

APPLICATIONS OF BIOTECHNOLOGY

Applications

[r-DNA Technique /
Gene transfer tech.]

- ↳ have been observed in many diff. fields.
- agriculture / Medical science.
(Food science) (Biopharmaceutical)
- environmental science / Bioremediation
(air pollution control)

Applications in:

- Green Biotech ~ agriculture
- Red Biotech ~ Medical science
- White / Grey Biotech ~ Industry
- Blue Biotech ~ Marine science

[1] application of Biotech. in agriculture:

(3) types.

- ① agrochemical based agri.
- ② organic agriculture
- ③ genetically engineered crops based agriculture. (GMO)

GMF (food)

GM crops are produced:

- ① To enhance nutritional quality of food.

eg. Golden Rice

- ↳ Rich in vit. A
- ↳ Carotene gene was transferred

Protein Rich Potato

- ↳ overcome protein deficiency

② To develop Tolerance against abiotic stresses

(flood, drought, frost, salinity etc.)

eg. Salt Tolerant Transgenic Tomato

↳ In this a gene was transferred which highly expressed $\text{Na}^+\text{-K}^+$ outpump in its membrane by which it accumulates all additional ions in its vacuole and later on release them out.

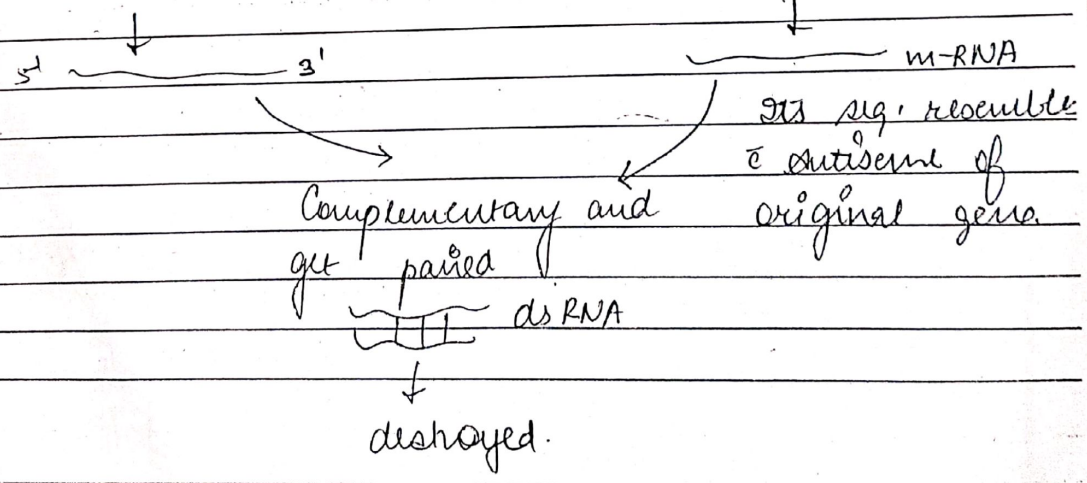
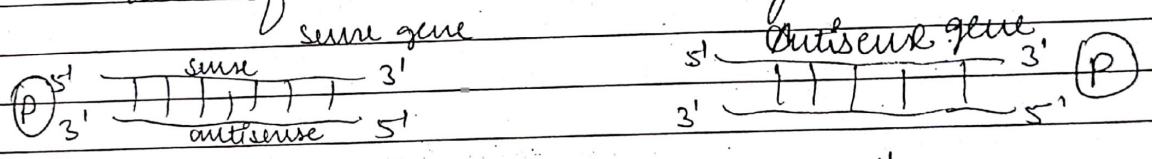
③ To reduce post harvest losses

eg. Plant - Save Tomato

↳ have long shelf life due to delayed ripening

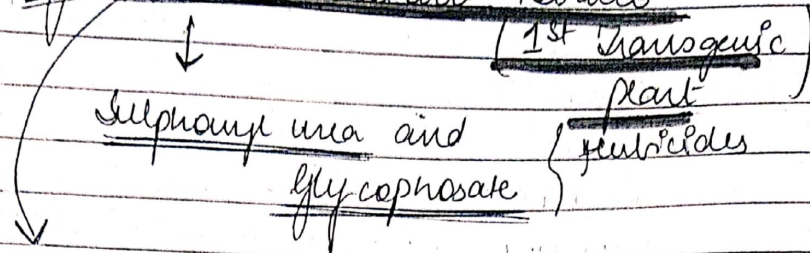
Antisense Technique

In this the expression of gene of ripening enzyme polygalactonase is slow down by the use of antisense technology



