Principles of Immunization

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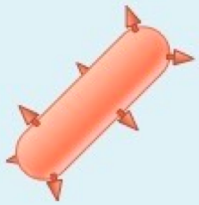
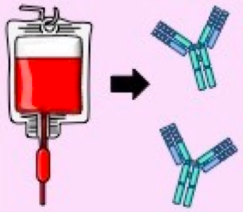
Objectives:

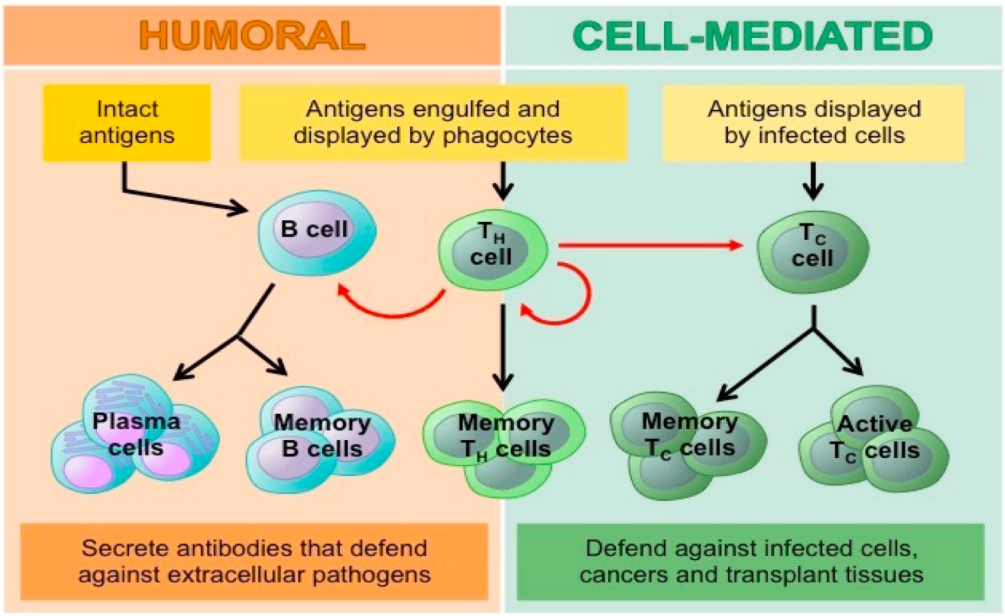
- To understand the types of acquired immunity
- To differentiate between the different types of vaccines used in preventing illness
- To understand the type of vaccine, its mode of delivery, and schedule for important immunizable diseases; TB, Pertussis, Rubella, Diphtheria, Measles, Tetanus, Hepatitis, Meningitis, Rabies, Polio
- To define and understand the cold chain and its importance
- To 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

Types of acquired immunity

Types of Immunity

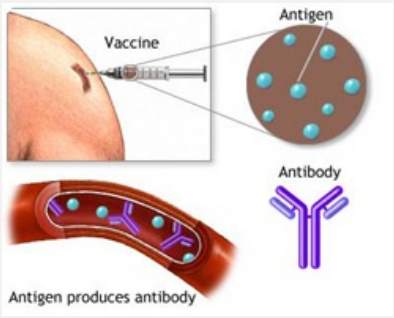
ACTIVE IMMUNITY		PASSIVE IMMUNITY	
Natural	**Artificial**	**Natural**	**Artificial**
			
Infection	Vaccination	Maternal antibodies	Monoclonal antibodies

Types of Active Immunity



Advantages of active immunity compared to passive immunity:

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



Herd immunity (Community immunity)

- When vaccination of a portion of population (or herd) provides protection to unprotected individuals.
  - 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.


Vaccines

Types of Used Vaccines

Live, attenuated vaccines

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

Contraindication

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

Types of Used Vaccines

Examples:

- **Viral**
  - Measles, mumps, rubella,
  - Zoster,
  - Varicella
  - Yellow fever,
  - Rotavirus
  - Influenza
  - Oral polio
- **bacterial**
  - Bacille Calmette-Guérin (BCG)
  - Oral typhoid vaccine.

Types of Used Vaccines

Inactivated vaccines

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

Types of Used Vaccines

Contraindication:

- Sever local or general reaction to a previous dose.

