

## PART-3 (PLANT BIOTECHNOLOGY IN PHARMACY AND INDUSTRY)

### Transgenics for Molecular Farming (Bioreactor)

(A) Quantitative and qualitative improvement of starch:

- (I) Transgenic potato with mutant gene for ADP glucose phosphorylase of *E. coli* produces high quantity of starch.
- (II) The antisense RNA approach for inhibition of enzyme granule bound starch synthase (GBSS) have been utilized to produce amylose free and high amylopectin content potato.
- (III) Cyclodextrin a hydrophilic carbohydrate used to solubilize hydrophobic pharmaceuticals (sterol) can be produced in potato by transferring gene for enzyme Cyclodextrin glycosyl transferase (bacterial gene) that catalyze the conversion of starch to cyclodextrins.
- (IV). Fructans (fructose polymer) serve as low calorie sweetener. <sup>Transgenic potato, beet-</sup> can be induced to produce enzyme fructosyl transferase by inserting gene from Streptomyces. The enzyme convert sucrose into fructans, alternative sweetener.

## Qualitative improvement of fat and oils

- Plant fats are synthesized by the involvement of plastid, cytoplasm and Endoplasmic reticulum. Fatty acids are synthesized in plastid from Acetate (Acetyl-CoA) and esterified with glycerol in Endoplasmic reticulum to produce series of enzyme catalyzed reactions.
- (1) Production of short chain fatty acid (C8-C14) needed for production of soaps, detergents, cosmetic etc. selected fatty acids can be produced by terminating Acyl-ACP by specific thioesterase (Lauryl ACP thioesterase from Umbellularia californica) gene. in rape seed. to produce Lauric acid (C<sub>12</sub>)
  - (2) Production of unsaturated fatty acids used as food by transferring antisense gene coding for enzyme desaturase in oil yielding plants (rape seed, soyabean) eg oleic acid.
  - (3) Production of saturated fatty acids by transferring gene for enzyme stearoyl-ACP desaturase isolated from Brassica rapa, above enzyme inhibit the conversion of saturated fatty acid (- stearic acid) to unsaturated fatty acids (oleic acid, linoleic acid, linolenic acid)
  - (4) Genetic modification efforts are being made to induce the synthesis Omega 3 polyunsaturated omega acid (Eicosapentaenoic acid docosahexaenoic acid) basically present in marine fishes and needed for human health

## TRANSGENICS FOR BIODEGRADABLE PLASTICS

- Polyhydroxy alkanates produced by microbial fermentation are called Bioplastics (biodegradable plastic).

Polyhydroxybutyrate (PHB) is most common bioplastic synthesized from Acetyl CoA by series of three step reactions catalyzed by enzymes in Alcaligenes eutrophus. (gene ~~phaA~~ <sup>PhaA</sup> coding for 3 ketothiolase; phaB coding for Acetoacetyl CoA reductase, phaC coding for PHB synthase).

Transgenic Arabidopsis plants produced by phaA, phaB, phaC gene construct inserted in chloroplast genome produces large amount of Polyhydroxybutyrate from Acetyl CoA.

## TRANSGENICS FOR THERAPEUTIC PROTEINS AND

### ENZYMES:

- (1) Hirudin a natural anticoagulant protein of leeches (Hirudo medicinalis) have been produced in Brassica napus by inserting gene for hirudin from leech with oleosin gene from Arabidopsis

(II) Industrial enzymes like  $\alpha$  amylase,  $\beta$  glucuronidase, Trypsin, Phytase (hydrolyse phytate) cellulase, xylanase have been produced in genetically modified plants

(IV) Lysosomal enzyme Glucocerebrosidase produced during destruction of erythrocytes, its deficiency causes Gaucher's disease.  
It was first lysosomal enzyme produced in transgenic tobacco and marketed as Cerezyme.

(V). Production of Antibodies (Plantibodies) in transgenic plants  
Secretory antibody IgA (SegA) have been produced in transgenic tobacco that target bacteria Streptococcus mutans present in dental caries. Different fragment of IgG, and single chain variable fragment (scFv) have been produced in plants.

(VI) Production of Vaccines (Veggie vaccines)

Transgenic plants have been used to produce vegetable vaccines (edible plant-based) in plants like tomato, banana etc.

(VII) Production of therapeutic protein: Chloroplast engineering is used to produce, hemoglobin, serum albumin, proinsulin etc. in plants