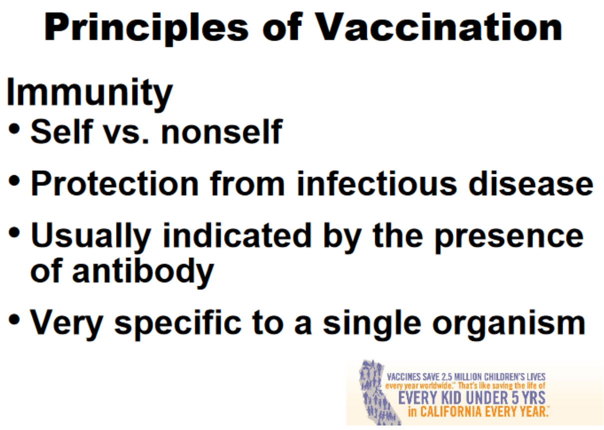
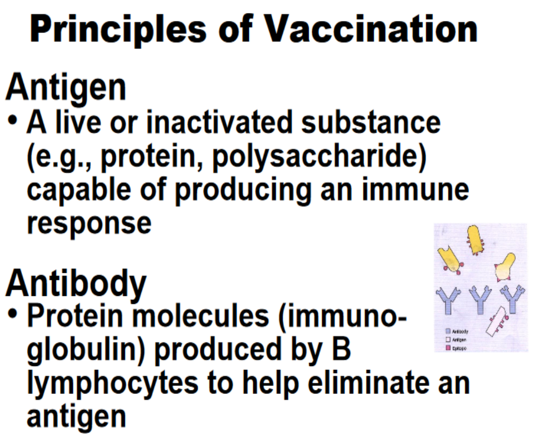
GENERAL MICROBIOLOGY LECTURE - week 10

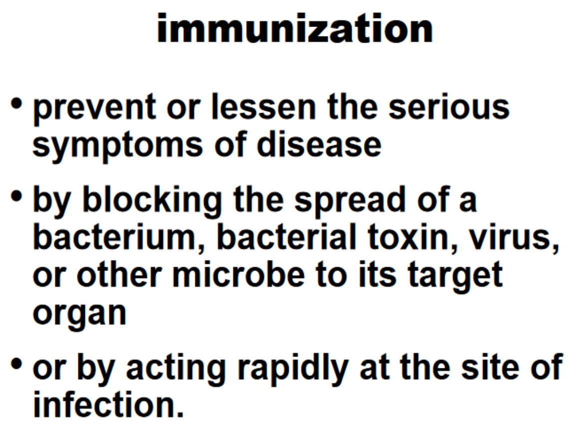
Principles of Vaccination.

Disinfection, Sterilisation.

