Principles of Immunization

Objectives

1.Understand the types of acquired immunity

2.Differentiate between the different types of vaccines used in preventing illness

3.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

4.Define and understand the cold chain and its importance

Resources : Slides and Doctors notes

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Important | notes|extra

Editing file – Feedback

Session Overview

- Types of immunity.
- Types of vaccines.
- Specific types of vaccine, their mode of delivery, and schedule for important immunizable diseases.
- The cold chain

Introduction

Objectives of Understanding of the basic function of the immune system:

Understand how vaccines work.

Immunity

The ability of the human body to tolerate the presence of material indigenous to the body ("self"), and to eliminate foreign ("non-self") material.

This discriminatory ability provides protection from infectious disease, since most microbes are identified as foreign by the immune system.

Immunity to a microbe is usually indicated by the **presence of antibody** to that organism.

Immunity is generally **specific** to a single organism or group of closely related organisms.

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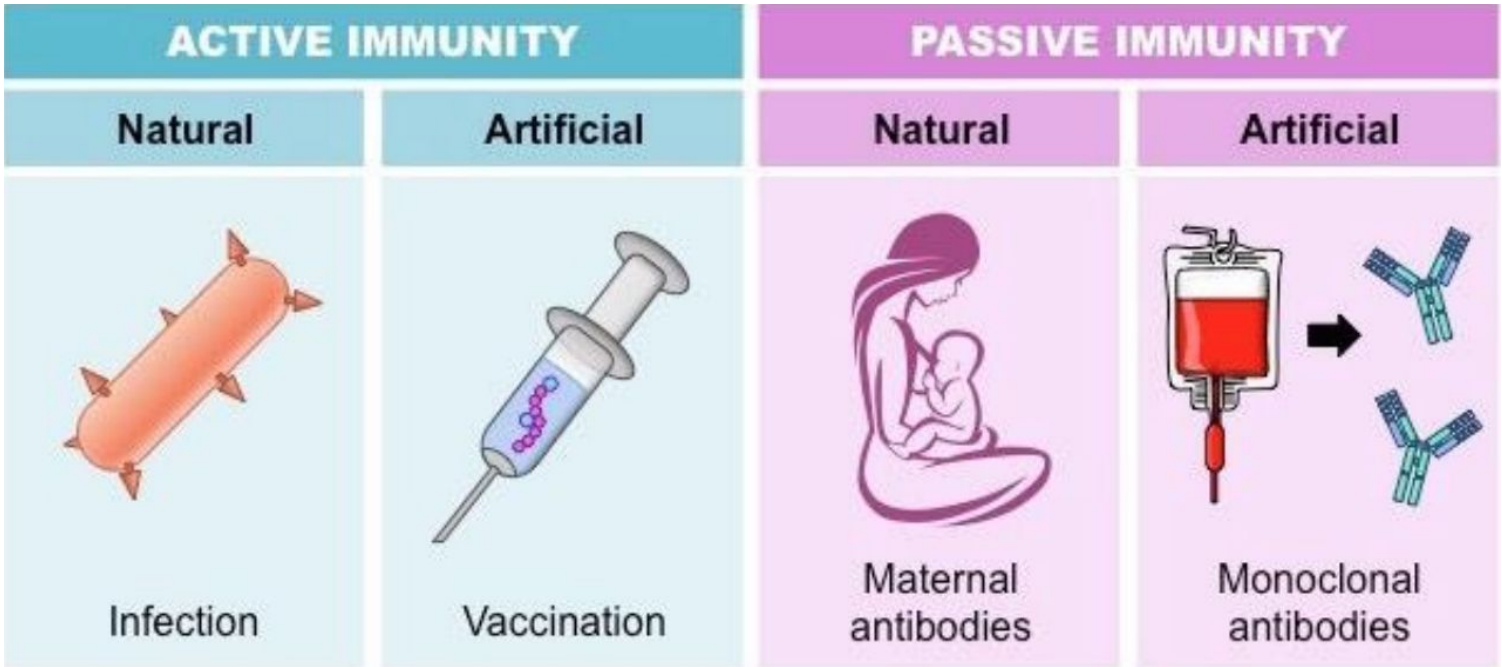
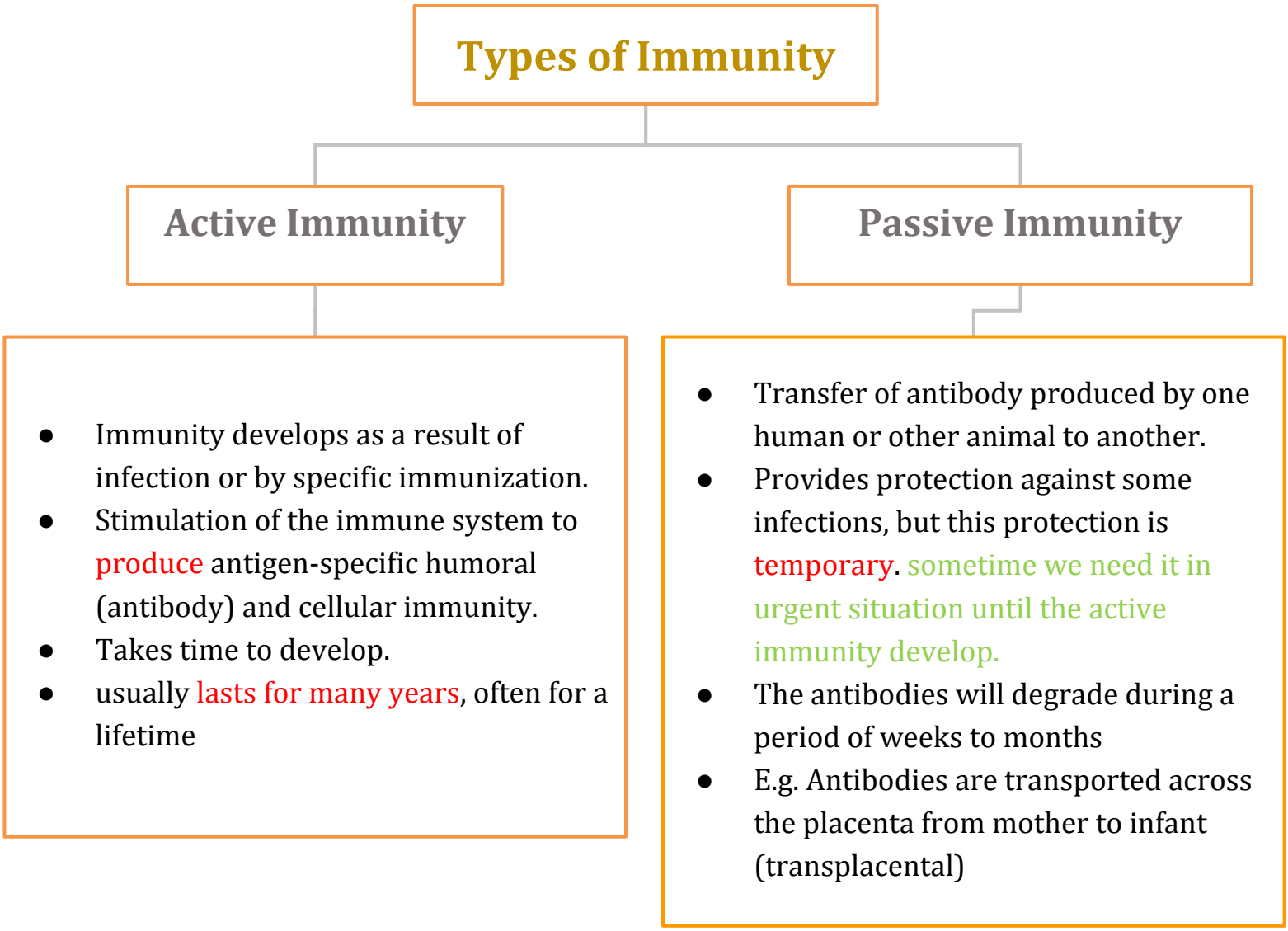


Types of acquired immunity

There are two basic mechanisms for acquiring immunity:

o Active

o Passive.



