

Module 2. Cultural knowledge - Topic 4. Understanding vaccines and vaccination

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1. INTRODUCTION

Vaccination is intended to protect individuals against diseases caused by bacteria or viruses. The first vaccine was developed in the 1798 by Edward Jenner and was about smallpox. Since then, at least 31 human diseases have been prevented due to vaccination. The understanding of the immune system and response has offered great advantages in antigen selection and vaccine delivery platforms. The impact of vaccines depends on the acceptance and cognitive of the value brought to society (Stern, 2016).

2. AIMS

The aim of this learning unit is the understanding of the way vaccines work, the vaccines' role in herd immunity and the differences between vaccine types.

3. LEARNING OUTCOMES

At the end of this training, the participants will be able to:

- Recognize the different types of vaccines.
- Comprehend the ways vaccines work.
- Understand the meaning of immunity and the involvement of vaccines in it.

4. THEORETICAL FRAMEWORK

4.1. Concepts and definitions

Vaccine: According to World Health Organization, vaccine is a simple, safe and effective way of protecting people against harmful diseases, before coming into contact with them. It uses body's natural defences to build resistance to specific infections and makes the immune system stronger. Vaccines train the immune system to create antibodies, just as it does when it's exposed to a disease (*Vaccines and immunization: What is vaccination?*, n.d.).

Types of vaccines:

- Live attenuated vaccines: The virus or bacteria is functional/alive but weakened so it can replicate in the body several times and generate an immune response without causing the disease, e.g., chickenpox, measles, tuberculosis. Live attenuated vaccines do not usually cause disease in vaccine recipients who have a healthy immune system. If administered to a person who has an impaired immune system response, a live attenuated vaccine may cause severe disease as a result of uncontrolled growth of the vaccine-virus.
- Inactivated or dead vaccines: Inactivated vaccines do not contain live viruses or bacteria. Viruses in these vaccines are inactivated or split, e.g., polio or influenza. These types of vaccine can be safely given to a person with an impaired immune system response.
- Subunit vaccines: These vaccines present proteins or sugars derived from the disease-causing organism. Protein or pure polysaccharide vaccines cannot cause the disease and the inclusion of adjuvants in some vaccines help generate an immune response. Also, there are the nucleic acid-based vaccines (like COVID-19 vaccine), that use the host's own cell machinery to make the antigen, which is then presented to the immune system (National Institute of Allergy and Infectious Disease).

Herd immunity: Herd immunity occurs when a high percentage of the community is immune to a disease (through vaccination and/or prior illness), making the spread of this disease from person to person unlikely. Even individuals not vaccinated (such as new-borns and the immunocompromised) are offered some protection because the disease has little opportunity to spread within the community. Herd immunity depends on the contagiousness of the disease. Diseases that spread easily, such as measles, require a higher number of immune individuals in a community to reach herd immunity. Herd immunity protects the most vulnerable members of our population. If enough people are vaccinated against dangerous diseases, those who are susceptible and cannot get vaccinated are protected because the germ will not be able to “find” those susceptible individuals (Association for Professionals in Infection Control and Epidemiology, 2021).

4.2. What the research says

- **Slifka, M. K., & Amanna, I. (2014). How advances in immunology provide insight into improving vaccine efficacy. *Vaccine*, 32(25), 2948–2957. <https://doi.org/10.1016/j.vaccine.2014.03.078>**
Because of the vaccines, many lives have been saved and the burden of infectious diseases has been reduced significantly. Most successful vaccines have been developed empirically, but recent advances in immunology are beginning to shed new light on the mechanisms of vaccine-mediated protection and development of long-term immunity. Although natural infection will often elicit lifelong immunity, almost all current vaccines require booster vaccination in order to achieve durable protective immune responses. The form of the vaccine antigen (e.g., soluble or particulate/aggregate) appears to play an important role in determining immunogenicity and the interactions between the immune cells.
- **Sallusto, F., Lanzavecchia, A., Araki, K., & Ahmed, R. (2010). From Vaccines to Memory and Back. *Immunity*, 33(4), 451–463. <https://doi.org/10.1016/j.immuni.2010.10.008>**
Vaccines work by eliciting an immune response and immunological memory that mediates protection from infection or disease. Recently new methods have been developed to dissect the immune response in experimental animals and humans which have led to increased understanding of the molecular mechanisms that control memory T and B cells. This study is an overview of the cellular organization of immune memory. Also, it underlines some of the questions on immunological memory and vaccination strategies.
- **Commun N. (2018). Vaccines work. *Nature Communications*, 9(1), Article 1. <https://doi.org/10.1038/s41467-018-04085-z>**
Vaccination has successfully reduced the burden of infectious diseases worldwide, but stagnating immunization coverage and lack of effective vaccines for many endemic and newly emerging pathogens pose a threat to sustainable global health. The World Health Organization (WHO) estimates that an average of 2 to 3 million deaths are prevented every year, thanks to worldwide vaccinations. Many more lives are protected from acute disease and life-long disabilities caused by infections.
- **Afrough, B., Dowall, S., & Hewson, R. (2019). Emerging viruses and current strategies for vaccine intervention. *Clinical and Experimental Immunology*, 196(2), 157–166. <https://doi.org/10.1111/cei.13295>**
During the past decade several viruses have suddenly become serious global health threats, causing concern about their epidemic transmission in immunologically naive human populations., Vaccines are considered a critical component of disease prevention for emerging viral infections because, in many cases, other medical options are limited or non-existent, or that infections result in such a rapid clinical deterioration that the effectiveness of therapeutics is limited. Apart from classic approaches to vaccine development, the application of molecular techniques in virology has made a great difference in understanding the virus biology.