Example:

- Polio, Hepatitis A, Rabies
- Pertussis, Typhoid, Cholera, Plague

Types of Used Vaccines

Polysaccharide Vaccines

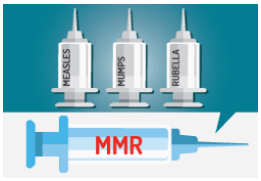
- Type of inactivated subunit vaccine composed of long chains of sugar molecules
- Pure polysaccharide vaccines are available for three diseases: pneumococcal disease, meningococcal disease, and Salmonella Typhi.
- The immune response to a pure polysaccharide vaccine is typically T-cell independent, which means that these vaccines are able to stimulate B cells without the assistance of T-helper cells.
- Conjugated polysaccharide (polysaccharide is chemically combined with a protein molecule). Example: Haemophilus influenzae type b (Hib)

Types of Used Vaccines

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



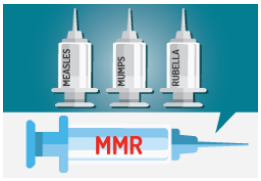
- If more than one kind of immunizing agent is included in the vaccine it is called a mixed or combined vaccine.

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 of adverse reactions

Combinations Vaccines



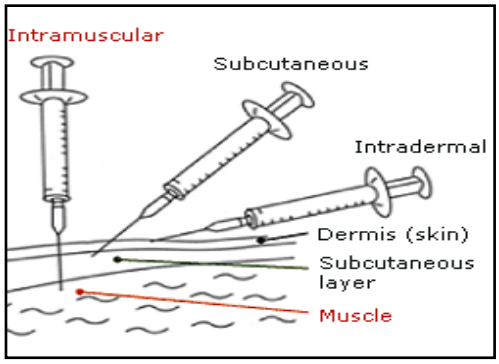
Examples

- DPT (Diphtheria-pertussis-tetanus)
- MMR (Measles, mumps and rubella)
- DPTP (DPT plus inactivated polio)
- DPT-Hep B-Hib (Diphtheria, pertussis, tetanus, hepatitis Band haemophilus influenza type B).

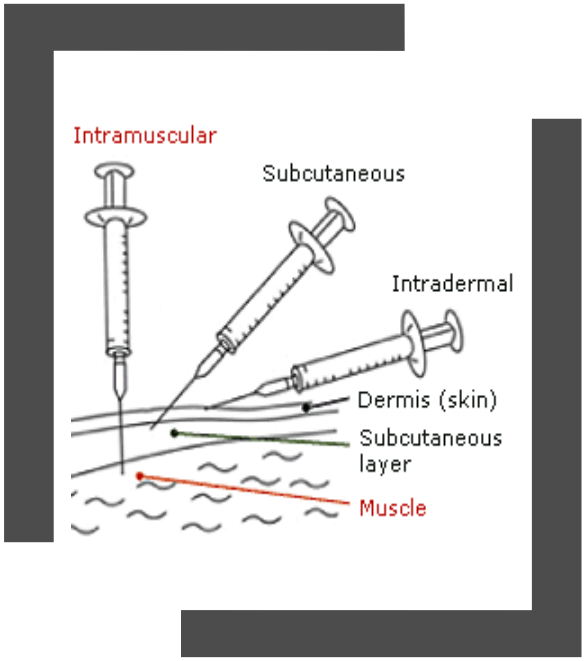
Route of administration of Vaccines

Routes of Administrating Vaccines

- The route of administration is the path by which a vaccine is brought into contact with the body.
- This is a critical factor for success of the immunization.
  - Intramuscular route
  - Subcutaneous route
  - Intradermal route
  - Oral route



Routes of Administrating Vaccines



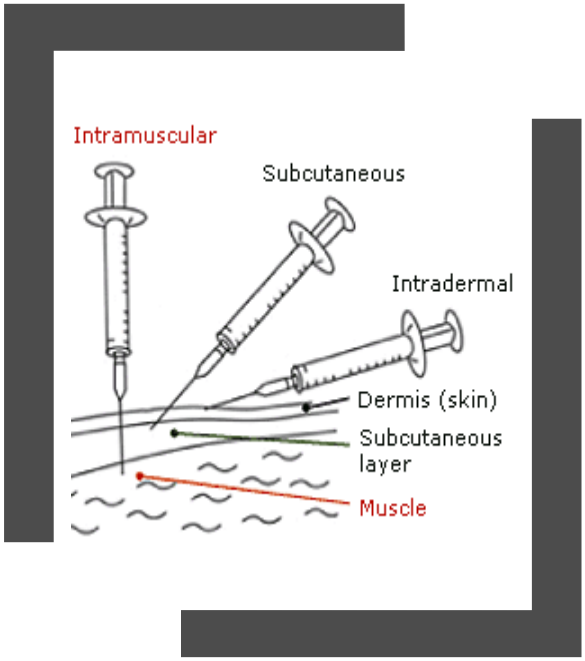
Intramuscular (IM) injection

- Administers the vaccine into the muscle mass.
- Vaccines containing adjuvants should be injected IM to reduce adverse local effects.

