

# Vaccine

## Introduction

Prevention of disease through vaccination is an important approach to maintain fish health. Exposure of a fish to a pathogen stimulates the immune response and the fish will develop the memory to these pathogens so that it can combat the pathogen very quickly during future encounter. This adaptive immunity is specific against the pathogen and persists for a relatively long period. This persistence is because of an adaptive change in the population of lymphocyte which results from the exposure of the fish to the pathogen that consist the antigen.

Vaccines exploit the two key elements of adaptive immunity and those are specificity and memory. This is because after vaccination the adaptive immune system responds specifically to the invading pathogen and the response become stronger and stronger on the second and subsequent exposure to the pathogen.

Vaccines are preparations of antigens derived from pathogenic organisms, rendered non-pathogenic by various means, which will stimulate the immune system in such a way as to increase the resistance to disease from subsequent infection by a pathogen.

Inducing a protective immune response to a pathogenic organism before the individual becomes naturally exposed to it seems at first sight an highly sensible way of preventing an infectious disease. Unfortunately, achieving this goal not an easy task. vaccines must be safe (no side effects) and potent (induce a high level of protection) and although occasionally it has been possible to achieve these characteristics using simple procedures (usually heat or chemical inactivation of cultures of pathogenic microorganisms) in most cases some degree of antigen purification or enrichment is necessary and the problem lies in identifying the relevant antigens, out of many hundreds present, which are important in stimulating a protective immune response.

Vaccines are generally of two types: Dead vaccines, which are composed of inactivated pathogens or extracts, and Live vaccines, which are attenuated pathogens with no or low virulence."

### Dead vaccines

- Inactivated virus or bacterial antigens
- Sub-unit vaccines
- Recombinant vaccines

### Live vaccines

- Attenuated live vaccine
- Gene deleted live vaccine

The Ideal Fish Vaccine should have

- Sustained immunity and protection
- Early mass application
- Efficacious for a broad number of species
- Safe to use
- Cheaply available
- Easily produced
- Should have stable antigen
- Can be stored for long time.
- Will not interfere with diagnosis
- Easily licensed

### **Killed whole cell vaccines**

Killed whole cell vaccine is a suspension of heat or chemical-killed pathogens that are able to induce specific protective immune response against those pathogens when administered into the host. Killed whole cell vaccine are administered when it is unsafe to use live microorganisms. These vaccines are prepared from normal wild type bacteria that are made nonpathogenic usually by treating with heat, formaldehyde or gamma irradiation.

Killed whole cell vaccine can be used in controlling some of the important fish bacterial pathogens like *V. anguillarum*, *V. salmonicida*, *V. ordalli*, *Y. ruckeri*, *E. tarda* and *A. salmonicida*.

Among carp virus killed vaccine of spring viremia of carp virus (SVCV) was commercially available for some years.

#### Advantages:

- Safe to use
- Cheaper than live attenuated vaccine
- Storage is easier than live vaccine

#### Disadvantages:

- Large number of microorganisms is required to stimulate immunity.
- High cost of their production in cell culture,
- Difficulty in the purification and delivery.
- In general killed vaccines alone trigger only the humoral immune response
- Needs to be given booster doses
- Presence of some un-inactivated microbes can lead to vaccine-associated disease.
- Inactivation, by formaldehyde may alter antigenicity.

### **Live-attenuated vaccines**

Live-attenuated vaccine is a suspension of attenuated live pathogens that are able to replicate inside the host and induce protective immune response but unable to cause disease. To make an attenuated vaccine, the pathogen is grown in foreign host such as animals, embryonated eggs or in tissue culture under controlled conditions and altered to a non-pathogenic form to make it less virulent. They mimic the actual infection by pathogens and hence a small dose of vaccine is enough to induce long lasting protective immune response. Live attenuated vaccines can induce both humoral and cell-mediated immune responses.

#### Advantages

- Live-attenuated vaccine can stimulate cellular immune responses, memory cells as well as humoral immune responses.
- Administering lesser quantities is sufficient to induce protection.
- Single administering of vaccine is sufficient to produce high efficacy and long lived immunity.
- Administration of live attenuated vaccine has a possibility to stimulate immune response to all protective antigens.

#### Disadvantages

- Live-attenuated vaccine may rarely revert to its virulence form and cause disease.
- Live-attenuated vaccine cannot be given to immunosuppressed individuals.
- Since they are live they require proper storage.

### **Subunit Vaccines**

Subunit vaccines are the purified antigens of the whole organisms. These antigens are capable of stimulating antibody response. Subunit vaccines may contain toxoids, subcellular fragments, or surface antigens. The effect of subunit vaccine can be increased by administering these subunits with adjuvants.

#### Advantages

- They can be safely administered to the immunosuppressed animal.
- The side effects caused by sub unit vaccines are very rare.

#### Disadvantages

- Since the vaccines are purified the purification process may affect antigen in retaining its native form, so the organism may not recognize the antigen on pathogen.
- These proteins may not stimulate the immune response.

### **DNA vaccine**

This vaccine is still in experimental form. Here the gene of the pathogen is clone into vector and the vector is inserted into the animal by using gene gun. Once the vector is introduced the protein that act as antigen is produced inside the host and stimulate the immune response. DNA vaccine can induce both humoral and cellular immunity.

#### Advantages

- DNA is stable, hence can be easily stored and transported.
- DNA sequence can be changed easily in the laboratory.
- DNA does not replicate and encodes only the proteins of interest

#### Disadvantages:

- Insertional mutation may be possible
- Anti DNA antibodies may be produced against the inserted vector
- Since the antigen is expressed in the host immunologic tolerance may develop.
- Ethical issues.