CHILDHOOD IMMUNIZATION: INTRODUCTION

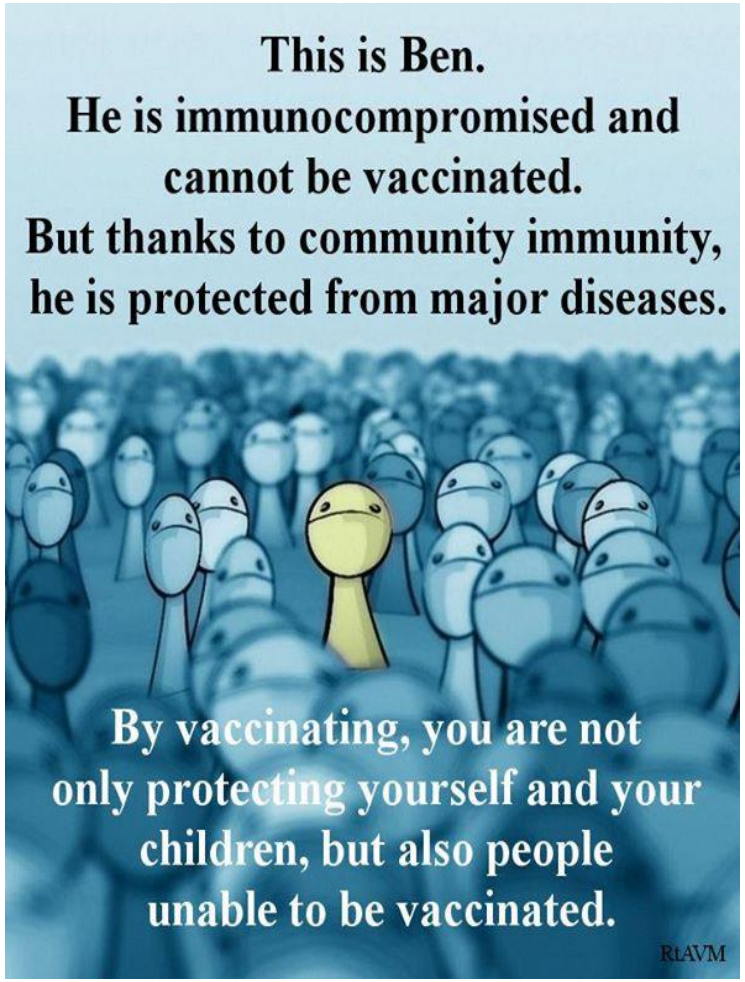
Prophylaxis

Introduction

- **Vaccination**:
  - The act of giving a vaccine (antigen)
- **Immunization**:
  - Induction of an immune response following exposure to an antigen

- The ultimate goals are eradication and control of disease.

- The immediate goal is prevention of disease.



Active vs Passive immunity

ACTIVE	PASSIVE
Immunogenic **antigen** is given **then the body forms its own protective antibodies**.	**Ready-made immune globulin** (antibodies) from human or animal sources are given to the body.
Long term protection (Sometimes life long)	Temporary immunity that decreases with time (turnover of the administered immunoglobulin)
Examples: **Natural**: Infection **Artificial**: Vaccination	Examples: **Natural**: Mother's Ig to infant (transplacental/breast milk) effective for about 6 months. **Artificial**: Adminestration of antibodies (e.g: Hepatitis B IG, Varicella IG)

Table 1.1. Comparison of 20th Century Annual Morbidity and Current Morbidity: Vaccine-Preventable Diseases[a]

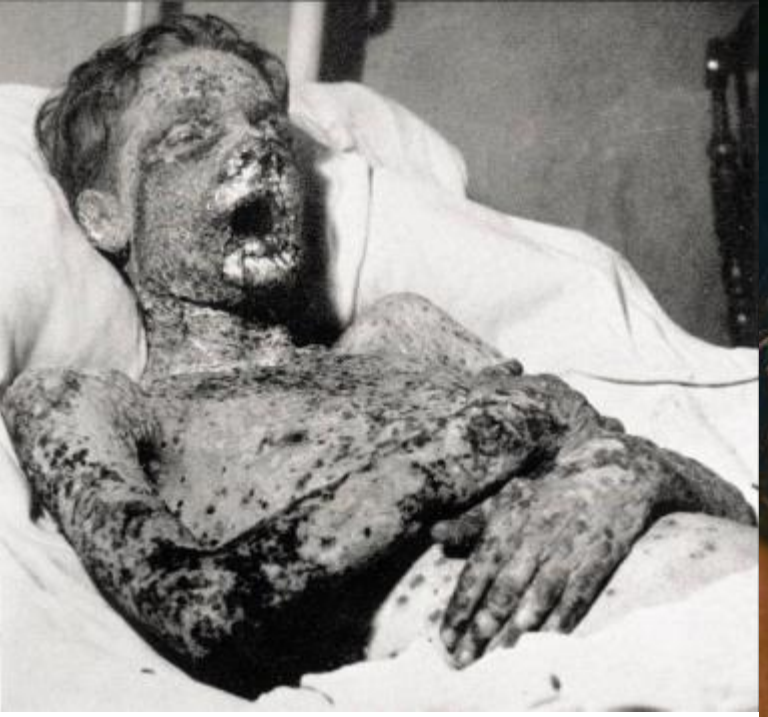
Disease	20th Century Annual Morbidity[b]	2010 Reported Cases[c]	Percent Decrease
Smallpox	29 005	0	100
Diphtheria	21 053	0	100
Measles	530 217	63	>99
Mumps	162 344	2612	98
Pertussis	200 752	27 550	86
Polio (paralytic)	16 316	0	100
Rubella	47 745	5	>99
Congenital rubella syndrome	152	0	100
Tetanus	580	26	96
Haemophilus influenzae	20 000	246[d]	99

