



AZERBAIJAN MEDICAL UNIVERSITY
DEPARTMENT OF MEDICAL MICROBIOLOGY and IMMUNOLOGY

Lesson 22.

Immunoprevention and immunotherapy. Vaccines and immune serums

FACULTY: General Medicine
SUBJECT: Medical microbiology - 1

Discussed questions:

1. Principles of immunoprevention.
2. Vaccines:
 - live vaccines.
 - inactivated (killed) vaccines.
 - molecular vaccines (protective antigen).
 - anatoxins (toxoids).
 - synthetic vaccines (chemically or biologically synthesized antigen).
 - recombinant vaccines.
4. Associative vaccines.
5. Adjuvants.
6. Principles of immune therapy.
7. Immune serums (antitoxic, antibacterial, antiviral serums), acquisition and application.
8. Diagnostic immune serums.

Purpose of the lesson:

- To acquaint students with the principles of immunoprophylaxis and immunotherapy. Provide information about vaccines and serums, types, their purchase and application.

Immunoprevention and immunotherapy.

- Immunoprevention and immunotherapy are aimed at the formation of active or passive immunity against the causative agent by forming insensitivity to their causative agents in order to prevent infectious diseases.
- Active or passive immunity is induced in the body as a result of immunization to protect against infectious diseases.

Vaccines

- Active immunity is formed as a result of immunization with vaccines.
- Vaccines are prepared from microorganisms or their antigens, their injection into the body causes the formation of artificially acquired immunity against the disease.

