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MICROBIAL BIOTECHNOLOGY AND BIOETHICS

SEMESTER -VI

EDIBLE VACCINE

SUBJECT CODE: 16SMBEMB3

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VACCINES

A vaccine is a **biological preparation** that **improves immunity** to a particular disease.

It contains an agent that resembles a disease-causing microorganism and is often made from weakened or killed forms of the microbe, its toxins or one of its surface proteins.

The **process of distributing and administrating vaccines** is referred to as **vaccination.** Vaccination is a form of immunization.

Continued.....

- **Immunization** **science of prophylaxis.**

- **Jenner in 1796 studied that inoculation of cowpox virus prevents small pox in human.**

Routes of administration, including oral, nasal, intramuscular (IM), subcutaneous (SC), and intradermal (ID).

EDIBLE VACCINES

Edible vaccines are nothing but transgenic plant and animal based production of or those that contain agents that trigger an animal's immune response. In simple terms, edible vaccines are plant or animal made pharmaceuticals

A vaccine in which an antigenic protein is engineered into an edible plant; after ingestion, the protein is unc loaked and recognized by the immune system

How do edible Vaccine work?

- Edible vaccines contain DNA fragments from the original pathogen. These fragments code for a protein that is usually a surface protein of the pathogen. This is responsible for eliciting the body's immune response
- Developed by Arntzen in 1900

CONCEPT OF EDIBLE VACCINE

Developed by Arntzen in the 1990s.

Introduce genes of interest into plants (Transformation)

↓

Genes expressed in the plant tissues edible parts (Transgenic plants)

↓

Genes encode putatively protective vaccine antigens from viral, bacterial, and parasitic pathogens that cause disease in humans and animals

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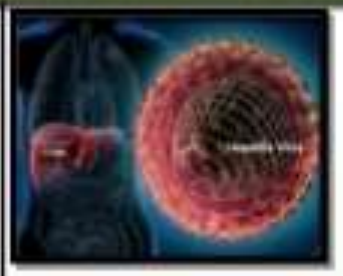
Ingestion of the edible part of the transgenic plant (Oral delivery of vaccine)

History of Ecdible vaccines



Hepatitis

Hepatitis B surface antigen (HBsAg)

Tobacco/leaf

E. Coli

Diarrhea

Heat labile toxin B subunit (LTB)

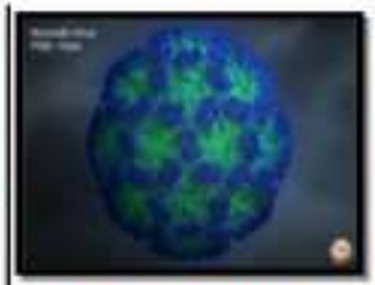
Potato/tuber, tobacco/ leaf

Rabies virus

Rabies

Rabies virus glycoprotein (RVG)

Tomato/leaf, fruit



Norwalk virus (NV)

Gastroenteritis

Norwalk virus capsid protein (NVCP)

Potato/tuber tobacco/leaf

V. Cholerae

Cholera

Cholera toxin B subunit (CTB)

Tobacco/leaf

Mason et al 1992 | Haq et al 1995 | McGarvey et al 1995 | Mason et al 1996 | Hein et al 1996 | ....