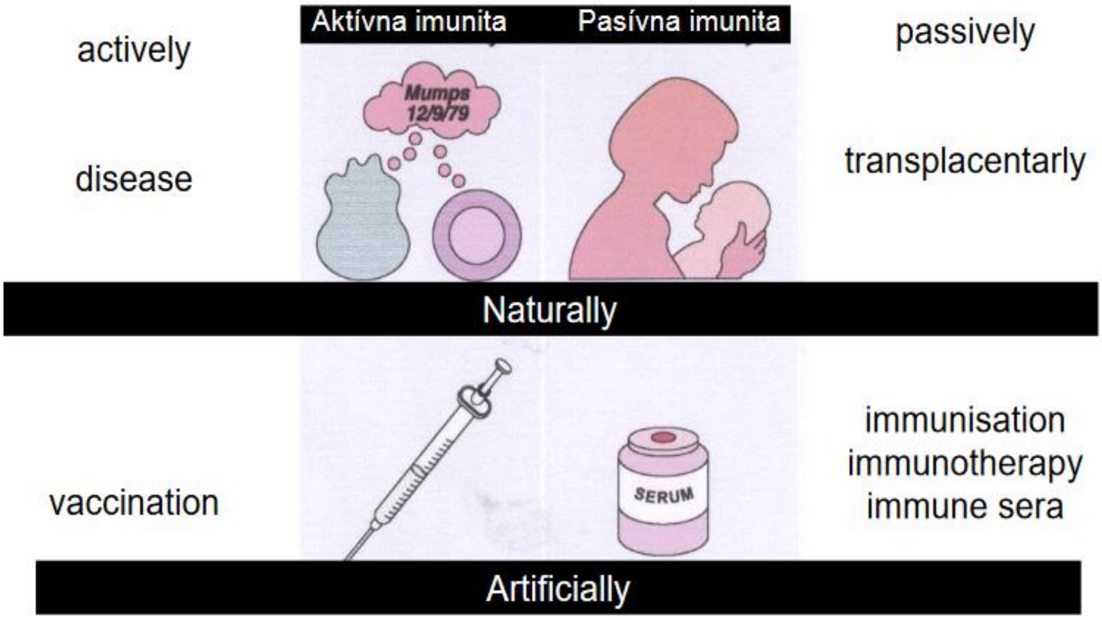


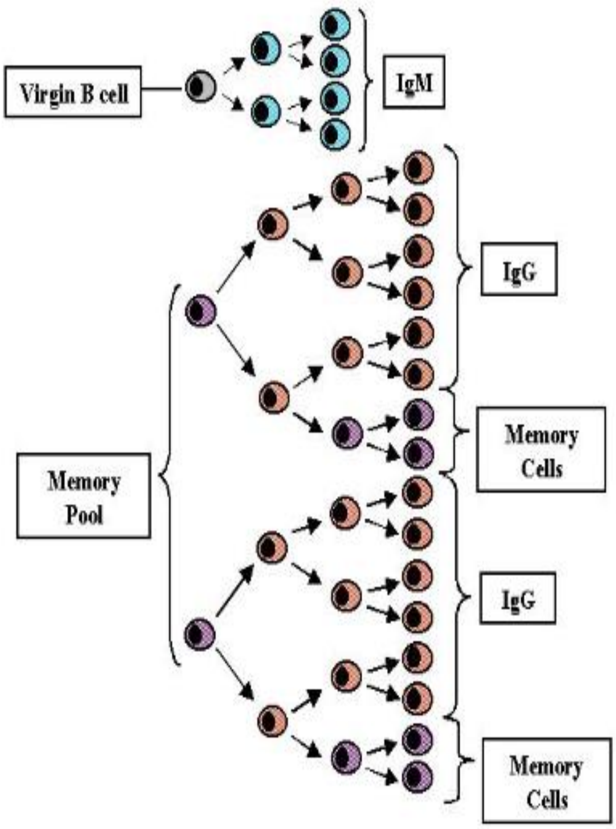
Vaccination can provide excellent protection to a population, even if not every individual in a population is vaccinated, because of a phenomenon known as **herd immunity**. As the fraction of the population that is vaccinated increases, the chances of an infectious agent “finding” an unprotected individual becomes increasingly smaller, leaving the population resistant as a whole. There are limits to herd immunity, however. If a significant number of unprotected individuals become infected, the infection could spread rapidly through the unprotected members of the population. In the course of that rapid replication, new mutant forms might arise that could evade the immune response and produce disease in vaccinated individuals as well.

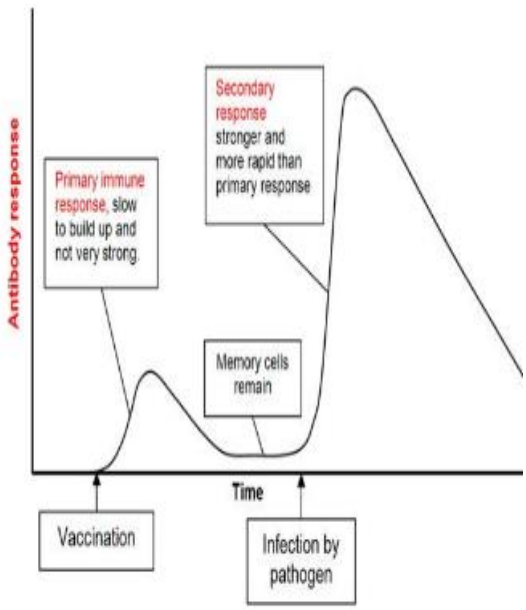




Way to get immunised







Types of vaccines

Vaccines can be prepared from a variety of materials derived from pathogenic organisms. **Live vaccines** are based on living organisms capable of normal infection and replication. Such vaccines are not appropriate for pathogens that are capable of causing severe or life-threatening diseases.