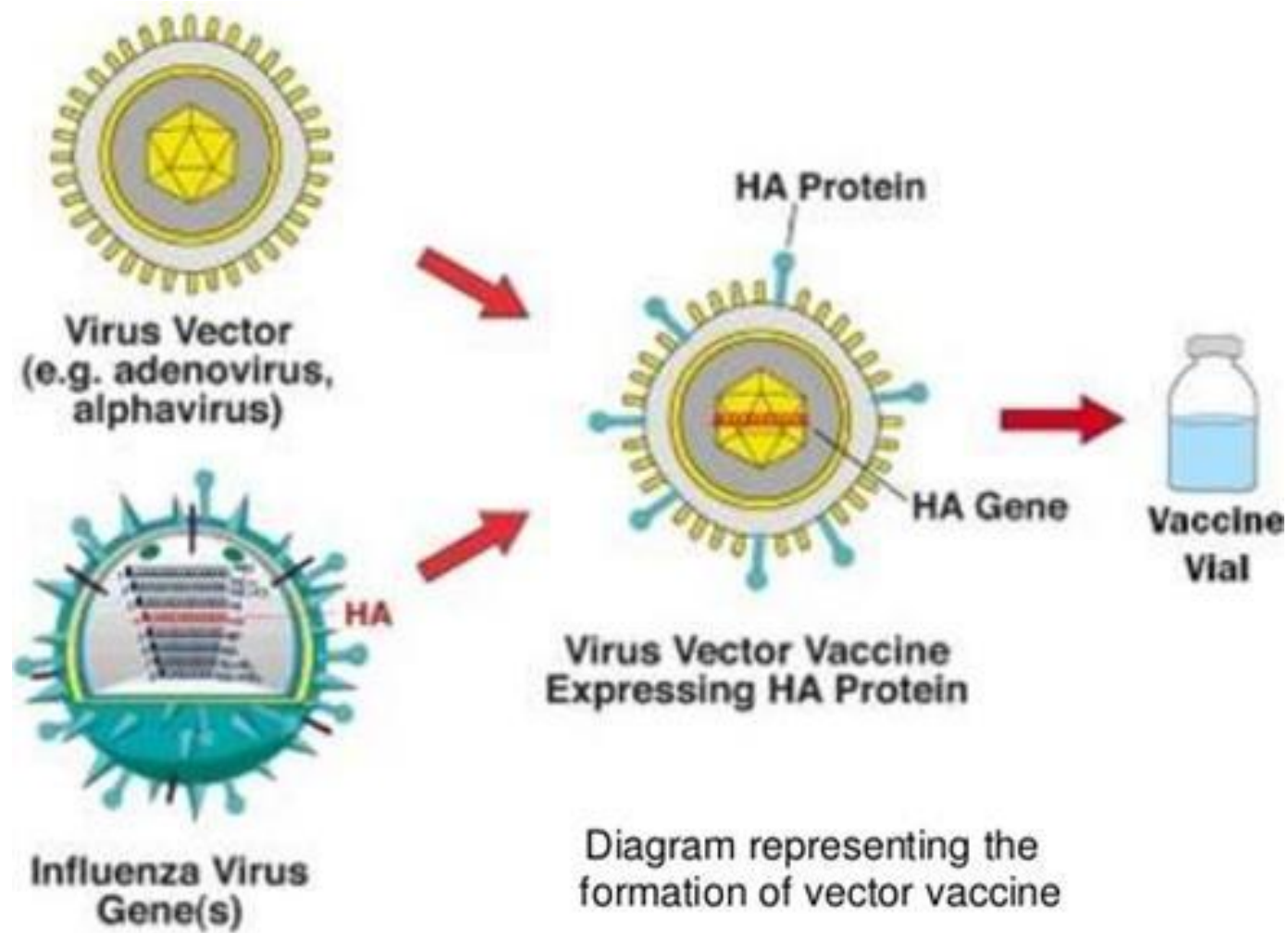
Inactivated (killed) vaccines

- Chemical substances (for example, phenol, formaldehyde), high temperature, etc. it consists of microorganisms that have lost their ability to live due to its influence and have been killed.
- To obtain inactivated vaccines, pathogenic microorganisms are cultivated in artificial nutrient media, then they are inactivated, purified, and obtain a liquid or lyophilized preparation.

Live (attenuated) vaccines

- It is prepared from the appropriate microorganism strains whose virulence is weakened.
- These vaccines consist of genetically modified microorganisms that have lost the ability to cause disease, but have acquired, retained the ability to form specific anti-infective immunity (BCG vaccine, rabies, measles vaccine, etc.).
- Currently, recombinant DNA technology is used to obtain attenuated vaccine strains. To prepare virus vaccines, the genes responsible for the synthesis of their antigens are transferred to vectors, for example, smallpox viruses with large DNA content. Such vaccines are called vector vaccines.

