APPLICATIONS OF GENETIC ENGINEERING

BY

PALLAVI.J

What made the G.E to enter agriculture:

- The “Green revolution” used the application of pesticides and fertilizers to increase the production of crops. This resulted in excessive use of chemicals, thereby polluting the soil and environment as well as various harmful effects to the consumer.
- Application of genetic engineering in the field of agriculture has greatly reduced the usage of fertilizers and chemicals.

1. GENETIC ENGINEERING IN AGRICULTURE:

Genetically Engineered Crops:

- Using genetic engineering and recombinant DNA technology, genes for the desired trait are introduced in the species. This type of genetically modified plant species is known as GM crop.

- **These GM plants have many benefits:**
- Crops can be made insect and pest resistant
- Nutritional value of the food can be increased
- Increases the yield by many folds
- Reduces the use of harmful chemicals and fertilizers
- Crops can be made more tolerant to environmental stress
- Efficient mineral utilization by plants
- Yield can also be increased by having a short maturing period

Examples of GM Plants:

- **Golden rice**: Vitamin A enriched variety of rice.
- **Bt. cotton, Bt. corn**: *Bacillus thuringiensis* produces an insecticidal protein, known as **Bt toxin**. These insect-specific Bt toxin genes are incorporated into the genome of certain plants like cotton, corn, etc. These modified crops have insect resistant quality.
- **Pest resistant tobacco plant**: A nematode *Meloidogyne incognita* lives as a parasite in the root of tobacco plants. The plant is made resistant to infection by using the RNA interference technique. The nematode specific genes are introduced in the plant using *Agrobacterium* vector. The transgenic plant produces double-stranded RNA, which silences mRNA of the nematode and they are unable to survive.

- **Virus resistant plants**: The gene encoding for the protein of virus coat is transferred to the host plant resulting in the virus-resistant plant species. This has been used to produce virus-resistant squash.
- **Flavr Savr Tomato**: Gene responsible for the production of the enzyme polygalacturonase is blocked. This enzyme is responsible for degrading pectin and softening of the fruit. The transgenic variety of tomato can stay fresh and retain flavour for a longer duration.

2. Application of Genetic engineering in Medicine:

- G.E has vast applications in the medical field. G.E is used for therapeutic, diagnostic, scientific investigations for forensic studies, production of vaccines, antibiotics and various drugs.

- **Production of antibiotics, vaccines, enzymes and proteins**: Using recombinant DNA technology, many safe and therapeutic drugs have been produced.
- These drugs do not induce an allergic reaction, which may be the case if the same product is isolated from any animal source.

- .**Production of antibiotics and vaccines**: Antibiotics are produced using plants.
- Desired genes are incorporated in plants and targeted proteins are produced.
- Edible vaccines have already been manufactured for some diseases, e.g. hepatitis B, measles, cholera.

- **Genetically Engineered Insulin**: Insulin is used for the treatment of diabetes.
- Earlier insulin was extracted from the pancreas of cattle and pigs, which has shown to induce allergic reactions.
- Using recombinant DNA technology, genes coding for human insulin were incorporated in the plasmid of non-pathogenic strains of E. coli.
- Forming chains of insulin, which are extracted and combined by disulfide bonds.
- The recombinant human insulin is known as **Humulin**. It is widely used to treat diabetic patients.

- **Digestive enzymes**: Microorganisms can be modified to produce digestive enzymes.
- These microorganisms can be colonised in the digestive tract to suffice for the insufficient enzymes.
- **Hirudin Protein:** The gene coding for hirudin protein, which prevents blood clotting is transferred into Brassica napus.
- The protein gets accumulated in the seeds, which can be purified and used medicinally
- **Single Cell Protein (SCP)**: It is a microbial protein, which has high-quality protein and less fat. It is used as a protein-rich supplement for the human diet.

- **Gene Therapy**: Gene therapy is used in correcting genetic defects in embryo and child.
- Normal genes are delivered to the embryo or an individual with a faulty gene so that the function of the faulty gene is restored.
- For the first time, gene therapy was performed on a girl with adenosine deaminase (ADA) deficiency in 1990.

- This is caused due to the deletion of the gene coding for ADA.
- Functional adenosine deaminase cDNA is incorporated into the lymphocytes extracted from the blood of the patient using a retroviral vector and reintroduced in the body.
- Genetically engineered lymphocytes have to be infused periodically.
- The disease can be cured permanently If the gene is isolated from marrow cell and it is introduced in the embryonic stage.

- **Molecular Diagnostics**: Genetic engineering has proven useful in early diagnosis of disease.
- **PCR (Polymerase chain reaction)**: very low concentration of virus and bacteria can be detected by amplifying the DNA.
- PCR is used to detect the HIV virus in AIDS patients. Mutation of the gene in a cancer patient can also be detected by using this technique.
- **Elisa (enzyme-linked immunosorbent assay)**: Presence of antibodies synthesised as a result of reaction with the antigen of the pathogen can be detected by this technique.

- **Transgenic Animals**: Transgenic animals are those animals whose genes are manipulated to express a foreign gene. These transgenic animals are useful in many ways, e.g.
- Study gene regulation during normal growth and development
- Understand the progression of the disease. Various treatments can be tried on transgenic models with life-threatening diseases

- For the production of various biological products, e.g. gene coding for protein α-1-antitrypsin used to treat emphysema was incorporated to form the transgenic animal
- Rosie, the first transgenic cow, produced milk containing a human protein, α-lactalbumin
- Safety of vaccines can be tested on transgenic animals, e.g. the polio vaccine was tested on transgenic mice
- Toxicity of drugs can be tested on transgenic animals

3. **Application of Genetic engineering in Industry:**

- Industrial processes can be made more efficient and environment-friendly by using biotechnology.
- Using biotechnology enzymes can be produced in large quantities. This can be used as a biocatalyst for the synthesis of many chemicals
- Genetically modified plants supply different resources like starch, fuel, pharmaceuticals in huge quantity
- Proteases are used in detergents
- Biofertilizers production
- The processed food industry is based on biotechnology and the use of microorganisms for the fermentation process

- Large scale production of fructose from glucose derived from inexpensive sources
- Corn can be used in place of petroleum to synthesize chemicals
- G.E is useful in getting a better quality of products, e.g. cotton produced through biotechnology is warmer, stronger and wrinkle resistant
- Production of biopesticide. Biopesticides act selectively by killing pathogens such as bacteria, viruses and insects. These are not harmful like chemical pesticides
- Production of aquatic species by using biotechnological tools has greatly enhanced the quality and growth of aquatic organisms

THANK YOU

END OF SEM -4 SYLLABUS