Principles of Immunization

- Understand the types of acquired immunity
- Differentiate between the different types of vaccines used in preventing illness
- Understand the type of vaccine, its mode of delivery, and schedule for important immunizable diseases; TB, Pertussis, Rubella, Diphtheria, Measles, Tetanus, Hepatitis, Meningitis, Rabies, Polio
- Define and understand the cold chain and its importance
- List the vaccines in the current National compulsory vaccination schedule

For each disease, briefly describe epidemiology and mode of transmission To identify the type of vaccine (live vs. inactivated), and route of administration

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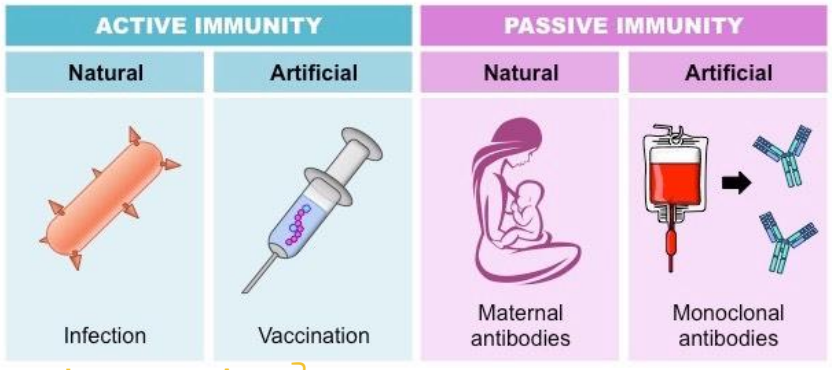
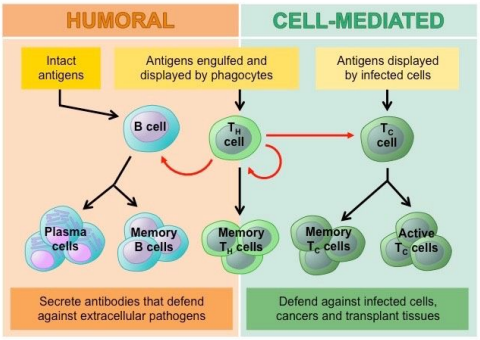
- Important
- Extra

Immunity

Types of Immunity [1]:

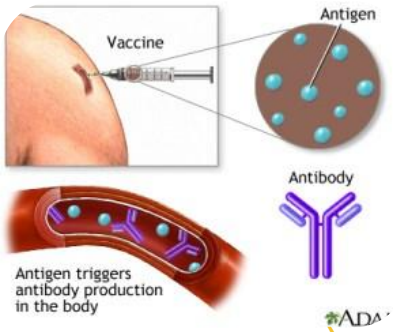


Types of **Active** Immunity [2]:



Advantages of active immunity compared to passive immunity [3]:

- Long-lasting protection
- Severe reactions are rare
- Higher protective efficacy
- Less expensive



Herd immunity (Community immunity):

- When vaccination [4] of a portion of population (or herd) provides protection to unprotected individuals. How?
  - Because it'll lessen the disease prevalence, which decreases the likelihood of getting infected
- Higher number of immune individuals, the lower likelihood that a susceptible person will come in contact with an infectious agent.
- Provides an immunological barrier to the spread of disease in the human herd.
- On-going immunization programme will keep the herd immunity at a very high level. E.g. during hajj

1- In active immunity, we introduce the antigen whether naturally (by getting infected) or artificially (by vaccination) to allow our immunity to identify the pathogen and build up memory cells for future infections.
2- Humoral immunity depends on identifying a pathogenic antigen and forming antibodies against it. For cell mediated immunity, it depends on the activation of phagocytes and other cytotoxic cells through T cells.
3- Passive immunity is the process of giving ready made antibodies whether naturally (mother to child through the placenta and breast milk) or artificially.
4- Herd immunity doesn't only include getting vaccinated. It can also include getting infected and developing natural active immunity.

