Principles of Communicable Diseases Epidemiology-L-3/23-24

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Objectives

- Recognize the types of immunity and vaccines
- Recall common combination vaccines for childhood immunizations
- Describe routine vaccine schedules for common childhood diseases in Iraq
- Identify the principles and components of cold chain

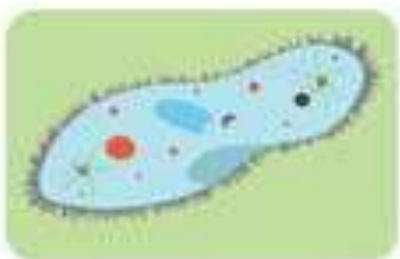
Acquired Immunity

Immunity that develops during your lifetime

Active Immunity

Natural

Antibodies developed in response to an infection



Artificial

Antibodies developed in response to a vaccination

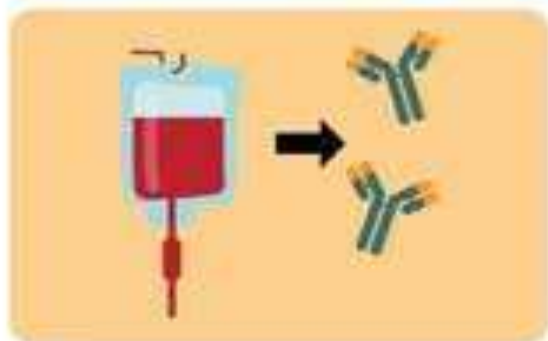
Passive Immunity

Natural

Antibodies received from mother, through breast milk

Artificial

Antibodies received from a medicine, from a gamma globulin injection or infusion



Immunization

Each year, vaccines prevent more than 2.5 million child deaths globally. An additional 2 million child deaths could be prevented each year through immunization .

Why vaccines are so special?

- **Vaccines promote health:** unlike many other health interventions, they help healthy people stay healthy, removing a major obstacle to human development.
- **Vaccines have an extensive reach:** they protect individuals, communities, and entire populations.
- **Vaccines have rapid impact:** the impact of most vaccines on communities and populations is almost immediate.

DIFFERENCE BETWEEN VACCINATION AND IMMUNIZATION

VACCINATION

VACCINATION IS THE ADMINISTRATION OF ANTIGENIC MATERIAL (A VACCINE) TO STIMULATE AN INDIVIDUAL'S IMMUNE SYSTEM TO DEVELOP ADAPTIVE IMMUNITY TO A PATHOGEN.

IMMUNIZATION

IMMUNIZATION IS THE PROCESS WHEREBY A PERSON IS MADE IMMUNE OR RESISTANT TO AN INFECTIOUS DISEASE, TYPICALLY BY THE ADMINISTRATION OF A VACCINE.

IMMUNIZING AGENTS

The immunizing agents may be classified as vaccine, immunoglobulin and antisera.

Vaccines

A vaccine is a biological preparation that improves immunity to a particular disease .

A vaccine typically contains an agent that resembles a disease –causing microorganism , and is often made from weakened or killed forms of the microbe or its toxins. The agent stimulates the body's immune system .

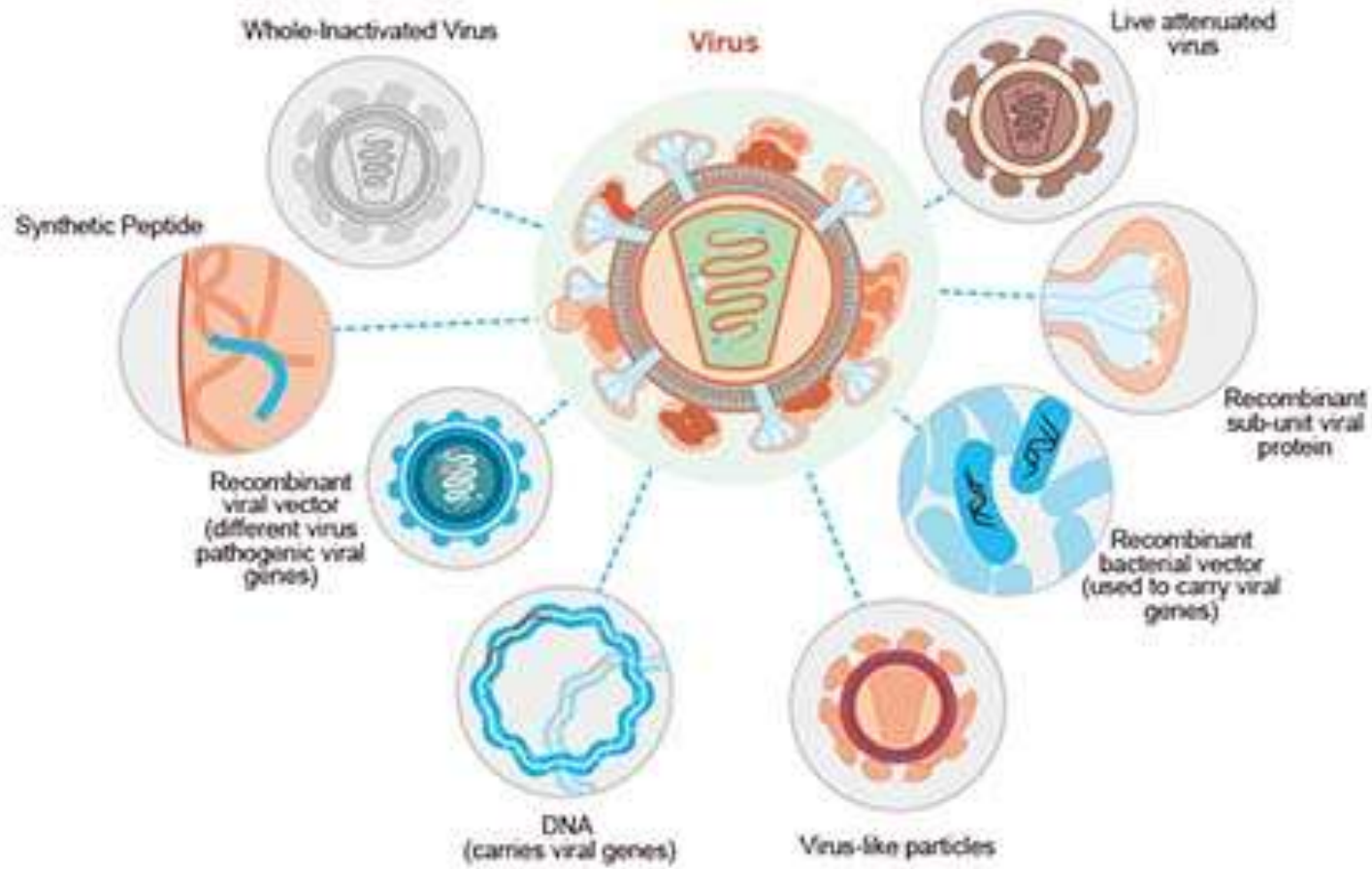
Characteristics of Effective Vaccines

- **Safety**
- **Protection**
- **Long-lasting effects**
- **Cost Inexpensive to produce and deliver**
- **Administration easy to deliver with no side-effects**

