

# Principles of Communicable Diseases Epidemiology

**LECTURE - 4**

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## **The cold chain**

**It is the system of storage and transportation of the vaccine at low temperature (cold condition) from the manufacture till it is consumed.**

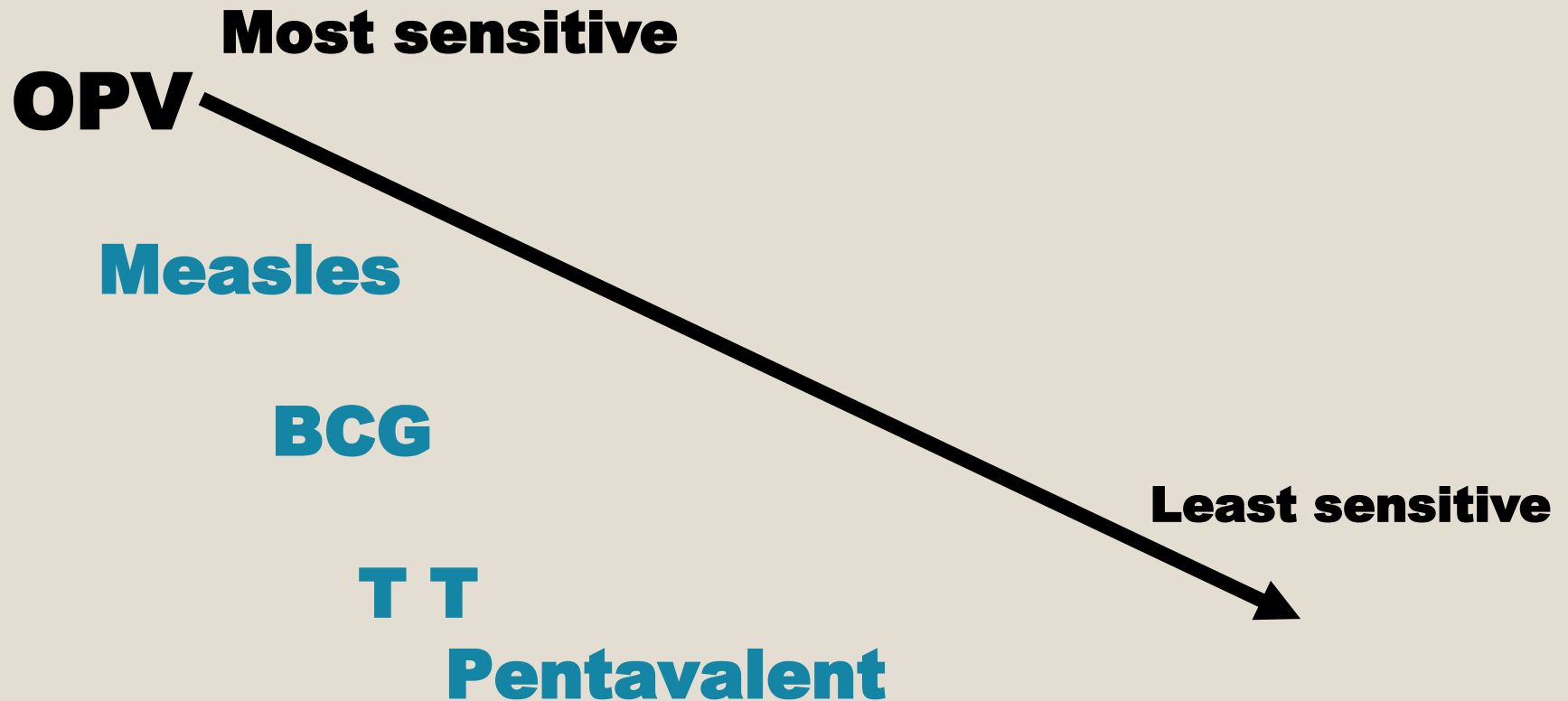
**System that ensures vaccine :**

- 1. Potency**
- 2. Quality**
- 3. Safety**

# Importance of cold chain

- **The cold chain is standard practice for vaccines throughout the pharmaceutical industry**
- **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.**
  - **Live attenuated vaccines are allowed to be frozen (OPV, Measles, MMR and BCG).**
  - **Inactivated vaccines must not be frozen ( DPT, DT, dT , TT and HB) .**

