Virology PHA-354

Lecture Series VI

Types of Vaccines

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Ideal vaccine

1- Effective (Protective).

2- Long lasting.

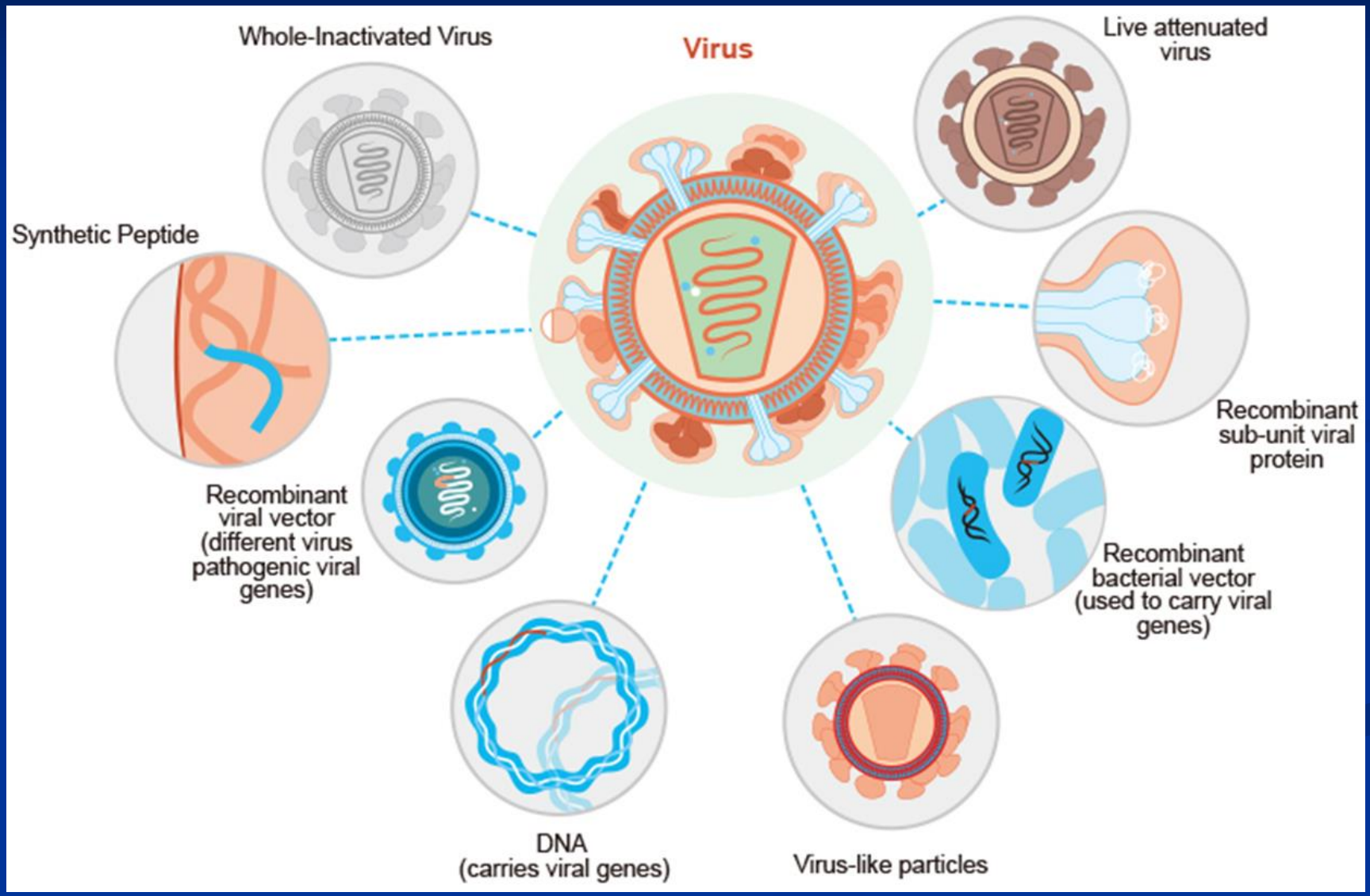
3- Safe.

4- Pure.