Subcutaneous (SC) injection

- Administers the vaccine into the subcutaneous layer above the muscle and below the skin.

Routes of Administrating Vaccines



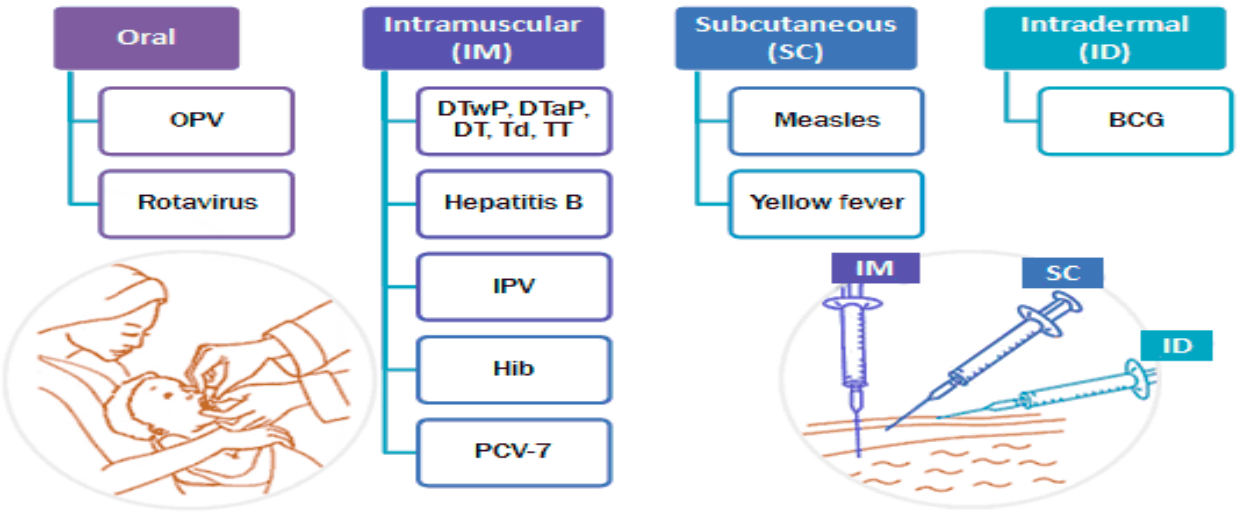
Intradermal (ID) injection

- 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.

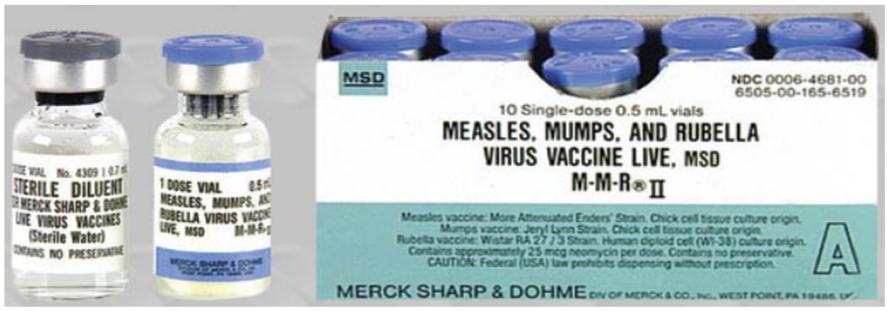
Oral administration

- Oral administration of vaccine makes immunization easier by eliminating the need for a needle and syringe.

Routes of Administrating Vaccines



Different types of vaccine vials



Single-Dose Vials

- 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.

Different types of vaccine vials

Multidose Vials

- 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 reached.