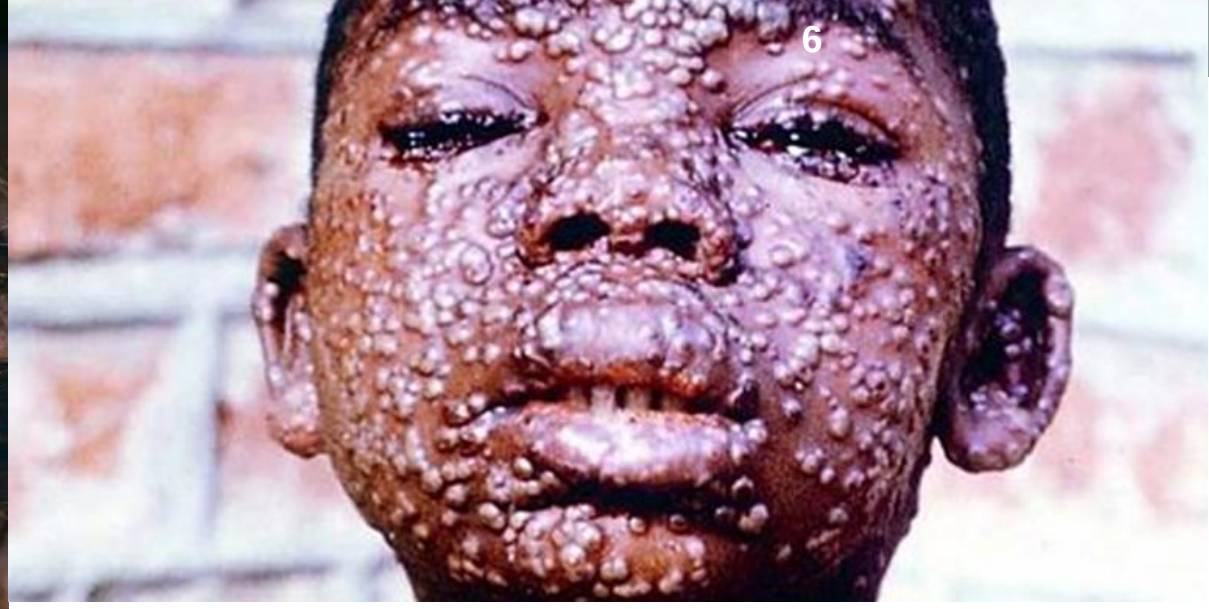
[a]National Center for Immunization and Respiratory Diseases. Historical Comparisons of Vaccine-Preventable Disease Morbidity in the U.S. Atlanta, GA: Centers for Disease Control and Prevention

[b]Roush SW, Murphy TV, Vaccine-Preventable Disease Table Working Group. Historical comparisons of morbidity and mortality for vaccine-preventable diseases in the United States. *JAMA*. 2007;298(18):2155–2163

[c]Centers for Disease Control and Prevention. Notice to readers: final 2010 reports of nationally notifiable infectious diseases. *MMWR Morb Mortal Wkly Rep*. 2011;60(32):1088–1101

[d]23 type b and 223 unknown serotype (<5 years of age).





Smallpox

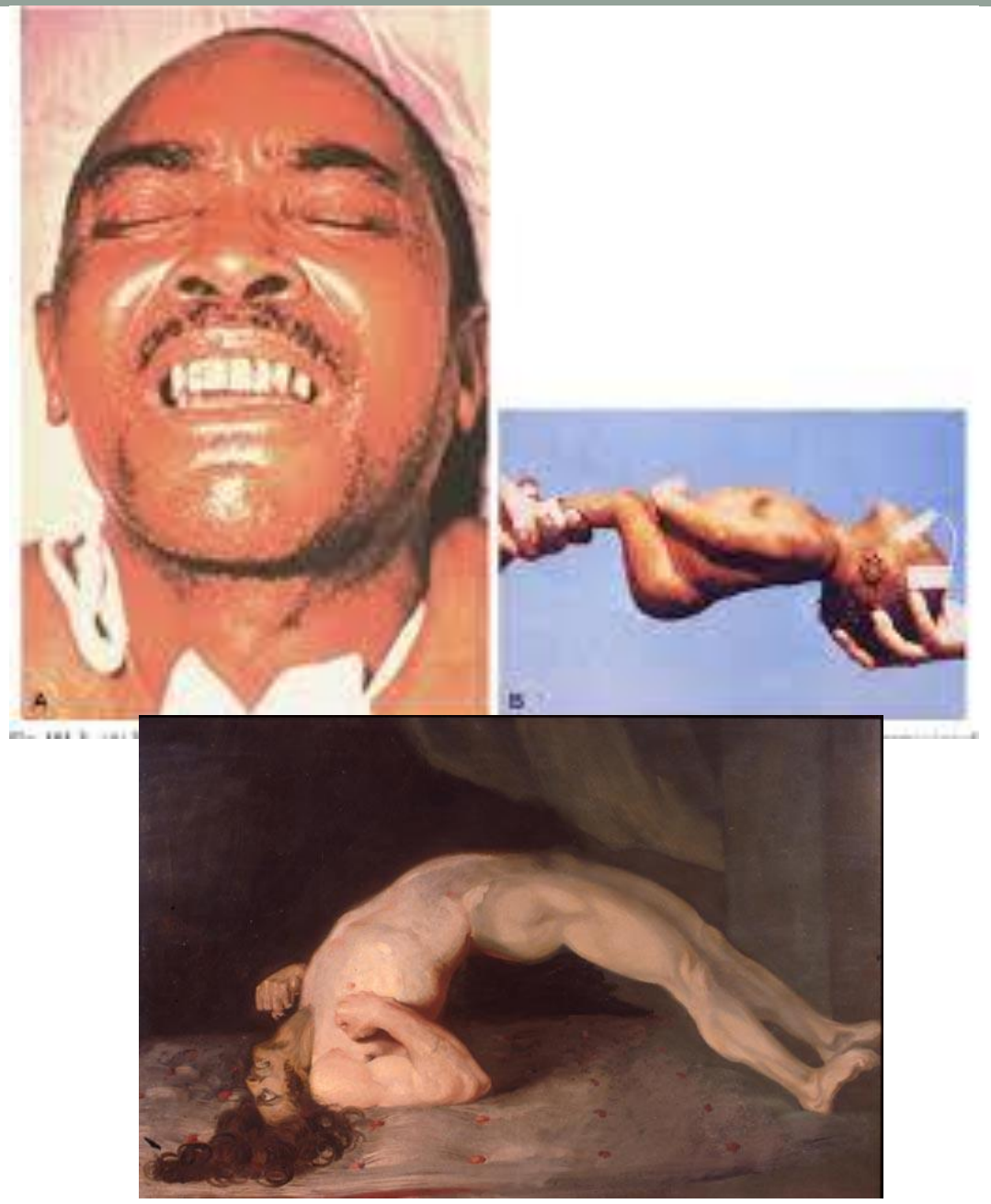
- Eradicated in 1980, case-fatality rate 30-50% according to type and age!

Poliomyelitis!

- Rapid **asymmetric acute flaccid paralysis** (paralytic poliomyelitis) caused by poliovirus
- Proximal muscles > distal
- Areflexia.
- Cranial nerve (bulbar poliomyelitis)
- Paralysis of the diaphragm may lead to impaired respiration.