# Vaccines sensitive to heat



# **Vaccine sensitivity to freezing**

## **Freeze sensitivity**

### **Most sensitive vaccines**

**DTaP**

**DTaP-hepatitis B-Hib-IPV  
(hexavalent), Hepatitis B**

**Meningitis C (polysaccharide-protein conjugate)**

**Pneumococcal (polysaccharide-protein conjugate)**

### **Cautions:**

- Never expose these vaccines to zero or subzero temperatures.**
- Avoid the use of ice for transport.**

**These vaccines are not damaged by freezing.**

**Bacillus Calmette- Guérin**

**Measles, MMR, OPV, Rabies, Rotavirus, Rubella.**

## **Light Sensitive**

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

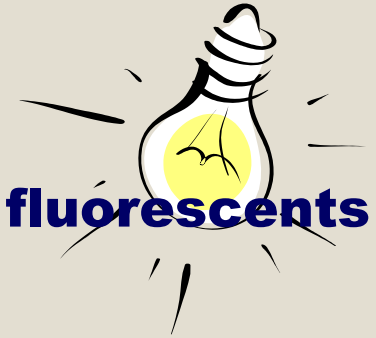
**BCG**

**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.**



# How long is the cold chain?

- ◆ **Manufacturer to airport; cold storage at airport**
- ◆ **Transport at the correct temperature from airport to storage in central, regional and district stores and in health centers**
- ◆ **Transported at the correct temperature to outreach sites**
- ◆ **Kept at correct temperature during immunization sessions**