Types of Used Vaccines

- **Vaccine** is an immuno-biological substance designed to produce specific protection against a given disease. It stimulates the production of protective antibody and other immune mechanisms. Vaccines may be prepared from live modified organisms, inactivated or killed organisms, extracted cellular fractions, toxoids or combination of these.

01 Live, attenuated vaccines

- Contain a version of the **living** [1] virus or bacteria that has been weakened
- It **does not cause serious disease** [2] in people with healthy immune systems.

Contraindication:

- immunocompromised persons (leukaemia, lymphoma or cancer)
- Persons with immune deficiency disease.
- Pregnancy

Example:

Viral		Bacterial
○ Measles, mumps, rubella ○ Zoster ○ Varicella ○ Yellow fever	○ Rotavirus ○ Influenza ○ **Oral polio** (I.M. polio is killed)	○ Bacille Calmette-Guérin (**BCG**) ○ Oral typhoid vaccine.

02 Inactivated vaccines (killed) less potency that live

- Produced by growing the bacterium or virus in culture media, then **inactivating** [3] it with heat and/ or chemicals (usually **formalin**).
- Not alive and **cannot replicate** [4].
- Cannot cause disease from infection, even in an immunodeficient person.
- Always require **multiple doses**.
- In general, the first dose "primes" the immune system. (also called primary response)
- A protective immune response develops after the second or third dose (boosters)

Contraindication:

- Severe local or general reaction to a previous dose.

Example:

- Polio (injectable NOT oral), Hepatitis A, Rabies
- Pertussis, Typhoid, Cholera, Plague

1- It is weakened by chemicals.
2- Produces signs and symptoms of the disease that are minimal and not dangerous. It also produces high potency of immune response against the disease.
3- This causes changes in the structure of the organism that kills it, but the pathogenic antigens are still there and an immune response can still occur.
4- Inactivated vaccines are safe for immunocompromised patients.

Types of Used Vaccines

03 Polysaccharide Vaccines (based on the preparation method)

Type of inactivated subunit vaccine composed of long chains of sugar molecules

Pure polysaccharide

The immune response to a pure polysaccharide vaccine is typically T-cell independent, which means that these vaccines are able to stimulate B cells without the assistance of T-helper cells.

Example: available for three diseases: pneumococcal disease, meningococcal disease, and Salmonella Typhi. (all of them are protected by a polysaccharide capsule)

Conjugated polysaccharide

Which are polysaccharides chemically combined with a protein molecule.

Example: Haemophilus influenzae type b (Hib)

04 Recombinant Vaccines

- Vaccine antigens may also be produced by **genetic engineering technology**.
- Four genetically engineered vaccines are currently available:
  - Hepatitis B
  - human papillomavirus (HPV)
  - Live typhoid vaccine (Ty21a)
  - Live attenuated influenza

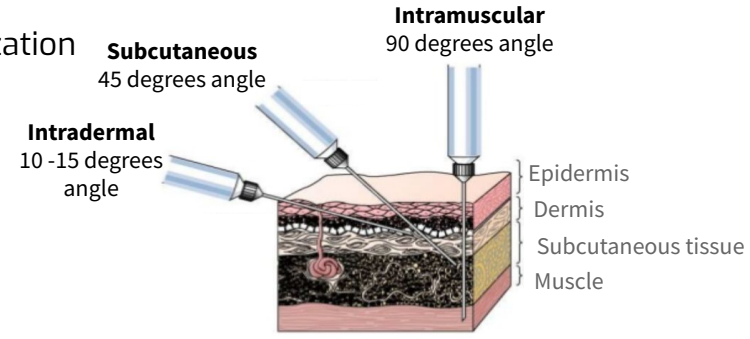
Combinations Vaccines

- If **more than one** kind of immunizing agent is included in the vaccine it is called a mixed or combined vaccine
- **The Aims of combined vaccines are to:**
  - Simplify administration
  - Reduce costs
  - Minimize the number of contacts of the patient with the health system
  - Reducing the storage cost
- Usually **does not increase the risk** [1] of adverse reactions
- **Example:**
  - DPT (Diphtheria-pertussis-tetanus)
  - MMR (Measles, mumps and rubella)
  - DPTP (DPT plus inactivated polio)
  - DPT-Hep B-Hib [2] (Diphtheria, pertussis, tetanus, hepatitis B & haemophilus influenza type B)