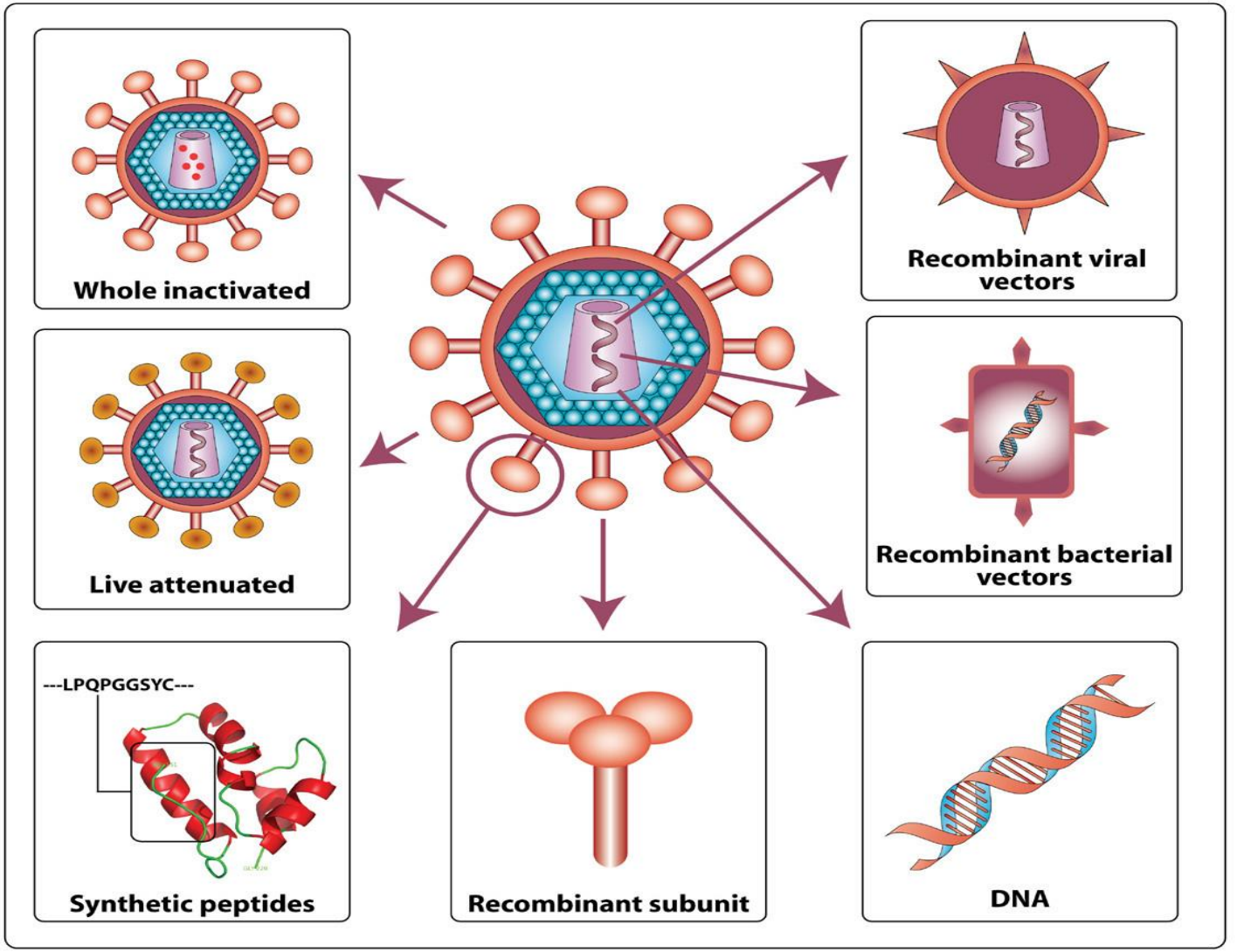
5- Stable.

6- Economic

Types of vaccine



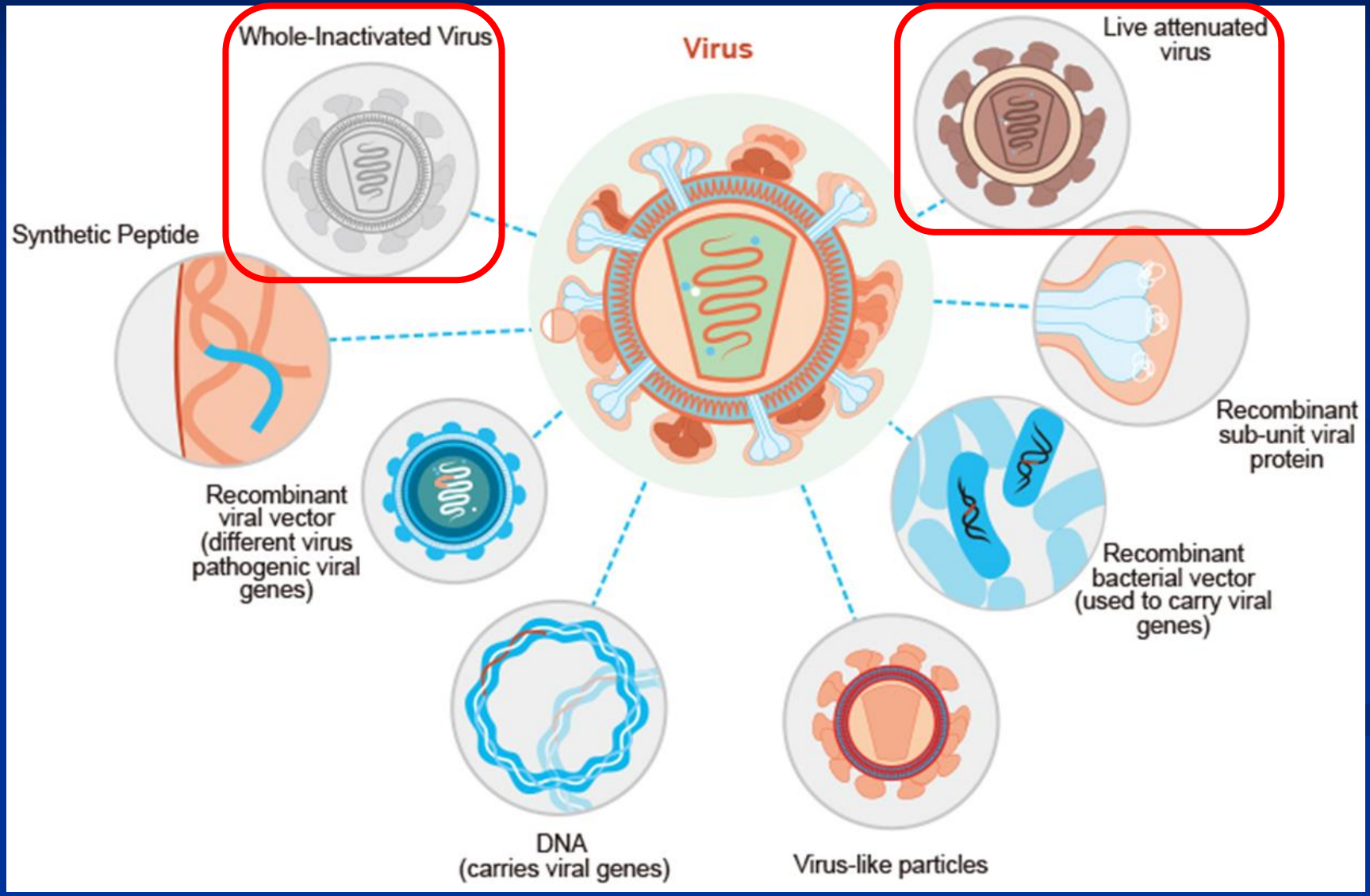
Types of vaccine



Types of vaccine

1. Live, attenuated vaccines
2. Inactivated vaccines
3. Subunit vaccines
4. Toxoid vaccines
5. Conjugate vaccines
6. DNA vaccines
7. Recombinant vector vaccines