There are several types of vaccines, including:

- **Inactivated vaccines**
- **Live-attenuated vaccines**
- **Messenger RNA (mRNA) vaccines**
- **Subunit, recombinant, polysaccharide, and conjugate vaccines**
- **Toxoid vaccines**
- **Viral vector vaccines**

Types of Vaccines



Live attenuated (LAV)

- Tuberculosis (BCG)
- Oral polio vaccine (OPV)
- Measles
- Rotavirus
- Yellow fever

Inactivated (killed antigen)

- Whole-cell pertussis (wP)
- Inactivated polio virus (IPV)

Subunit (purified antigen)

- Acellular pertussis (aP).
- *Haemophilius influenzae* type B (Hib).
- Pneumococcal (PCV-7, PCV-10, PCV-13)
- Hepatitis B (HepB)

Toxoid (inactivated toxins)

- Tetanus toxoid (TT).
- Diphteria toxoid

1-LIVE VACCINE:

Only small pox vaccine is no more in uses at present.

2- LIVE ATTENUATED VACCINE:

Live attenuated vaccines contain whole bacteria or viruses which have been “weakened”(attenuated) so that they create a protective immune response but do not cause disease in healthy people.

For most modern vaccines this “weakening” is achieved through genetic modification of the pathogen either as a naturally occurring phenomenon or as a modification specifically introduced by scientists.

Live vaccines tend to create a strong and lasting immune response

- Live attenuated vaccines should not be administered to persons with immune deficiency diseases or to persons whose immune response may be suppressed because of leukemia, lymphoma or malignancy or because of therapy with corticosteroids, alkylating agents, anti - metabolic agents, or radiation.
- Pregnancy is another contraindication.
- When two live vaccines are required they should be given either simultaneously at different sites or with an interval of at least 3 weeks.
- In the case of live attenuated vaccines, immunization is generally achieved with a single dose.

Available live attenuated vaccines are

BCG **Use for prevention of TB. ID injection in left deltoid**

OPV (oral polio vaccine) (Sabin)

- OPV live attenuated , 2 drops

NORMAL BCG REACTIONS

- < 5 mm of erythematous induration,
- bluish-red pustule @ 2 - 3 wks
- Ulceration, drainage, crust formation @ 4 - 6 wks
- healing 10 - 12 wks,
- small scar

- Non suppurative adenopathy

- ✓ **Measles**
- ✓ **MMR (measles, mumps, rubella)**
- ✓ **Rubella**

•**0.5 ml** •**Subcutaneous -arm**

Rotavirus vaccine

A rotavirus vaccine protects children from rotaviruses, which are the leading cause of severe diarrhea among infants and young children.

Rota virus vaccine is a live, oral pentavalent vaccine that contains five rotaviruses.

3-INACTIVATED VACCINES (killed vaccine)

Inactivated vaccines contain whole bacteria or viruses, which have been killed or have been changed, so that they cannot replicate. Because inactivated vaccines do not contain any live bacteria or viruses, they cannot cause the diseases against which they protect, even in people with severely weakened immune systems.

Inactivated vaccines do not always create such a strong or long-lasting immune response as live attenuated vaccines.

They tend to provide a shorter length of protection than live vaccines and are more likely to require boosters to create long-term immunity.

TAB (ENTERICA), Pertussis, cholera, Salk (parenteral) for polio, hepatitis A and rabies vaccine.

4 - Sub unit vaccines

use specific pieces of the germ—like its protein, sugar, or capsid (a casing around the germ).

Because these vaccines use only specific pieces of the germ, they give a very strong immune response that's targeted to key parts of the germ.

Subunit vaccines can be further categorized into:

- **Protein-based subunit vaccines**
- **Polysaccharide vaccines**
- **Conjugate subunit vaccines**

- **They can also be used on almost everyone who needs them, including people with weakened immune systems and long-term health problems.**

- **One limitation of these vaccines is that need to give booster shots to get ongoing protection against diseases.**

❖Protein-based subunit vaccines

- **Protein based subunit vaccines present an antigen to the immune system without viral particles, using a specific, isolated protein of the pathogen.**
- **A weakness of this technique is that isolated proteins, if denatured, may bind to different antibodies than the protein of the pathogen.**
- **Commonly used protein-based subunit vaccines are the following:**

❑**Acellular pertussis (aP) vaccines contain inactivated pertussis toxin (protein) and may contain one or more other bacterial components.**

The pertussis toxin is detoxified either by treatment with a chemical or by using molecular genetic techniques.

- Hepatitis B vaccines are composed of the hepatitis B virus surface antigen (HBsAg), a protein produced by hepatitis B virus.

Earlier vaccine products were produced using purified plasma of infected individuals.

This production method has been replaced by recombinant technology that can produce HBsAg without requiring human plasma increasing the safety of the vaccine by excluding the risk from potential contamination of human plasma

Advantages and disadvantages of protein subunit vaccines

- **Well-established technology**
- **Suitable for people with compromised immune systems**
- **No live components, so no risk of the vaccine triggering disease**
- **Relatively stable**
- **Relatively complex to manufacture**
- **Adjuvants and booster shots may be required**
- **Determining the best antigen combination takes time**

❖Polysaccharide Vaccine

- **Some bacteria when infecting humans are often protected by a polysaccharide (sugar) capsule that helps the organism escape the human defense systems especially in infants and young children.**

Polysaccharide vaccines create a response against the molecules in the pathogen's capsule.

These molecules are small, and often not very immunogenic.

As a consequence they tend to:

1. Not be effective in infants and young children (under 18–24 months)

2. Induce only short-term immunity (slow immune response, slow rise of antibody levels, no immune memory).

Examples of polysaccharide vaccines include Meningococcal disease caused by Neisseria meningitidis groups A, C, W135 and Y, as well as Pneumococcal disease.

❑ Conjugate Vaccines

Conjugate subunit vaccines also create a response against the molecules in the pathogen's capsule.
In comparison to plain polysaccharide vaccines, they benefit from a technology that binds the polysaccharide to a carrier protein that can induce a long-term protective response even in infants.

Various protein carriers are used for conjugation, including diphtheria and tetanus toxoid.
Conjugate subunit vaccines, can therefore prevent common bacterial infections for which plain polysaccharide vaccines are either ineffective in those most at risk (infants) or provide only short-term protection (everyone else).