Tetanus (Lockjaw)!

- Caused by Clostridium Tetanus that excretes Neurotoxin in a contaminated wound.
- Generalized tetanus (lockjaw): trismus and severe painful generalized muscular spasms.
- Autonomic dysfunction: diaphoresis, tachycardia, blood pressure, and arrhythmias.

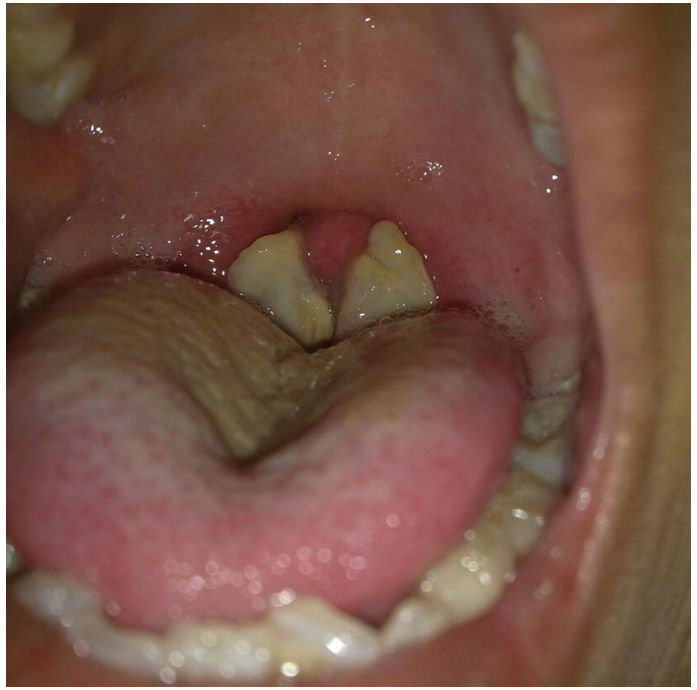


Pertussis (Whooping cough)

- Bordetella Pertussis
- Catarrhal stage, paroxysmal stage and convalescent stage (6 to 10 weeks).
- Complications: syncope, sleep disturbance, incontinence, rib fractures, pneumonia, conjunctival bleeding, hernia, hypoxia, seizures (2%), encephalopathy, and death.
- <6 months can be atypical: gasping, bradycardia, or apnea; absence of whoop.

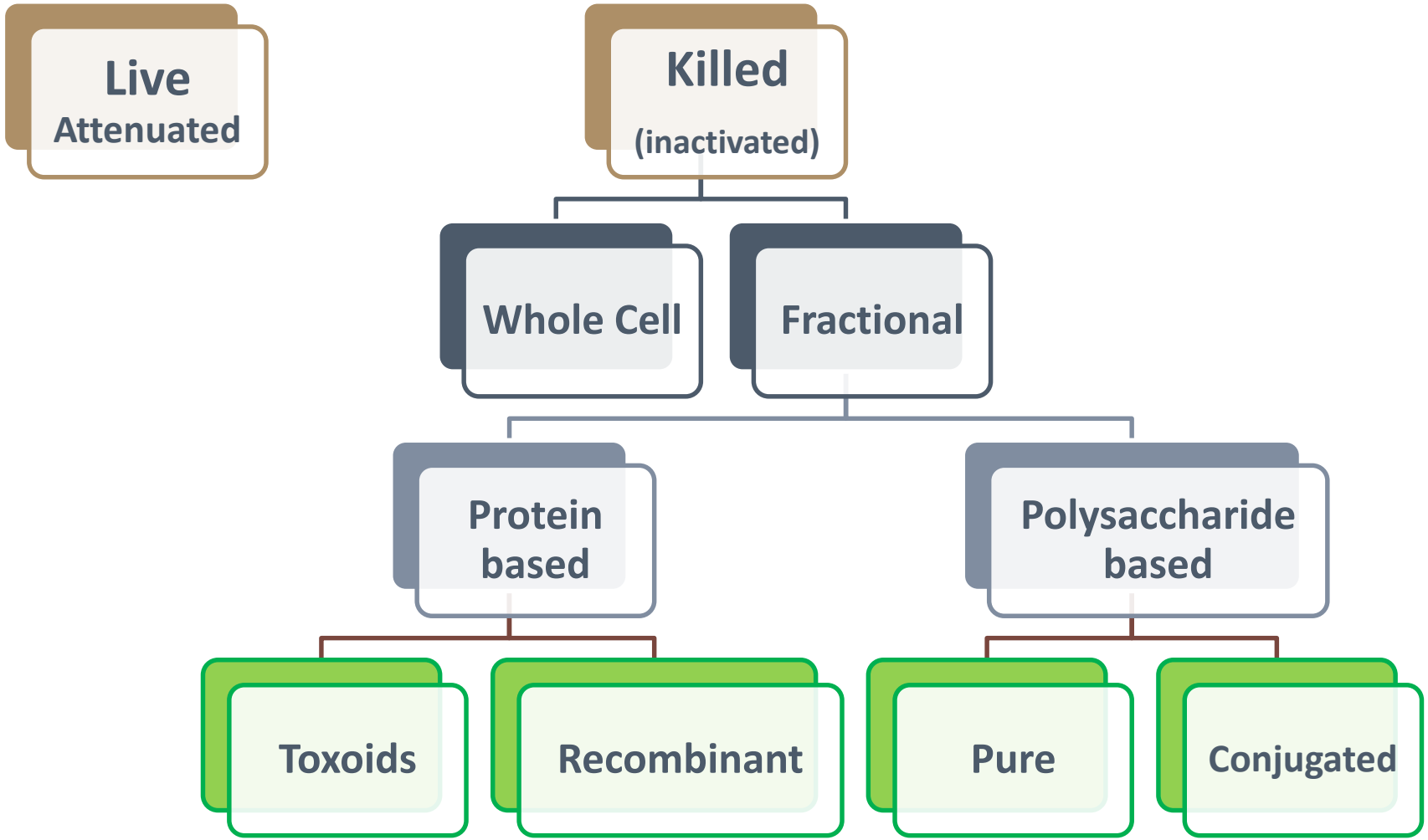
Diphtheria!

- Membranous nasopharyngitis or obstructive laryngotracheitis caused by diphtheria toxin.
- Extensive neck swelling with cervical lymphadenitis (bull neck) is a sign of severe disease.
- Complications:
  - upper airway obstruction;
  - myocarditis with heart block;
  - cranial and peripheral neuropathies.
- Case fatality rates up to 10%, sometimes > 20% in older adults.



