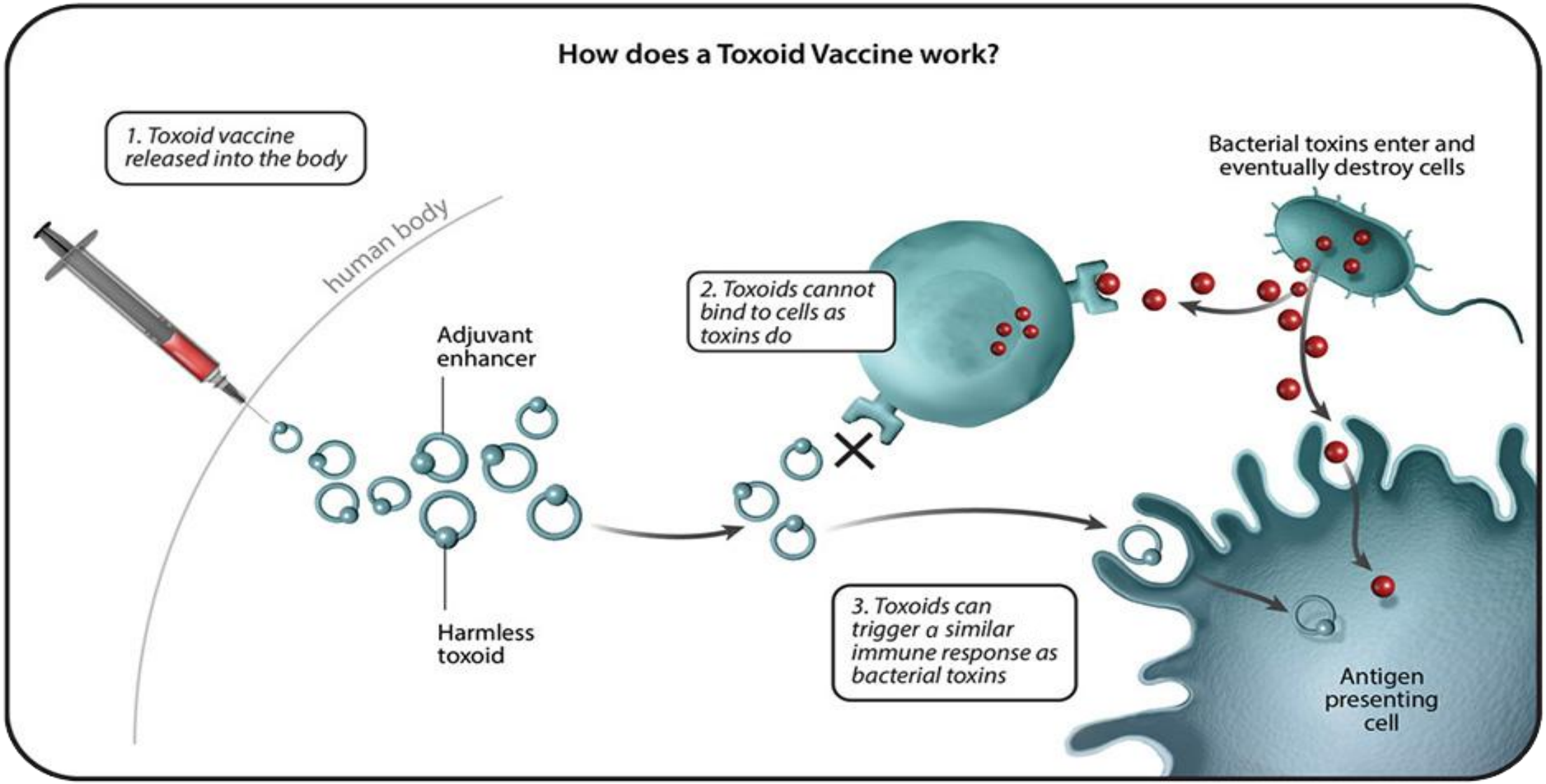
# EXAMPLES OF BACTERIAL DISEASES AND TOXOID VACCINES

Common diseases caused by bacterial toxins are typically immunized against using toxoid vaccines.

Specific examples include vaccinations against :

1. Tetanus *(Clostridium tetani)*
2. Diphtheria *(Corynebacterium diphtheriae)*
3. Botulism *(Clostridium botulinum)*
4. Pertussis *(Bordetella pertussis* – bacteria).