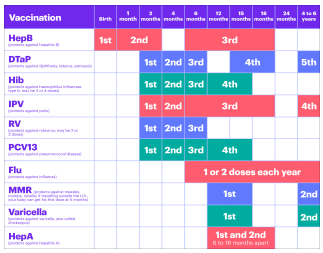
Different types of vaccine vials

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

Immunization Schedules

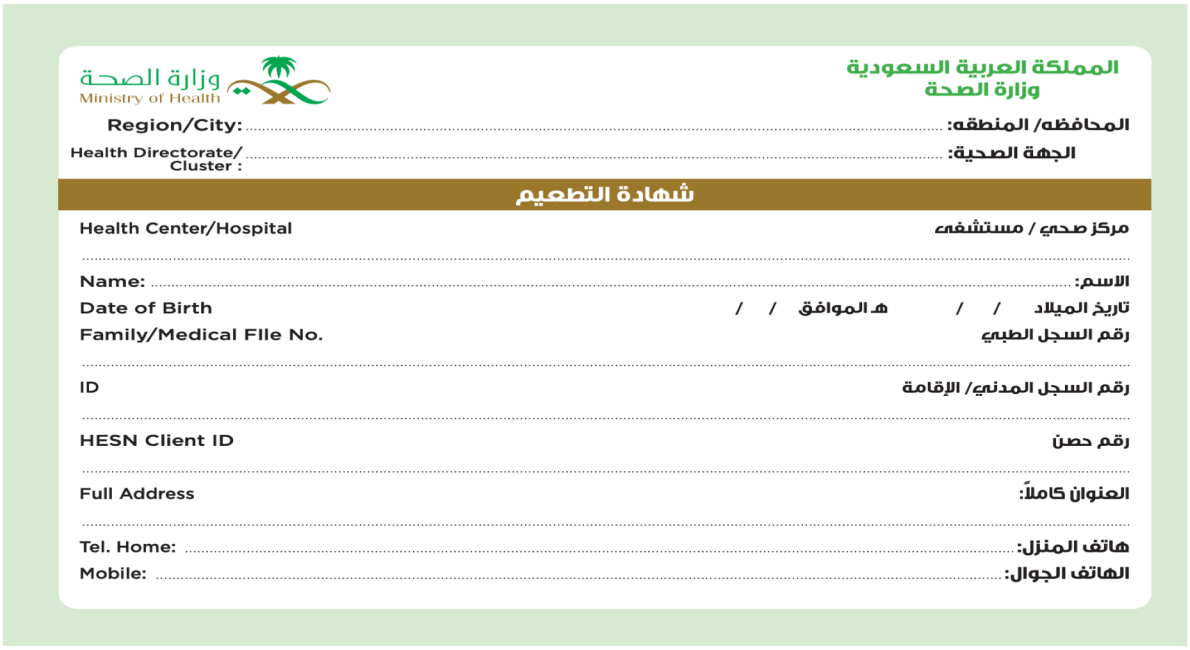


Vaccination	Birth	1 month	2 months	4 months	6 months	12 months	15 months	18 months	24 months	4 to 6 years
HepB	1st	2nd			3rd					
DTaP			1st	2nd	3rd		4th			5th
Hib			1st	2nd	3rd	4th				
IPV			1st	2nd		3rd				4th
RV			1st	2nd	3rd					
PCV13			1st	2nd	3rd	4th				
Flu					1 or 2 doses each year					
MMR							1st			2nd
Varicella							1st			2nd
HepA							1st and 2nd 6 to 18 months apart			

- 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



المملكة العربية السعودية
وزارة الصحة

وزارة الصحة
Ministry of Health

Region/City: ..... المحافظه/ المنطقه: .....

Health Directorate/ Cluster : ..... الجهة الصحية: .....

شهادة التطعيم

Health Center/Hospital ..... مركز صحي / مستشفى .....

Name: ..... الاسم: .....

Date of Birth / / هـ الموافق / / تاريخ الميلاد / /

Family/Medical FIle No. ..... رقم السجل الطبي .....

ID ..... رقم السجل المدني/ الإقامة .....

