The Vaccine and Vaccination

Vaccine

- **Vaccine:** is an antigen prepared artificially as complete virulent, attenuated or killed microorganism or its metabolic products; gave to animals to induce immune response against that (same) antigen result in short or long-termed immunity depending on that vaccine.
- **Vaccination:** The administration of an antigen (vaccine) to stimulate a protective immune response against an infectious agent.

What are the characteristics of a vaccine?

- 1- It must give a strong immunity.
- 2- It must immunize the animal and its fetus.
- 3- It must be cheap and stable.
- 4- It must be free of side effects.
- 5- It must be enough to vaccinate large population of animals.
- 6- It should stimulate an immune response distinguishable from that due to natural infection.

Immunization

- ***Administration of Antigens or Antibodies to confer immunity.***

  1-Active Immunization

  Using of Ags of different types

  2-Passive Immunization

  Using of Abs naturally or artificially

1-ACTIVE IMMUNIZATION

- **Types of Active Vaccines**

I-Live Vaccines

A-Fully Virulent Vaccines

(Contagious Ecthyma Virus Vaccine)

B-Attenuated Live Vaccines.

Methods of Attenuation

1-Using of heat below of the killing tempreture.

2-Using of chemicals below the killing concentration.

3-The adapting organisms to grow in unusual conditions.

for example:

a-The BCG (Bacille Calmette Guerin) strain of Mycobacterium bovis was rendered avirulent by being grown for 13 years on bile-saturated medium.

b- Brucella abortus strain 19 vaccine was grown underconditions in which there was a shortage of nutritions.

c-Viruses have traditionally been attenuated by growth in cells or species to which they are not naturally adapted. Example: attenuation of rinderpest virus of cattle in rabbits.

Live vaccines.....

C-Heterologous Live Vaccines

Examples: **1-The use of human measles virus to vaccinate dogs against canine destemper virus.**

2-Cow poxvirus for vaccination against small poxvirus.

II-Killed Vaccines

A-Bacterins

Killed bacteria are used.

Killing was performed by:

1-formaline

2-alkylating agents:

ethylene oxide

acetylethelenimine

β-propiolactone

Killed vaccine----

B-Toxoids

Inactivated toxines of certain microorganisms.

example: Cl.tetani toxines can be activayted by Aluminum hydroxide and then used as vaccines.

C-Mixed Vaccines

Killed m.o. + toxoids or

Bactrins + killed viruses

Killed vaccines.....

D-Subunit Vaccines

using of antigenic fragments of m.o.

Sometimes genetic engineering was implemented: gene of subunit protein----- genome of bacteria or yeast------ Bacterail or yeast growth----purification of Ags protein

- Hepatitis B vaccine
- Feline leukemia virus vaccine

Killed vaccines--------

E-Anti-idiotypic Vaccine

Ags injected in rabbits------ Abs-1 from rabbits collected----- Abs-2 injected in horses------- Abs-2 are collected from horses---- purified Abs-2 used as a vaccine for humans.

Such immunization leads to formation of Abs-3 against the original Ags.

A comparison between live and killed vaccines

	Live Vaccine		Killed Vaccine
1	Give prolonged immunity	1	Give short-term immunity
2	Small doses can be used	2	Large doses used
3	May cause a disease	3	Cannot cause a disease
4	Adjuvants are not necessary	4	Adjuvants are necessary
5	No or low possibility of hypersensitivity	5	Hypersensitivity is possible
6	Viral vaccines induce interferon production	6	Vaccines in general cannot induce the production of interferon
7	Difficult to store live vaccines	7	Can be stored easily

Adjuvants

- **Adjuvant:** any substance that when given with an antigen, enhances the immune response to that antigen.

Adjuvants may help in:

1-increasing the effective size of the immunogen.

2-enhancing the persistance of the immunogen.

3-activating cells such as microphages and lymphocytes.

Types of Adjuvants

	Type	Adjuvant	Mode of Action
1	Aluminum salts	Aluminum phosphate	Slow release of Ag
		Aluminum hydroxide	==========
		Alum	==========
2	Water-in-oil emulsion	Freund's incomplete adjuvant	Slow release of Ag
3	Bacterial fragments	Freund's complete adjuvants (killed mycobacterium)	Slow release of Ag and activate macrophages and lymphocytes
		Corynebacterium Bordetell pertussis Lipopolysaccharides	= = =
4	Surface active agent	Saponin	Stimulate Ag processing
5	Complex carbohydrate	Dextran sulphate	Macrophage stimulator
6	Mixed adjuvants	Freund's complete	Slow release of Ag and

Vaccines Against Parasites

A-Babesia vaccine

The parasite can be attenuted by many passages of the parasite in calves (Spleenoctamized cavles).

***B-Verminous pneumonia* vaccine**

larvae are treated X-ray (40,000 Rad). After attenuation, the vaccine administered by two doses to calves.

C-Ancylostoma caninum

The vaccine used to protect pups from *Ancylostoma caninum*. Larvae attenuted with X-ray followed by administration of the vaccine to 3 days old pups.

III-Modern Vaccine Technology

1-Antigens Generated by Genetic Engineering

-Isolation of DNA coding Ag.