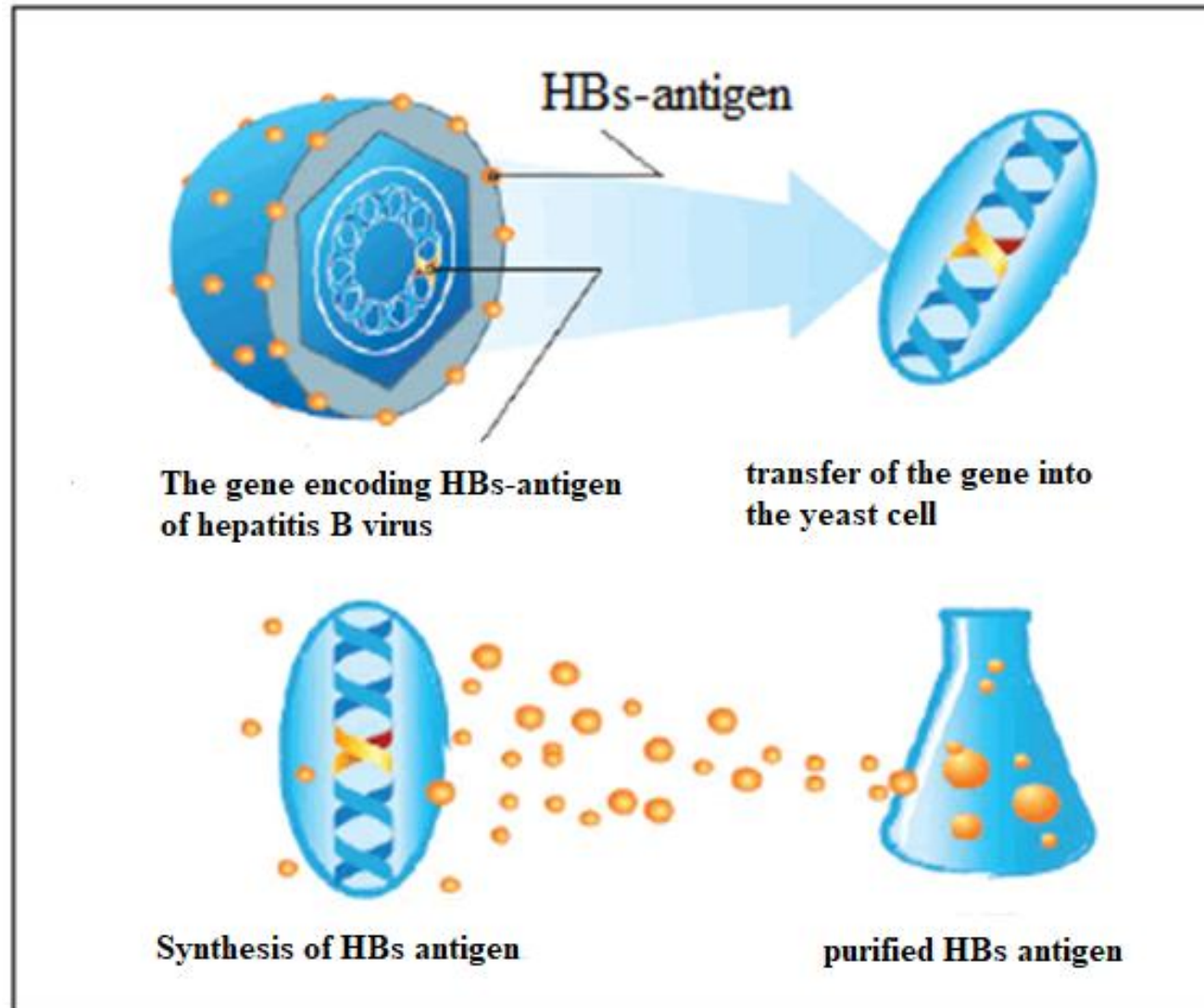
Preparation of vector vaccines



Chemical vaccines

- It is obtained by disintegration of microbial cells, consisting of separate components (antigens) of microbial cells.
- Recently, these vaccines are obtained through genetic engineering, they are called recombinant vaccines. For this, recombinant yeast strains are created by transferring the genes that ensure the synthesis of the immunodominant antigen of any microorganism to the producer cells, for example, to the cells of yeast fungi.
- As the resulting recombinant yeast cells have the genes that will ensure the synthesis of a certain antigen, they synthesize the appropriate antigen substance.
- Currently, a vaccine prepared from the virus antigen (HBs-antigen) synthesized by recombinant yeast strains is used in the specific prophylaxis of hepatitis B.

Scheme of preparation of recombinant vaccine from HBs-antigen of hepatitis B virus