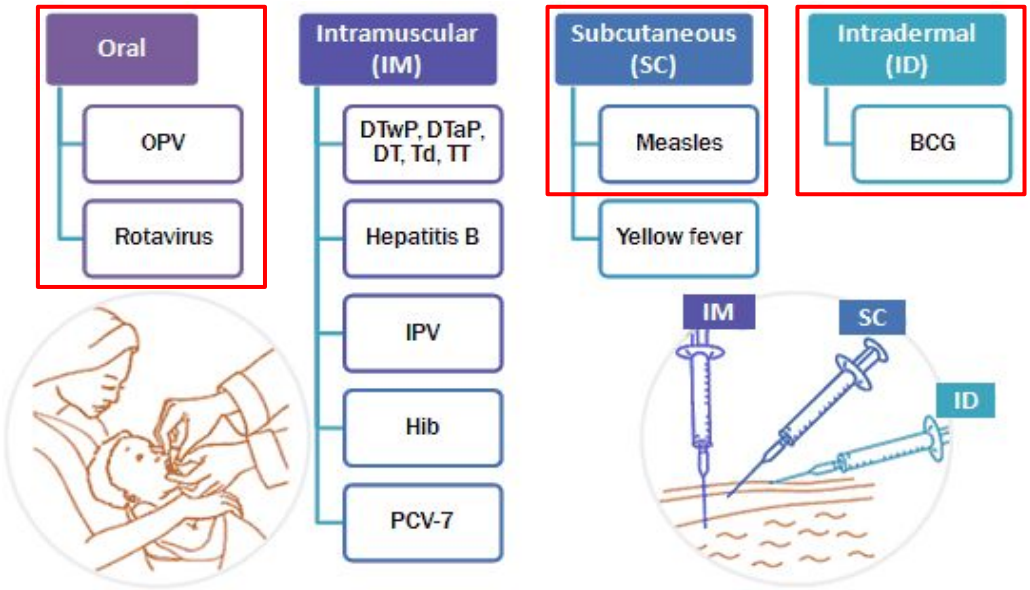
1- You can assure the patient that combined vaccines don't increase the risk for adverse reactions neither do they carry a decrease in efficacy nor potency
2- Pentavalent vaccine

Routes of Vaccines Administration

- **The route of administration** [1] is the path by which a vaccine is brought into contact with the body.
- This is a critical factor for success of the immunization
- Routes:
  - Intramuscular route [2]
  - Subcutaneous route
  - Intradermal route [3]
  - Oral route [4]



Route of Administration			
Intramuscular injection	Subcutaneous injection	Intradermal injection	Oral administration
Administers the vaccine into the muscle mass. Vaccines containing adjuvants [5] should be injected IM to reduce adverse local effects	Administers the vaccine into the subcutaneous layer above the muscle and below the skin	· Administers the vaccine in the topmost layer of the skin. · **BCG is the only vaccine with this route** of administration. · Intradermal injection of BCG vaccine reduces the risk of **neurovascular injury**	Oral administration of vaccine makes immunization easier by eliminating the need for a needle and syringe.



1- We never give vaccines IV
2- It is the most common route of administration. In adults, shots are usually given through the deltoid muscle while in children it's more common to be given in the thigh
3- Only BCG, because it can injure the nerves
4-Mainly polio and rotavirus
5- Sometimes a substance is added to a vaccine to enhance the immune response by degree and/or duration, making it possible to reduce the amount of immunogen per dose or the total number of doses needed to achieve immunity. The commonly used adjuvant are aluminium salts

Types of Vaccines Vials

Single-Dose Vials [1]

- A single-dose vial (SDV) contains **one** dose and should be used **one** time for **one** patient.
- SDVs do not contain preservatives to help prevent microorganism growth.