Advantages of active immunity compared to passive immunity:

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

Types of Immunity

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.

we don't have to vaccinate everyone to reach the herd immunity

Ways for acquiring active immunity

1.Following clinical infection

o once persons recover from infectious diseases, they will have lifelong immunity to that disease

o E.g. chickenpox, rubella and measles

2.Following immunization with an antigen

o Vaccines interact with the immune system and produce an immune response similar to that produced by the natural infection, but they do not subject the recipient to the disease and its potential complications.

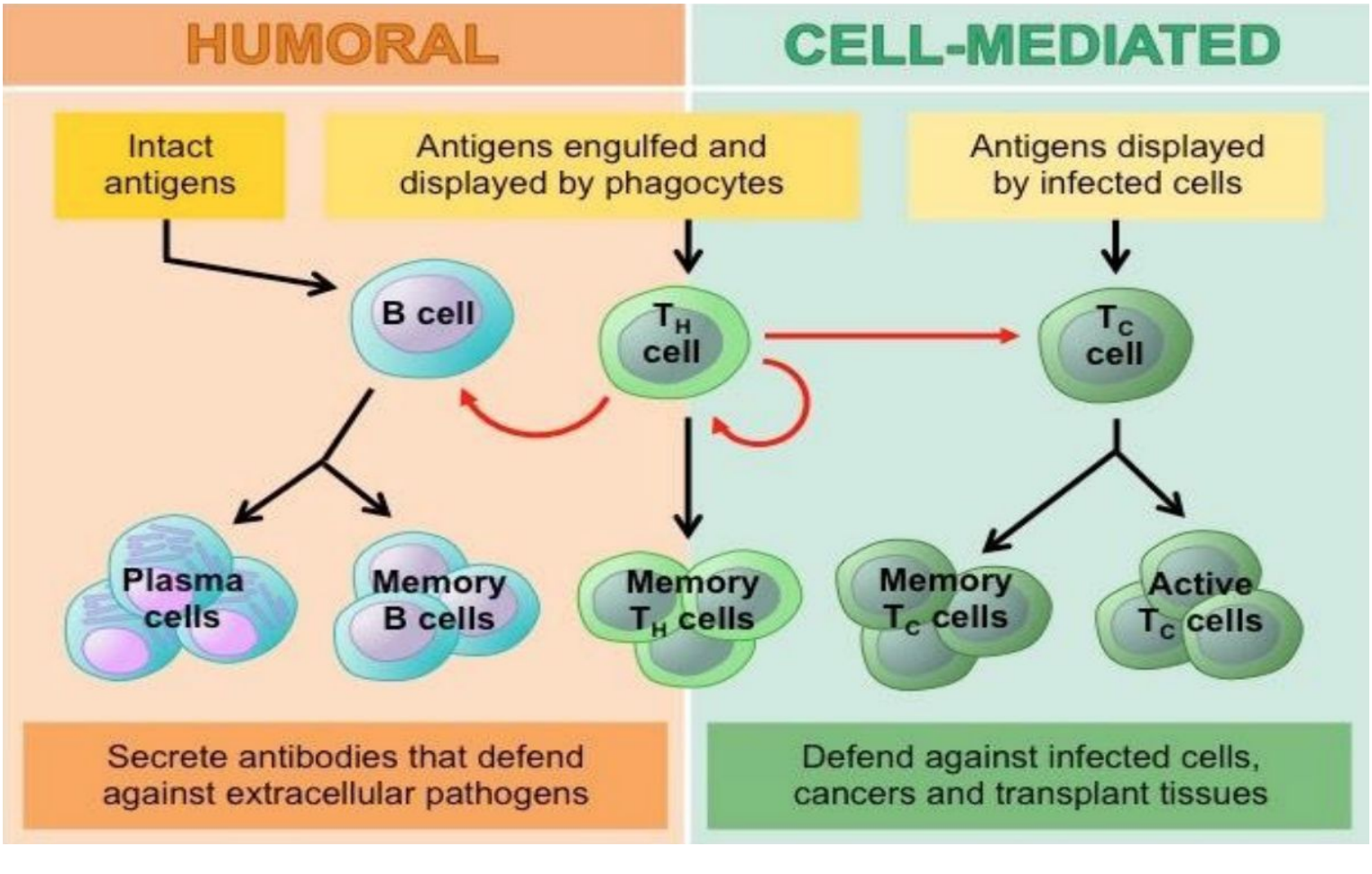
Types of Active Immunity

Humoral Immunity

- From B-cells (B-lymphocyte)
- Produce specific antibodies against foreign antigen.
- Immunoglobulins classes: IgG, IgM, IgD, IgA, IgE
- Antibodies are specific, they do not provide protection against more than one antigen