IDEAL PROPERTIES

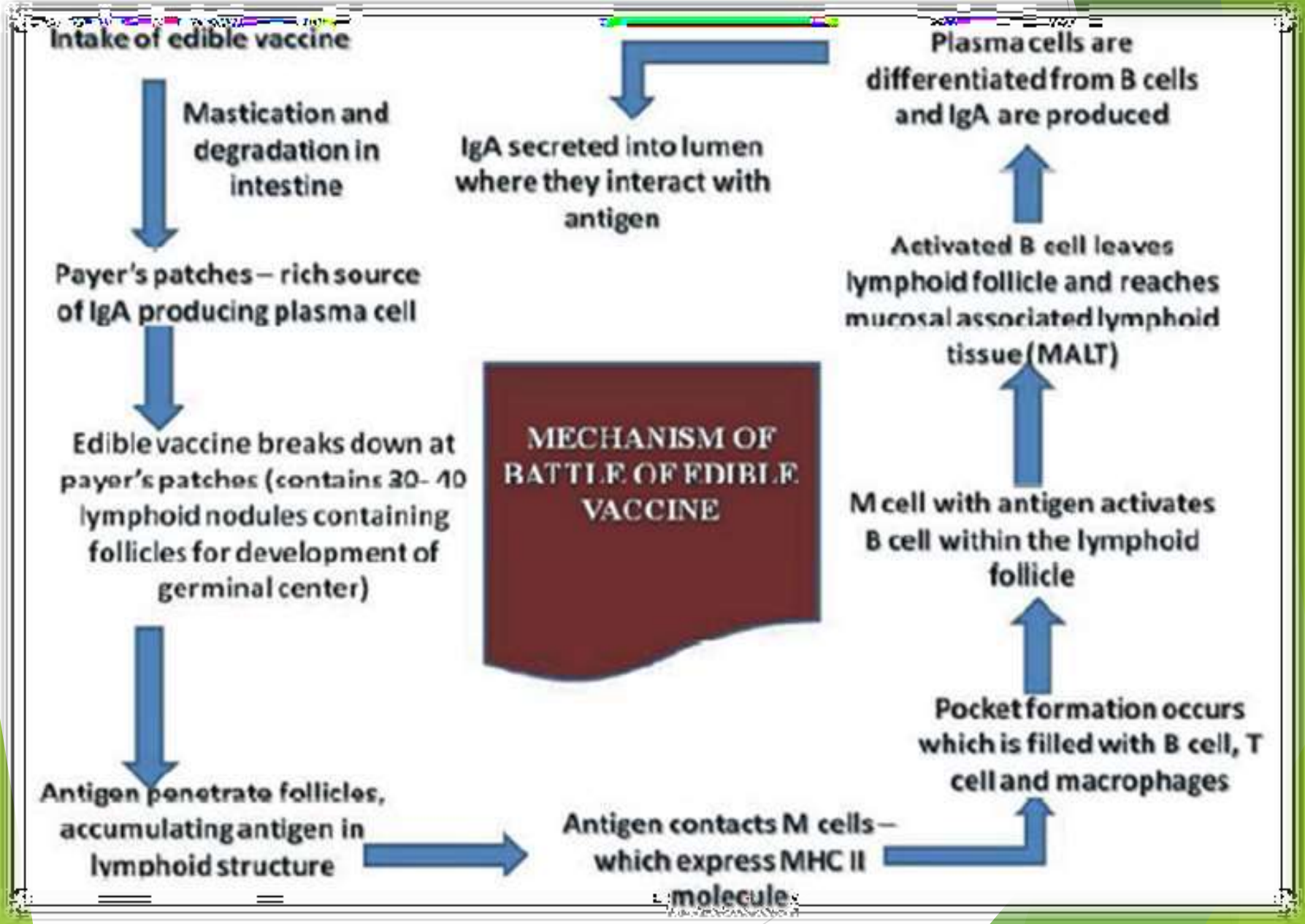
EDIBLE VACCINES

- Should be effective in affordable
- Nontoxic or Nonpathogenic
- Vaccination should be Simple
- very low levels of side effects
- Not contaminate the Environment
- Not cause problems in individuals with impaired immune system
- Long lasting humoral and cellular immunities

DIFFICULTIES IN TRADITIONAL VACCINES

- Dependence on cold chain system, store and transport the vaccine under strict controlledconditions.
- Risk of adverse reactions
- Restricted production
- Painful needle procedure

MECHANISM OF EDIBLE VACCINE




Selection of strongly immunogenic antigen
Designing gene for high level tissue specific expression of target protein
Plant transformation (Transient or sable)
Selection of transgenic lines with high expression of desired protein
Regeneration of transgenic cells/tissue/plant
Multiplication and growth of plants in contained field conditions
Up-scaling of cell suspensions/hairy roots in bioreactor
Harvesting plant material
Purification of desired protein
Standardization of antigen dose to be delivered orally
Injectible or oral formulation development
Edible formulation development
Biosafety, efficacy and functional equivalence tests

STEPS

Plant used as Edible vaccine

- Easily transformation
- Stored for long period without refrigeration
- No Cooking

- 2-3 years to mature&12 months to bear fruit
- Spoils rapidly after ripening
- Contains very little protein

- Grow quickly
- High content of vitamin A may boost immune response
- Heat-stable
- Do not need special facilities for storage and transportation.
- They taste good.