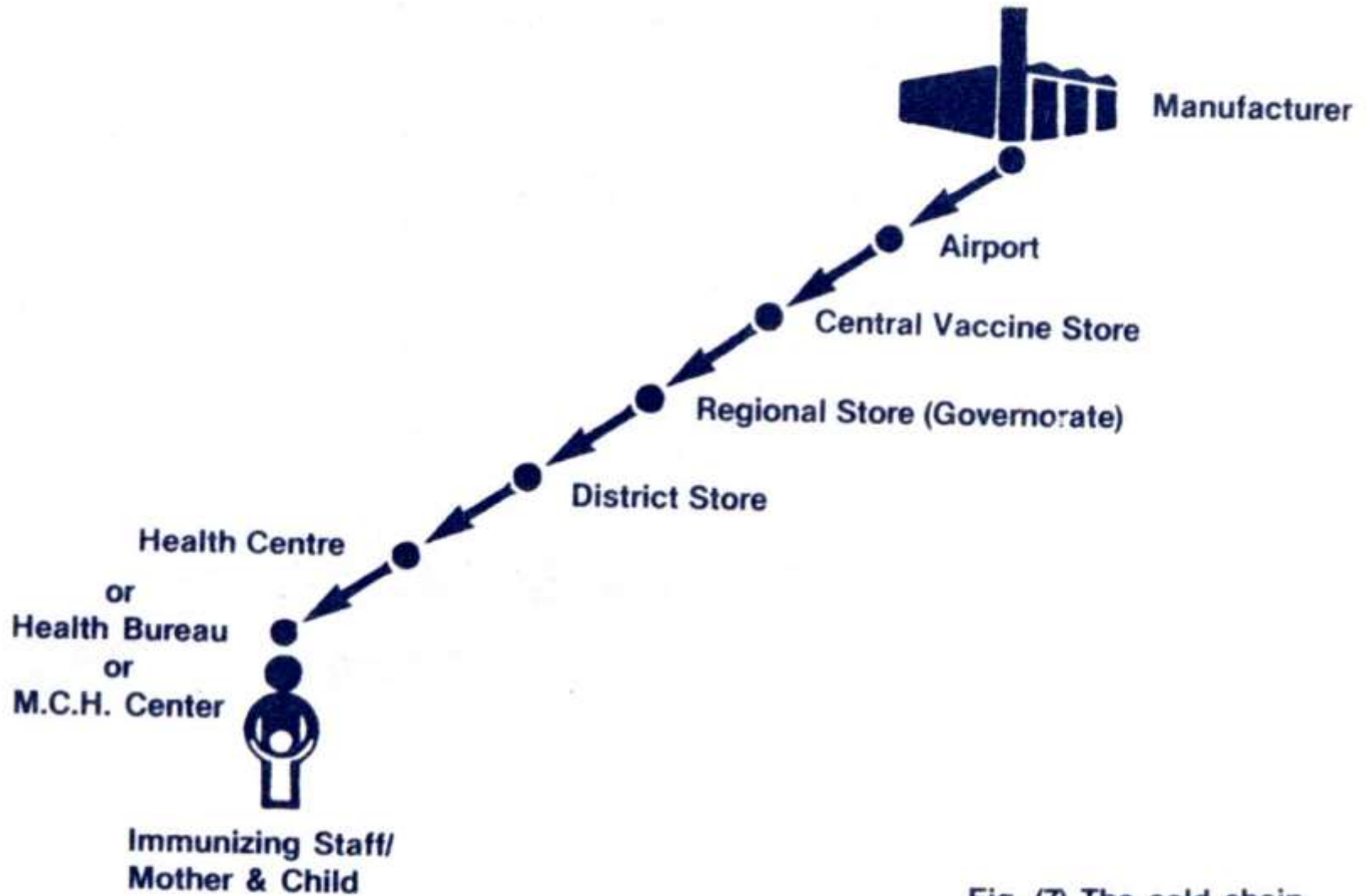


Fig. (7) The cold chain

## The administrative levels of cold chain according to the duration of the storage and the temperature required to keep the vaccine potent

<b>The administrative level</b>	<b>Storage period</b>	<b>Temperature</b>	<b>The vaccines</b>
<b>Central &amp; regional stores</b>	Maximum three months	- 20° to- 30°C	OPV, Measles, MMR,BCG
		+2° to +8°C	DPT, DT, dT, TT& HB,Hib
<b>Districts stores&amp; local immunization centers</b>	Maximum one month	0°C to+8°C	OPV, Measles, MMR, BCG
		+2° to +8°C	DPT, DT, dT, TT& HB,Hib

# The components of the cold chain

**The equipment and  
tools**

**The health staff**

**The procedures**

**What is the optimum Temperature of the  
refrigerator in the health center?**

**+2° C to +8°C**

Cold Chain Box

Cold Chain Bag

Vaccine



# Refrigeration equipment:

- **Refrigerator**

- **Cold boxes**

- **Vaccine carriers**

- **The ice packs retained in the freezer:**

- **To stabilize the temperature of the refrigerator at the optimum level.**

- **Fully frozen ice-packs are used for lining the vaccines carriers and the cold boxes during storing the vaccines**

# 1-The refrigerator :

- Placed in the coolest place of the health centers away from sunlight
- Well ventilated and adequate air circulation around it .
- Kept locked and open only when necessary.
- Defrosted regularly .
- Ice packs are kept in the freezer.
- Its temperature is recorded twice daily.
- Drugs, drinks or food must ***not be*** stored in the refrigerator.
- Both the monitor and thermometer are placed in the refrigerator.
- The temperature chart is stuck on the door outside the refrigerator.
- The diluents should be kept on the lowest shelf.