Cellular Immunity

- From mainly T-cells (T-lymphocyte)
- Recognition of antigen and initiation of a chain of responses e.g. activation of macrophage, release of cytotoxic factors, secretion of immunological mediators…
- Responsible for immunity against many diseases such as Tuberculosis and Brucellosis.



Classification of Vaccines

Vaccine

Immuno-biological substance designed to produce specific protection against a given disease.

It stimulates the production of protective antibody and other immune mechanisms.

Vaccination is the most effective medical strategy to control infectious diseases.

Vaccine may be prepared from:

- Live modified organisms
- Inactivated or killed organisms
- Extracted cellular fractions
- Toxoid
- Combination of these

Live Vaccines

Prepared from live or wild organisms (modified in laboratory)

These organisms lost their capacity to induce full disease but retain their immunogenicity.Stimulate the immune response but with no capacity to induce sign and symptoms

These wild viruses or bacteria are attenuated, or weakened, in a laboratory, usually by repeated culturing.

To produce an immune response, live attenuated vaccines must replicate (grow) in the vaccinated person. Otherwise no immune response will occur

More potent immunizing agents.

- Multiply in the host for a large antigenic dose
- Have all antigenic components.

Contraindications for administering live vaccine:

o Immunocompromised persons (leukemia, lymphoma or cancer)

o Persons with immune deficiency disease.

o Pregnancy

there will be risk of multiplication, therefore the immune system can't control it

Live attenuated vaccines produce immunity in most recipients with one dose, except those administered orally

A small percentage of recipients do not respond to the first dose of an injected live vaccine (such as MMR or varicella) and a **second dose is recommended to provide a very high level of immunity** in the population

Live attenuated vaccines are **fragile** and can be damaged or destroyed by heat and light. They must be handled and stored carefully.

Examples:

- **Viral vaccine**s
  - Measles, mumps, rubella, varicella, zoster, yellow fever, rotavirus, and influenza (intranasal).
  - Oral polio vaccine (OPV)
- **Bacterial vaccines**
  - Bacille Calmette-Guérin (BCG)
  - Oral typhoid

Inactivated or Killed 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.

Some inactivated vaccines may require periodic supplemental doses to increase, or "**boost**," antibody titers.

Usually administered by **subcutaneous** or **intramuscular** route Not given orally because it can't cross the mucosal barrier

More stable than live vaccine. Transport cost much less than the live vaccine

Contraindication:

o Severe local or general reaction to a previous dose.

Example:

o Polio, Hepatitis A, Rabies

o Pertussis, Typhoid, Cholera, Plague

Subunit Vaccines

Vaccine made of single or multiple **antigenic components** of a microorganism that are capable of stimulating a specific immune response sufficient to protect from the relevant pathogen infection or from the clinical manifestation of the disease.

o Toxoids

o Protein vaccines

o Recombinant protein vaccines

o Polysaccharide-based vaccines

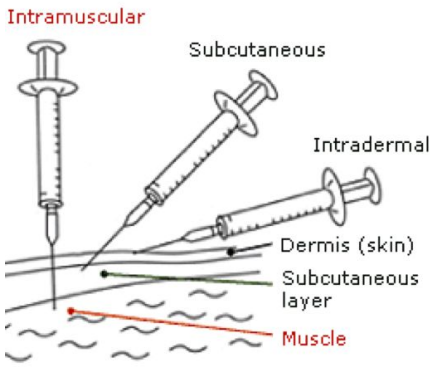
o Combinations

Toxoids	• Certain organisms produce exotoxins, e.g., diphtheria and tetanus bacilli. • The toxins produced by these organisms are **<u>detoxicated</u>** and used in the preparation of vaccines. • In general, toxoid preparations are highly efficacious and safe☆ immunizing agents.
Protein vaccines	• Proteins can be purified from in-vitro cultures of a pathogenic microorganism. • **Pertussis vaccines** currently available contain from two to four different proteins purified from B. pertussis and are able to confer protection against whooping cough comparable to that obtained with the whole cell vaccine. • The influenza vaccine it can be other than protein vaccine depending on the strain and mode of administration