Conventional Vaccines



Modified Live (ML) Vaccines

- Live, attenuated vaccines contain a version of the living microbe that has been weakened in the lab so it can't cause disease.
- Because a live, attenuated vaccine is the closest thing to a natural infection, these vaccines are good "teachers" of the immune system.
- Example: Vaccines against measles, mumps, and chickenpox

Modified Live (ML) Vaccines

A- Naturally Avirulent Pathogen

Lentogenic strains of Newcastle disease virus

B- Immunologically related pathogen from different host species "Heterotypic vaccines"

Turkey herpes virus against Marek's disease in chicken

Sheep pox virus against LSD in cattle

Vaccinia against small pox in human

Modified Live (ML) Vaccines

C- Attenuated vaccines:

- **By serial passaging in different host system (cell culture, ECEs)** ***…. Accumulation of point mutations that lead to loss of virulence.***

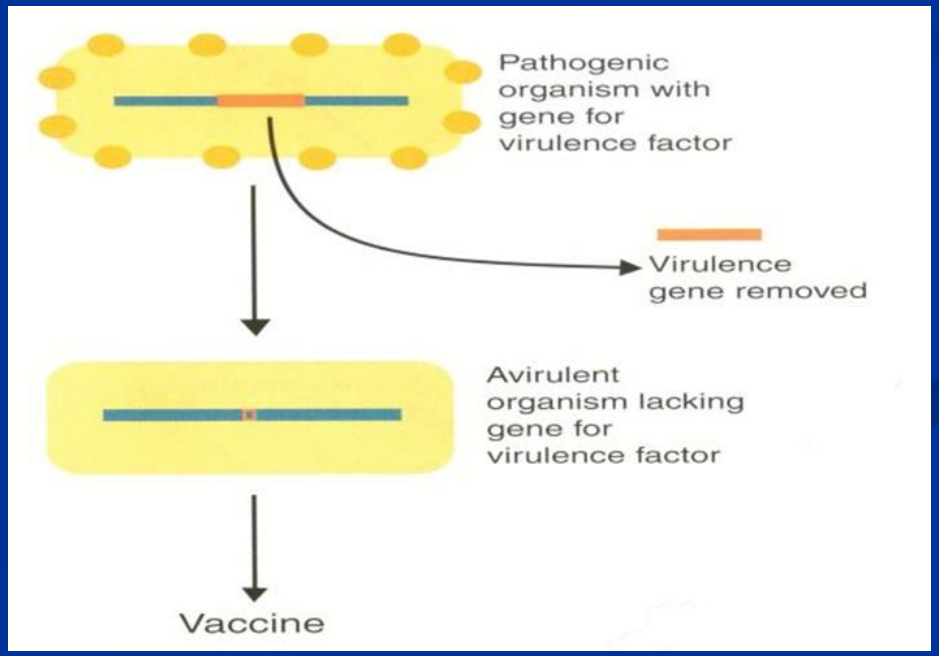
- **By selection of mutants** ***(e.g. temperature sensitive mutants).***

Modified Live (ML) Vaccines

C- Attenuated vaccines:

- By removal of partial or complete sequence of a gene that is not essential for replication but contribute in virulence (this vaccine enables DIVA).

TK gene of herpesviruses



Modified Live (ML) Vaccines

Advantages:

When safe it is the best

1- Local and systemic immunity.

2- Induces immunogenic memory.

3- Raises immune response to all protective antigens.

4- Quick and long-lasting immune response.

5- Low cost (Good for use in developing countries).

6- Cross protection.

7- Easily administrated by all routes (injection, oral, …)

8- Can lead to elimination of wild-type pathogen from the community.

Modified Live (ML) Vaccines

Disadvantages:

1- Potential reversion to virulence.

2- Spread to contacts of vaccines who have not vaccinated.

3- Poor stability (requires cold chain).

4- Contraindicated in immunosuppressed individuals.

Inactivated (Killed) Vaccines

- Made from virulent pathogen by destroying its infectivity using physical or chemical agent, while retaining its immunogenicity.
- The most commonly used inactivated agents are formaldhyde, B-propiolactone, ethylenimine and azuridine.
- Adjuvants and non-specific immunostimulants are added to strengthen the immune response and prolongs its duration.

Inactivated (Killed) Vaccines

Advantages:

1- Gives sufficient humoral immunity if boosters given.

2- No risk of pathogenicity or virulence.

3- Safe for pregnant and immuno-deficient individuals.

4- Stable (Preferred for use in tropical countries).

Inactivated (Killed) Vaccines

Disadvantages:

1- Require booster doses (Short immunity).

2- High antigen concentration is needed.

3- Local immunity is poor.

4- Administration only by injection.

5- Provokes mostly humoral immunity (Adjuvants are essential for cellular immunity).

6- Inactivation process may alter antigenicity.

7- Less economic (adjuvant – high antigen conc.).

