VACCINES

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Introduction to Vaccines

- **Definition**: Vaccines are biological preparations that stimulate the immune system to recognize and fight specific pathogens (bacteria or viruses).
- They contain weakened, inactivated, or fragments of microbes.
- **Purpose**: To prevent diseases by inducing immunity without causing illness.
- Vaccines are a major tool in disease eradication and prevention.

Historical Background

- **1796 – Edward Jenner**: First successful smallpox vaccine using cowpox virus.
- **1880s – Louis Pasteur**: Developed vaccines for rabies and anthrax.
- **20th century**: Polio vaccine (Salk and Sabin), BCG for tuberculosis.
- **21st century**: mRNA vaccines (COVID-19), HPV, malaria vaccines.

Importance of Vaccination

- Prevents life-threatening infectious diseases.
- Protects both individuals and communities (herd immunity).
- Eradicated smallpox and drastically reduced diseases like polio and measles.
- Reduces healthcare burden, disability, and mortality.
- Essential in public health programs and global health initiatives.

How Vaccines Work

1. **Introduction of Antigen**: A harmless form of the pathogen (or its toxin) is introduced.
2. **Immune Activation:** The immune system recognizes it as foreign and produces antibodies.
3. **Memory Formation**: Memory B and T cells are created.
4. **Future Protection**: Upon real infection, the immune system responds faster and more effectively.

Types of Vaccines

1.Live Attenuated Vaccines :

Contain weakened form of the virus/bacteria.

Strong and long-lasting immunity.

Examples: MMR, BCG, oral polio.

2. Inactivated (Killed) Vaccines:

Microbes are killed by heat/chemicals.

Safer but may need boosters.

Examples: Inactivated polio (IPV), hepatitis A.

3. Subunit, Recombinant, and Conjugate Vaccines:

Use specific parts (antigens) of the pathogen.

Lower risk of side effects.

Examples: Hepatitis B, HPV, Hib .

4. Toxoid Vaccines:

Use inactivated toxins (toxoids).

Examples: Tetanus, diphtheria.

5. mRNA and DNA Vaccines:

Contain genetic instructions to produce antigen inside host.

Examples: Pfizer-BioNTech and Moderna COVID-19 vaccines.

Components of a Vaccine

- **Antigen:** The active component that triggers immune response.
- **Adjuvants:** Enhance the body's immune response to the antigen.
- **Preservatives:** Prevent contamination (e.g., thimerosal).
- **Stabilizers:** Maintain effectiveness during storage.
- **Diluents:** Liquids used to dilute a vaccine to proper concentration.

Immunization Schedule

- Set by WHO and national health bodies.
- Examples of childhood vaccines:
- BCG – At birth
- DPT – 6, 10, 14 weeks
- MMR – 9 months
- Polio – OPV/IPV
- Hepatitis B – Birth, 1, 6 months
- **Booster doses** are required to maintain long-term immunity.

Eligibility	Vaccine/s
Infants & children	
At Birth	BCG, OPV – 0, Hepatitis – B
6 weeks of age	Pentavalent – 1, Rotavirus vaccine – 1, fIPV (inactivated Polio, fractional dose) – 1, OPV – 1, Pneumococcal Conjugate vaccine (PCV) – 1
10 weeks of age	Pentavalent – 2, Rotavirus vaccine – 2, OPV – 2
14 weeks of age	Pentavalent – 3, Rotavirus vaccine – 3, fIPV (inactivated Polio, fractional dose) – 2 OPV – 3, Pneumococcal Conjugate vaccine (PCV) – 2
9 – 12 months of age	Measles-Rubella – 1, PCV – booster, Vitamin A – first dose, fIPV – 3, JE* – 1
16 – 24 months of age	DPT – first Booster, OPV booster, Measles-Rubella – 2, JE* – 2, Vitamin A – second dose followed by every 6 months till 5 yr. age
5 – 6 years of age	DPT second booster
10 and 16 years of age	Td
Pregnant women	
Pregnant Woman	Td 1 & Td 2 (Td – booster only if vaccinated within previous 3 years)
* JE in endemic Districts only	

Adverse Effects of Vaccines

- **Mild**: Local pain, swelling, mild fever.
- **Moderate**: Allergic reactions, febrile seizures.
- **Severe (rare):** Anaphylaxis, Guillain-Barré syndrome.
- **Monitoring systems:** AEFI (Adverse Events Following Immunization) surveillance ensures safety.

Challenges in Vaccination

- **Vaccine Hesitancy**: Due to misinformation and cultural beliefs.
- **Cold Chain Maintenance**: Proper storage and transport of vaccines.
- **Accessibility**: Rural and low-income populations often lack access.
- **Mutation of Pathogens**: E.g., influenza virus needs yearly vaccine updates.

Future of Vaccination

- **mRNA and DNA Technologies**: Rapid development and customization.
- **Cancer Vaccines**: Personalized vaccines targeting tumors.
- **Universal Vaccines**: Efforts to develop universal flu or coronavirus vaccines.
- **Needle-free Vaccines:** Nasal sprays, patches, edible vaccines.

Conclusion

Vaccines are one of the greatest achievements in medical science.

They have drastically reduced infectious disease burden.

Continued public awareness, research, and vaccination coverage are crucial for global health security.

THANKS !