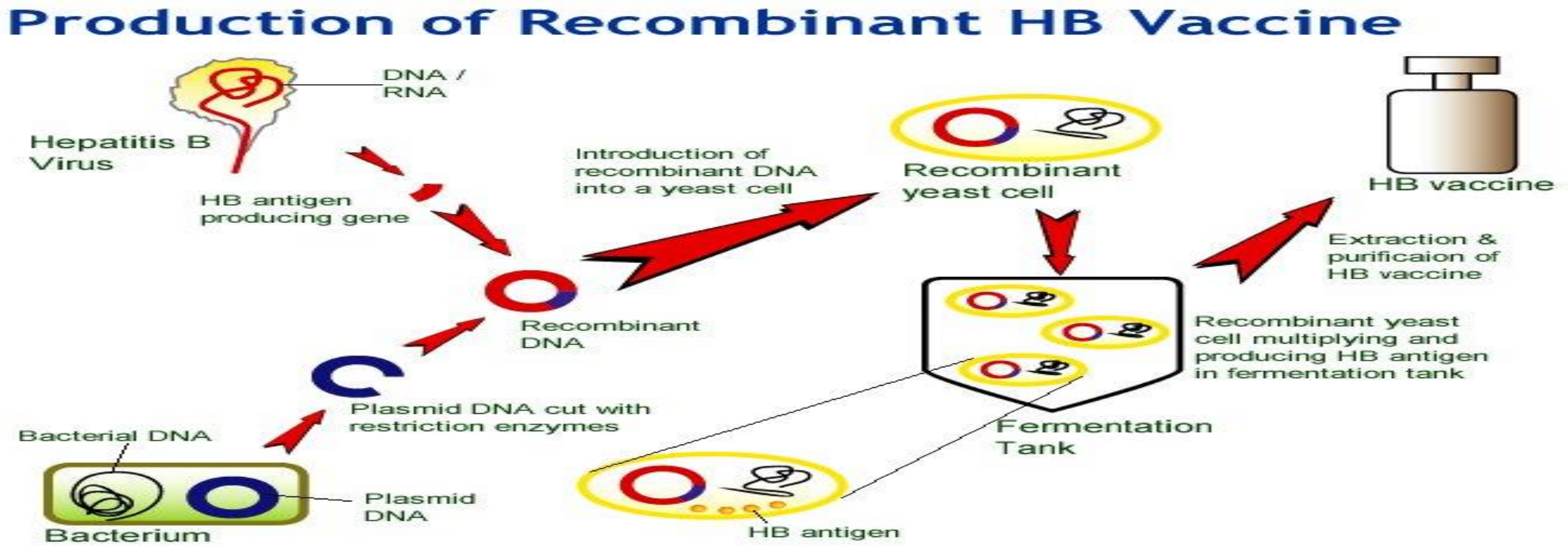
Live attenuated	Inactivated vaccine
Live organisms ➢Lost ability to induce the disease ➢Retain capacity to grow but slowly and locally only	**Killed organisms** ➢(by heat/chemicals [formaldehyde]).
Can produce antigens continuously: ➢More potent ➢1 Dose is sufficient ➢Longer immunity	**Cannot keep producing antigens:** ➢Less potent ➢Need booster doses ➢Shorter immunity
Induce humoral & cellular immunity	**Induce humoral immunity only** ➢Antibody titers fall with time
Risk of infection ➢Can mutate back to its virulent form	**No risk of infection**
▪**Not safe for immunocompromised people** 1-immunocompromised individuals. 2-People being treated for certain chronic illnesses (steroids used) 3-Pregnant women unless absolutely necessary.	**Safe**

Types Of Vaccines



Recombinant Vaccines

- They are made by **inserting viral genes** that code for important antigens **into** common baker's **yeast**. The yeast then **produces the antigens**, which are collected and **purified** for use in the **vaccine**



Polysaccharide-based Vaccines

- **Pure polysaccharide vaccines:**
  - They induce a T-cell INDEPENDENT immune response. This means that they **stimulate B cells without the need for T helper cells** (humoral immunity only)
  - This causes them to have weaknesses:
    1. Not immunogenic in children younger than 2 years of age (underdeveloped immune system. B cells must be activated through T cells)
    2. No booster response in adults (antibody titers don't increase)

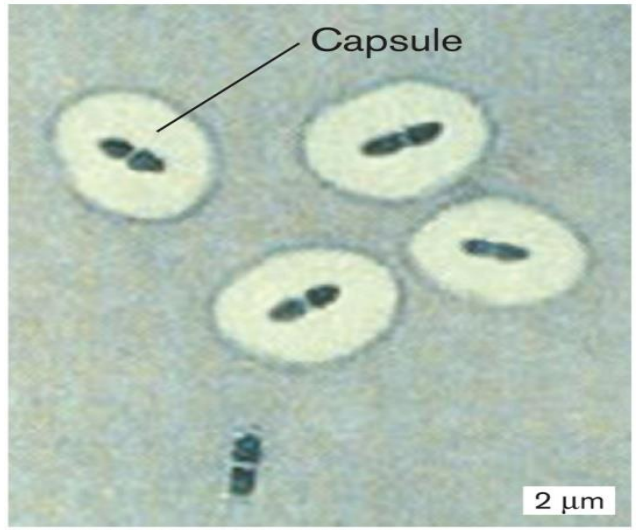
- How was this problem solved?
  - By joining the polysaccharide molecule to a protein molecule and making a **conjugated** polysaccharide vaccines**.**

- This way the polysaccharide vaccine will stimulate a T cell DEPENDENT immune response.

- **Conjugated vaccines:**
  1. Induce an immune response in children younger than 2 years
  2. have a booster response.

Images of phagocytosis

***Streptococcus pneumoniae* and capsule**



CDC

Microbiology: An Evolving Science, Third Edition Figure 23.28d

Types of vaccines

- **Live-attenuated:** **BCG, MMR, OPV, Rota,** Varicella, (oral typhoid, yellow fever), Nasal Influenza virus vaccine.

- **Inactivated:** **DTaP** (toxoids and inactivated components) **(Tdap, Td, DTP), IPV, Hib** (polysaccharide conjugate), Hepatitis A (inactivated), Meningococcal, pneumococcal (polysaccharide conjugate or polysaccharide), Influenza virus (inactivated)

- **Genetically engineered** (recombinants antigens): Hepatitis B, HPV

- Live-attenuated vaccines are contraindicated in cases of cell-mediated immune defects and pregnancy.