Live-attenuated vs Inactivated Vaccines

	Live-attenuated Vaccines	Inactivated Vaccines
Route	imitating natural infection	Injection subcutaneously
Doses	small	Large
Times	once	Twice or more
Side effects	slight	severe
Duration	Long (3~5years or life long)	Short (months~1 years)
Mutation	possible	impossible
Preservation	4°C or lymphilization	easy to preserve

Live-attenuated vs Inactivated Vaccines

CHARACTERISTICS	Inactivated virus (IV)	Modified live-virus (MLV)
Quantity of antigen / dose	Higher	Lower
Need for adjuvant	Higher	Medium
Humoral responses; total antibodies (one dose)[1]	Low or Null	High
Humoral responses; neutralizing antibodies (one dose)[1]	Null	Low-Medium
Cell-mediated immunity (one dose)[1]	Null-Low	Low-Medium
Effectiveness of protection (one dose)[1]	Variable (lower)	Variable (higher)
Viraemia (vaccine virus can be detected in blood)	No	Yes
Excretion of vaccine virus	No	Yes
Transmission to non-vaccinated pigs		
Horizontal spread	No	Yes
Vertical spread	No	Yes
Stability at room temperature	High	Low

Molecular-based Vaccines

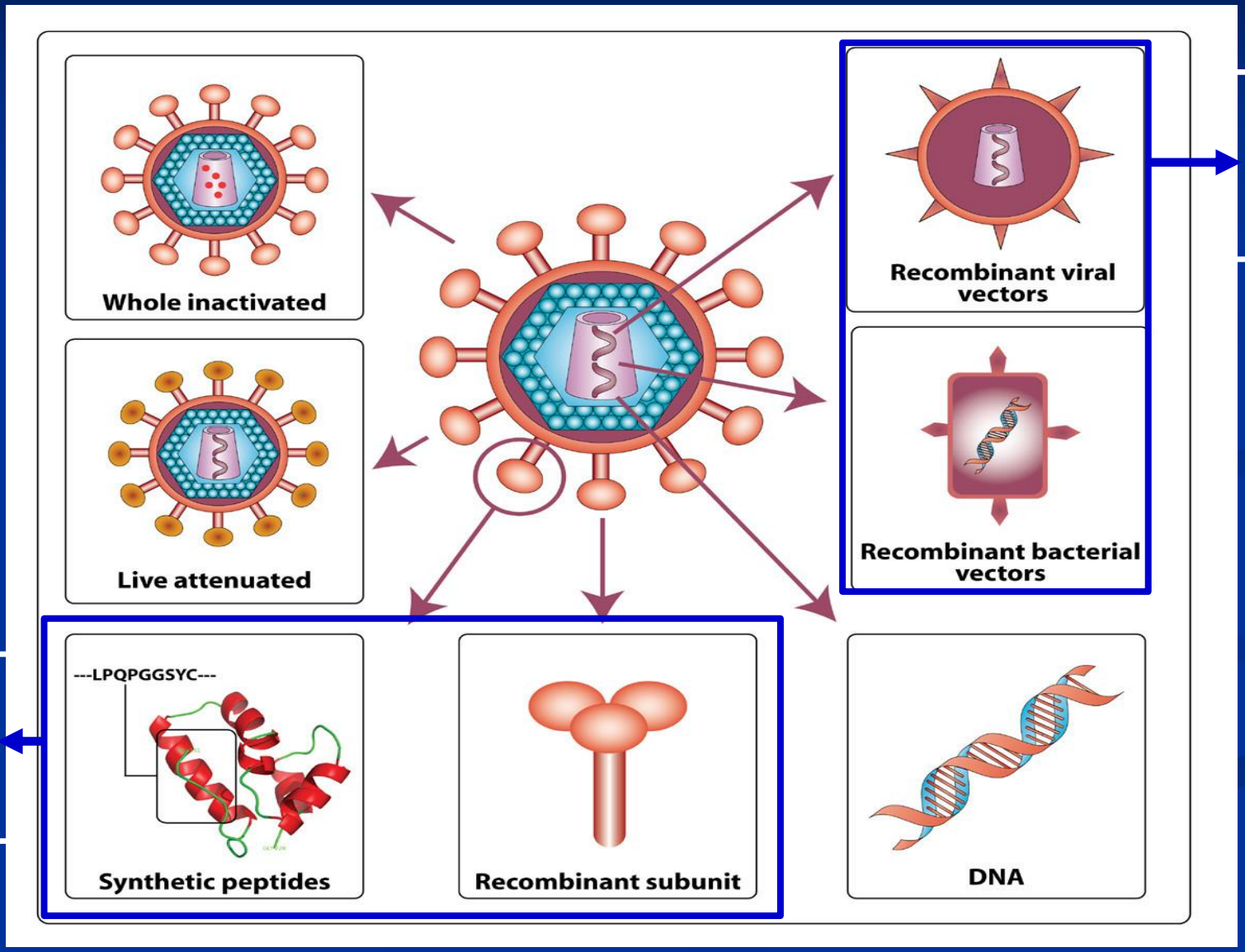
USDA classification of Genetically Engineered Veterinary Biologics:

Category I:
Vaccines contain inactivated recombinant organisms or purified antigens derived from recombinant organisms.

Category II:
Vaccines contain live organisms that contain gene deletion or heterologous marker genes.

Category III:
Vaccines contain live expression vectors containing heterologous genes for immunizing antigens.