# Type of Vaccine Thermometer

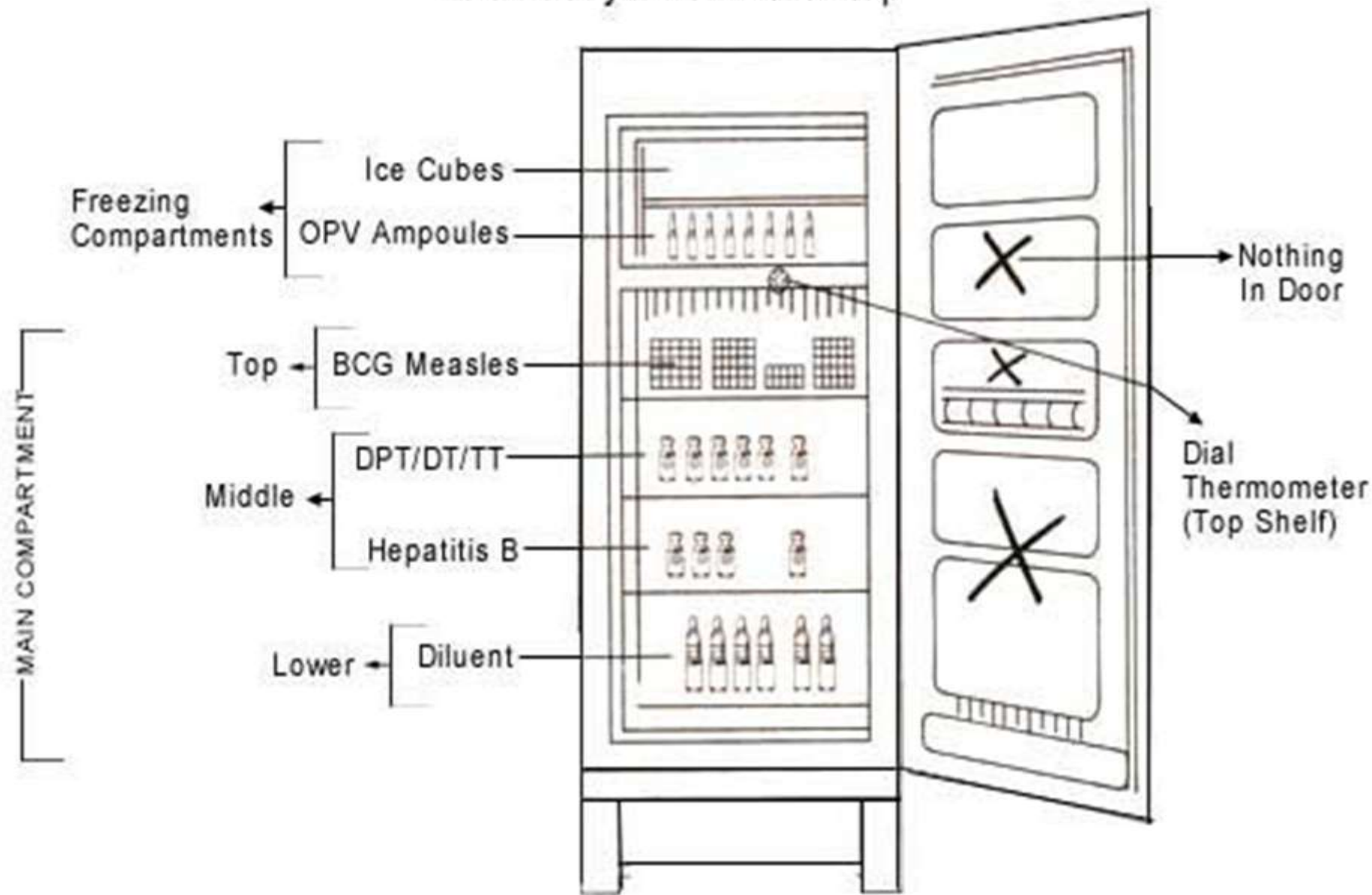
**Dial type Thermometer**



**Bar type Thermometer**



# Refrigerator Showing vaccines Stored Correctly in Clinic Setup





## **Tools for monitoring the cold chain:**

- 1- Cold Chain Monitor Card.**
- 2- Freeze Watch Indicator**
- 3- Cold Chain Refrigerator Graph**
- 4- Vaccine Vial Monitors**
- 5- Shake Test**

**Cold Chain Monitor Card:** is used to show cumulative exposure to Temp. above the safe range during storage & transportation .

It has an indicator that responds to two different Temps: the first part marked as **ABC**, responds to **Temp above +10°C**; the **2nd part** marked as **D** responds to **Temps. above +34°C**.

# Cold Chain Monitor (CCM)



## Vaccine Cold Chain Monitor

Date in	Index	Location	Date out	Index

**3M** INDEX/INDICE / دليل 10°C 34°C  
**MonitorMark™** Indicator  
**A B C D**

	If A all blue	If B all blue	If C all blue	If A & B & C & D all blue
Polio	Use within 3 months	<b>TEST VACCINE BEFORE USE</b> These vaccines may be used	Use within 3 months	
Measles & Yellow Fever	Use within 3 months			
DPT & BCG				
TT & DT & Hepatitis B				