Live Attenuated Vaccines

- Severe reactions possible
- Interference from circulating antibody
- Fragile – must be stored and handled carefully

Pure Polysaccharide Vaccines

- Not consistently immunogenic in children younger than 2 years of age
- No booster response
- Antibody with less functional activity
- Immunogenicity improved by conjugation

Attenuated vaccines are based on organisms that are living but have had their virulence and ability to replicate reduced by treatment with heat, chemicals, or other techniques. Attenuated vaccines typically cause only subclinical or mild forms of the disease at worst, but they do carry the possibility that mutation might enable the organisms in the vaccine preparations to revert to wild type.

Killed vaccines include organisms that are dead because of treatment with physical or chemical agents. In the case of toxins, they will have been inactivated (toxoids). They should be incapable of infection, replication, or function but still able to provoke immunity. It must be understood, however, that it might be difficult to guarantee that every organism in a preparation is dead.

Extract vaccines do not contain whole organisms but are composed of materials isolated from disrupted and lysed organisms but not whole organisms. These vaccines are most suitable for providing protection against diseases in which the organisms are so virulent that even killed vaccines are not used because of the risk that even a few organisms might have survived treatment.

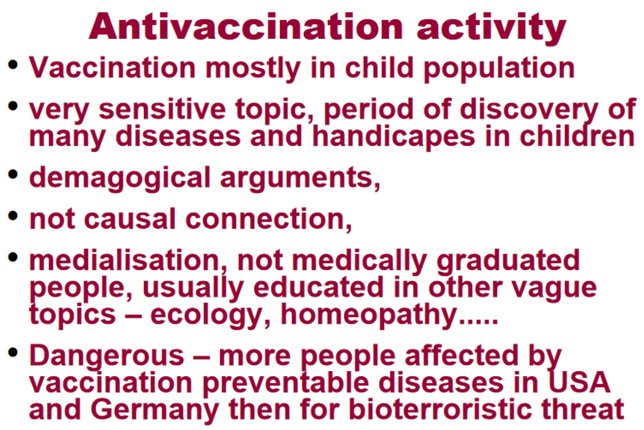
Recombinant vaccines have been made possible by molecular biology techniques that allow creation of organisms from which the removal of certain genes impairs their virulence and/or reproduction. Such organisms can infect host cells and perhaps even proliferate but cannot induce disease.

DNA vaccines are those in which the host is injected with naked DNA extracted from a pathogen. The DNA is also often engineered to remove some of the genes that are critical to development of the disease. The objective is for host cells to take up the naked DNA and express the gene products from the pathogen. DNA vaccine stimulus typically lasts longer than other methods in which the vaccine is rapidly eliminated from the host.

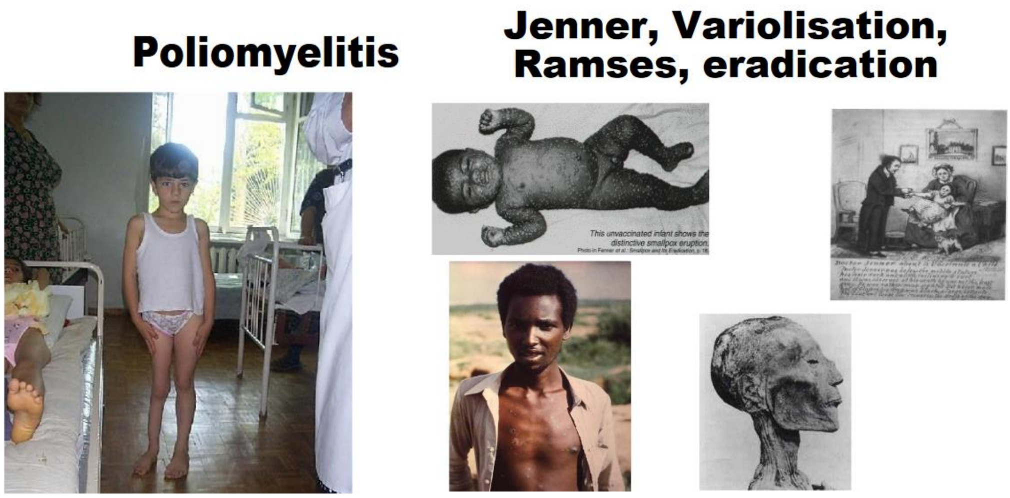
As a rule, live vaccines are best at generating immune responses, followed by attenuated vaccines, and then by killed vaccines and extracts. Replicating organisms produce the molecules that stimulate the immune responses, but killed and extract vaccines might contain few or none of those molecules. Thus, paradoxically, the safety of a vaccine may be inversely proportional to its effectiveness. The coadministration of adjuvants can heighten the effectiveness of many vaccines.