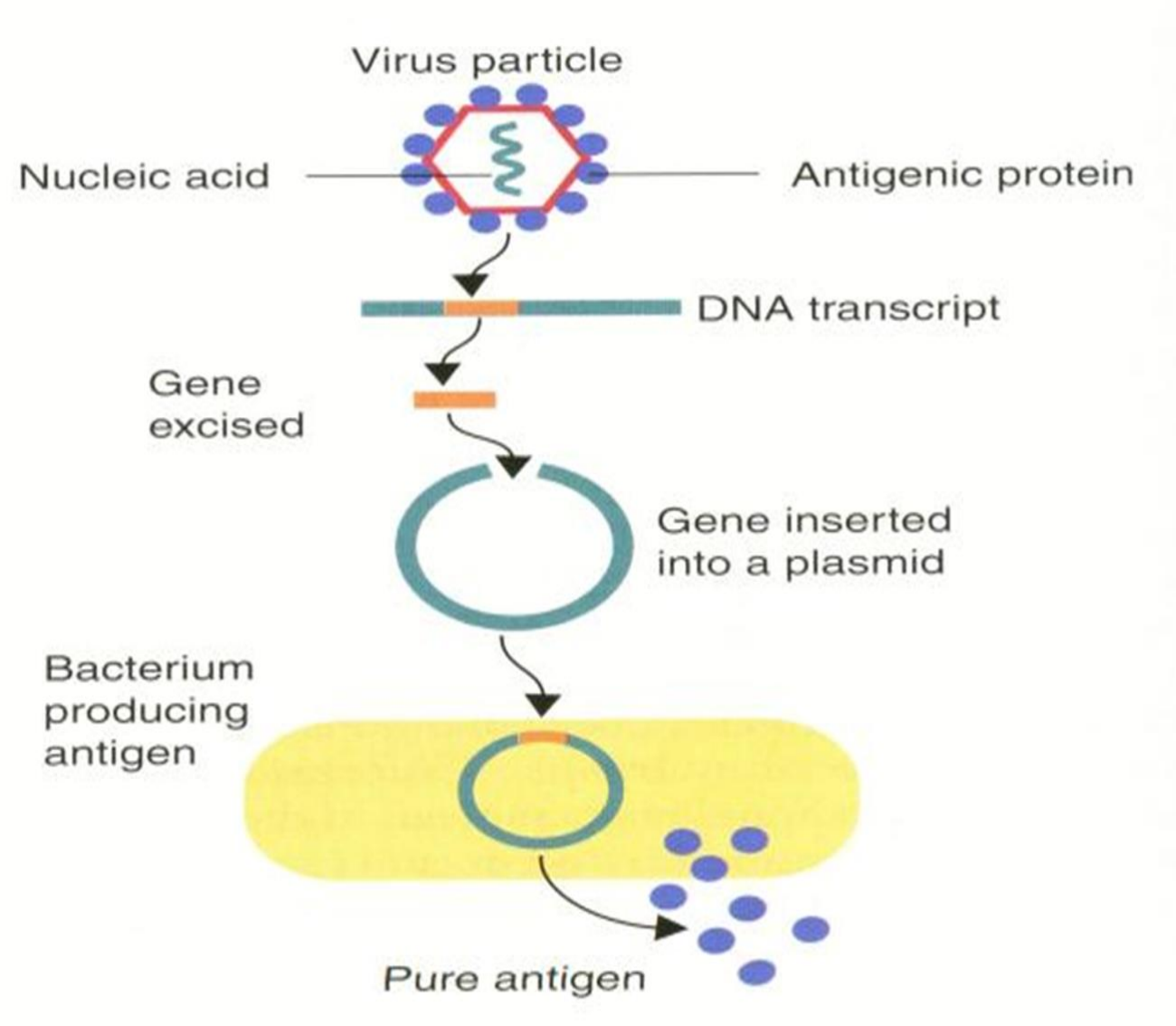
Molecular-based Vaccines



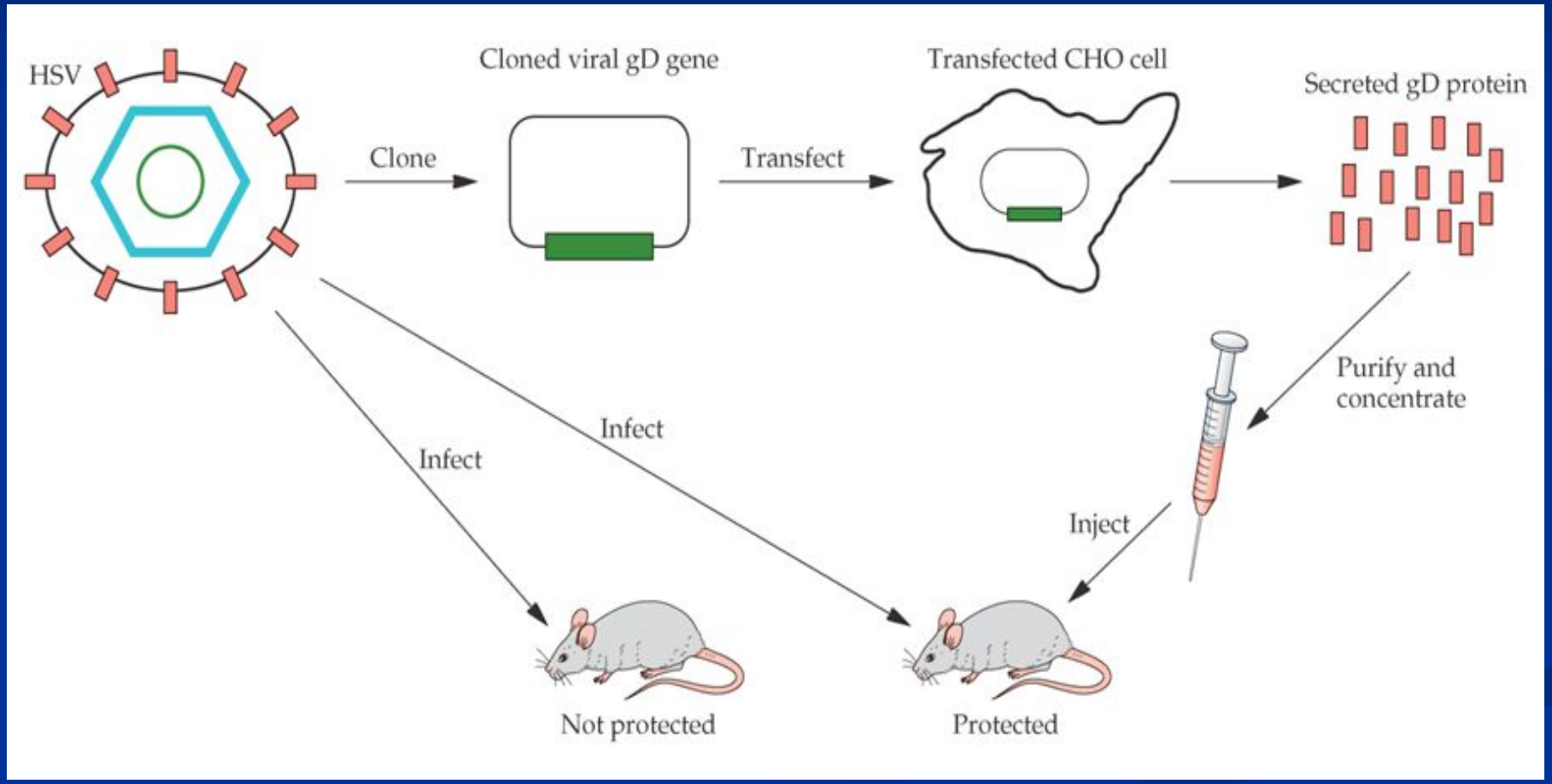
Category III

Category I

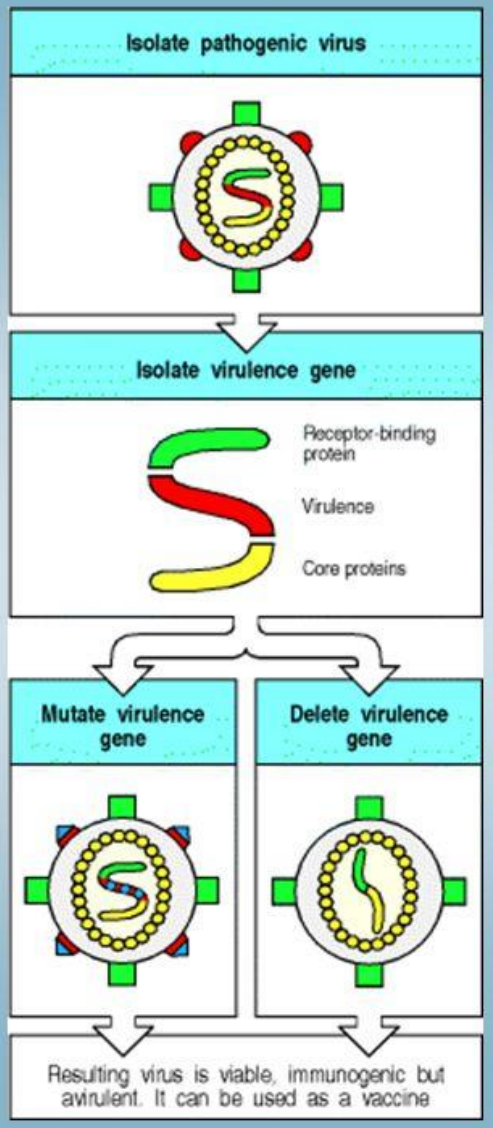