- *OPV is the only vaccine contraindicated when household contains an immunocompromised member.*

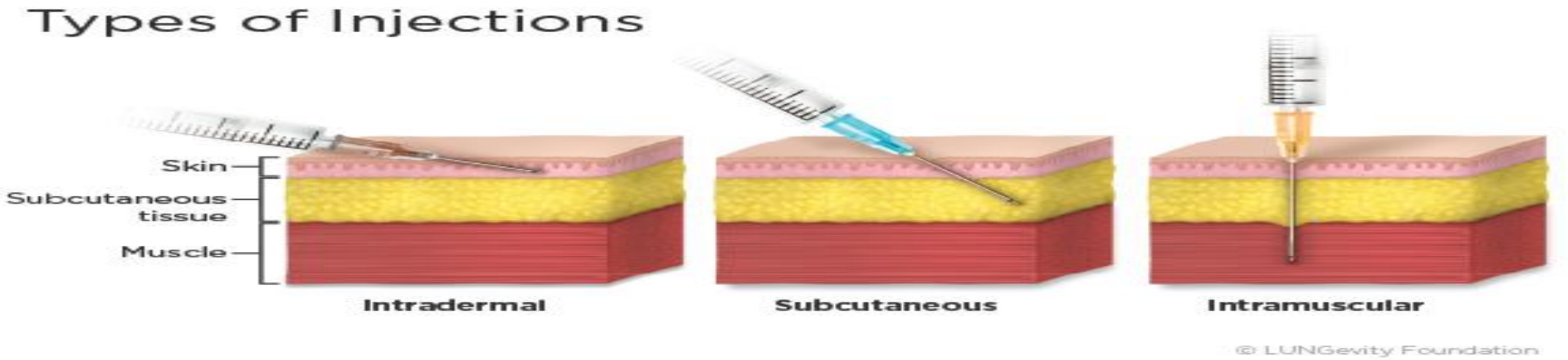
Examples For Each Type Of Vaccines

Live attenuated	Whole cell	Subunit (conjugated)	Subunit (recombinant)	Toxoids
• BCG • MMR • OPV • Rota • Varicella • Yellow fever	• Pertussis • IPV • Flu • HepA	• Hib • Pneumo • Meningo	• HepB	• Tetanus • Diphtheria

Administration

- Most: IM (Ant-lat thigh or deltoid).

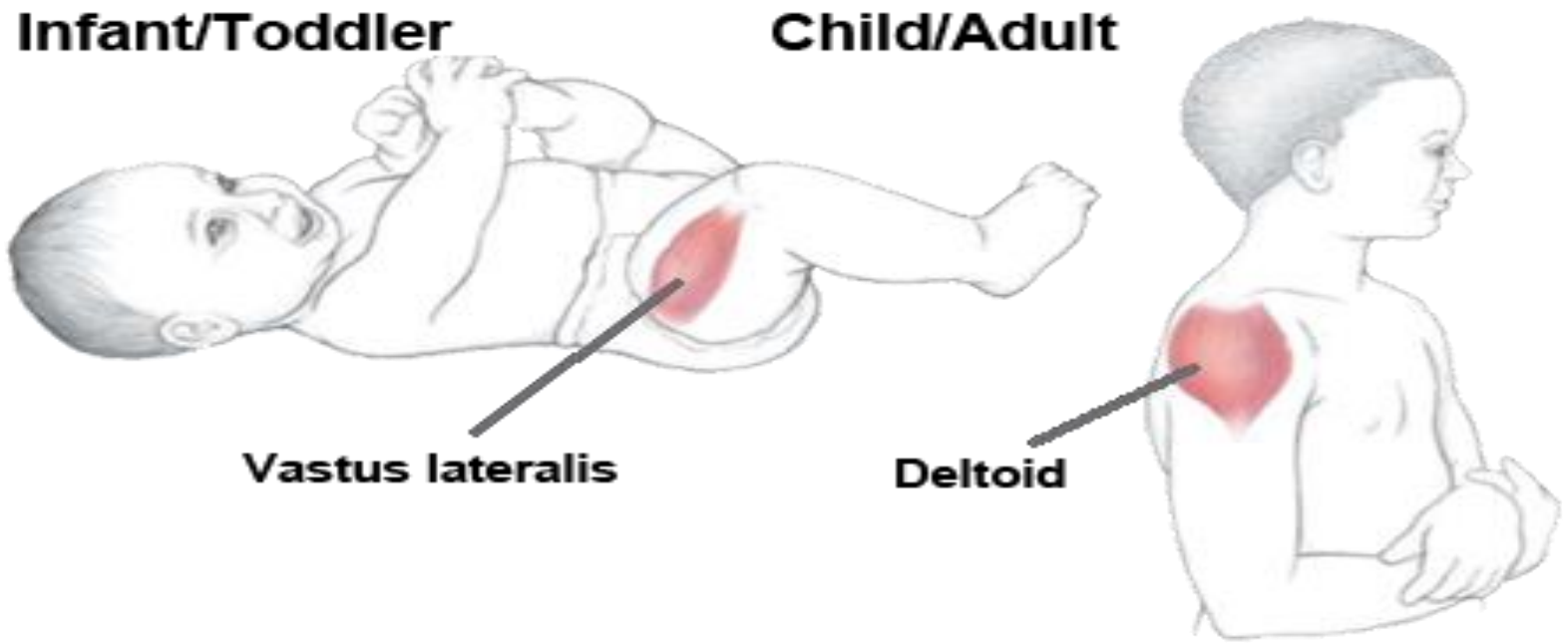
- Intradermal (ID): BCG (or SC)
- SC: MMR, Varicella, Polysaccharide vaccines, IPV (or IM)
- Intranasal: Nasal influenza vaccine
- Oral: OPV, Rota



Site of Administration

- You must avoid vascular, neural or tissue injury when injecting the vaccine.

- The preferred sites for IM administration are:
  - **Anterolateral** aspect of the **thigh in infants**
  - The **deltoid** region in **children and adults .**



Administration

- Combined vaccines, concurrent administration
- Catch up vaccines.
- Interval for live-vaccines administration after: Chemotherapy, high dose steroids, blood products.

Antigen Combination	Recommended Minimum Interval Between Doses
2 or more inactivated[a]	May be administered simultaneously or at any interval between doses
Inactivated plus live	May be administered simultaneously or at any interval between doses
2 or more live[b]	28-day minimum interval if not administered simultaneously

[a] See text for exceptions.