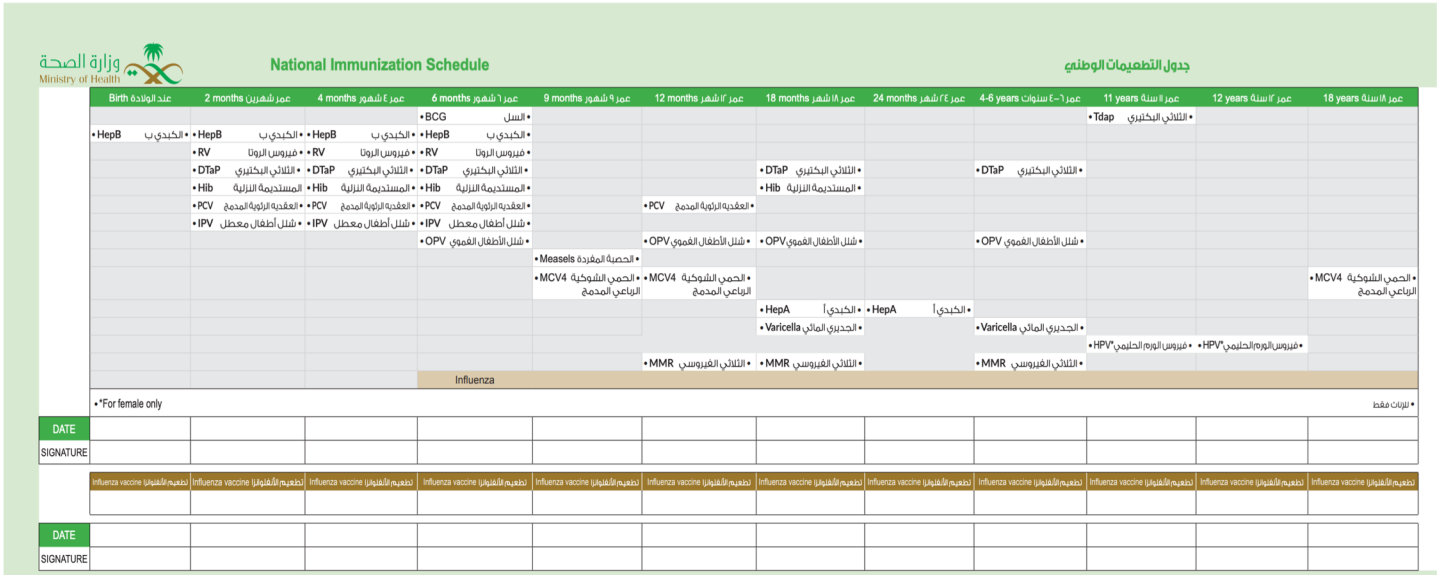
HESN Client ID ..... رقم حصن .....

Full Address ..... العنوان كاملاً: .....

Tel. Home: ..... هاتف المنزل: .....

Mobile: ..... الهاتف الجوال: .....

National Immunization Schedule



وزارة الصحة
Ministry of Health

National Immunization Schedule

جدول التطعيمات الوطني

عند الولادة Birth	عمر شهرين 2 months	عمر ٤ شهور 4 months	عمر ٦ شهور 6 months	عمر ٩ شهور 9 months	عمر ١٢ شهر 12 months	عمر ١٨ شهر 18 months	عمر ٢٤ شهر 24 months	عمر (٤-٦ سنوات) 4-6 years	عمر ١١ سنة 11 years	عمر ١٢ سنة 12 years	عمر ١٨ سنة 18 years
			• السل BCG						• الثلاثي البكتيري Tdap		
• الكبدي ب HepB	• الكبدي ب HepB	• الكبدي ب HepB	• الكبدي ب HepB								
	• فيروس الروتا RV	• فيروس الروتا RV	• فيروس الروتا RV								
	• الثلاثي البكتيري DTaP	• الثلاثي البكتيري DTaP	• الثلاثي البكتيري DTaP			• الثلاثي البكتيري DTaP		• الثلاثي البكتيري DTaP			
	• المستديمة النزلية Hib	• المستديمة النزلية Hib	• المستديمة النزلية Hib			• المستديمة النزلية Hib					
	• العقدية الرئوية المدمج PCV	• العقدية الرئوية المدمج PCV	• العقدية الرئوية المدمج PCV		• العقدية الرئوية المدمج PCV						
	• شلل أطفال معطل IPV	• شلل أطفال معطل IPV	• شلل أطفال معطل IPV								
			• شلل الأطفال الفموي OPV		• شلل الأطفال الفموي OPV	• شلل الأطفال الفموي OPV		• شلل الأطفال الفموي OPV			
				• الحصبة المفردة Measles							
				• الحمى الشوكية الرباعي المدمج MCV4	• الحمى الشوكية الرباعي المدمج MCV4						• الحمى الشوكية الرباعي المدمج MCV4
						• الكبدي أ HepA	• الكبدي أ HepA				
						• الجدري المائي Varicella		• الجدري المائي Varicella			
									• فيروس الورم الحليمي HPV*	• فيروس الورم الحليمي HPV*	
					• الثلاثي الفيروسي MMR	• الثلاثي الفيروسي MMR		• الثلاثي الفيروسي MMR			
			Influenza								
• *For female only											• للبنات فقط
DATE											
SIGNATURE											