- Spoils easily

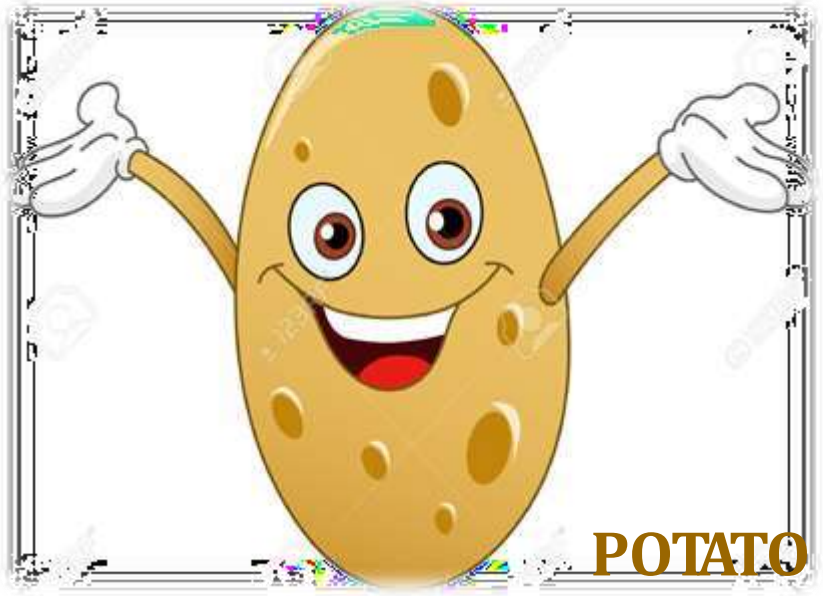
TOMATO

- Commonly used in baby food low allergenic potential
- High expression of proteins
- Vaccine does not dissolve when exposed to stomach acids.
- Less risk of contaminating than normal crop

- Grows slowly
- specialized glasshouse conditions

cheaper
not need to be refrigerated

need cooking to use
take a time to reach



POTATO

- Dominated clinical trials
- Easily transformed
- Stored for long period without refrigeration
- Cooking of the potatoes does not always destroy the full complement of an antigen
- Need cooking

- Good model for evaluating recombinant proteins.
- Easy purification of antibodies
- stored in the seeds
- Large harvests, number of times/year