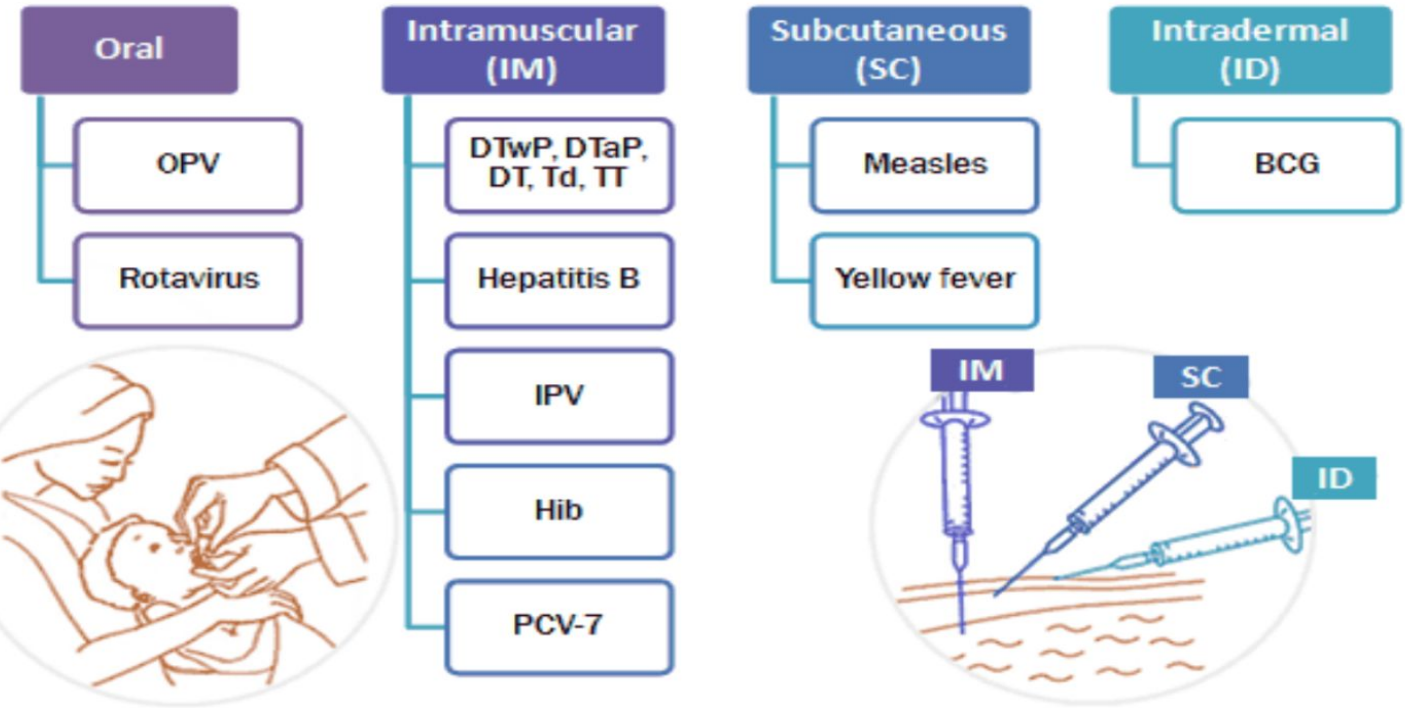
Polysaccharide-based vaccines	• Stimulation of an antibody response against the surface polysaccharide of pathogenic bacteria is a strategy for the development of vaccines against **capsulated** bacteria. • The chemical structure or capsular polysaccharides varies between different strains within a single species and As a consequence, a limitation of polysaccharide-based vaccine is that the **immune responses they elicit are often serotype specific**. • **Examples**: S. pneumoniae, Hib (haemophilus influenza type B), and Salmonella
Combinations	• 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 **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

- 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.



