    - 2 Types: Whole agent vaccines (deactivated whole microbes), and subunit vaccines (antigenic fragments of microbes)
    - Advantages
        - Safer than live vaccines because inactive microbes can't replicate, revert, mutate, or retain virulence
    - Disadvantages
        - Due to not being able to replicate, they require multiple does to get full immunity
        - No contact immunity
        - For whole agent vaccines, sometimes non-antigenic portions stimulate a painful response for some people. So, subunit vaccines are becoming more popular
        - Antigenically weak since inactivated vaccines can't reproduce
        - Multiple or high doses increases risk of allergies and can stimulate inflammation
    - Adjuvants can increase antigenicity of the vaccine by stimulating immune cell receptors
- Toxoid Vaccines
    - Chemically or thermally modified toxins used in vaccines to stimulate active immunity.
    - They stimulate antibody-mediated immunity – like killed vaccines, and have few antigenic determinants
    - They require multiple childhood doses as well as reinoculations every 10 years
- Combination Vaccines
    - Combination of antigens from several toxoids and inactivated pathogens administered at the same time.
- Vaccines Using Recombinant Gene Technology
    - Advantages
        - More effective, cheaper, safer
        - Can selectively delete virulence genes from a pathogen, creating an irreversible attenuated mutant that can't revert back to virulence
        - Can produce large quantities of pure viral or bacterial antigens for use in vaccines
    - Disadvantages
        - Can express the antigen and act as a live vaccine

Describe three methods by which recombinant genetic techniques can be used to develop improved vaccines

- They can delete virulence genes from a pathogen producing an irreversible attenuated microbe that can't revert to a virulent pathogen
- Scientists isolate the gene that codes for an antigen and inserts it into a bacterium, yeast, or other cell that then expresses and releases the antigen.
- DNA coding for a pathogen's antigen can be inserted into a plasmid that is then injected into the body. The body's cell take the plasmid (with antigen's DNA) and then transcribes and translates the gene to produce antigen that then triggers the immune response. Results in body's own cell expresses the antigen

Delineate the risks and benefits of routine vaccination in healthy populations, mentioning contact immunity and herd immunity

- Benefits
    - Contact immunity can occur where vaccinated individuals can infect those around them