Multidose Vials [2]

- A multidose vial (MDV) contains **more than one dose of vaccine**.
- MDVs typically **contain a preservative** to help prevent the growth of microorganisms, they can be entered or punctured more than once.
- Only the number of doses indicated in the manufacturer's package insert should be withdrawn from the vial.
- **After the maximum number of doses have been withdrawn, the vial should be discarded**, even if there is residual vaccine or the expiration date has not been

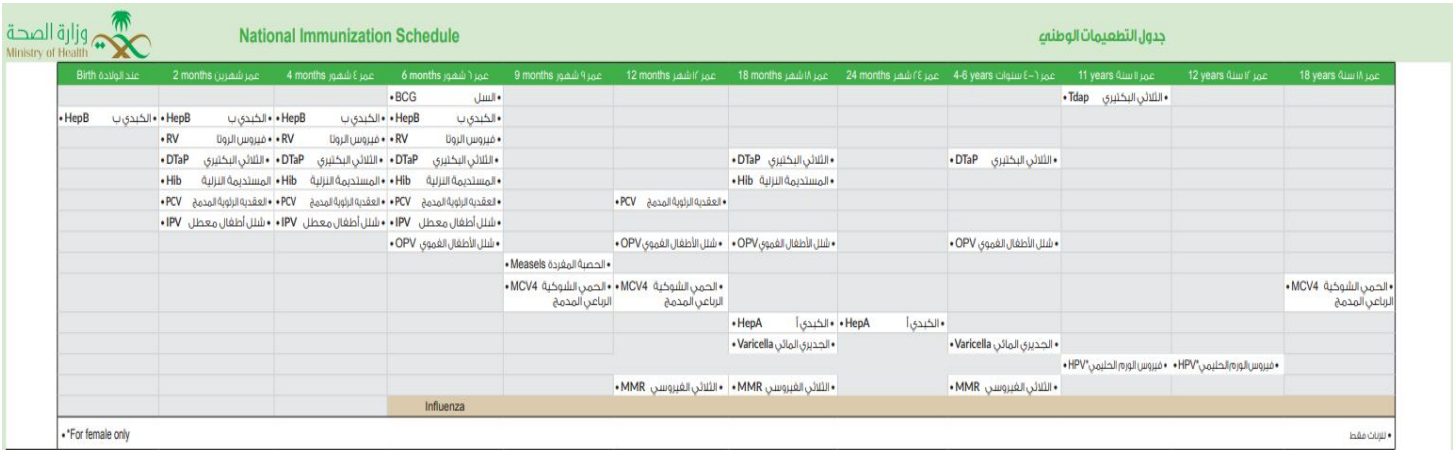
Manufacturer-Filled Syringes

- A manufacturer-filled syringe (MFS) is prepared and sealed under sterile conditions by the manufacturer.
- Activate an MFS (i.e., remove the syringe cap or attach the needle) only when ready to use.
- An MFS does not contain a preservative to help prevent the growth of microorganisms.
- Once the sterile seal has been broken, the vaccine should be used or discarded **by the end of the workday**.

Immunization Schedules

- Each country determines its own immunization schedule and chooses vaccine presentations.
- Health workers should always refer to their national schedules and vaccine handling instructions when providing immunization services.

National Immunization Schedule [3]



1- Whenever we open it we need to discard it by the end of the day
2- Can be used for multiple people
3- I**t is very important to memorize every vaccine and when should it be given for both MCQs and OSCEs**. This immunization schedule was updated this year. Changes include postponing BCG vaccine till the 6th month to avoid serious rxns in immunodeficient infants. They also added new vaccines from the age of 11 and onward.