④ To develop herbicide resistant plant.

eg. Herbicide Resistant Tobacco



In this ALS gene of Arabidopsis was transferred.

ALS → acetolactate synthetase

⑤ For production of Biopharmaceutical compounds:

eg. gene of Humulin was transferred in Brassica napus (Rapeseed oil)

↓
It produces Humulin which collects in its seed.

↓
Seeds are crushed.

↓
Oil obtained.

↓
Humulin separated.

↳ used as Blood anticoagulant.

eg. Edible Vaccine → Trans. Banana } for Hepatitis and cholera
→ " " Tanato }
→ " " Sugarcane → for foot & mouth dis.
→ " " Banana } for Diarrhoea
→ " " potato }

①

⑥ To develop Pest Resistant plants

- Insect Resistant plants [eg] Bt plants / crops
- Nematode —————

1st Biopesticide developed by Bt.

In them a Bt gene / cry protein of *Bacillus thuringiensis* Bact. is transferred.

↓
It produces a toxic, insecticidal protein which kills many insects

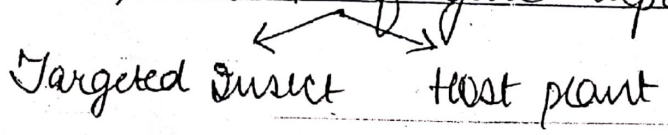
- ★ Insects of three groups →
- ① Lepidoptera (army worm, tobacco bud)
 - ② Coleoptera (beetles)
 - ③ Diptera (flies, mosquito)

This protein never kills its own Bacteria because in Bacteria it is found in insoluble inactive crystal forms (endotoxin) (protoxin) ∴ this protein is known as crystal protein / Cry protein

Insect Resistant plants

When insect feeds this protein the insoluble protein gets dissolved in its midgut due to alkaline med. and it becomes active. This active pt. binds to midgut ep. creates pores causes swelling and lysis of cell and thus ultimately insect will die.

- ↳ cry gene → insect group specific
- several types of cry genes.
 - selection of gene depends on:



(2)

eg. Cry IAc gene and Cry IAb gene \rightarrow for Bollworm
Cry IAb gene \rightarrow for corn Borer insect.

* a suitable cry gene is selected and isolated from bacteria and transferred in host by Ti-plasmid vector.

eg. Bt cotton
Bt tobacco
Bt soybean
Bt corn
Bt rice
Bt Brinjal
Bt Mustard

} these are all resistant to insects.

Bt cotton \rightarrow resistant to Bollworm.

Nematode Resistant plants

\rightarrow They also causes diseases in some plants. (only few are pathogenic) pest

eg. Meloidogyne incognita

\rightarrow causes Red Knot disease in Tobacco.

(3)

• nematode resistant plants are developed by its
• a very special technique RNA Interference
• (RNAi) Technique.

↓
• It is a
• natural method of
• cellular defence
• in eukaryotes.

↓
studied in detail by
Fire and Mello
(2006 → noble prize)

• RNAi → It is the technique of gene silencing

vector and
transposons/
retrovirus

↓
• In this the expression of any gene
is inhibited by destroying
its m-RNA.

↓
• This m-RNA is destroyed by a comple-
-mentary ds RNA

Source of ds complementary RNA.

