Biotechnology and Its Applications Class 12 Key Points

CBSE Class 12 Biology · NCERT · for boards, NEET and JEE revision

ChapterNotes

What Biotechnology Delivers

Best catalyst · Optimal conditions · Downstream processing

GMO = an organism whose genes have been altered by manipulation.

- Every bioprocess needs the best catalyst (improved microbe/enzyme)
- Plus optimal conditions (temperature, pH, substrate) for it to work
- Plus downstream processing to purify the final product

Three Application Fields & Food Routes

Fields: healthcare · agriculture · environment/industry

Don't confuse the 3 research problems with the 3 application fields.

- Food routes: agrochemical, organic, genetically engineered farming
- Green Revolution tripled food but needed costly agrochemicals
- Biotech offers GMOs as a more sustainable alternative

Genetically Modified Crops

Golden rice → vitamin-A (β-carotene) enriched

Also reduces pesticide use and post-harvest losses.

- Tolerate abiotic stress: cold, drought, salt, heat
- Reduce pesticide dependence and post-harvest losses
- Raise mineral-use efficiency and nutritional value

Bt Toxin & the cry Gene

cry gene → Cry protein (Bt toxin); cryIAc + cryIIAb → Bt cotton

Gene is written cry (lowercase, italic); protein is Cry.

- cryIAc, cryIIAb → cotton bollworms (lepidopterans)
- cryIAb → corn borer
- Bt cotton is the classic NEET example

How Bt Toxin Kills the Insect

inactive protoxin → alkaline gut activates → binds midgut → pores → lysis

Bacterium is safe because the toxin stays an inactive protoxin (crystal).

- Insect eats inactive protoxin crystals
- Alkaline pH of insect gut solubilises and activates the toxin
- Active toxin binds midgut epithelium, forms pores, insect dies

RNA Interference (RNAi)

sense + antisense RNA → dsRNA → silences nematode mRNA

This is post-transcriptional gene silencing; needs a dsRNA trigger.

- dsRNA binds the complementary mRNA and blocks translation
- Used to make tobacco resistant to nematode Meloidogyne incognita
- Genes delivered via Agrobacterium; parasite can't survive

Recombinant Insulin (Humulin)

Chain A (21 aa) + Chain B (30 aa) joined by disulphide bridges

Eli Lilly, 1983: A and B chains made separately in E. coli, then joined.

- Body first makes pro-insulin with an extra C-peptide
- C-peptide is removed during maturation
- Recombinant route avoids allergy from animal-source insulin

Gene Therapy & Molecular Diagnosis

First gene therapy (1990): ADA deficiency (SCID)

Lymphocyte ADA cDNA is temporary; permanent cure needs early embryonic bone-marrow cells.

- Gene therapy inserts a normal gene to correct a defect
- PCR amplifies tiny pathogen nucleic acid (HIV, cancer)
- ELISA uses antigen-antibody interaction for early detection

Transgenic Animals

Rosie (1997) → human α-lactalbumin (2.4 g/L) in milk

Molecular pharming = making valuable proteins in animals.

- Uses: study physiology, disease models, biological products
- Also vaccine safety testing and chemical (toxicity) testing
- First transgenic cow = Rosie; product = human alpha-lactalbumin

Biopiracy, Biopatents & GEAC

Biopiracy examples: Basmati · Turmeric (Haldi) · Neem

GEAC = Genetic Engineering Approval Committee (India).

- GEAC approves GM research and safety of GMO release in India
- Biopatent: a patent on a biological entity, product or process
- Biopiracy: using bio-resources/knowledge without authorisation or payment

Quick revision

- Bt crops: Cry protein (from B. thuringiensis) → kills insect larvae; Bt cotton uses Cry1Ac/Cry2Ab
- RNAi: dsRNA silences specific gene → nematode-resistant tobacco
- Humulin: human insulin from E. coli (Eli Lilly, 1983)
- Gene therapy: ADA deficiency - first example; lymphocytes + ADA gene via retrovirus
- Rosie: first transgenic cow (human α-lactalbumin in milk)
- Golden Rice: β-carotene enriched
- Biopiracy: neem, turmeric, basmati cases
- GEAC: regulatory body for GMOs in India

Full chapter notes with solved examples and practice questions: https://chapternotes.in/cbse/class-12-biology/biotechnology-and-its-applications-class-12-notes/