**SUPPLIER  
FOURNISSEUR**

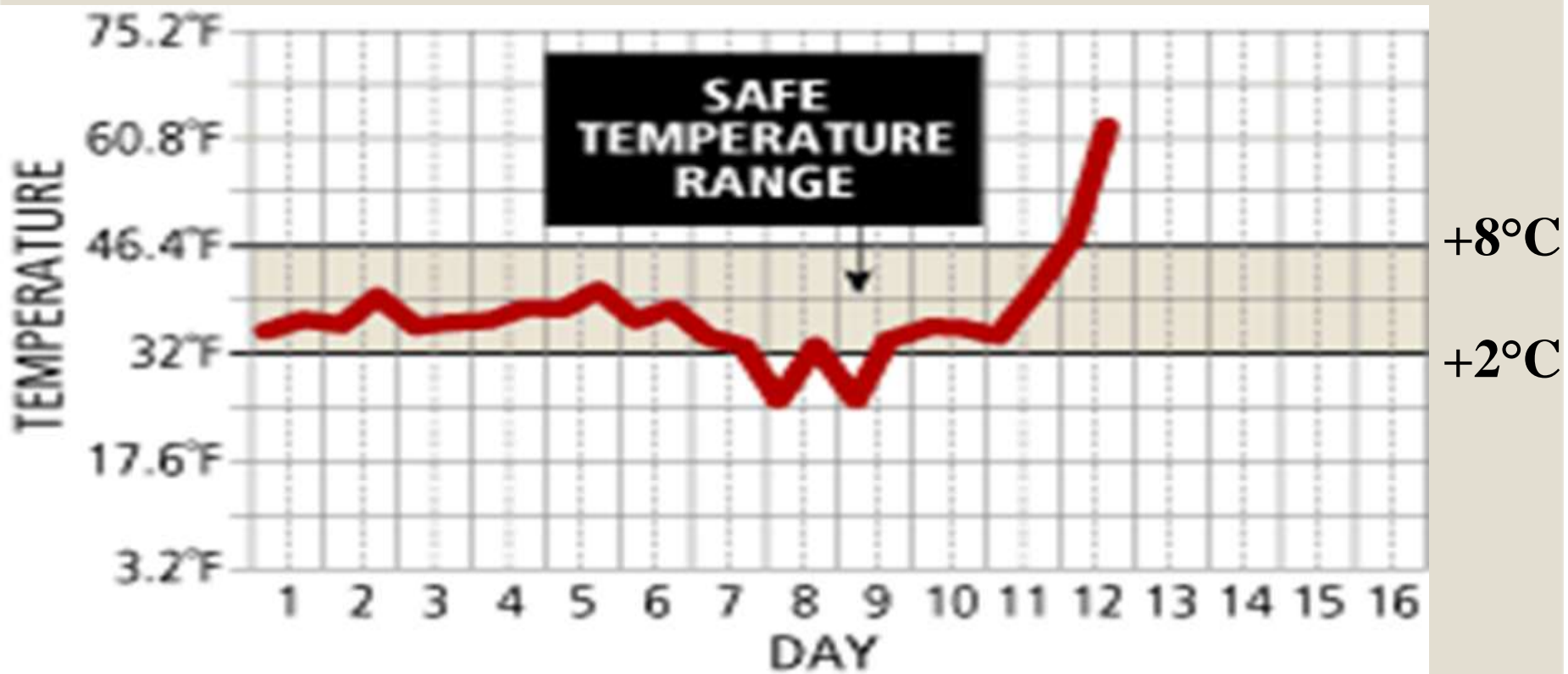
Name: \_\_\_\_\_  
 Nom: \_\_\_\_\_  
 Date of dispatch: \_\_\_\_\_  
 Date d'expédition: \_\_\_\_\_  
 Vaccine: \_\_\_\_\_  
 Vaccin: \_\_\_\_\_

## Cold Chain Refrigerator Graph

The vaccines are stored in refrigerators, they are monitored twice a day and readings are recorded on a chart to ensure a safe temperature is maintained.

Emergency provisions made.

Vaccines moved to cold storage for 48 hours.



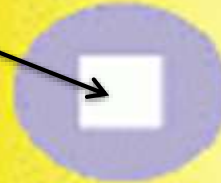
## **Vaccine vial monitors:**

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



## The Vaccine Vial Monitor says...

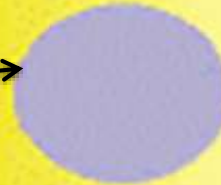
*If the expiry date is not passed,*



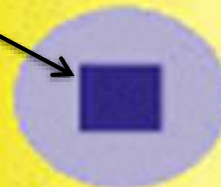
**USE** the vaccine



**USE** the vaccine  
**FIRST**



**DO NOT USE**  
the vaccine



**DO NOT USE**  
the vaccine

### **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.**

## 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.**



# **What damage 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.**

# HERD IMMUNITY




**Herd immunity (or community immunity) describes a form of immunity that occurs when the vaccination of a significant portion of a population (or herd) provides a measure of protection for individuals who have not developed immunity.**


**Herd immunity theory proposes that, in contagious diseases that are transmitted from individual to individual, chains of infection are likely to be disrupted when large numbers of a population are immune or less susceptible to the disease.**


**The greater the proportion of individuals who are resistant, the smaller the probability that a susceptible individual will come into contact with an infectious individual**

# WHY DOES MY CHOICE MATTER TO OTHERS?

It matters because of the concept of "herd immunity." Here's how it works:

 Not immunized  
but still healthy

 Immunized  
and healthy

 Not immunized,  
sick and contagious



When no one is  
immunized ...

... disease spreads through  
the population.



When some of the  
population is immunized ...