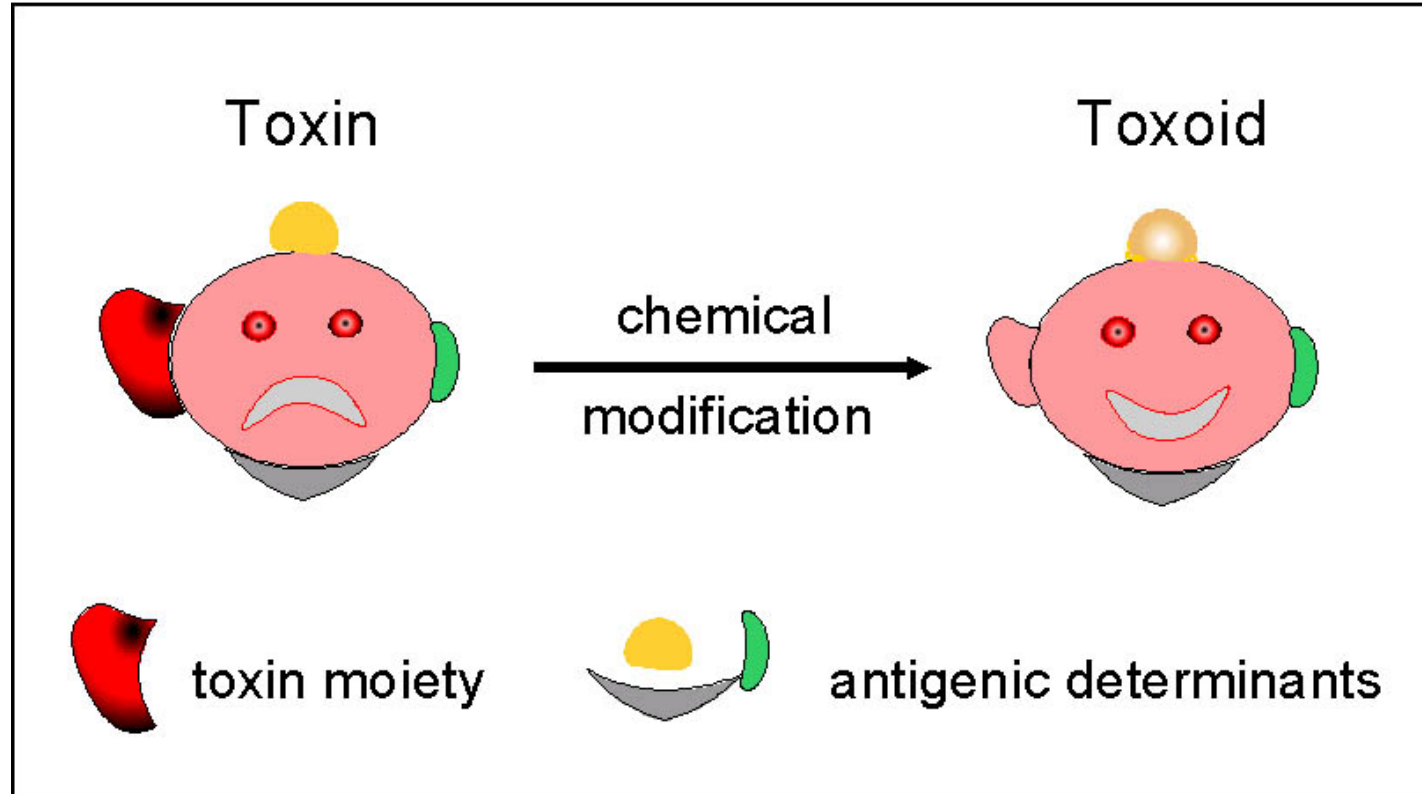
Synthetic vaccines

- The preparation of synthetic vaccines is based on the use of the artificially synthesized immunodominant antigen (protective antigen) of the disease-causing microorganism. For this, the amino acid sequence of the immunodominant antigen is studied and synthesized, the resulting protective antigen can theoretically be used as a vaccine.
- However, synthetic peptides are weak antigens, and to increase immunogenicity, it is necessary to combine them with a carrier protein or a synthetic biopolymer (muramyl peptide, D-glutamine copolymers, etc.). Automatic synthesizers are used to produce such vaccines
- So far, efforts to use a synthetic vaccine against foot-and-mouth disease have been unsuccessful. This vaccine has been tested in guinea pigs, pigs and cattle. Although the vaccine protected against the disease, the antibody response induced by it was 10-100 times weaker than immunization with whole virions. This vaccine has not found wide practical application.

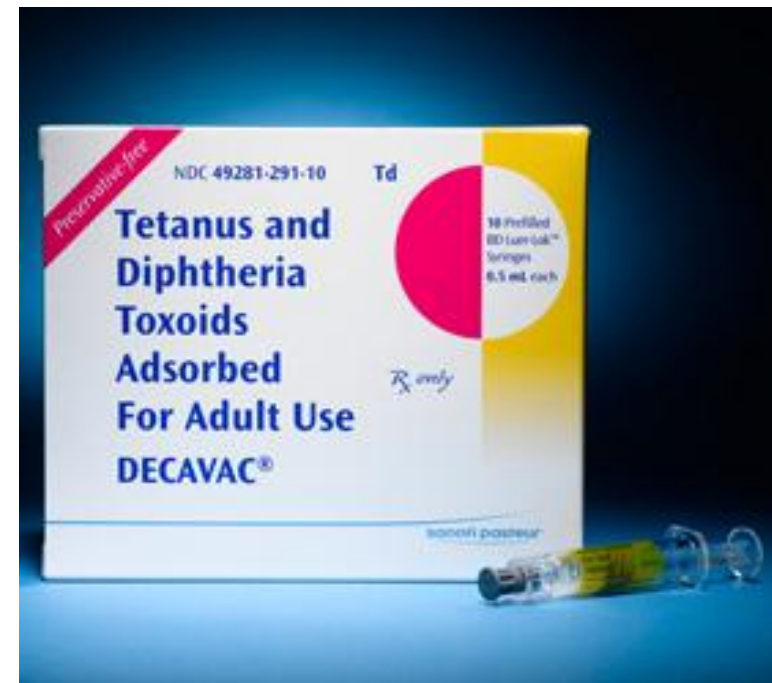
Anatoxins or toxoid vaccines

- Some vaccines contain toxoids instead of microorganisms, which do not cause disease, but have the ability to induce an immune response.
- Exotoxins lose their toxicity in 3-4 weeks under the influence of 0.4% formaldehyde at 37°C, but are transformed into anatoxin (toxin) while keeping their specific antigenicity.