Immunization in Pregnancy

- Influenza Vaccine Each Influenza Season.
- Tdap With Each Pregnancy.
- Pregnancy is generally a contraindication for live-virus vaccines
- Killed Vaccines not Indicated and not contraindicated.

Possible side effects to all vaccines

- In general they occur early **within 24-48 hours of vaccination** and are **self-limited**.
- However, reactions following **live vaccines** (e.g. **MMR**) may be **delayed** and resemble a **mild version of the disease**.

1. Local reactions to injectable vaccines
2. **Anaphylaxis** to the vaccine or one of it's components (**contraindications for further similar doses**)
3. Syncope
4. Fever

Not a contraindication!

- The followings are NOT a contraindications to vaccine administration:

1. Mild illness with or without fever
2. Breast feeding
3. Local rxns or fever after previous vaccine
4. Preterm birth
5. Penicillin allergy
6. Concurrent antibiotics use
7. Family history of seizure, controlled seizures

Vaccines included in the national immunization program (NIP)

- **Viral (6)**: Measles, mumps, rubella (MMR); poliovirus (IPV, OPV) hepatitis A and B viruses, Rotavirus

- **Bacterial (5)**: Haemophilus influenzae type b (Hib), Tuberculosis (BCG), Diphtheria, Tetanus, Pertussis (DTP, DTaP, Td)

- **Other vaccines in the American NIP**: Tdap, varicella, meningococcal, pneumococcal, human papilloma virus, influenza virus.

- **Other vaccines for travelers or exposure**: Typhoid, yellow fever, rabies

برنامج التطعيم الوطني للأطفال (قبل سن دخول المدرسة)

العمر والجرعة	المطعوم
أقرب وقت بعد الولادة (أول مراجعة للمركز الصحي)	التـــدرن BCG
على عمر شهرين (61 يوم) يعطى الطفل الجرعة الأولى من:	• مطعوم شلل الأطفال IPV • المطعوم الثلاثي DaPT (ضد الدفتيريا والسعال الديكي اللاخلوي والكزاز) • مطعوم المستدمية النزلية نوع (ب) • مطعوم التهاب الكبد نوع + (ب) • مطعوم الروتا فيروس
على عمر 3 شهور (91 يوم) يعطى الطفل الجرعة الثانية من:	• مطعوم شلل الأطفال IPV • المطعوم الثلاثي DaPT (ضد الدفتيريا والسعال الديكي اللاخلوي والكزاز) • مطعوم المستدمية النزلية نوع (ب) • مطعوم التهاب الكبد نوع + (ب) مطعوم الشلل الفموي + (OPV) • مطعوم الروتا فيروس
على عمر 4 شهور (121 يوم) يعطى الطفل الجرعة الثالثة من:	• مطعوم شلل الأطفال IPV • المطعوم الثلاثي DaPT (ضد الدفتيريا والسعال الديكي اللاخلوي والكزاز) • مطعوم المستدمية النزلية نوع (ب) • مطعوم التهاب الكبد نوع + (ب) مطعوم الشلل الفموي + (OPV) • مطعوم الروتا فيروس
على عمر 9 شهور	• مطعوم الحصبة • مطعوم الشلل الفموي OPV • Vit. A 100000 I.U.
عند بلوغ الطفل عامه الأول يعطى الطفل:	• الجرعة الأولى من مطعوم الثلاثي الفيروسي (MMR) ضد الحصبة والحصبة الألمانية والنكاف
على عمر 18 شهر يعطى الطفل:	• الجرعة المدعمة من مطعوم الشلل ومطعوم (DPT) • الجرعة الثانية من مطعوم الثلاثي الفيروسي (MMR) • Vit. A 200000 I.U.

Motherhood & More

جدول المطاعيم Vaccination Schedule

اسم المطعوم	تاريخ أخذ الجرعات					ملاحظات
	الجرعة الأولى I	الجرعة الثانية II	الجرعة الثالثة III	الجرعة الرابعة IV	الجرعة المدعمة	
التدرن BCG	٨/٧/٢٠١٧					
شلل الأطفال المقتول IPV						
شلل الأطفال الفموي OPV		٦/٩/٢٠١٧	٨/١٠/٢٠١٧	١١/٣/٢٠١٩	٢٦/١٢/٢٠١٧	
الثلاثي البكتيري DPT					٢٦/١٢/٢٠١٧	
الخماسي المحسن DPT IPV +Hib	٥/٨/٢٠١٧	٦/٩/٢٠١٧	٨/١٠/٢٠١٧			
الخماسي العادي DPT+BV +Hib						
التهاب الكبد الوبائي HBV	٥/٨/٢٠١٧	٦/٩/٢٠١٧	٨/١٠/٢٠١٧			
المستدمية النزلية Hib						
الحصبة Measles فيتامين أ(١٠٠ألف وحدة دولية)	١١/٣/٢٠١٩					
الثلاثي الفيروسي MMR فيتامين أ(٢٠٠ألف وحدة دولية)	٥/٦/٢٠١٩	٢٦/١٢/٢٠١٧				
مطعوم الروتافيروس *						
أخرى Others						
هل تم أخذ عينة المسح الطبي للتحري عن الأمراض الوراثية	☐ نعم ☐ لا					

* ملاحظة: عدد الجرعات يعتمد على الشركة المصنعة للمطعوم

Table 1 Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger, United States, 2021

These recommendations must be read with the notes that follow. For those who fall behind or start late, provide catch-up vaccination at the earliest opportunity as indicated by the green bars. To determine minimum intervals between doses, see the catch-up schedule (Table 2). School entry and adolescent vaccine age groups are shaded in gray.

Vaccine	Birth	1 mo	2 mos	4 mos	6 mos	9 mos	12 mos	15 mos	18 mos	19–23 mos	2–3 yrs	4–6 yrs	7–10 yrs	11–12 yrs	13–15 yrs	16 yrs	17–18 yrs
Hepatitis B (HepB)	1st dose	◄— 2nd dose —►			◄— 3rd dose —►												
Rotavirus (RV): RV1 (2-dose series), RV5 (3-dose series)			1st dose	2nd dose	See Notes												
Diphtheria, tetanus, acellular pertussis (DTaP <7 yrs)			1st dose	2nd dose	3rd dose			◄— 4th dose —►				5th dose					
Haemophilus influenzae type b (Hib)			1st dose	2nd dose	See Notes		◄— 3rd or 4th dose, See Notes —►										
Pneumococcal conjugate (PCV13)			1st dose	2nd dose	3rd dose		◄— 4th dose —►										
Inactivated poliovirus (IPV <18 yrs)			1st dose	2nd dose	◄— 3rd dose —►							4th dose					
Influenza (IIV)					Annual vaccination 1 or 2 doses								or	Annual vaccination 1 dose only			
or																	
Influenza (LAIV4)											Annual vaccination 1 or 2 doses			Annual vaccination 1 dose only			
Measles, mumps, rubella (MMR)					See Notes		◄— 1st dose —►					2nd dose					
Varicella (VAR)							◄— 1st dose —►					2nd dose					
Hepatitis A (HepA)					See Notes		2-dose series, See Notes										
Tetanus, diphtheria, acellular pertussis (Tdap ≥7 yrs)														Tdap			
Human papillomavirus (HPV)														See Notes			
Meningococcal (MenACWY-D ≥9 mos, MenACWY-CRM ≥2 mos, MenACWY-TT ≥2years)			See Notes											1st dose		2nd dose	
Meningococcal B															See Notes		
Pneumococcal polysaccharide (PPSV23)											See Notes						