- **PCV (children's pneumococcal vaccine)**
- **Hib vaccine**

5- Virus Like Particles

Virus-like particles (VLPs) are molecules that closely resemble viruses, but are non-infectious because they contain no viral genetic material.

A few VLP-based vaccines are currently used worldwide:

- **Hepatitis B vaccine**
- **HPV vaccine**

6-Nucleic Acid Vaccines

❖ Messenger RNA vaccines—also called mRNA vaccines

mRNA vaccines make proteins in order to trigger an immune response.

- **mRNA vaccines have several benefits compared to other types of vaccines, including shorter manufacturing times and, because they do not contain a live virus, no risk of causing disease in the person getting vaccinated.**

- **There are two RNA vaccines authorized for emergency use at present. The Pfizer BioNTech and the Moderna COVID-19 vaccines are both RNA vaccines.**

❖ DNA vaccines

There are currently no licensed DNA vaccines, but there are many in development.

7-Viral Vectored Vaccines

As with nucleic acid vaccines, viral vectored vaccines are a newer technology, using harmless viruses to deliver the genetic code of target vaccine antigens to cells of the body, so that they can produce protein antigens to stimulate an immune response.

The Oxford-AstraZeneca COVID-19 vaccine

8-TOXOIDS

Some bacterial diseases are not directly caused by a bacterium itself, but by a toxin produced by the bacterium.

They are detoxicated exotoxins preparations which stimulate formation of humoral antitoxin immunity.

Diphtheria toxoids & tetanus toxoids are widely used for active immunization, each by itself or in combinations (DPT& DT) ,Pertussis toxoids (less reaction), Cholera toxoid ;oral , against cholera exotoxin, which is the major pathogenic factor of cholera vibrios.

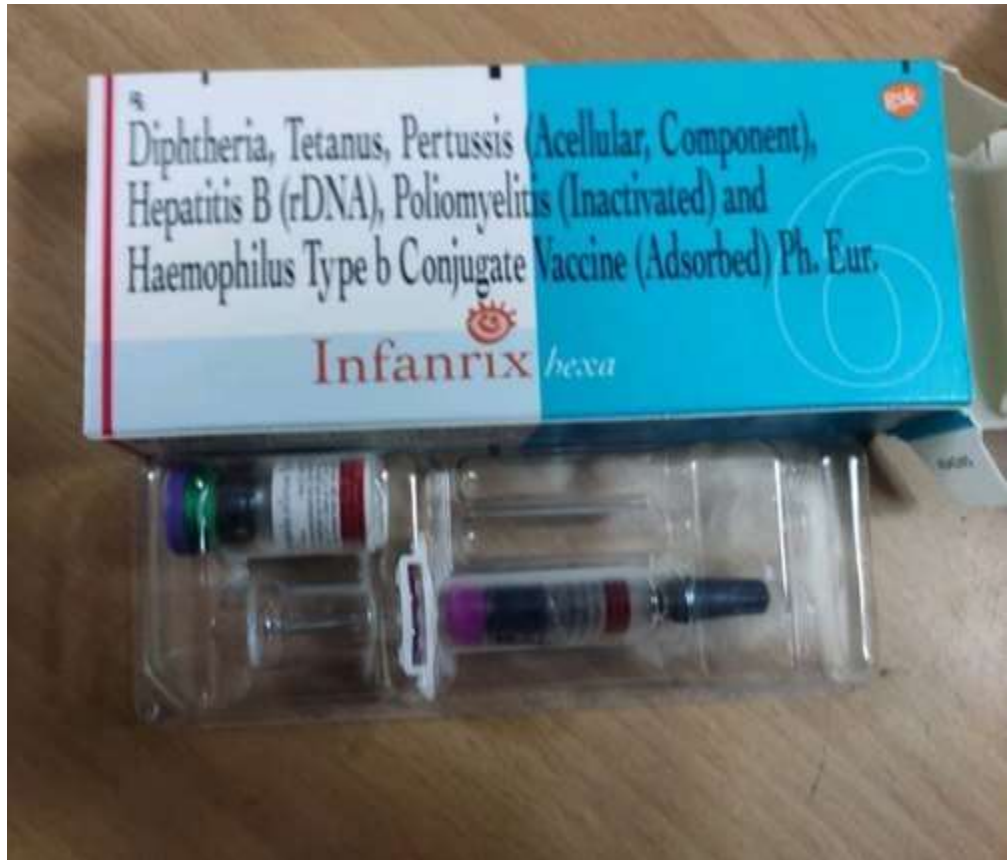
Toxoids can actually be considered killed or inactivated vaccines, but are sometimes given their own category to highlight that they contain an inactivated toxin, not an inactivated form of bacteria.

Combination Vaccines

Combination vaccines take two or more vaccines that could be given individually and put them into one shot.

Combination vaccines defines as “a product whose components can be equally divided into independently available routine vaccines.”

Some examples of combination
DPT
MMR
DT
DTaP-Hib-polio
DTaP-hepatitis B- IPV
DTP-HB-Hib –IPV



Advantages of combination vaccines

1. Fewer injections
2. Reduced trauma to the infant
3. Higher rates of compliance with complex vaccination schedules[3,4]
4. Better vaccine coverage[5]
5. Timely vaccination – vaccination schedule completed on time[5]
6. Reduced administration costs
7. Lower storage space requirements
8. Allows incorporation of new vaccines into immunization schedules[7]

SCHEDUALE of ACTIVE IMMUNIZATION in IRAQ (CHILDREN)

Age &dose	Vaccine
After birth(1st week	BCG, OPV (0 dose) , HBV-1 (within 24hr)
2 Months 1st dose	(الخماسي)[Panta -1] (DwPT+ Hib , HBV)& Rota virus & OPV-1+ Pneumococcal(PCV13-1)
4Months 2nd dose	Panta-2 [DwPT, Hib , HBV] , IPV-1 Rota virus-2 OPV-2+ Pneumococcal (PCV13-2)
6Months 3rd dose	[D wPT, Hib , HBV] . IPV-2, OPV-3 + Pneumococcal(PCV13-3)
9Months	Measles vaccine + vit A (100.000 IU)
12 Months	MMR
18 Months	[DwPT +Hib] الرباعيTetra (1st booster dose) MMR , OPV 1st booster , vit A (200.000IU)
4- 6 Years	DwPT الثلاثي (2ND booster dose), OPV, Vit A(200.000IU)

Protective period of full primary & booster immunization:

- short period of some months; cholera & plague vaccines which are protective for about 6M.
- 3- 5 years: DPT, Tetanus toxoids
- 5 or more years : BCG
- Solid, lifetime immunity: Measles, MMR, Mumps.