Vaccines

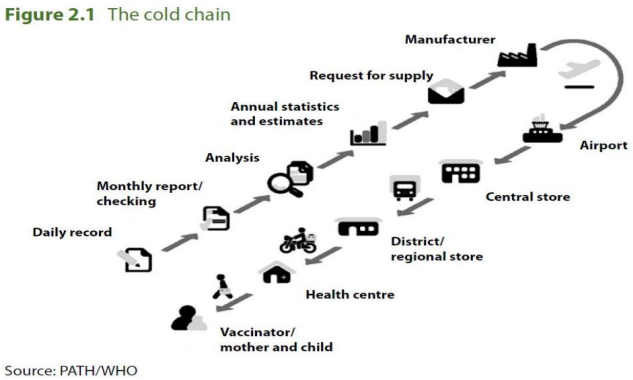
Disease	Vaccine	Dose/Route of administration	Timing	Side effects
Tuberculosis	Bacille Calmette-Guérin (BCG)	0.05 ml Intradermal	At 6 months	**Severe**: generalized disease or infections such as osteomyelitis (bone infection); abscess; regional lymphadenitis (lymph node inflammation) **Mild**: injection site reactions & fever
Hepatitis B	**Monovalent (HepB)** **Pentavalent:** with Diphtheria, tetanus, pertussis, and Haemophilus influenzae type b **Quadrivalent:** DTP+HepB	0.5 ml Intramuscularly	At birth 2, 4, 6 months	**Severe**: rare anaphylaxis **Mild**: injection site reactions (pain, redness, swelling); headache; fever
Diphtheria	(DT/ dT) with tetanus (DTP) with tetanus and pertussis **Pentavalent**: with tetanus, pertussis, hepatitis B and Haemophilus influenzae type b	0.5 ml Intramuscularly	2, 4, 6, 18 months and 4- 6 years	Severe adverse events due to diphtheria toxoid alone have not been reported **Mild**: injection site reactions, fever
Pertussis	**Trivalent** (DTP) with tetanus and diphtheria **Pentavalent**: with tetanus, diphtheria, hepatitis B and Haemophilus influenzae type b	0.5 ml Intramuscularly	2, 4, 6, 18 months and 4- 6 years	**Severe**: rare anaphylaxis, hypotonic–hyporesponsive episodes (loss of muscle tone & responsiveness/ consciousness); febrile seizures; prolonged crying. **Mild**: injection site reactions (pain, redness, swelling); fever and agitation
Tetanus Recommended during pregnancy	**Monovalent** (TT) **Divalent** (DT/ dT) with diphtheria **Trivalent** (DTP) **Pentavalent**: with diphtheria, pertussis, hepatitis B and Haemophilus influenzae type b	0.5 ml Intramuscularly	2, 4, 6, 18 months and 4- 6 years	**Severe**: rare anaphylaxis, brachial neuritis **Mild**: injection site reactions and fever
Haemophilus influenzae type b (Hib)	Monovalent Hib **Pentavalent:** with diphtheria, tetanus, pertussis and hepatitis B	0.5 ml Intramuscularly	2, 4, 6, 18 months	**Severe**: none reported to date **Mild**: injection site reactions, fever
Measles	**Monovalent** Measles only (M) **Divalent** with rubella (MR) **Trivalent** with mumps/ rubella (MM, MMR) **Quadrivalent** with varicella (MMRV)	0.5 ml Subcutaneous	9, 12, 18 months and 4-6 years	**Severe**: thrombocytopenia, anaphylaxis, encephalitis **Mild**: fever, rash 5–12 days following administration
Mumps Contradicted during pregnancy	**(MMR)**	0.5 ml Subcutaneous	12, 18 months and 4-6 years	**Serious**: aseptic meningitis (with some strains); orchitis (inflammation of the testicles); sensorineural deafness; acute myositis **Mild**: injection site reactions; parotid swelling

Disease	Vaccine	Dose/Route of administration	Timing	Side effects
Rubella	(MR)→with Measles (MMR) →with mumps/measles	0.5 ml Subcutaneous	12, 18 months and 4-6 years	**Mild**: injection site reactions
Meningococcal disease	**Quadrivalent** Meningococcal conjugate (A,C,W135,Y-D)	0.5 ml Subcutaneous	9 and 12 Months	**Severe**: rare anaphylaxis **Mild**: injection site reaction, fever
Pneumococcal disease	PCVs	0.5 ml Intramuscular	2, 4, 6 and 12 months	**Severe**: none known **Mild**: injection site reactions and fever
Poliomyelitis	OPV/ IPV	OPV→2 drops orally IPV→ 0.5 ml intramuscularly	2, 4, 6, 12,18 months and 4-6 years	**OPV** – Rare vaccine associated paralytic polio (VAPP) **IPV** – No known serious reactions; mild injection site reactions do occur
Rotavirus gastroenteritis	RV→Monovalent RV,Rotarix	1.5 ml of liquid Oral	2 and 4 months	**Severe**: intussusception **Mild**: irritability, runny nose, ear infection, diarrhoea, vomiting