Category I – Subunit vaccine



Category I – Subunit vaccine



Category II – Marker vaccine

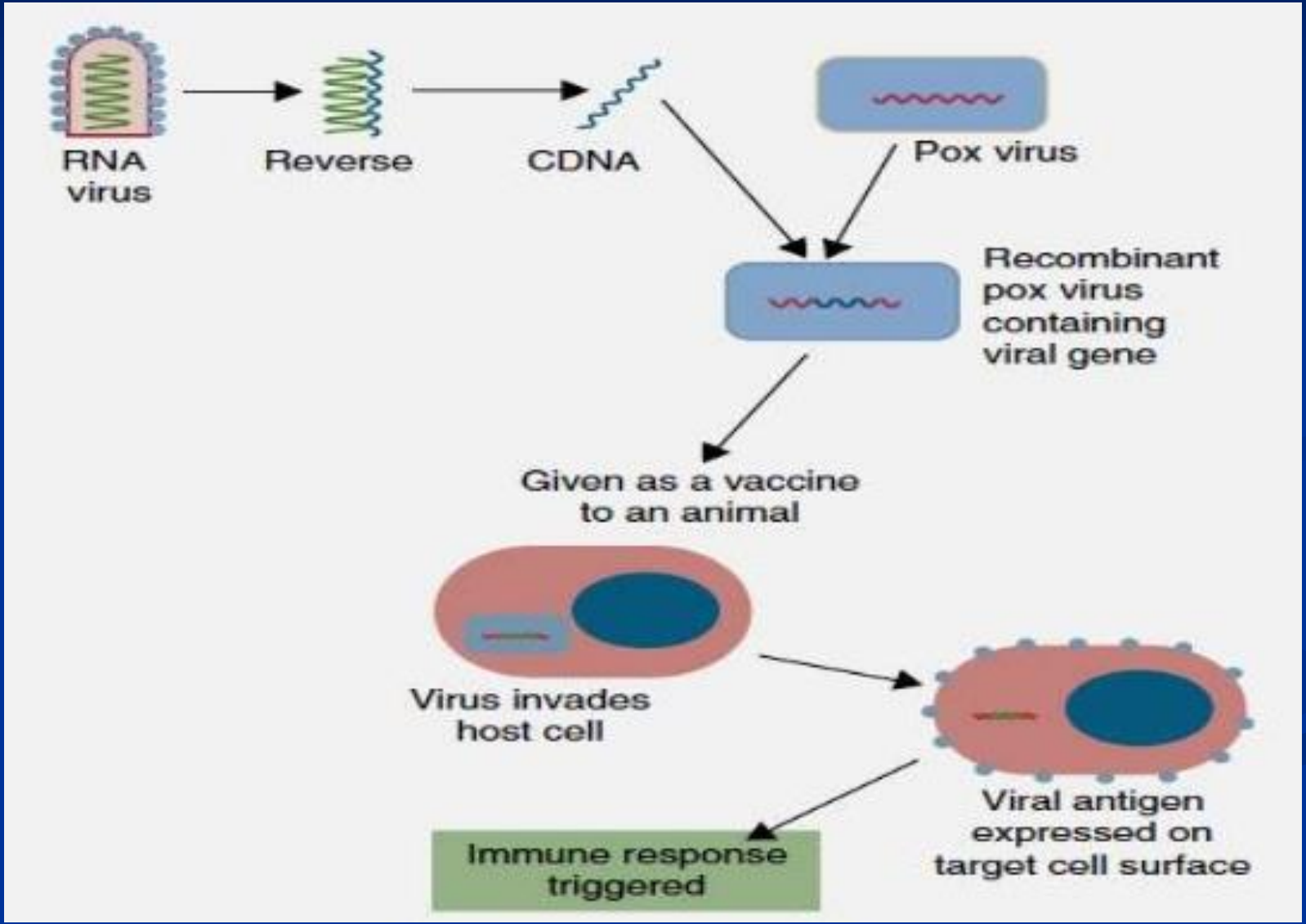


Pathogenic virus