What are the factors determining effectiveness of active immunization prevention of a particular infectious disease in the community?

1-Vaccine or toxoids:

* Protective (immunologic) value.

* How handled since prepared until used, including the cold chain.

* For organisms characterized by frequent antigenic changes – influenza vaccine must be prepared from the prevailing organisms of outbreak or epidemic.

2-Process of immunization: requirements of primary & booster immunization, or revaccination, including doses, spacing & route of administration must be fulfilled.

3-Vaccination coverage: it is the percent of individuals of at risk group or population, who has been fully immunized. For satisfactory benefit of a given vaccine, coverage must be not less than 80- 85%.

Why an actively immunized individual may get disease when exposed to infection?

1-Causes related to the vaccine/ toxoids & process of immunization : inactivation of live attenuated vaccine used; not using updated vaccine of antigenic ally changing organisms, moderate protective value of vaccine

2- Host factors:

* **Unsatisfactory or impaired immune response .**

* **Serum antibody level at time of immunization; the higher the level, less immune response to active immunization & vice versa.**

Application of active immunization

- **Infants and children expanded immunization program EPI (schedule)**

- **Active immunization for adult females(MMR vaccine is given in adolescence girls, or rubella vaccine .Tetanus toxoid in pregnancy**

❑Vaccination for special occupations

- **Health care workers:** hepatitis B, influenza, MMR, polio
- **Public safety personnel** (police, fire fighters) **and staff of institutions for the developmentally disabled:** hepatitis B, influenza
- **Vets and animal handlers:** rabies, plague and anthrax
- **Sewage workers:** DT, hepatitis A, polio, TAB
- **Food handlers:** TAB
- **Military troops and camp dwellers:** pneumococcal, meningococcal, influenza, BCG (for non reactors), tetanus.

- **Vaccinations for special health status persons.**

✓ **Immuno-compromised persons (Leukemia, lymphoma, HIV, malignancy…)**

Hemodialysis and transplantation should receive the following vaccines according to their situation:
HBV, Influenza, Pneumococcal vaccines

- **Vaccinations in travel: Haj for instance necessities meningococcal vaccination from all over the world , TAB, YF from places like south Africa, and cholera from places like India.**

cold chain

The cold chain is a set of rules and procedures that ensure the proper storage and distribution of vaccines to health services from the national to the local level.
The cold chain is interconnected with refrigeration equipment that allows vaccines to be stored at recommended temperatures to maintain their potency.

What are the 3 main components of cold chain?

The cold chain has three main components:

- ✓ **Transport and storage equipment**
- ✓ **Trained personnel**
- ✓ **Efficient management procedures.**

All three elements must combine to ensure safe vaccine transport and storage

- **Maintaining the cold chain ensures that vaccines are transported and stored according to the manufacturer's recommended temp range +2C to +8C until point of administration**

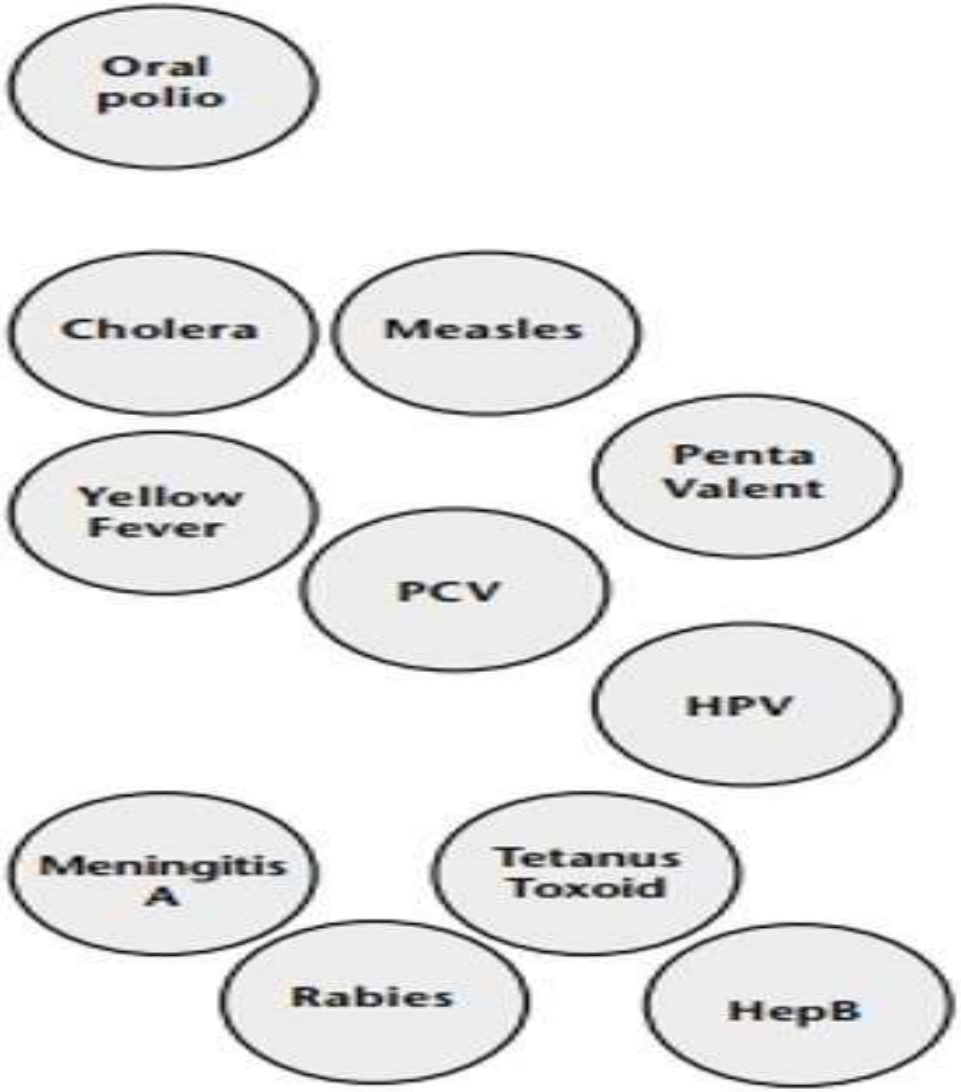
- **Polio vaccine is the most sensitive vaccine to heat.**
- **Vaccine sensitivity to freezing**
- **Most sensitive**