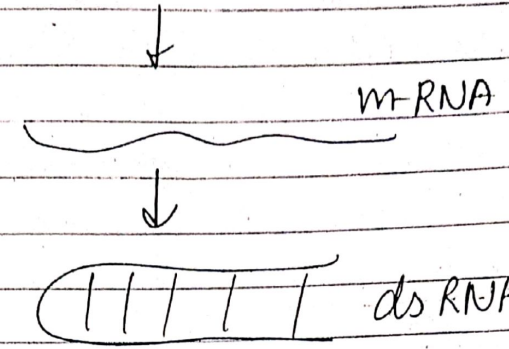
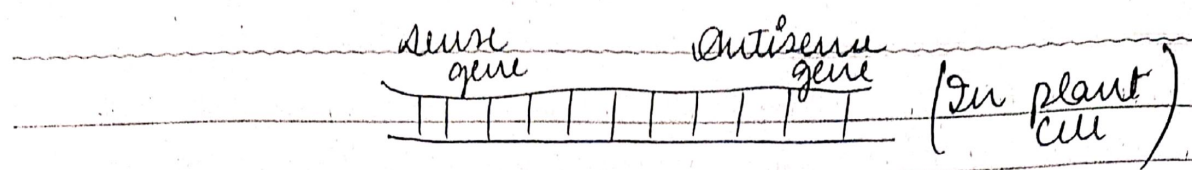
artificially
and transferred
in cell with the
help of some
vector like
retrovirus /
transposons.

↓
• A pair of sense and antisense
gene is introduced in
a cell which forms a
ds RNA inside the cell
and this ds-RNA initi-
ates RNAi in cell.

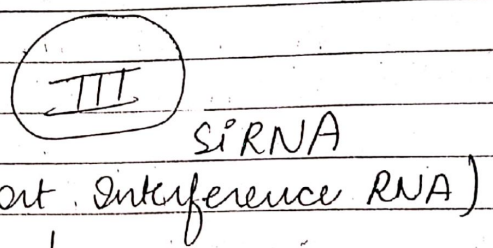
• This ds RNA later on
initiates RNAi in cell &
causes gene silencing.

(4)

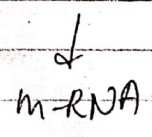
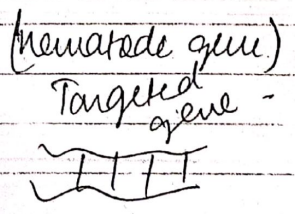
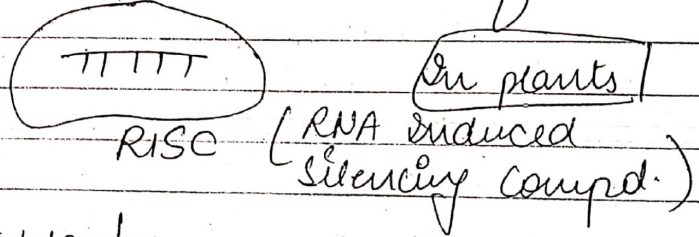
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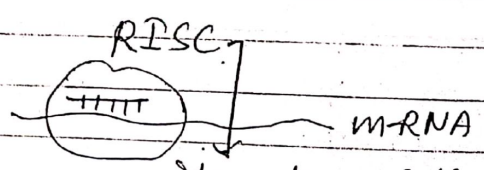
To this, Dicer proteins binds which cleave it into fragments



To this, a multicomponent nucleare comp. compound binds (RISC Helicase activity) It removes one one strand of dsRNA



Bind to mRNA



It cuts mRNA into fragments

gene get silenced ← m-RNA destroyed

(5)

(Red Biotech)

Application of Biotechnology in Medical Science.

- Involves formation of medicines.
- Treatment of disease.
- Diagnosis of disease
- Formation of medicines.

↳ Recombinant Therapeutics

↳ Very effective

↳ pure

↳ safe

↳ Low side effects

So far about

30 recombinant

medicines are being

used all over the

world.

In India only 12 recombinant medicines are
used.

e.g. genetically engineered Insulin !

↓
proteinaceous hormone which
regulate blood glucose level.

If insulin is less in amount then glucose
level increases in Diabetes Mellitus. Then
it is given from outside

↓
Initially it was obtained
from Cattle and pigs
(Bovine Insulin)

↓
was usually allergic to human
beings.

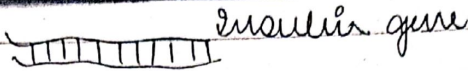
natural method of insulin formation in Humans.