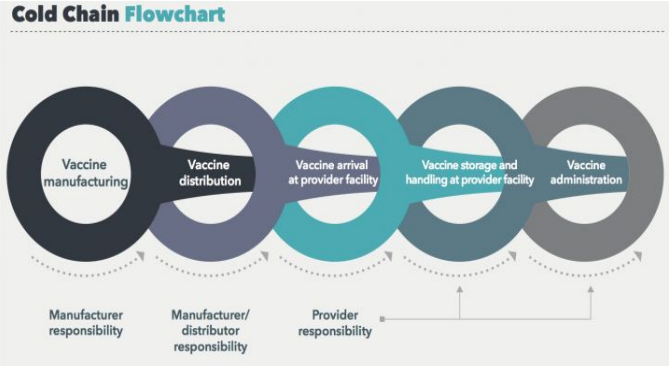
Vaccines Safety and Efficacy

- **Vaccine storage and handling**
- Vaccine administration (considered a medical error)
- Timing and spacing of vaccine
- Observation of precautions and contraindications (needs to be reported)
- Management of suspected side effects (life support equipments must be there)
- Reporting of suspected side effects (need to be reported)
- Communication about vaccine benefits and risks

Proper storage and handling begin with an effective **vaccine cold chain** [2]



Stored in refrigerator

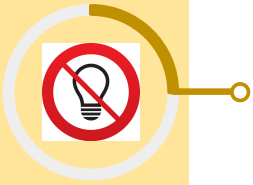


1- In general all vaccines must be stored under the conditions recommended by the manufacturer in the literature accompanying the vaccine, otherwise they may become denatured and totally ineffective. Vaccines must be protected from sunlight and prevented from contact with antiseptics.
2- The "cold chain" is a system of storage and transport of vaccines at low temperature from the manufacturer to the actual vaccination site. The cold chain system is necessary because vaccine failure may occur due to failure to store and transport under strict temperature controls. This is of concern in view of the fairly frequent reports of vaccine preventable disease occurrence in populations thought to have been well immunized. In other words - the success of national immunization programme is highly dependant on supply chain system for delivery of vaccines and equipment, with a functional system.

Cold Chain

- A **temperature-controlled** supply chain that includes all vaccine- related equipment and procedures.
- It begins with the **cold storage unit** at the manufacturing plant, extends to the transport and delivery of the vaccine and correct storage at the provider facility (clinic), and ends with administration of the vaccine to the patient.

- Vaccines are **sensitive biological products**. Some vaccines are sensitive to freezing, some to heat and others to light. If not maintained, **vaccine potency may be lost**, resulting in a useless vaccine supply.
- **Potency is reduced** every time a vaccine is exposed to an improper condition. (This includes overexposure to heat [1], cold, or light at any step in the cold chain). Once lost, potency cannot be restored.



- Vaccines that are as **sensitive to light** as they are to heat include BCG, measles, measles-rubella, measles-mumps-rubella and rubella.
- These vaccines are often supplied in dark glass vials that give them some protection from light damage; but they should be kept in their secondary packaging for as long as possible to protect them during storage and transportation

Purpose of the vaccine "cold chain"

- To maintain **product quality** from the time of manufacture until the point of administration by ensuring that vaccines are stored and transported within WHO-recommended temperatures ranges.

Vaccine Storage

- Carefully select and use the **proper vaccine storage units** to store vaccines.
- Rotate vaccine stock so the oldest vaccines are used first.
- Store vaccines in their original packaging with lids closed until ready for administration.
- Have a properly **calibrated thermometer** or temperature recording device inside each storage compartment.
- Check and record storage unit minimum and maximum temperatures at the start of each workday.