... disease spreads through  
some of the population.



When most of the  
population is immunized ...

... spread of the disease  
is constrained.



**Herd immunity can effectively stop the spread of disease in the community. It is particularly crucial for protecting people who cannot be vaccinated.**

**These include children who are too young to be vaccinated, people with immune system problems, and those who are too ill to receive vaccines (such as some cancer patients).**

## **Mechanism**

**Vaccination acts as a sort of firebreak or firewall in the spread of the disease, slowing or preventing further transmission of the disease to others.**

**Unvaccinated individuals are indirectly protected by vaccinated individuals, as the latter are less likely to contract and transmit the disease between infected and susceptible individuals.**

# Herd Immunity

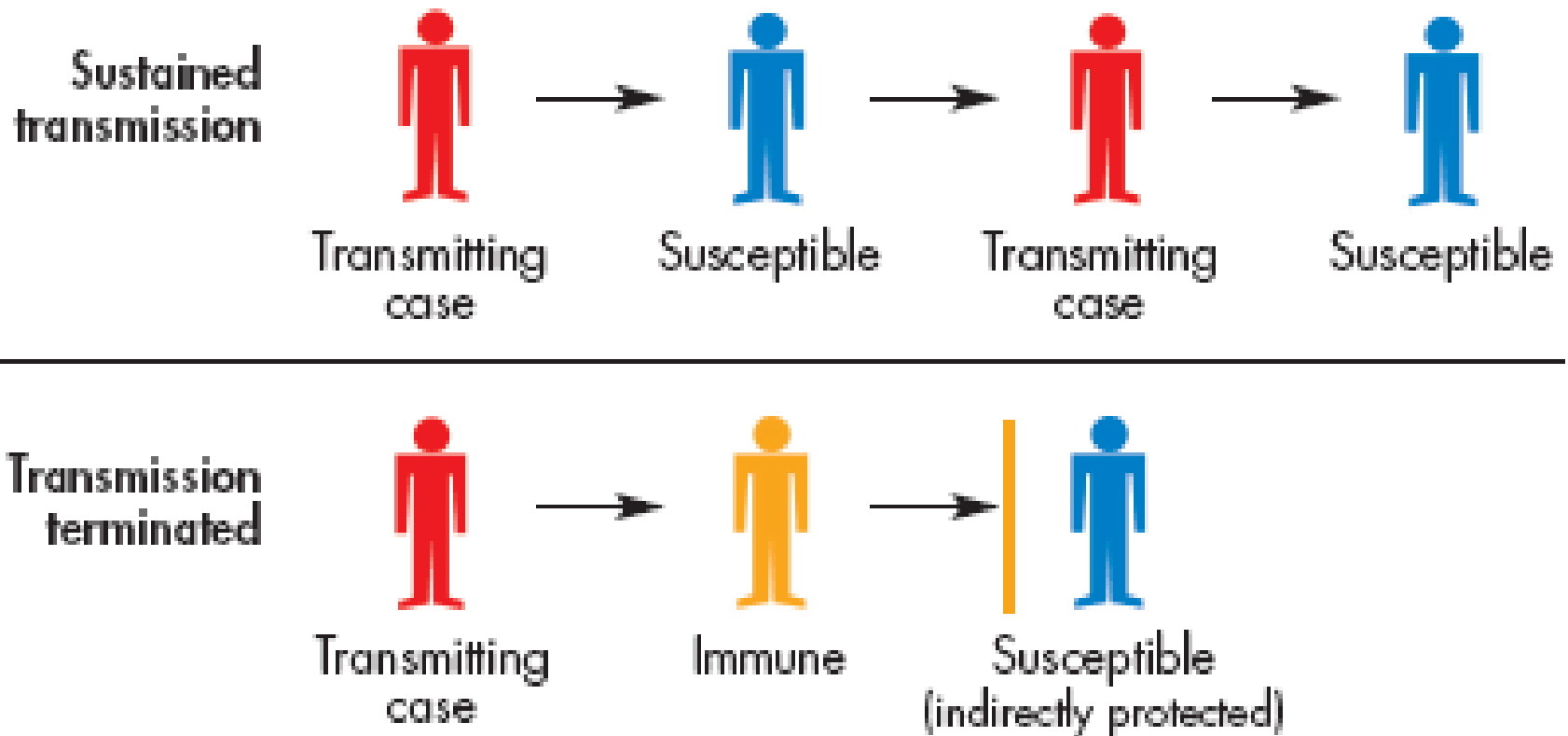
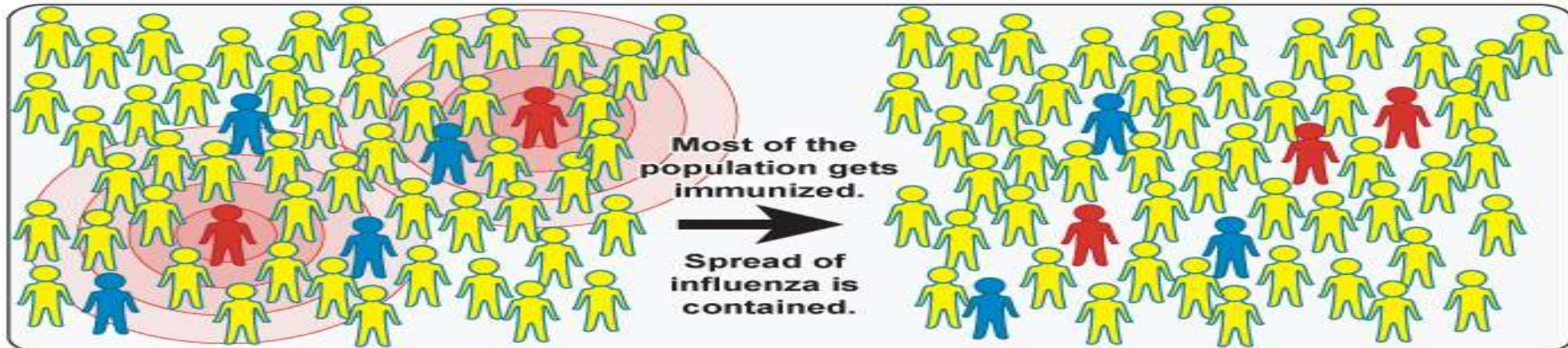
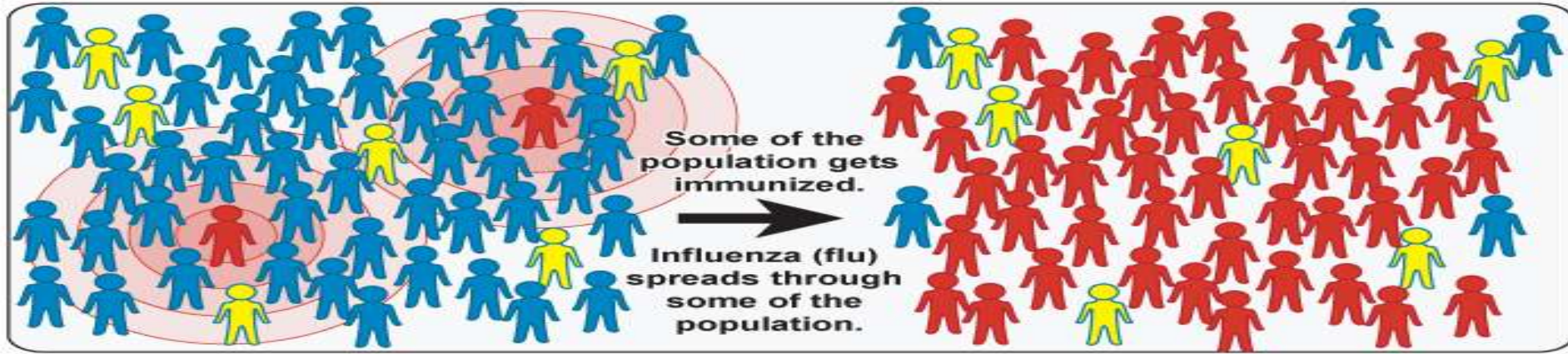
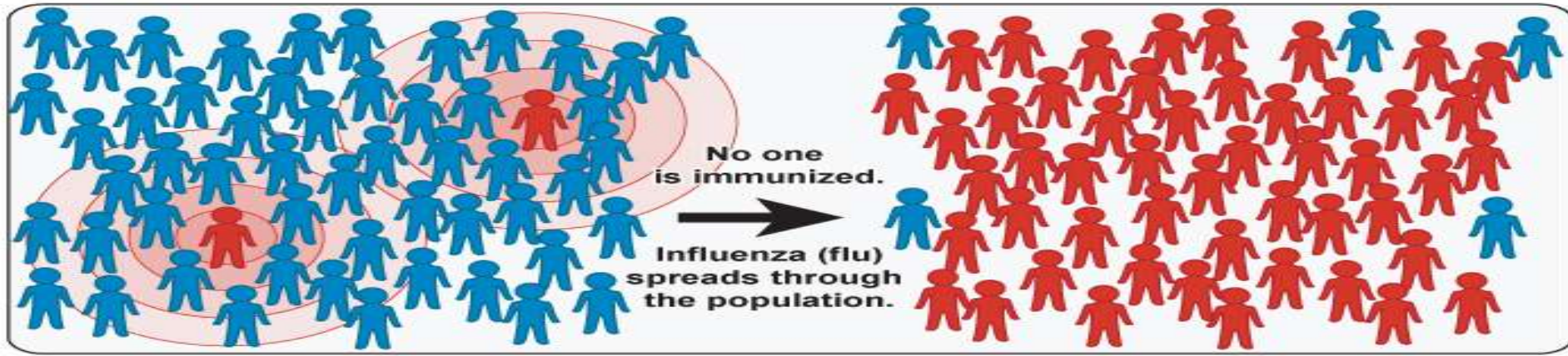