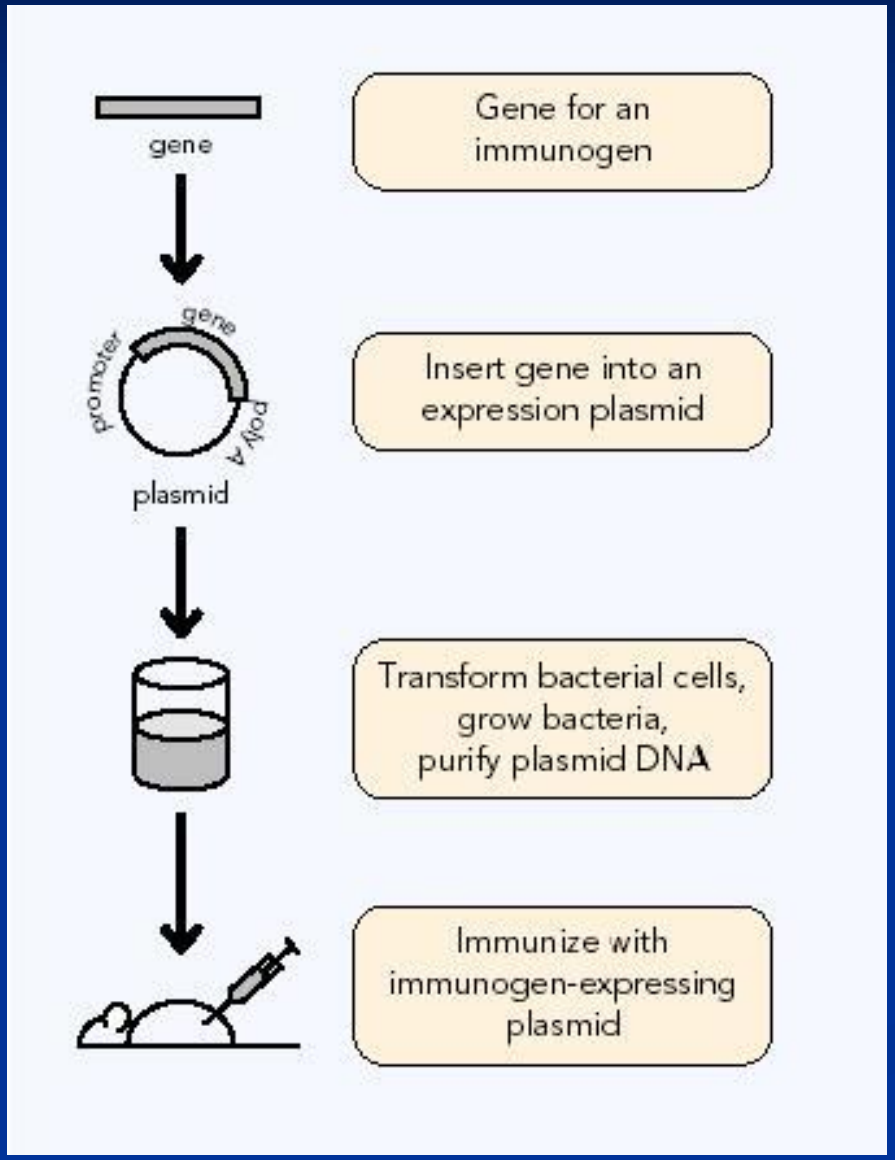
Mutation or deletion of virulence gene

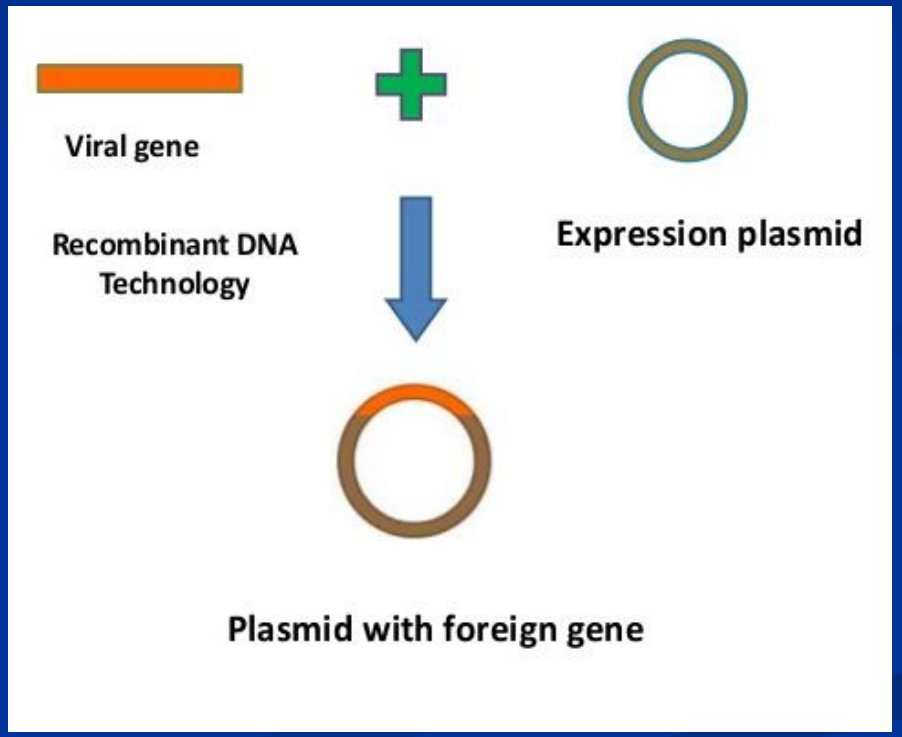
Immunogenic but avirulent virus -> vaccine