تطعيم الأنفلونزا Influenza vaccine	تطعيم الأنفلونزا Influenza vaccine	تطعيم الأنفلونزا Influenza vaccine	تطعيم الأنفلونزا Influenza vaccine	تطعيم الأنفلونزا Influenza vaccine	تطعيم الأنفلونزا Influenza vaccine	تطعيم الأنفلونزا Influenza vaccine	تطعيم الأنفلونزا Influenza vaccine	تطعيم الأنفلونزا Influenza vaccine	تطعيم الأنفلونزا Influenza vaccine	تطعيم الأنفلونزا Influenza vaccine	تطعيم الأنفلونزا Influenza vaccine
DATE											
SIGNATURE											

National Immunization Schedule

وزارة الصحة
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National Immunization Schedule

جدول التطعيمات الوطني للكبار

vaccine* التطعيم	Influenza [1] الأنفلوانزا	Tdap or Td [2] الثلاثي البكتيري		MMR [4] الثلاثي الفيروسي	Varicella [5] الجديري المائي	Herpes Zoster [6] الحنا النطاقي	HPV [7] فيروس الورم الحليمي	Pneumococcal المكورات العقدية الرئوية		Hep B [10] الكبدي ب	MCV4 [11] الحمى الشوكية الرباعي المدمج	Other Vaccinations تطعيمات اخري
		Adults [2] للكبار	Pregnants [3] للحوامل					PPSV23 [8] المكورة الرئوية المتعدد	PCV [9] العقدية الرئوية المدمج			
Date and Signture												
Date and Signture												
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Date and Signture												

Timing/ Indication

1. 1 dose annually
2. 1 dose TdaP then Td booster every 10 years.
3. Pregnant women (For each pregnancy between 27 & 36 Weeks).
4. For unvaccinated individuals, premarital and post natal women if no evidence of immunity or prior disease (1 or 2 doses depend on indication).
5. If no evidence of immunity or prior disease (2 doses 8 weeks apart)
6. 2 doses 2-6 m apart for adult age 50 years or older
7. 3 doses (0,1-2,and 6m) from the first dose catch up immunization for female age 15-26 years
8. 1 dose adults aged 65 years or older (1 year after PCV 13 dose) from the first dose.
9. 1 dose adults with comrobid/immunocompromised condtions and adults aged 65 years or older.
10. 3 doses (0,1m and 6m) if no previous immunization or no evidence of immunity.
11. 1 dose depending on indication, then booster every 5 years if risk remains.

الوقت/ دواعي الاستعمال

١. جرعة واحدة سنوياً.
٢. جرعة واحده ثم جرعة منشطة كل ١٠ سنوات.
٣. للحوامل جرعة مع كل حمل جديد (في الفترة مابين الأسبوع ٢٧ إلى ٣٦).
٤. اذا لم تكن هناك مناعة مؤكدة أو مرض سابق جرعة واحدة أو اثنان تبعاً لحالة تطعيم السيدات قبل الزواج وبعد الولادة.
٥. إذا لم تكن هناك مناعة مؤكدة أو مرض سابق جرعتان بينهما ٨ أسابيع.
٦. جرعتان بينهما ٢-٦ أشهر لعمر ٥٠ سنة أو أكبر.
٧. ثلاث جرعات للنساء عمر ١٥-٢٦ سنة الجرعة الثانية بعد شهرين من أول جرعة و الجرعة الثالثة بعد ٦ أشهر من الجرعة الاولى.
٨. جرعة واحدة للكبار من عمر ٦٥ أو أكبر بعد جرعة البكتريا العقدية الرئوية بعام واحد.
٩. جرعة واحدة لمناقوص المناعة أو أصحاب الأمراض المزمنة المصاحبة و أيضا لعمر ٦٥ سنة أو أكبر.
١٠. ثلاث جرعات إذا لم يكن هناك مناعة مؤكدة أو تطعيم سابق الجرعة الثانية بعد شهر من الجرعة الأولي و الجرعة الثالثة بعد ٦ أشهر.
١١. جرعة واحدة حسب الحالة ثم جرعة منشطة كل ٥ سنوات.