Figure – The principle underlying herd immunity is that the presence of enough immune persons in a community interrupts the transmission of an infectious agent, thereby providing indirect protection for unimmunized (or “susceptible”) persons.

 = not immunized but still healthy

 = immunized and healthy

 = not immunized, sick and contagious



**Herd immunity generally applies only to diseases that are contagious.**

**It does not apply to diseases such as tetanus (which is infectious, but is not contagious), where the vaccine protects only the vaccinated person from disease.**

**Nor does it apply to the IPV poliomyelitis vaccine that protects the individual from viremia and paralytic polio but does not prevent the fecal-oral spread of infection.**

**Herd immunity should not be confused with contact immunity, a related concept wherein a vaccinated individual can 'pass on' the vaccine to another individual through contact.**

## People who depend on herd immunity

**Some people in the community rely on herd immunity to protect them. These groups are particularly vulnerable to disease, but often cannot safely receive vaccines:**

- **People without a fully-working immune system, including those without a working spleen**
- **People on chemotherapy treatment whose immune system is weakened**
- **People with HIV**
- **Newborn babies who are too young to be vaccinated**
- **Elderly people**
- **Many of those who are very ill in hospital**

## **Elements which contribute to herd immunity**

**a- Occurrence of clinical and sub-clinical infection in the herd**

**b-immunization of the herd**

**c- herd structure. Herd structure is never constant.**

**It is subject to constant variation because of new births, deaths and population mobility. An on-going immunization programme will keep up the herd immunity at a very high level.**

**The herd structure includes not only the hosts (population) belonging to the herd species but also the presence and distribution of alternative animal hosts and possible insect vectors as well as those environmental and social factors that**



**favors or inhibit the spread of infection from host to host. The herd structure thus plays a critical role in the immunity status of the herd.**

**If the herd immunity is sufficiently high, the occurrence of an epidemic is regarded as highly unlikely.**

**Studies have shown that it is neither possible nor necessary to achieve 100 per cent herd immunity in a population to stop an epidemic or control disease, as for example eradication of Smallpox.**

**Just how much less than 100 per cent is required is a crucial question, for which no definite answer can be given.**

**Herd immunity may be determined by serological surveys.**

# PASSIVE IMMUNIZATION

**(SEROPROPHYLAXIS)**

**Passive immunization needed for rapid, but temporary protection of susceptible, either after exposure to infection or before expected exposure (occasionally). The duration of immunity induced is short and variable (1-6 weeks). Passive immunization has a limited value in the mass control of disease, it is recommended for non-immune persons under special circumstances.**

**Three types of preparations are available for passive immunity**

**A- normal human immunoglobulin**

**B- specific [hyper immune] human immunoglobulin**

**C- antisera or antitoxins**

## **APPLICATION OF IMMUNOGLOBULIN:**

**1-After exposure ; associated with either**

- \* Sero prevention ; when given early in incubation period**
- \* Sero attenuation ; when given later in incubation period.**
- \* Not effective; if given late in incubation.**

**2-Before expected exposure; travelers from free to endemic areas can be given seroprophylaxis for expected infection; hepatitis A.**

**Specific immunoglobulin's are available for seroprophylaxis; antiviral (mumps, hepatitis A,B, measles, rubella, rabies. antitoxic (diphtheria & tetanus), and antipertussis (for exposed susceptible infants).**

**Serotherapy:** tetanus ,diphtheria and rabies have specific antitoxin immunoglobulin that can be used for both prophylaxis & therapy in bigger doses. But there is no antiviral Serotherapy.