-The DNA inserted in a bacterium, yeast or other cells.

-The Ag is expressed in new host.

-Collected, purified and used as a vaccine.

Examples: **a-FMD (VP1 gene)**

b-Feline leukemia virus (gp70 gene)

Modern Vaccine-----

2-Genetically attenuated organisms

-modification of genes so the m.o. becomes avirulent

Example: Pseudorabies virus vaccine

3-Live Recombinant Organisms.

-Insertion of requisted gene of Ag in a carrier organism like vaccinia virus. This recombinant virus can be used as a vaccine against the particular Ag.

Examples: **a-Vaccinia virus carrying rabies virus glycoprotein.**

b-Vaccinia virus carrying H and F rinderpest proteins.

Modern Vaccines------

4-Nucleic Acid Vaccines.

-Specific DNA gene of Ag can be purified

-The purified gene can be inserted in E.coli plasmids.

-These plasmids can be amplified.

-The amplified and purified recombinant plasmids can be injected in an animal to be vaccinates (im).

-The transfected host cells will express the vaccine Ags.

Modern vaccines----

Examples: **DNA vaccines against**

- **-Bovine herpes**
- **-Avian influenza**
- **-Canine and Feline rabies**
- **-Bovine Viral diarrhea**
- **-T.B.**

Modern Vaccines------

5-Synthetic Peptides

-Complete sequencing of the gene of immunogenic epitop.

-Following chemical procedures to synthesis of that protein epitop.

-Synthetic and purified epitop can be used as a vaccine.

Example: **-Hepatitis B vaccine**

-Diphtheria toxin vaccine

-FMD

-Influenza A

2-Passive Immunization

A-Natural Passive Immunization

-From mothers

B-Artificial Passive Immunization

Requires that antibodies be produced in a donor animal by active immunization and these antibodies be given to susceptible animal in order to confer immediate protection.

Passive----

Examples: **Production of antibodies in**

-Cattle against anthrax

-dogs against distemper

-cats against panleukopnia

-humans against measles

-Tetanus immune globulins prepared in horses

Doses for treatment:

1500 IU injected in horses and cattle

500 IU to calves, sheep, goat and swine

250 IU to dogs

Administration of Vaccines

1-Subcutaneous
2-Intramuscular
3-Intranasal
can be used for IBR in cattle
Streptococcus equi in horses
Feline rhinotracheitis in feline
IB and NDV in poultry
4-Aerosolization of vaccines in case of flocks
5-In feed and drinking water
NDV and IB
6-Fish may be vaccinated by adding antigen to the water.

Administration -------

NOTE: **Adjuvants can be used but we have to consider the followings:**

1-It is not preferable to use oily adjuvants in animals used for human consumption.

2-Do not use Complete Freund's Adjuvant in vaccination of above-mentioned animals.

Factors Effecting Immunization

1-It is not preferable to vaccinate animals early in life because of maternal antibodies.
2-Mothers may be vaccinated during the late stages of pregnancy. Why??
3-It is necessary to vaccinate young animals at least twice.
4-Booster doses are too necessary each 6 months for killed vaccines and 2-3 years in live vaccines.
5-Some diseases are seasonal, so that booster doses are necessary to be given before disease spread. For example:
-Dictycolous viviparus vaccinatin in Summer
-Anthrax vaccination in Spring
-Cl.chauvoei (before grazing).

Vaccine Assessment

To measure the efficacy of a vaccine, animals must be vaccinated and then challenged with virulent m.o.

The percentage of vaccinated and control animals that survive this challenge can be measured.

The true efficacy of a vaccine called Preventable Fraction (PF).

Vaccine assessment

$$PF = \frac{\%\text{of controls dying} - \%\text{ of vaccinates dying}}{\%\text{ of controls dying}}$$

For example: a challenge killed 80% of control animals and 40% of vaccinates, the PF equal to

$$PF = \frac{80-40}{40} = 50\%$$

Good effective vaccines should have a PF of at least 80%

Failures in Vaccination

- I-Incorrect administration of vaccination due to:
  - Inappropriate route of administration.
  - Death of live vaccine.
  - Administration to passively protected animals.

II-Correct administration but failure of vaccination due to:-

A-Animal responds weakly due to;

1-Vaccine is given too late.

2-The animal is already infected.

3-wrong strain of m.o. is used.

4-N on protective antigen is used.

B-Animal fails to respond due to:

1-Prior passive immunization

2-The animal is immuno-suppressed.

3-Biological variations.

4-Inadequate vaccine.

Adverse Consequences of Vaccination

1-Local reactions due to formaldehyde used in inactivation.
2-Some vaccines may lead to immuno-suppression and death of animal due to:
    a-Errors in vaccine preparation.
        1-Bacterial or viral contamination
        2-Abnormal toxicity
        3-Residual virulence of m.o.
    b-Errors in administration that lead to contamination.
3-Normal side effects like fever, inflammation and pain.
4-Some vaccines may cause:
    a-hypersensitivity
    b-neurological reactions.
    c-foreign-body reactions like fibrosarcoma and granuloma formation