BIOTECHNOLOGY AND IT'S APPLICATIONS

Three Critical research areas of Biotechnology

1. Providing best catalyst in form of improved organism usually a microbe or a pure enzyme.
2. Creating optimal conditions through engineering for a catalyst to act.
3. Downstream processing technologies to purify the protein.

Applications of Biotechnology

- **Agriculture**
  - → BT cotton
  - → Golden rice
  - → Flavr Savr Tomato
  - → RNA interference
- **Medicine**
  - → Humulin
  - → Gene Therapy
  - → Molecular diagnosis
- **Transgenic animals**
- **Ethical Issues**

Applications in Agriculture

1. Made crops tolerant to abiotic stress (cold, drought, salt, heat).
2. Pest Resistant Crops (BT cotton)
3. Reduced post harvest losses
4. Increased efficiency of mineral usage
5. enhanced nutritional Value
   e.g. – Golden Rice (Vit A enriched) ★
6. Increased shelf Life:–
   eg.– Flavr Savr tomato

(1) BT Cotton

→ examples of BT crops → Tomato, Potato, Corn, Cotton, Rice, Soyabean, Brinjal.

India → Bt Cotton → Most Grown Brinjal ★ 1st BT

→ BT toxin targets →
- Lepidopterans (tobacco budworm, armyworm)
- Coleopterans (beetles)
- Dipterans (flies, mosquitoes)

→ Bt toxin produced as 'prototoxin' (Inactive) in Bacillus thuringiensis.

→ Toxin gets activated by alkaline pH of midgut of Insects. ★
→ Midgut epithelial cells are lysed, causing death of insect.
→ Cry IAc, Cry II Ab → Cotton Bollworm ★
→ Cry I Ab → Cornborer

(2) RNA Interference

→ Another method of making pest resistant plant.
→ Meloidegyne incognita infects root of tobacco plant and cause 'Root Knot' Disease.
→ RNAi takes place in all eukaryotic organisms as a method of cellular defense
→ An important mRNA of the nematode is silenced by a complementary ds RNA produced by genetically modified plant.
→ Using Agrobacterium Vectors, nematode specific genes were introduced into host plants.
→ These genes produced both sense and antisense RNA.

Biotechnological Applications in Medicine.

↳ Worddwide 30 recombinant proteins are approved for human use, 12 are marked in India.

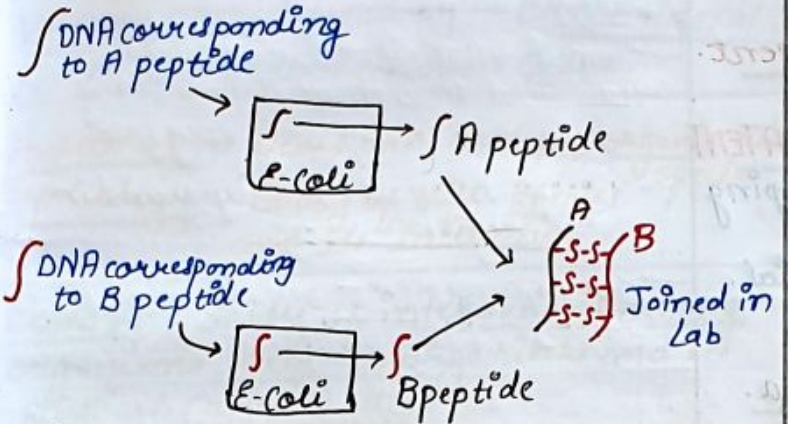
(1) Genetically Engineered Insulin — Humulin

For diabitic patients →
Bovine Insulin, Porkine Insulin → allergic to Humans

→ Proinsulin

A peptide, C peptide, B peptide → processing → A–S–S–S–S–S–B disulphide bond.

→ Bacteria can't do this complex processing.
→ In 1983, Eli lily, an American Company found a solution.



(2) Gene Therapy

→ 1st gene therapy:→
→ For Adenosine Deaminase Deficiency.
→ Disease: SCID (Severe Combined Immuno Deficiency).
→ In 1990, to a 4 year old girl
→ Enzyme is very important for functioning of immune system. It is produced by lymphocytes.
→ Approaches: Bone Marrow Transplant.
Enzyme Replacement therapy
↳ Not completely curative

→ Gene Therapy.
→ Lymphocytes grown out of the body.
→ A functional ADA (DNA is introduced) (using retrovirus)
→ Lymphocytes returned to body.
→ Periodic infusions of such lymphocytes

Only permanent Cure
Functional ADA gene introduced in cells at early embryonic stages.

(3) Molecular Diagnosis - PCR

→ Early detection with convectional methods of diagnosis (serum and urine analysis) is not possible
→ So genetic material of pathogen can be amplified using PCR and detected easily.

→ Routinely used to detect HIV in AIDS suspect.
→ To detect gene mutation in suspected cancer patients.

Method:→
→ A probe (ssDNA/RNA, tagged with radioactive material) is allowed to hybridise with complementary DNA (suspected of mutation)
→ A normal DNA would hybridise with probe while the mutated DNA won't.
→ The hybridisation is detected by autoradiography.

→ ELISA (Enzyme Linked Immuno-sorbant Assay).
→ Based on antigen-antibody interaction

Transgenic Animals

→ Transgenic rats, rabbits, pigs, sheep, cows and fish have been produced.
→ 95% of all transgenic animals are mice.

(1) Normal physiology and Development
(2) Study of Disease.
↳ Transgenic models for human diseases such as cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's exist.
(3) Biological Products.
→ α-1-antitrypsin to treat emphysema
→ In 1997, 1st transgenic Cow, Rosie produced human protein alpha-lactalbumin (2.4gm/ltr) in milk. (more balanced for human babies) than normal cow milk.
(4) Vaccine Safety Testing
(5) Chemical Safety Testing

Ethical Issues

→ GEAC (Genetic Engineering Approval Commitee)
↳ Set up by Indian Goverment.

→ Several companies of developed countries are being granted BIOPATENT for products that people of developing and underdeveloped countries have been using since time immemorial.

→ eg.– 2 Lakh Varities of Rice in India.
27 Documented Varieties of Basmati.

→ In 1997, an american company got patent right on Basmati Rice.

e.g.– Attempts have been made to patent medicines and herbs of India.
e.g.– Turmeric, Neem

Biopiracy

→ Use of bioresources by multinational companies and other organisations without proper authorisation from countries and people concerned without compensatory payment.

→ Second Amendment of Indian Patents Bill has been passed.