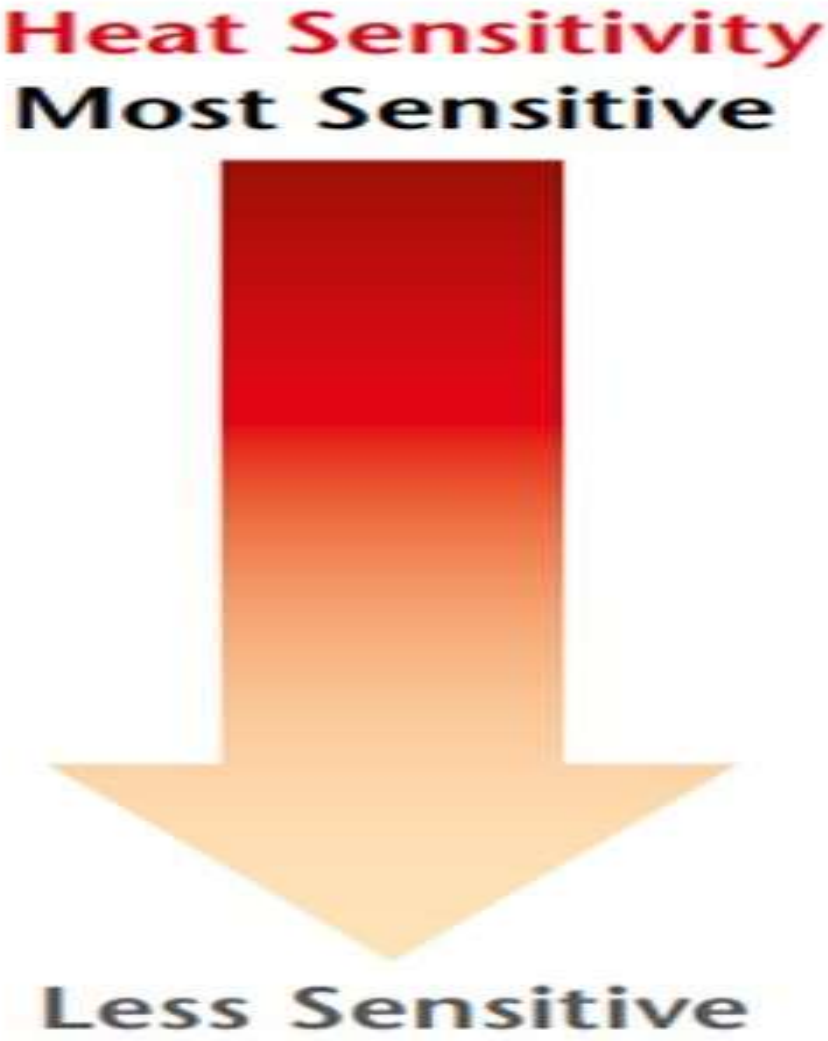
DTaP
DTaP-hepatitis B-Hib-IPV (hexavalent)

Hepatitis B

SENSITIVITY TO HEAT OF DIFFERENT TYPES OF VACCINES (SOURCE: PATH/WHO 2013[5])

Note: Individual vaccines of the same type but from different manufacturers can have different stabilities.





These vaccines are not damaged by freezing are:

Bacillus Calmette- Guérin(BCG)

Measles
Measles, mumps, rubella
Oral poliovirus
Rabies
Rotavirus
Rubella

Light Sensitive

Sensitive to strong light, sunlight, ultraviolet, fluorescents (neon)