Schedule of the NIP and UNRWA in Jordan

Time of vaccination	Vaccine (s)	Comments
Within the first month of life	BCG	Only 1 dose
2 months of age (60+ days)	(DTaP, IPV, Hib: الخماسي المحسن), HepB, RotaV	Not in NIP at this age: PCV 13
3 months (90+ days)	(DTaP, IPV, Hib), HepB, RotaV, OPV	
4 months (120+ days)	(DTaP, IPV, Hib), HepB, RotaV, OPV	Final doses of Hib, HepB and RotaV. Not in NIP at 6mo: FluV
9 months	Measles, OPV	Monovalent measles
12 months	MMR, HepA	Not in NIP : Varicella
18 months	MMR, OPV[b], DTP[b], , HepA	Final MMR. [b] indicates booster
6 years, first grade	OPV[b], Td	Reduced diphtheria vaccine
10th grade	Td	Not in NIP: At 11 y: HPV, MCV4

Vaccines: BCG

- **Bacillus Calmette–Guérin** (the only bacterial live attenuated)

- Reduce disseminated and life-threatening manifestations of TB in young children (**meningitis and miliary TB**, 80% efficacy)

- Specific adverse events: generally not serious
  - 1%, **localized abscess and lymphadenopathy**.
  - Osteitis, as long as several years after BCG.
  - Disseminated (2 per 1 million).
  - Anti-tuberculosis recommended for osteitis and disseminated.

- Live vaccine contraindications.

Vaccines: HepB

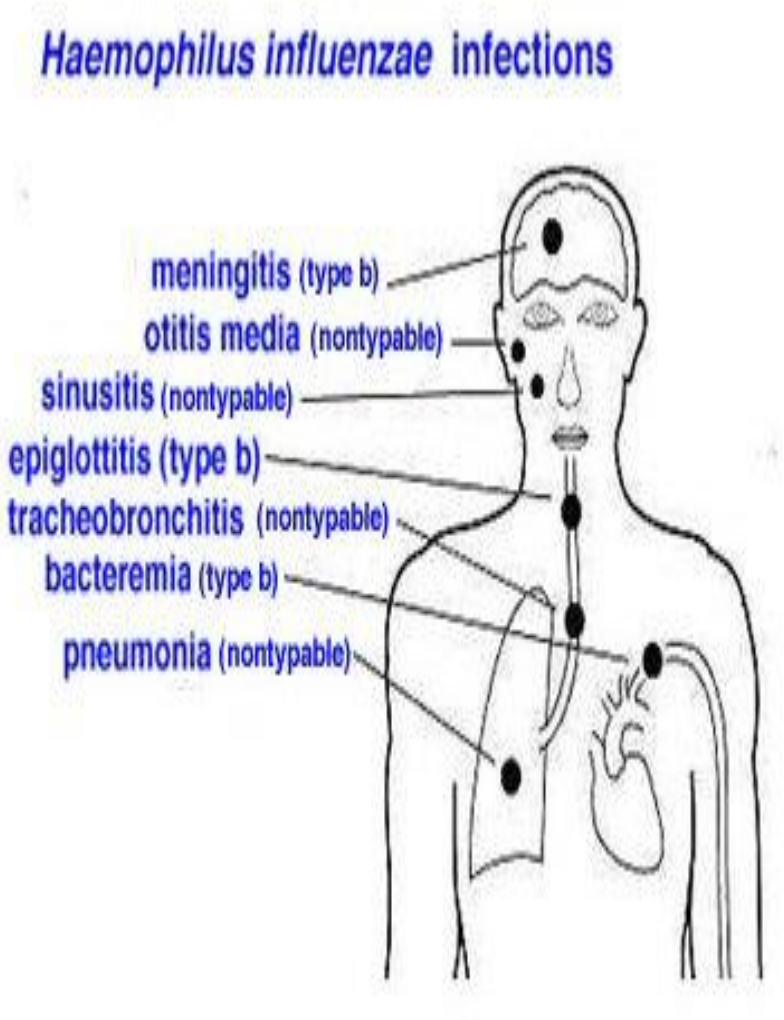
- **To whom?**
  1. Infants
  2. Adults at high risk.
  3. Special circumstances (infant born to a HepB +ve mother)

- **For infants born to HBsAg + mothers**: HepB vaccine and 0.5 mL of hepatitis B immune globulin (HBIG) within 12 hours of birth

- Efficacy 90-95%. Protection for 20 years or longer

Vaccines: Hib

- Typable H. influenzae include 6 serotypes from A to F including H. influenzae B.
- Haemophilus influenzae type B (Hib) was the most common cause of **childhood bacterial meningitis**.
- It is given to individuals at increased risk for invasive Hib:
  1. Splenic dysfunction,
  2. immuncompromised
  3. younger than 5 years of age
- Efficacy 95-100%
- Adverse events and contraindications



Vaccines: IPV/OPV

- The IPV covers all the 3 serotypes of poliovirus while OPV covers serotypes 1 and 3.

- Efficacy 99-100%

IPV

- **Type of vaccine?**
  - Inactivated/whole cell
- **Route of administration?**
  - IM
- **To whom?**
  - Can be given to immunocompromised people
  - Can be given to immunocompromised contacts of an infected/recently vaccinated person

OPV

- **Type of vaccine?**
  - Live attenuated
- **Route of administration?**
  - Oral
- **To whom?**
  - Only to immunocompetent people and who don’t have an immunocompromised household.