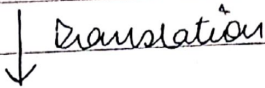
Insulin



Its gene is not on short arm
of chromosome 11.

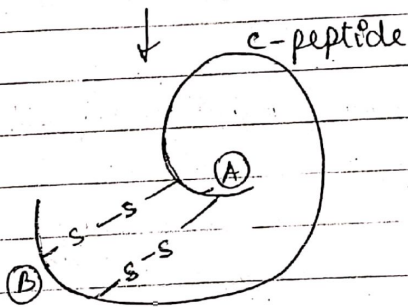


MRNA

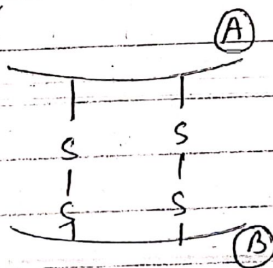


PROINSULIN (Inactive)

Formation of
Disulphide Bond



only in Humans
not in
Bacteriae.
(Removal of
C-peptide
By β -cell peptidases)



Insulin

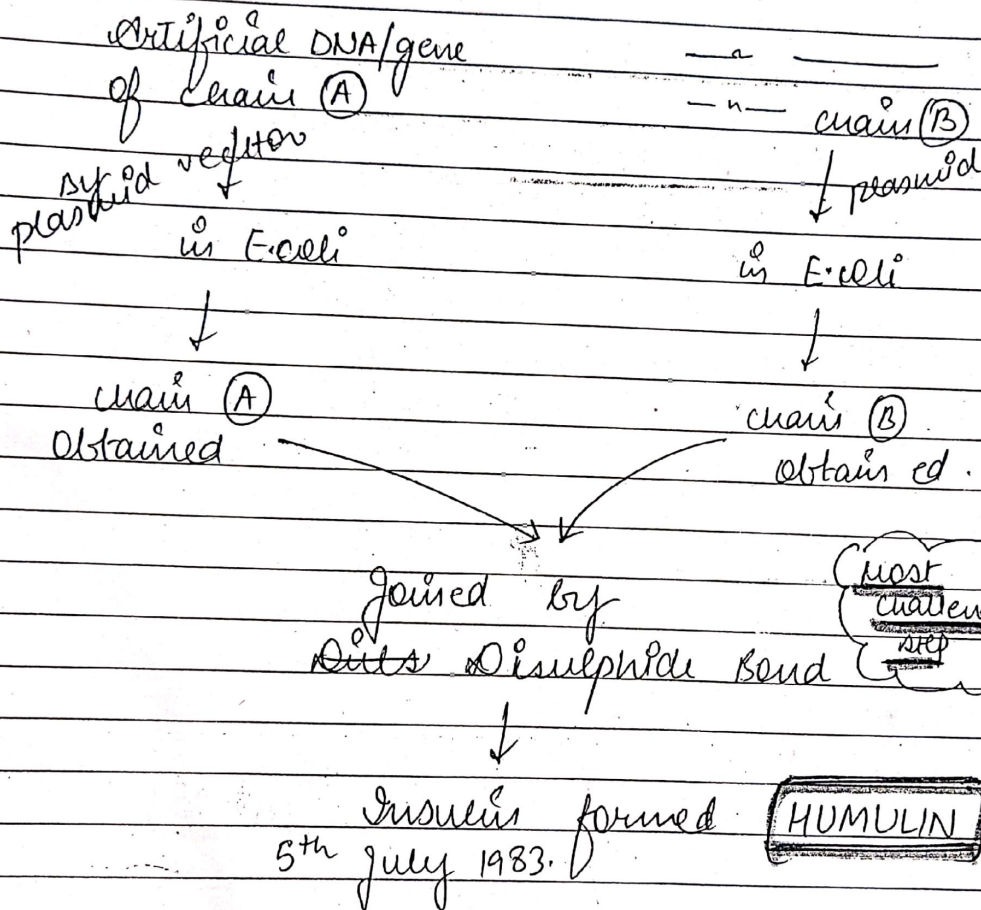
+ c-peptide

↳ digested in stomach.