{most sensitive}BCG

MMR

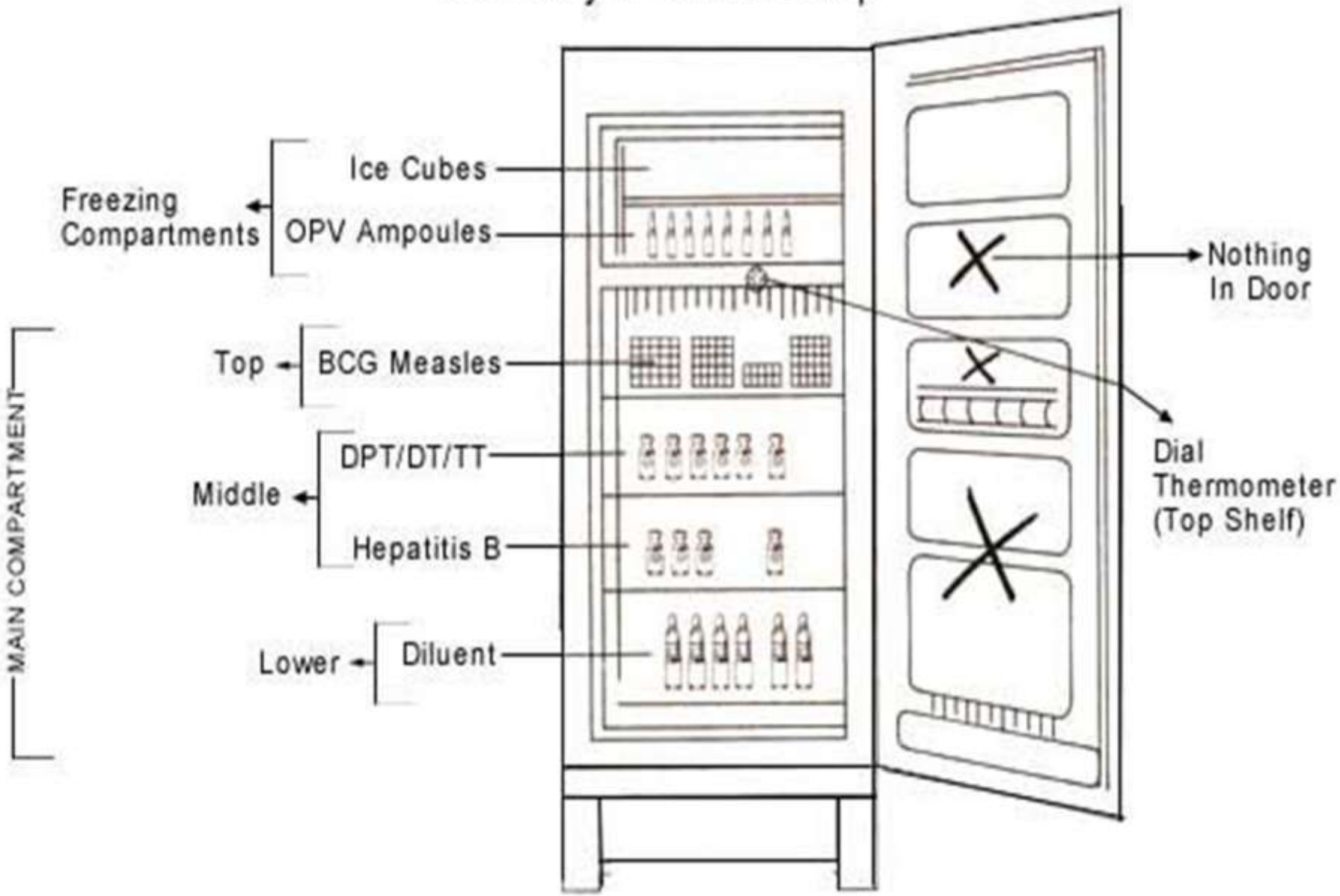
Varicella

Meningococcal C Conjugate

Most DTaP containing vaccines

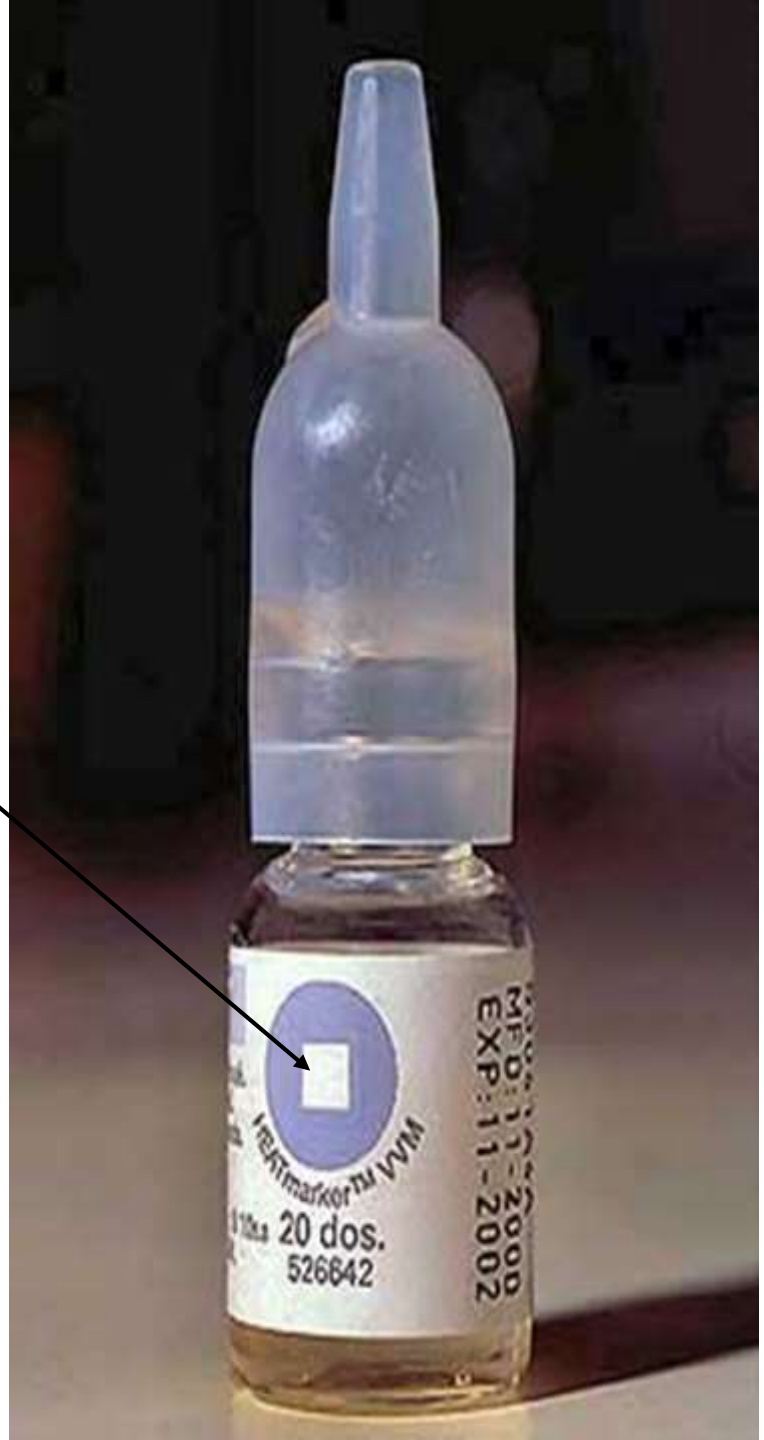
Vaccines should always be stored in their original packaging until point of use to protect them from light.

Refrigerator Showing vaccines Stored Correctly in Clinic Setup



Vaccine vial monitors

Every vial is shipped with a temperature-sensitive label, that health workers monitor during vaccination sessions.