- **Kim, T. H., Johnstone, J., & Loeb, M. (2011). Vaccine herd effect. *Scandinavian Journal of Infectious Diseases*, 43(9), 683–689. <https://doi.org/10.3109/00365548.2011.582247>**
The herd effect (or herd immunity) is a way to extend vaccine benefits beyond one directly targeted population. It refers to the indirect protection of unvaccinated people, whereby an increase in the prevalence of immunity by the vaccine prevents circulation of infectious agents in susceptible populations. The herd effect has had a major impact in: the eradication of smallpox, the reduction of pertussis' transmission, and the protection against influenza and pneumococcal disease.
- **Kramarz, P., Lopalco, P. L., Huitric, E., & Celentano, L. P. (2014). Vaccine-preventable diseases: The role of the European Centre for Disease Prevention and Control. *Clinical Microbiology and Infection*, 20, 2–6. <https://doi.org/10.1111/1469-0691.12430>**
The role of the European Centre for Disease Prevention and Control (ECDC) is to strengthen the capacity of the European Union (EU) Member States to protect human health through the prevention and control of infectious diseases. The main objective of the program on vaccine-preventable diseases is to provide evidence and high-quality technical support to the EU Member States. In addition to surveillance of diseases, ECDC is collecting information and monitoring other parameters that are of crucial importance for a well-functioning immunization system, including vaccination coverage.

5. LEARNING ACTIVITIES

Activity 1 (duration: 15 minutes):

No.	Title and description of the resource	Type	Language of resource	Learning, training, assessment and evaluation activities	Access URL/download
1.	How do vaccines work	Video 2'27''	English*	Individual learning Presentation	https://www.youtube.com/watch?v=-muloWofsCE&ab_channel=OxfordVaccineGroup
2.	Vaccines and Herd Immunity	Video 4'49''	English*	Individual learning Presentation	https://www.youtube.com/watch?v=kLUzwT9tWxY&ab_channel=BozemanScience

*Subtitles auto-generated in all languages


Watch the videos “How do vaccines work” and “Vaccines and Herd Immunity” with durations 2'27” and 4'49” respectively.

- Discuss the information presented in the videos. After the discussion, the students should be able to answer the following questions:
 1. How does the immune system work?
 2. How do vaccines enable the body to make the right sort of antibodies to fight a disease?
 3. How do immune individuals in a population give the entire group's herd immunity?
 4. What is herd immunity threshold?
- Resources needed: online video on Youtube, social platform for individual or collaborative learning.

Activity 2 (duration: 15 minutes):


No.	Title and description of the resource	Type	Language of resource	Learning, training, assessment and evaluation activities	Access URL/ download
1.	Types of vaccines	comic image	English	Individual learning	https://media.chop.edu/data/files/pdfs/types-of-vaccines.pdf
2.	Types of vaccines	Article	English	Individual learning	https://www.health.mil/Military-Health-Topics/Health-Readiness/Immunization-Healthcare/Clinical-Consultation-Services/Types-of-Vaccines

WEAKEN THE VIRUS



Viruses are weakened so they reproduce poorly inside the body.

INACTIVATE THE VIRUS




Viruses are completely inactivated (killed) with a chemical.

TYPES OF VACCINES


USE PART OF THE PATHOGEN

USE PART OF THE PATHOGEN



Part of the virus or bacteria is used as the vaccine.

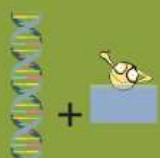
INACTIVATE THE TOXIN



A harmful protein made by the bacteria (toxin) is inactivated (killed) with a chemical. The inactivated toxin is called a toxoid.


USE PART OF THE GENETIC CODE

VECTOR VIRUS




The gene from the pathogen is put into a virus that can't reproduce itself but can still enter cells and deliver the gene.

mRNA



mRNA that is the blueprint for a protein from the pathogen is used as the vaccine.

DNA



DNA, the genetic code from which mRNA is made, is used as the vaccine.

GO TO [VACCINE.CHOP.EDU/TYPES-OF-VACCINES](https://vaccine.chop.edu/types-of-vaccines) FOR MORE INFORMATION.

- See the picture and read the article.
- Answer the following questions:
 1. What are the types of vaccines?
 2. Give examples for each vaccine type.

Activity 3: Crossword Puzzle (duration: 10 minutes) (Optional. Only in English language):

- Fill out the crossword puzzle with the suitable term or sentence concerning the understanding of vaccine and vaccination. Available [here](#). Please upload a screenshot or pdf file of the solved puzzle on the platform for collaborative learning.
- Resource: Crossword Labs a tool for creating online crosswords; social platform for collaborative learning.

6. ASSESSMENT ACTIVITIES

Quiz: True or False (duration: 5 minutes):

1. MMR (Measles/Mumps/Rubella) is a live/attenuated vaccine.
2. Herd immunity threshold is the same for all the diseases.
3. Immunocompromised people can get vaccinated with live/attenuated vaccines.

7. REFERENCES

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