- Produces high level of toxic alkaloids

TOBACCO

Lettuce

Fast-growing But, Spoils readily

Wheat

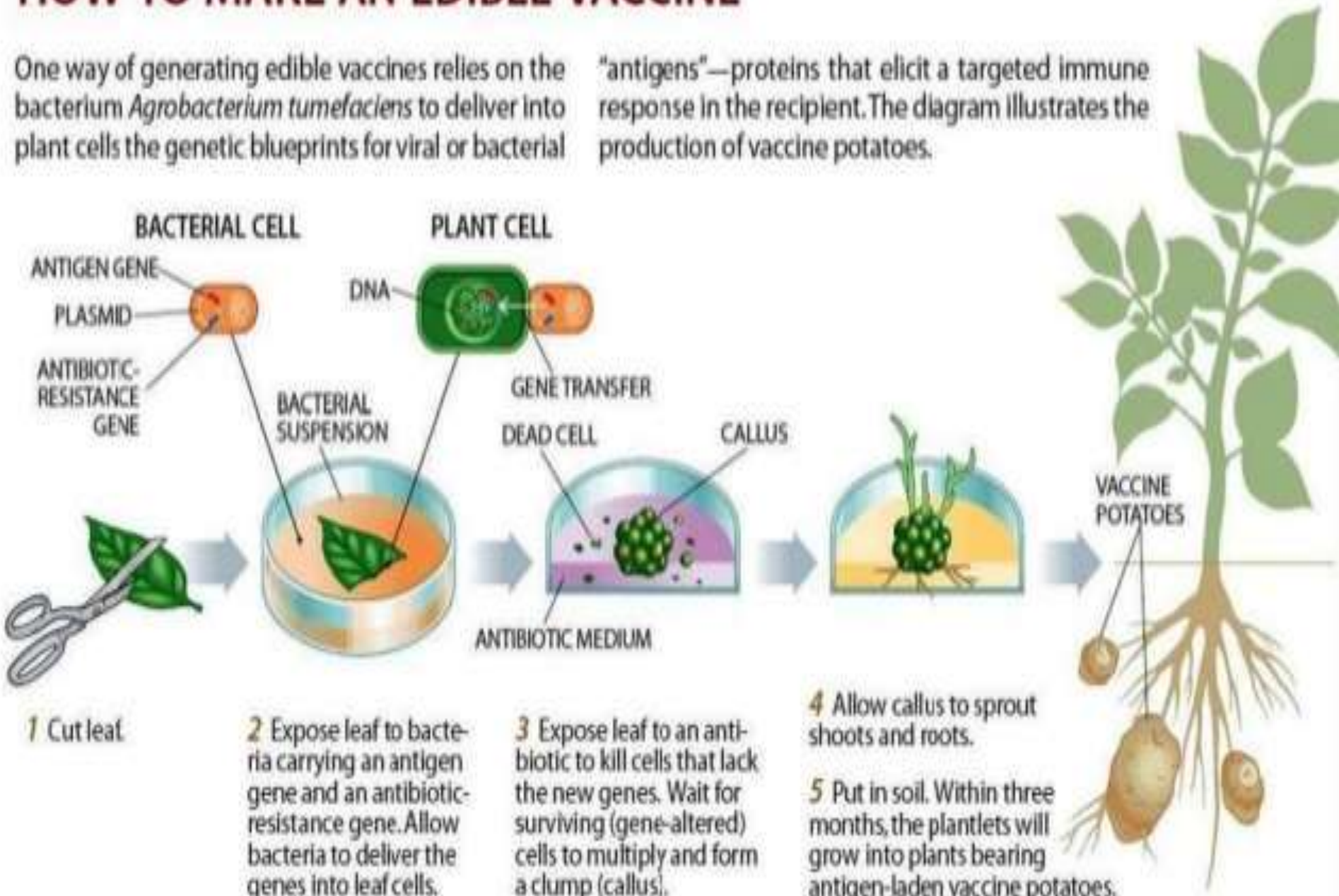
Large number of seeds help in increased harvest. but, Need cooking

Carrot

Rich in β carotein, production of Insulin

HOW TO MAKE AN EDIBLE VACCINE

One way of generating edible vaccines relies on the bacterium *Agrobacterium tumefaciens* to deliver into plant cells the genetic blueprints for viral or bacterial "antigens"—proteins that elicit a targeted immune response in the recipient. The diagram illustrates the production of vaccine potatoes.



1 Cut leaf.

2 Expose leaf to bacteria carrying an antigen gene and an antibiotic-resistance gene. Allow bacteria to deliver the genes into leaf cells.

3 Expose leaf to an antibiotic to kill cells that lack the new genes. Wait for surviving (gene-altered) cells to multiply and form a clump (callus).