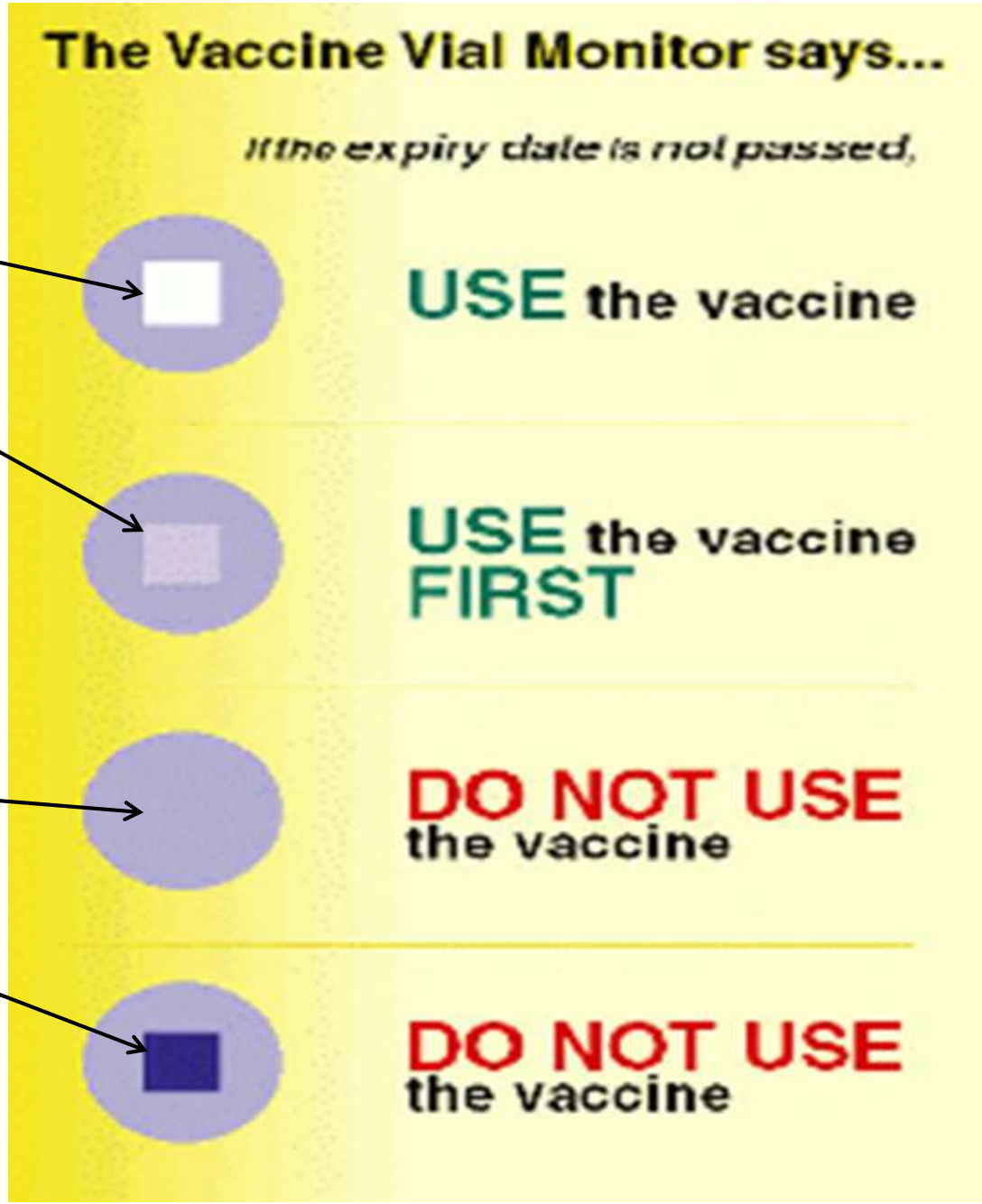


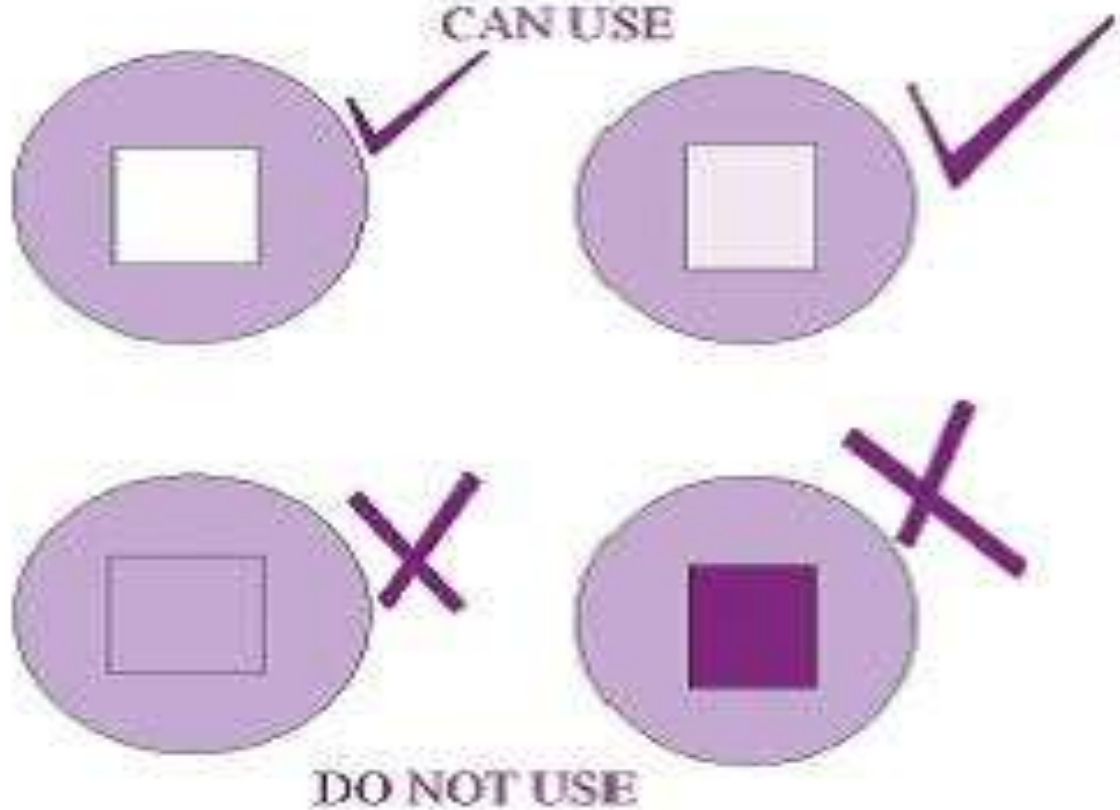
SAFE

If the inner square is lighter than the outer ring and the expiration date is valid, the vaccine is usable

SPOILED

If the inner square matches or is darker than the outer ring, the vaccine must be discarded.




CAN USE
DO NOT USE

THE SHAKE TEST

DPT, hepatitis B and tetanus toxoid vaccines can all be damaged by freezing. By shaking two vials, side-by-side, one that might have been frozen and one that has never been frozen, health workers can determine if a vaccine has spoiled.