Adjuvants

Adjuvants are bacterial components or other substances, typically suspended in a medium such as oil that prolongs their dispersal into the tissues, administered together with vaccines to heighten the effectiveness of the vaccination. The bacterial (or other) material provokes a mild inflammation that attracts phagocytes and accelerates their activation and antigen presentation to T cells for development of specific adaptive immune responses.
Some vaccine components themselves can serve as adjuvants. The pertussis component (from *Bordetella pertussis*) in **DTP** (Diphtheria-Tetanus-Pertussis) vaccine is also an effective adjuvant. Other adjuvants include alum and **BCG** (Bacillus Calmette Guerin). BCG includes material derived from *Mycobacterium* and is in wide use around the world as a vaccine against tuberculosis, particularly in areas of high incidence. Its use has declined in some areas where the incidence of tuberculosis has significantly declined. In the United States (and several other countries), BCG is not used routinely for human vaccinations because it interferes with the use of skin testing (creating false positives) in tuberculosis studies and because of adverse reactions (e.g., disseminated BCG infection). However, BCG is still used in the United States for certain high-risk individuals or populations.



EXAMPLES OF PREVENTABLE DISEASES:



DISINFECTION, STERILISATION

Terminology

Antisepsis: Prevention of infection by inhibiting or arresting the growth and multiplication of germs (infectious agents). Antisepsis implies scrupulously clean and free of all living microorganisms.

Disinfection describes a process that eliminates many or all pathogenic microorganisms, except bacterial spores, on inanimate objects. In health-care settings, objects usually are disinfected by liquid chemicals or wet pasteurization. Each of the various factors that affect the efficacy of disinfection can nullify or limit the efficacy of the process.

Sterilization describes a process that destroys or eliminates all forms of microbial life and is carried out in health-care facilities by physical or chemical methods. Steam under pressure, dry heat, EtO gas, hydrogen peroxide gas plasma, and liquid chemicals are the principal sterilizing agents used in health-care facilities. Sterilization is intended to convey an absolute meaning; unfortunately, however, some health professionals and the technical and commercial literature refer to “disinfection” as “sterilization” and items as “partially sterile.” When chemicals are used to destroy all forms of microbiologic life, they can be called chemical sterilants. These same germicides used for shorter exposure periods also can be part of the disinfection process (i.e., high-level disinfection).

Disinfectants are antimicrobial agents designed to inactivate or destroy microorganisms on inert surfaces Disinfection does not necessarily kill all microorganisms, especially resistant bacterial spores; it is less effective than sterilization, which is an extreme physical or chemical process that kills all types of life. Disinfectants are different from other antimicrobial agents such as antibiotics, which destroy microorganisms within the body, and antiseptics, which destroy microorganisms on living tissue. Disinfectants are also different from biocides — the latter are intended to destroy all forms of life, not just microorganisms. Disinfectants work by destroying the cell wall of microbes or interfering with their metabolism.

Sanitizers are substances that simultaneously clean and disinfect. Disinfectants kill more germs than sanitizers. Disinfectants are frequently used in hospitals, dental surgeries, kitchens, and bathrooms to kill infectious organisms.

Bacterial endospores are most resistant to disinfectants, but some fungi, viruses and bacteria also possess some resistance.

Disinfectants are used to rapidly kill bacteria. They kill off the bacteria by causing the proteins to become damaged and outer layers of the bacteria cell to rupture. The DNA material subsequently leaks out.

Sources:

https://www.jfmed.uniba.sk/fileadmin/jlf/Pracoviska/ustav-mikrobiologie-a-imunologie/VLa/imu_pract_11_vakcination.pdf

Lippincott´s Illustrated reviews Immunology. Chapter VI. Vaccination

Centers for Disease Control and Prevention: Introduction, Methods, Definition of Terms Guideline for Disinfection and Sterilization in Healthcare Facilities Available from:
https://www.cdc.gov/infectioncontrol/guidelines/disinfection/introduction.html#anchor_1554392531