DO NOT FREEZE THESE VACCINES!!!

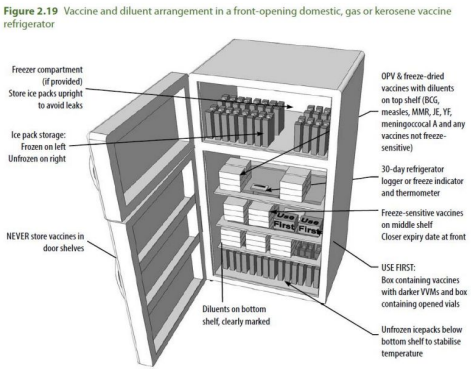
- Cholera
- DTaP-hepatitis B-Hib-IPV (hexavalent)
- DTwP or DTwP-hepatitis B-Hib (pentavalent)
- Hepatitis B (Hep B)
- Hib (liquid)
- Human papillomavirus (HPV)
- Inactivated poliovirus (IPV)
- Influenza
- Pneumococcal
- Rotavirus (liquid and freeze-dried)
- Tetanus, DT, Td

1- Among the vaccines, polio is the most sensitive to heat, requiring storage at minus 20 degree C. Vaccines which must be stored in the freezer compartment are : polio and measles.

Refrigerator and Freezer Recommendations

- There are several types of vaccine storage units available. [1]
- Purpose-built units are specifically designed to store vaccines. It's ok to store other things but they have to be in the lower shelf

This is not acceptable because there is a freezer on the top, making the temperature not well controlled



- Place water bottles or ice packs on the top shelf and floor and in the door racks.
- Putting water bottles in the unit can help maintain stable temperatures caused by frequently opening and closing unit doors or a power failure.

Temperature Monitoring Devices (TMD)

- Every vaccine storage unit **must have a Temperature monitoring devices** (TMD).
- An accurate temperature history that reflects actual vaccine temperatures is critical for protecting your vaccines.
- There are several types of (TMD).

Vaccine Organizing and Storing

To confirm vaccines are stored correctly and to minimize the risk of administration errors, implement the following practices:

1. Store each type of vaccine or diluent in its original packaging and in a separate container.
2. Position vaccines and diluents **two to three inches** from the unit walls, ceiling, floor, and door.
3. Whenever possible, store diluent with the corresponding refrigerated vaccine. Never store diluent in a freezer.
4. Avoid placing or storing any items other than vaccines, diluents, and water bottles inside storage units.
5. If other medications and biological products must be stored in the same unit as vaccines, they must be **clearly marked** and stored in separate containers or bins from vaccines.
6. Potentially contaminated items (e.g., blood, urine, stool) **should be properly contained and stored below vaccines** due to risk of contamination from drips or leaks.
7. Arrange vaccines and diluents in rows and **allow space between them** to promote air circulation.

1- Is it ok to use conventional refrigerator if a medical one is not available? **yes**

Practice Questions

Q1: which of the following diseases is acquired mainly by contamination of wounds?

A. TB	B. Rubella	C. Measles	D. Tetanus

Q2: which of the following statements is not correct regarding the vaccine storage?

A. Proper vaccine storage units	B. Have Calibrated thermometer	C. Record storage temp. At the end of each week	D. Rotate vaccines stock

Q3: which one of the following considered as an advantage of active immunity?

A. Cause serious diseases in healthy immunity people	B. Short-lasting protection	C. Higher protective efficacy	D. Expensive

Q4: Which of the following vaccine is more precise for pregnancy?

A. Tetanus	B. Pertussis	C. Mumps	D. Measles

Q5:Which of the following vaccine is given orally?

A. IPV	B. Hepatitis B	C. Rotavirus	D. Yellow fever

Q6: which of the following vaccine vials contains preservatives to prevent microorganism growth?

A. Single dose vials	B. Multidose vials	C. Manufacturer-Filled syringes	D. None of them

Answer key:

1 (D) , 2 (C) , 3 (C) , 4 (A) , 5 (C) , 6 (B)

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تذكر أن غالب نقاط التحول
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لا محبة، واضطراراً لا اختياراً