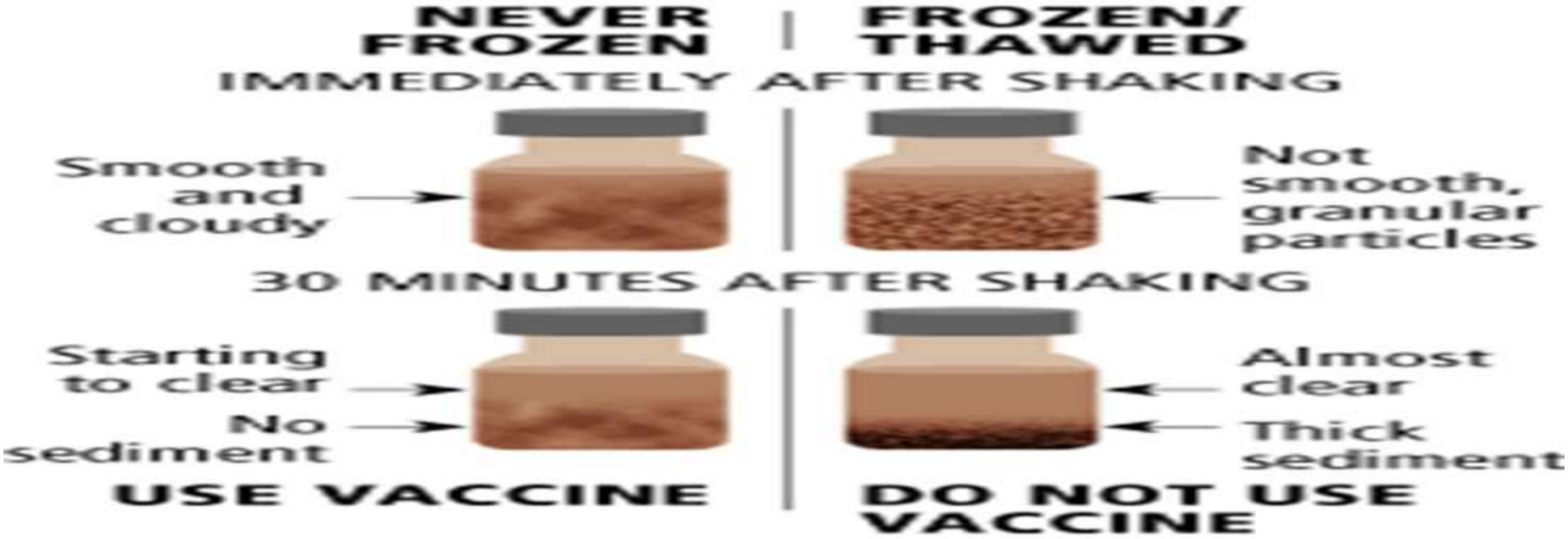


Fig. 4.10: Shake Test Passed - Vaccine usable

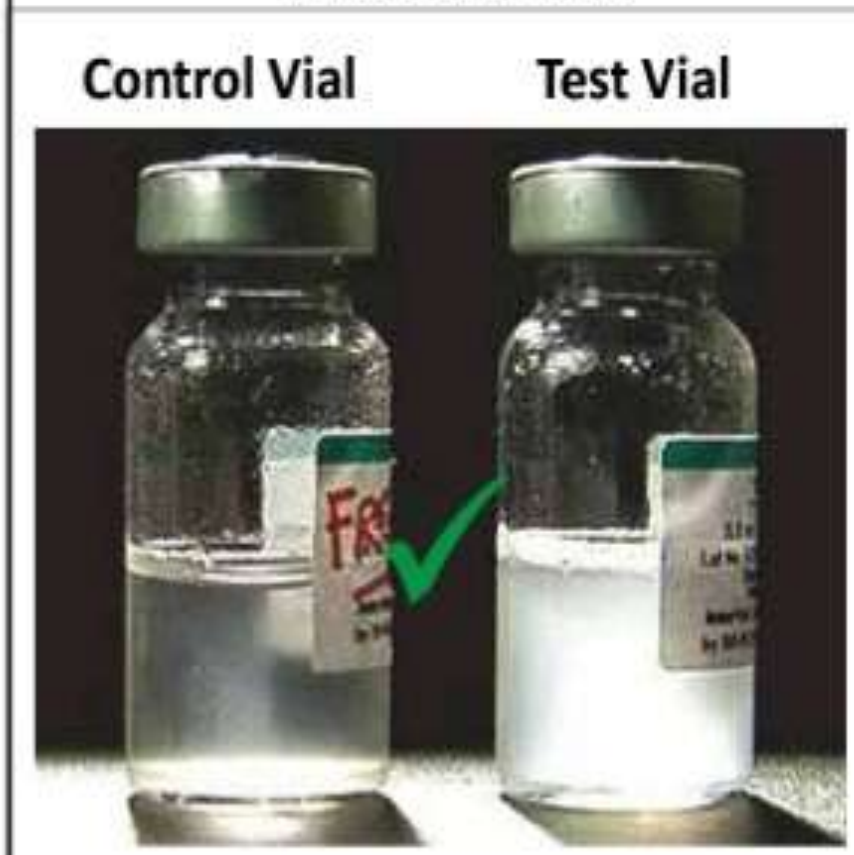
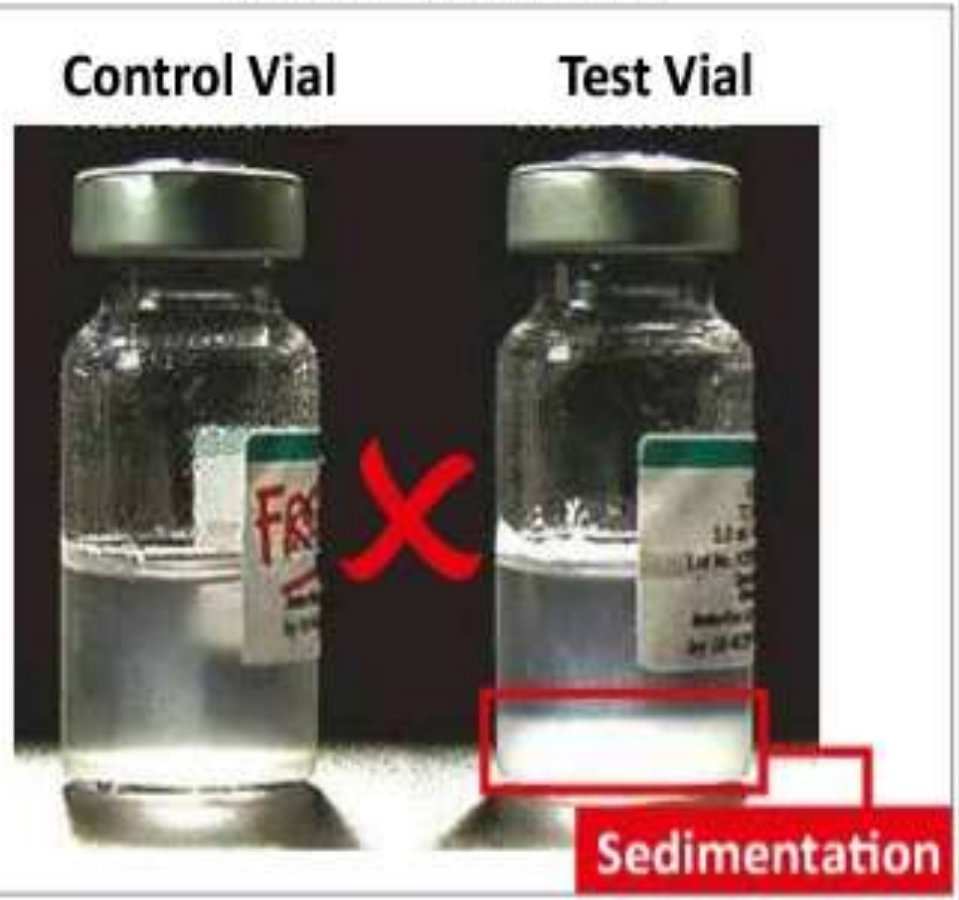


Fig. 4.11: Shake Test Failed - Do not use Vaccine



WHAT DAMAGES THE VACCINES?

1. Any defect in the cold chain.
2. Out date expiry.
3. Using skin antiseptic at the site of injection (e.g. BCG).
4. Using the reconstituted vaccine (MMR, measles, BCG) after the recommended period (6 hours).
5. Exposure of the vaccine to unacceptable temperature during the immunization session.
6. Exposure of the vaccine to direct sunlight.

ANY QUESTION?

References:

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