IPV

- **Advantages?**
  - No vaccine associated paralytic polio
  - Can be given to immunocompromised patients

- **Disadvantages?**
  - No mucosal immunity
  - No contact immunity
  - Harder to administer
  - Costly

OPV

- **Advantages?**
  - Mucosal immunity
  - Contact immunity
  - Use in outbreaks
  - Gives herd immunity
  - Easy to administer
  - Cheaper

- **Disadvantages?**
  - Vaccine associated paralytic polio

- **Contraindications:**
  - Immunodeficiency including antibody disorders,
  - household of immunocompromised child.

Vaccines: DTaP

- **Type of vaccine and components?**
  1. Inactivated/ Whole cell (DTP) (newer versions are **inactivated acellular DTaP; currently in use; it is a combined purified antigens; fewer side effects, more prolonged immune response and can be given to adults**)
  2. Tetanus and diphtheria are toxoid vaccines.

- There are several different types of vaccines that can safely prevent diphtheria, tetanus, and pertussis:
  1. **DTaP** (diphtheria, tetanus, and acellular pertussis) vaccine, which is given to children <7 yrs
  2. **DT** (diphtheria and tetanus) vaccine, which is given to children
  3. **Tdap** (combined tetanus, diphtheria and acellular pertussis) vaccine, which is given to adolescents and adults (including pregnant)
  4. **Td** (tetanus and diphtheria) vaccine, which is given to adolescents and adults (including pregnant)

- Tetanus and Diphtheria booster every 10 years.

- Efficacy: 98-100% after 5 doses

Side effects of the DTP vaccination

- **Mild** (Common):
  - **Fever, Redness, swelling, Soreness** (1 in 4)
  - Fussiness ,Tiredness or poor appetite and Vomiting (1 in 50).
  - These problems occur more often **after the 4th and 5th doses** of the DTP series than after earlier doses.

- **Moderate Problems** (Uncommon):
  - **Seizure** (1 in 14,000),
  - Non-stop crying for 3 hours or more (1 in 1,000)
  - High fever (1in 16,000)

- **Severe Problems** (Very Rare) :
  - Serious allergic reaction (1 in a million dose)
  - Long-term **seizures**, coma, or lowered consciousness
  - Permanent **brain damage**.

Vaccines: DTaP

- **Absolute Contraindications:**
  1. Encephalopathy **(e.g., coma, decreased level of consciousness; prolonged seizures)** within 7 days of previous dose (to pertussis vaccine)
  2. Anaphylactic reaction to a previous dose.

- **Relative contraindications:**
  1. **Progressive neurologic disorder (infantile spasms/ uncontrolled epilepsy/ progressive encephalopathy)**
     - vaccine postponed until symptoms are controlled
  2. **Temperature of 40.5° C or higher** within 48 hours after vaccination with a previous dose of DTP/DTaP
  3. **Collapse or shock-like state** (i.e., hypotonic hyporesponsive episode) within 48 hours after receiving a previous dose of DTP/DTaP
  4. **Seizure within 3 days** after receiving a previous dose of DTP/DTaP
  5. **Persistent, inconsolable crying** lasting 3 or more hours within 48 hours after receiving a previous dose of DTP/DTaP

Vaccines: Rota V

- Live attenuated; given orally.

- Contraindications:
  - Severe Combined Immune Deficiency.
  - History of intussusception

- Precautions:
  - Severe illness including gastroenteritis
  - Other types of immunodeficiency
  - Chronic GI illness

Latest Rotavirus Vaccines Recommendations

Rotarix (RV1)	RotaTeq (RV5)
2	3
6 wks	6 wks
20 wks	12 wks
24 wks	32 wks

	ACIP Reco 2009
Doses	--
Min age	6 wks
Max age- 1st dose	14 wks 6 days*
Max age- any dose	8 mon 0 days*

Vaccines: MMR

- Efficacy after 1 dose 95%, 2 doses 99%
- Live vaccine contraindications

- Side effects:

1. Measles-like rash (rash and fever) within 7 days
2. Arthralgia or arthritis (rubella component) (7-21 days after the vaccine)
3. Mild form of mumps (swelling of the cheek and neck): 3-4 weeks after vaccine.
4. Febrile seizures
5. Orchitis, parotitis (mumps component)
6. Thrombocytopenia (measles component)

❖**Vitamin A enhanced the antibody response to measles vaccine** given at 9 months of age significantly. And decrease the severity of measles infection.

Hepatitis A (HepA)

- Inactivated virus.
- Newly introduced in Jordanian National Program.
- Given IM × 2 doses (1st dose at 12 months with 6-month interval for the 2° dose).

VACCINES NOT PART OF THE JORDANIAN VACCINATION PROGRAM

Pneumococcal vaccine

There are 2 types of pneumococcal vaccines against Strep. pneumonia:

A. **Pneumococcal conjugated vaccine(PCV13):** Given for children **<2 years old** and can be given **for children older than 2 years?**
   1. Cystic fibrosis or chronic lung disease.
   2. Cochlear implants
   3. Patients with Splenectomy / Asplenia
   4. Immunocompromised patients (increased risk of infection)
   5. Nephrotic syndrome
   6. leaks of cerebrospinal fluid
   7. Sickle cell disease

B. **Pneumococcal polysaccharide vaccine (PPV)/ Pneumovax:** protects against 23 different types of pneumococcus bacteria. Given to **older children** and **adults**.

Meningococcal vaccine

- **What are the two types of meningococcal vaccine available in the US?:**

1. Tetravalent polysaccharide vaccine (MPSV4): For ages 2 years and up
2. Tetravalent polysaccharide-protein conjugate vaccine (MCV4): Less than 2 years

- Both protect against serogroups **A, C, Y, and W-135** of **Neisseria Meningitis**

- **There is new vaccine currently available against serogroup b**, which is actually the most prevalent and lethal one.

- **Whom is the vaccine given to?**

1. Impaired immunity: Nephrotic syndrome (immunoglobulin loss), Splenectomy and Complement deficiencies.
2. Travelers to areas endemic or epidemic with meningococcal infection.

Influenza vaccine

- **Type of vaccine?**
- Inactivated/Whole cell

- **Each injected seasonal influenza vaccine contains three killed influenza viruses:**

1. one influenza **type A subtype H3N2** virus strain
2. one influenza **type A subtype H1N1 (swine flu)** virus strain
3. one influenza **type B** virus strain

- Vaccination **before** the start of influenza seasons **annually** is usually recommended for any individual above 6 months of age.

- **Route of administration?**
- IM→ Killed

- Nasal spray→ live attenuated

Varicella vaccine

- Live attenuated

- First dose: 12- 15 months of age
- Second dose: up to 4 years of age

Thanks