Vaccines (1)

Disease	Vaccine	Dose / Rout 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
Hepatitis B	**(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

Vaccines (2)

Disease	Vaccine	Dose / Rout of administration	Timing	Side effects
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	**(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 and responsiveness/consciousness); febrile seizures; prolonged crying **Mild**: injection site reactions (pain, redness, swelling); fever and agitation

Vaccines (3)

Disease	Vaccine	Dose / Rout of administration	Timing	Side effects
Tetanus	**TT** **(DT/ dT)** with diphtheria **(DTP)** with diphtheria and pertussis **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)	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	Measles only **(M)** **(MR)** → with rubella **(MM, MMR)** →with mumps/ rubella **(MMRV)** → with varicella	0.5 ml Subcutaneous	9, 12, 18 months and 4-6 years	**Severe**: thrombocytopenia, anaphylaxis, encephalitis **Mild**: fever, rash 5–12 days following administration

Vaccines (4)

Disease	Vaccine	Dose / Rout of administration	Timing	Side effects
Mumps	**(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
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	Meningococcal quadrivalent conjugate [A,C,W135,Y-D]	0.5 ml Intramuscular	9 and 12 Months	**Severe**: rare anaphylaxis • **Mild**: injection site reaction, fever

Vaccines (5)

Disease	Vaccine	Dose / Rout of administration	Timing	Side effects
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

Vaccine Safety and Efficacy

As an immunization provider, you play a key role in helping to ensure the safety and efficacy of vaccines through proper:

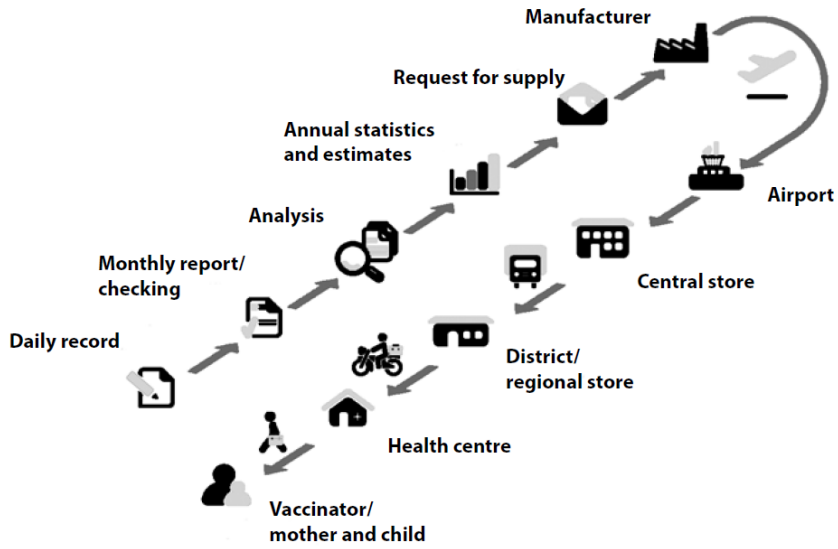
- Vaccine storage and handling
- Vaccine administration
- Timing and spacing of vaccine doses
- Observation of precautions and contraindications
- Management of vaccine side effects
- Reporting of suspected side effects
- Communication about vaccine benefits and risks

Why proper vaccine storage and handling are important?

Proper storage and handling begin with an effective

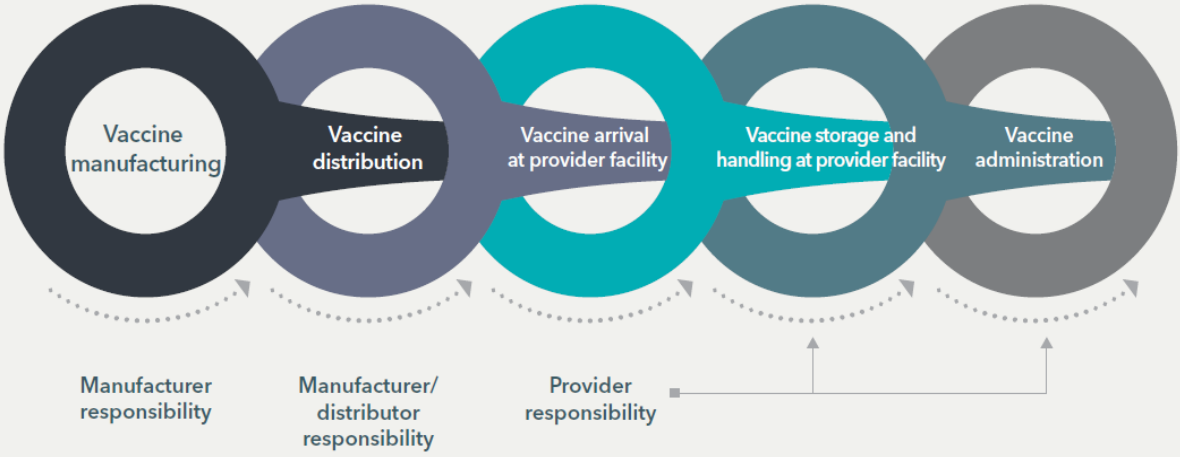
vaccine cold chain

Figure 2.1 The cold chain



Source: PATH/WHO

Cold Chain Flowchart



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, and ends with administration of the vaccine to the patient.