# HOW TOXOIDS WORK ?

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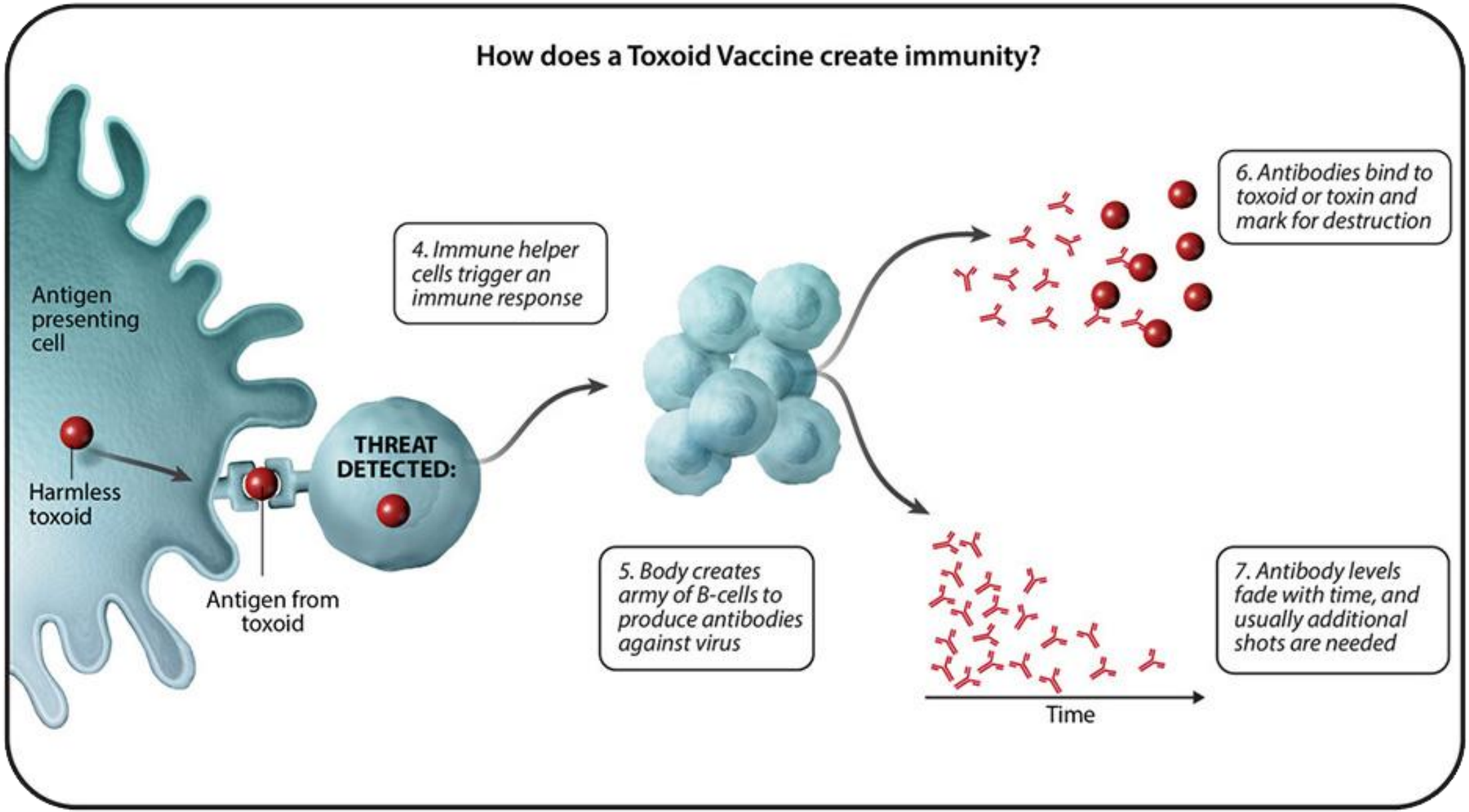


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# BACTERIAL AND VIRAL

## BACTERIA :

Bacteria can be beneficial – for instance, gut bacteria help us to digest food – but some are responsible for a range of infections. These disease-causing varieties are called pathogenic bacteria. Many bacterial infections can be treated successfully with appropriate antibiotics, although antibiotic-resistant strains are beginning to emerge. Immunisation is available to prevent many important bacterial diseases.

## VIRUS :

A virus is an even smaller micro-organism that can only reproduce inside a host's living cell. It is very difficult to kill a virus. That's why some of the most serious communicable diseases known to medical science are viral in origin.

## HOW BACTERIA AND VIRUS ENTER THE BODY ?

To cause disease, pathogenic bacteria must gain access into the body. The range of access routes for bacteria includes:

1. Cuts
2. Contaminated food or water

3. Close contact with an infected person

4. Contact with the faeces of an infected person

5. Breathing in the exhaled droplets when an infected person coughs or sneezes

6. Indirectly, by touching contaminated surfaces – such as taps, toilet handles, toys and nappies.

## CURING A BACTERIAL INFECTION :

The body reacts to disease-causing bacteria by increasing local blood flow (inflammation) and sending in cells from the immune system to attack and destroy the bacteria. Antibodies produced by the immune system attach to the bacteria and help in their destruction. They may also inactivate toxins produced by particular pathogens, for example **tetanus and diphtheria.**

Serious infections can be treated with antibiotics, which work by disrupting the bacterium's metabolic processes, although antibiotic-resistant strains are starting to emerge. Immunisation is available to prevent many important bacterial diseases such as Hemophilus influenza Type b (Hib), tetanus and whooping cough..

## CURING A VIRAL INFECTION :

Antibiotics are useless against viral infections. This is because viruses are so simple that they use their host cells to perform their activities for them. So antiviral drugs work differently to antibiotics, by interfering with the viral enzymes instead.

Antiviral drugs are currently only effective against a few viral diseases, such as **influenza, herpes, hepatitis B and C** and **HIV** – but research is ongoing. A naturally occurring protein, called interferon (which the body produces to help fight viral infections), can now be produced in the laboratory and is used to treat hepatitis C infections.