Anatoxins or toxoid vaccines



Widely used toxoid vaccines



Adjuvants

- Adjuvant (helper) - complex substances used to increase the immune response when administered simultaneously with an immunogen.
- Unlike immunomodulators, they are used to increase a certain immune response in the body (for example, during vaccination) and to normalize a weakened immune response.
- Most adjuvants by adsorbing antigens on their surface create a depot and ensure their long-term storage in the body, which increases the duration of the effect on the immune system.

More commonly used adjuvants

- Adjuvants can be inorganic (aluminum and calcium phosphates, calcium chloride, etc.) and organic (agar, glycerol, protamines, etc.). Currently, the following adjuvants are more commonly used:
 - Freund's incomplete adjuvant. It is a water-in-oil emulsion containing petroleum jelly, lanolin and an emulsifier. By storing the antigen, it enhances its capture by phagocytes.
 - Freund's Complete Adjuvant. The above components include BCG or muramyl dipeptide. This allows activation of macrophages and costimulation of T-cells.
 - Aluminum hydroxide - $\text{Al}(\text{OH})_3$ stores antigens due to its high sorption capacity and enhances phagocytosis.

Vaccination

- It is carried out according to planned and epidemiological instructions.
- Each country has a preventive vaccination calendar and control over the planned preventive vaccinations.
- Mandatory administration of such vaccinations is regulated by legislation.

Immune serums

- In order to form passive immunity in immunoprevention and immunotherapy, preparations containing antibodies against the relevant causative agent or its toxin are used - immune serum and immunoglobulins.
- The mechanism of action of the immune serums used for these purposes is related to the neutralization of the specific antibodies in their composition against the corresponding microorganisms and their toxins.

Immune serums used for seroprevention and serotherapy

- Immune serum and immunoglobulins are used for two purposes: for prevention (seroprevention) and for treatment (serotherapy).
- In order to receive immune sera, mainly large animals, for example, horses, are hyperimmunized with microorganisms or their antigens. Then, after cleaning the blood serum of such animals from ballast substances, it is used as an immune serum.
- In some cases, the serum of people who have had a disease, or the blood serum of specially immunized donors, as well as placental blood serum, are used as immune serum.

Application of immune serums

- Immune serums are especially used for the treatment of toxinemic infections (tetanus, botulism, diphtheria, gas gangrene), as well as some bacterial and viral infections (measles, measles, plague, anthrax, etc.).
- The prophylactic dose of these drugs is significantly less than the treatment dose.
- To create passive immunity, the drug is usually administered intramuscularly to people who have been in contact with patients or other sources of infection. Immunity is formed quickly and usually lasts up to a month. After this period, the immunity disappears as the antibodies are removed from the body.

Diagnostic immune serums

- Diagnostic immune serum are used to identify microorganisms in various serological reactions.
- These sera are usually obtained by hyperimmunizing small animals, such as rabbits, with microorganisms or their antigens.
- Blood serum of laboratory animals (mainly rabbits) hyperimmunized with appropriate antigens is used as diagnostic immune serum, which contains specific antibodies in high titers.



Measles



Children infected by parotitis virus

Mumps



Rubella (German Measles)



Polio



Rotavirus



Pneumococcal



Hib



<http://www.vaccineinformation.org/photos/polioac002.jpg>
http://www.duke.edu/~ema5/Goljan/Slides/3/gastrointestinal5_files/GI230.jpg
<http://www.vaccineinformation.org/photos/pneuaap001.jpg>
<http://www.aap.org/immunization/press/photos/174.jpg>

Vaccination	Birth	1 month	2 months	4 months	6 months	12 months	15 months	18 months	24 months	4 to 6 years
HepB (protects against hepatitis B)	1st	2nd			3rd					
DTaP (protects against diphtheria, tetanus, pertussis)			1st	2nd	3rd		4th		5th	
Hib (protects against haemophilus influenzae type b; may be 3 or 4 doses)			1st	2nd	3rd	4th				
IPV (protects against polio)			1st	2nd	3rd				4th	
RV (protects against rotavirus; may be 2 or 3 doses)			1st	2nd	3rd					
PCV13 (protects against pneumococcal disease)			1st	2nd	3rd	4th				
Flu (protects against influenza)					1 or 2 doses each year					
MMR (protects against measles, mumps, rubella; if travelling outside the U.S., your baby can get his first dose at 6 months)						1st				2nd
Varicella (protects against varicella, also called chickenpox)						1st				2nd
HepA (protects against hepatitis A)						1st and 2nd 6 to 18 months apart				