4 Allow callus to sprout shoots and roots.

5 Put in soil. Within three months, the plantlets will grow into plants bearing antigen-laden vaccine potatoes.

Examples of edible Vaccine

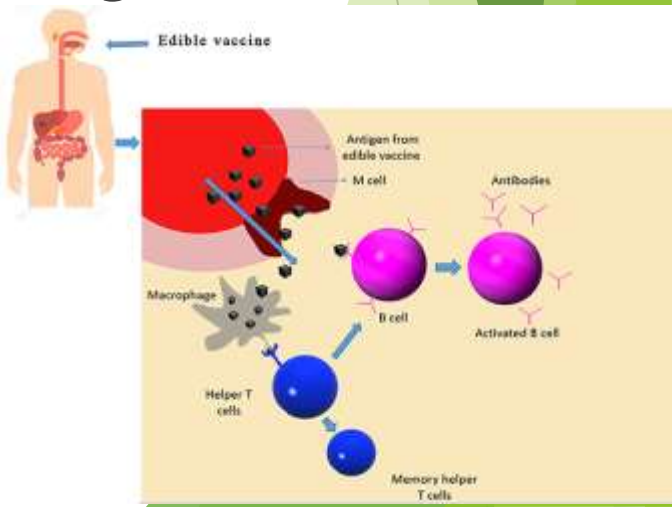
Sl. No.	Vaccines	Vector used	Diseases/condition it is used for
1.	Hepatitis B virus	Tobacco Potato Lettuce	Hepatitis B
2.	Norwalk virus	Tobacco Potato	Diarrhoea Nausea Stomach cramps
3.	Rabies virus	Tobacco	Rabies
4.	Transmissible gastroenteritis Corona virus	Tobacco Maize	Gastroenteritis
5.	Rabbit haemorrhagic diseases virus	Potato	Hemorrhage
6.	HIV virus	Tomato	AIDS
7.	*Vibrio cholera*	Potato	Cholera

Methods of Developing an Edible Vaccine

- Gene encoding antigen from pathogenic organisms (virus, bacteria or parasites) that have been characterized and for which antibodies are available, can be produced in the edible parts of the plants in two ways.
- In one case, the entire structural gene is inserted into a plant transformation vector.This will allow transcription and accumulation of coding sequence in plant.
- In second case, epitope within the antigen are identified, DNA fragment encoding these can be used to construct genes by fusion with a coat protein gene from plant virus, e.g., TMV or CMV.
- The recombinant virus is then used to infect stabilized plants. The resultant edible plant vaccines are utilized for further immunological studies.

Immune Response

- After the vaccine is orally ingested reach digestive tract, stimulate mucosal immune system,this provides first line of defense
- M cells found in peyer's patches push the antigen into antigen presenting cells surface such as T cells and B cells.activated B cells move to mesentric lymphnodes to produce IG A.
- It combines with secretary IG A ,combines with specific epitope and work together to eliminate pathogen



FACTORS AFFECTING EFFICACY OF EDIBLE VACCINES

FACTORS AFFECTING EDIBLE VACCINES

- Antigen selection (Safe, suitable, Stable)
- Efficacy in model systems (small qty)
- Choice of plant species (Suitable, easy grown, storage, cost)
- Delivery and dosing issues
- Safety issues (allergic & toxic potential)
- Public perceptions and attitudes to genetic modification
- Quality control and licensing (consistent)

Edible Vaccines

DISADVANTAGES

- The difficulty in Providing a standard dose
- Contaminate the food supply with antigens or weedy relatives
- Ideal plant with expression of stable gene is difficult task

ADVANTAGES

- Cheap
- Mass-production
- Can be ingested
- The need to process and purify does not arise
- Extensive storage
- Trigger the immunity at the
- mucosal surfaces , Which is the body's first line of defense

Application of Edible vaccines

Preventing :

1) infectious disease

AIDS
Measles
Smallpox
Transmissible gastroenteritis
Tuberculosis
Infuenza
Anthrax
Tetanus
Severe Acute Respiratory Syndrome (Sars)
Human Papillomavirus
Cysticercosis
Plague
Foot and mouth disease
Central nervous system disease
Newcastle disease
Rabbit hemorrhagic syndromes
Canine parvovirus disease
Bluetongue

2) Autoimmune disease

Type-I Diabetes
multiple sclerosis

3) Cancer therapy

Colon cancer
Cervical cancer

Conclusion

- Edible vaccine creating inexpensive vaccines that might be particularly useful in immunizing people in developing countries , where high cost , transportation and the need for certain vaccines to be refrigerated ,can hamper effective vaccination programs .
- Edible vaccine might be solution to get rid of various aliments as it has more advantages compared to traditional vaccine .
- Edible plant – derived vaccine may lead to a future of safer and more effective immunization .

THANK YOU