Cold Chain

- 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, cold, or light at any step in the cold chain). Once lost, potency cannot be restored.

Cold Chain

- 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.

Vaccine Storage

Figure 2.4 Freeze sensitive vaccines

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

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 temperature ranges.

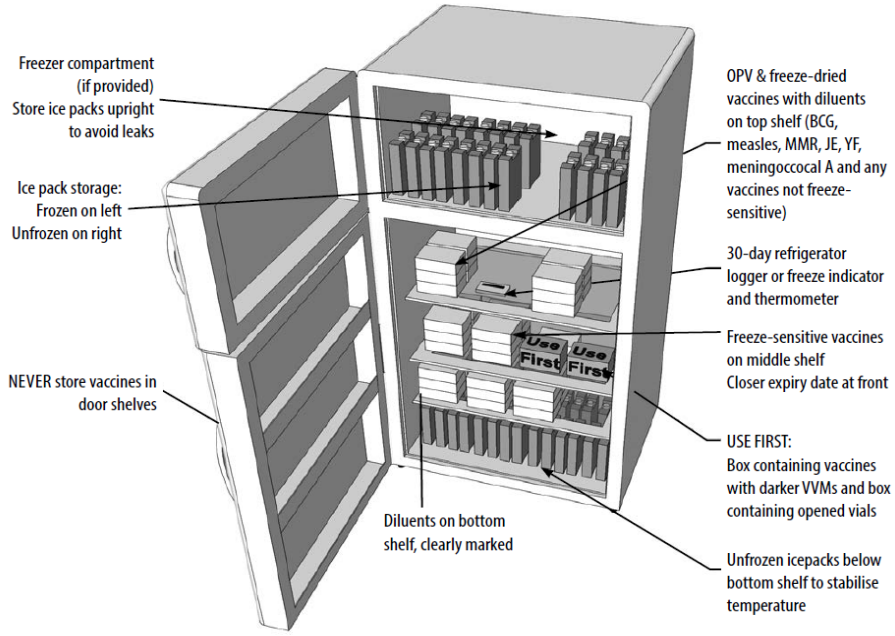
Vaccine Storage

- 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.

Refrigerator and Freezer Recommendations

- There are several types of vaccine storage units available.
- Purpose-built units are specifically designed to store vaccines.

Figure 2.19 Vaccine and diluent arrangement in a front-opening domestic, gas or kerosene vaccine refrigerator



Refrigerator and Freezer Recommendations

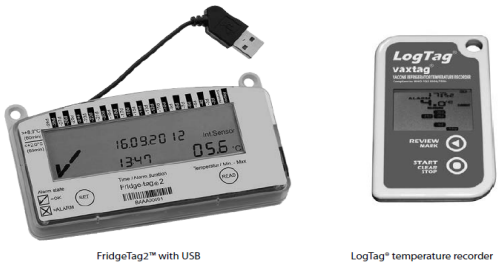
- Place water bottles on the top shelf and floor and in the door racks.
- Putting water bottles in the unit can help maintain stable temperatures caused by frequently opening and closing unit doors or a power failure.

Refrigerator and Freezer Recommendations

Vaccine Storage Units: Refrigerator and Freezer Recommendations

- 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)

Figure 2.12 30-day electronic temperature loggers



FridgeTag2™ with USB

LogTag® temperature recorder

Vaccine Organizing and Storing

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

- Store each type of vaccine or diluent in its original packaging and in a separate container.
- Position vaccines and diluents **two to three inches** from the unit walls, ceiling, floor, and door.
- Whenever possible, store diluent with the corresponding refrigerated vaccine. Never store diluent in a freezer.

Vaccine Organizing and Storing

- Avoid placing or storing any items other than vaccines, diluents, and water bottles inside storage units.
  - 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.
  - 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.

- Arrange vaccines and diluents in rows and allow space between them to promote air circulation.


THANK YOU