Oral administration	Intramuscular (IM) injection	Subcutaneous (SC) injection	Intradermal (ID) injection
Oral administration of vaccine makes immunization easier by eliminating the need for a needle and syringe.	Administers the vaccine into the muscle mass. infant < 1 in the thigh, >1 in the lateral aspect of the arm Vaccines containing adjuvants(ex.Aluminium) 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.



immunization Schedules

The immunization schedule is different in each country depending on the (epidemic and pandemic infections). For example BCG vaccine is mandatory in Saudi arabia and other developing countries, while it's not in united states and other western countries.

BCG	–	Birth – 2 weeks
OPV	–	Birth; 6 weeks, 10 weeks and 14 weeks; 16–18 months, 5 years
DPT	–	6 weeks, 10 weeks and 14 weeks; 16–18 months and 5 years
Hepatitis B	–	Birth, 6 weeks and 14 weeks *or* 6 weeks, 10 weeks and 14 weeks
Hib Conjugate	–	6 weeks, 10 weeks and 14 weeks
Measles	–	9 months, 16–24 months
MMR	–	15 months Not before one year
Typhoid	–	2 years, 5 years, 8 years, 12 years
TT/Td	–	10 years, 16 years
TT	–	2 doses one month apart for pregnant women, or booster dose if previously immunized.

Vaccines that can be given after discussion with parents

Varicella	–	15 months (or after 1 year)
Hepatitis A	–	high-risk selected infants, 18 months, and 6 months later
Pneumococcal conjugate vaccine	–	6 weeks
Influenza vaccine	–	6 months of age to high risk selected infants anually

Examples of Currently Used Vaccines

Vaccine	Type	Mode of administration
Measles	Live attenuated	Subcutaneous
Rubella	Live attenuated	Subcutaneous
Mumps	Live attenuated	Intramuscular
Diphtheria	Toxoid	Intramuscular
Pertussis	whole-cell pertussis vaccines and acellular pertussis vaccines	Intramuscular

The "Cold Chain"

a system of storage and transport of vaccines at low temperature from the manufacturer to the actual vaccination site.

it's Important to avoid the "vaccine failure"

The success of national immunization programme is highly dependent on supply chain system for delivery of vaccines and equipment, with a functional system that meets **6 rights** of supply chain (The right vaccine in the right quantity at the right place at the right time in the right condition (no temperature breaks in cold chain) and at the right cost

Summary

- **How to acquire immunity?**

1- following clinical infection 2- following immunization

- **Acquired immunity:**

1. **Active** (stimulated immune system): takes time to develop – lasts for a long time
2. **Passive** (antibodies from outside): from animals or other human – temporary

- **Herd immunity**: Vaccinated portion of the population protects unvaccinated portion.

- **Cold chain**: system of storage and transport of vaccines from manufacturer to recipient.

  - includes "6 rights"

  - Important to avoid "vaccine failure"

Vaccines		
Types	**1- Live Vaccine**	**2- Inactivated Vaccine**
About	- From weakened (attenuated) organism but immunogenic. - MUST replicate in the body. - Mostly one dose except oral. - Fragile to handle and store.	- Inactivated or killed organism. - Cannot replicate. - Always multiple doses. - May need booster doses. - SC or IM but NEVER oral. - More stable to handle.
Contraindications	- Immunocompromised - Immunodeficient - Pregnant	- Local or general reaction to the dose. - But it's good for low immunity patients.
Examples	Virus :- Measles, Mumps, rubella - Oral polio vaccine (OPV) Bacteria: - BCG (for TB) - Oral typhoid	- Hepatitis A, Polio, Rabies - Pertussis, Typhoid

Subunit vaccines				
Types	**Toxoids**	**Protein Vaccines**	**Polysaccharide based Vaccines**	**Combination**
About	- Organisms that produce exotoxins (Diphtheria, Tetanus) - Exotoxin gets detoxicated to make the vaccine. - Effective - SAFE	- Purified proteins of the organism. - Pertussis vaccine was found to protect from whooping cough as good as whole cell vaccine.	- From polysaccharides on the surface of capsulated bacteria. - Limitation: serotype specific. - Strep. Pneumo, Hib, salmonella	- More than one kind of immunizing agent. - examples: MMR, DPT, DPTP…

Community Medicine

THE END

436 TEAMS