Category III – Vectored vaccine

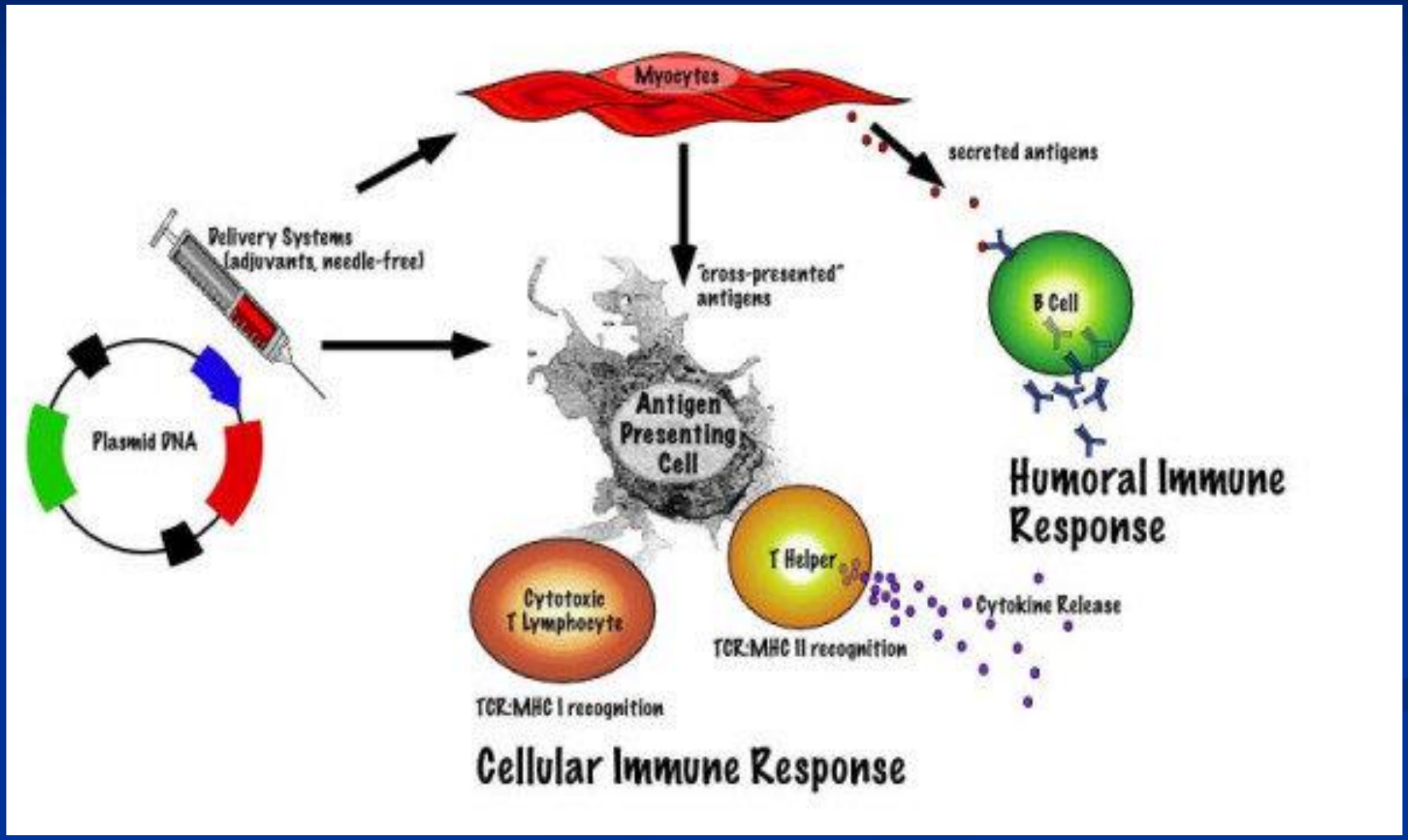


DNA Vaccine


gene
Gene for an immunogen
promoter
gene
poly A
plasmid
Insert gene into an expression plasmid
Transform bacterial cells, grow bacteria, purify plasmid DNA
Immunize with immunogen-expressing plasmid


Viral gene
Expression plasmid
Recombinant DNA Technology
Plasmid with foreign gene

DNA Vaccine


Myocytes
secreted antigens
Delivery Systems
(adjuvants, needle-free)
"cross-presented"
antigens
B Cell
Plasmid DNA
Antigen
Presenting
Cell
Humoral Immune
Response
T Helper
Cytotoxic
T Lymphocyte
Cytokine Release
TCR:MHC II recognition
TCR:MHC I recognition
Cellular Immune Response

DNA Vaccine

Advantages:

1- Induce humoral and cellular responses.

2- Stability during storage and shipping.

3- Ease of development and production.

4- Relatively economic.

5- No immune response against the vector itself.

6- Fast production and scale up.

7- Non-infectious (Safe).

DNA Vaccine

Disadvantages:

1- Potential integration of plasmid into host genome leading to insertional mutagenesis

2- Induction of autoimmune responses (Pathogenic anti-DNA antibodies)

3- Induction of immunogenic tolerance.

4- Lower efficiency in large animals and human (poor immunogenicity).

5- Require multiple doses.

6- No mass application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