(7)

Genetically engineered insulin
↳ developed by an American pharma
company Eli Lilly (1983)

They developed two artificial gene of
chain A and chain B and
transferred them into two separate
E. coli.



(2) HUMALOG is more purified than Humulin
(By - Eli Lilly & Ransbury)

② Gene Therapy

↳ method of treatment of some genetic dis.
It is the collection of all those methods which are involved in treatment of a genetic disorder that has been identified in an embryo/child

* ↳ 1st successful gene therapy was done in 1990 in a 4-yr old girl suffering from ADA deficiency.

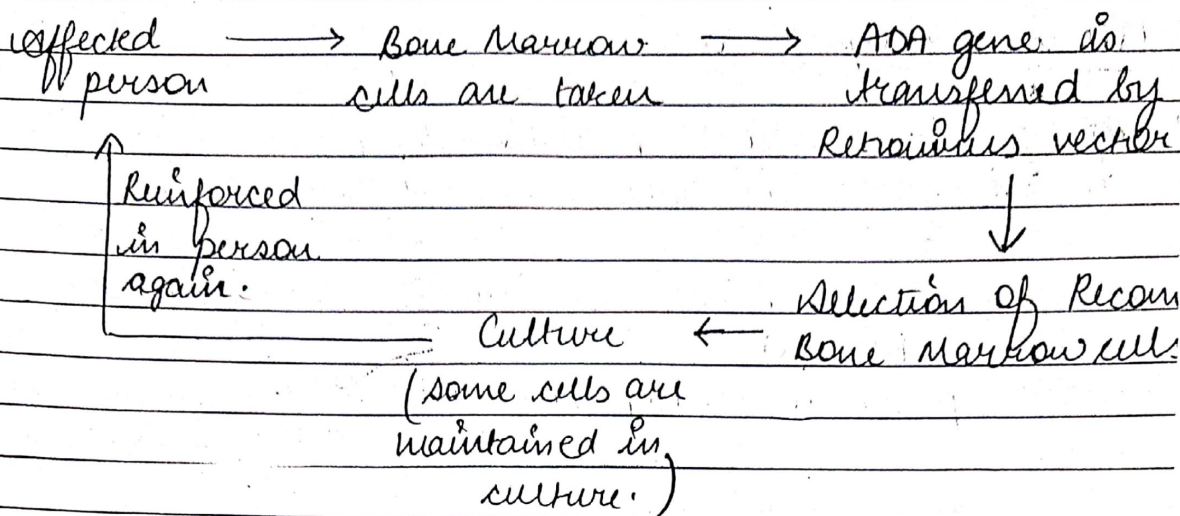
↓
- succ of en: adenosine deaminase
↓
used immunity - req. for the formation of functional T-lymphocytes from bone marrow cells.

results in "SCID"
"Severe Combined Immuno deficiency"

Treatment :

- ① enz. Replacement Therapy
- ② Bone Marrow transplantation
- ③ gene Therapy

(9)



For the permanent cure this gene transfer should be done at embryonic stage.

③ Molecular Diagnosis

Here the techniques of Biotechnology are used for very early and accurate diagnosis of any disease / pathogen in any human.

| Technique | Application |
|---------------------------|---|
| Hybridisation (X-ray DNA) | In disease diagnosis in Adults (After birth) ↳ DNA pattern on X-ray film → +ve test. (Disease confirmed) |
| PCR | In disease diagnosis in Embryonic stage (Before Birth) ↳ DNA pattern on X-ray film → -ve test. (Disease X) |
| ELISA | |

Small, single stranded radioactive DNA / RNA probe are used.

TRANSGENIC ANIMALS

Less in comparison to plants and microbes.

Mainly, Mice > more than 95%

sheep

goat, cow, pigs etc.

* Uses and Applications

① For the production of some important Biological / Industrial product.

Organism

Gene Transferred
(Human)

Uses

Trans. sheep \rightarrow Blood clotting factor VIII / B gene \rightarrow Treatment of Haemophilia

Trans. sheep \rightarrow Human α -1 antitrypsin gene \rightarrow Treatment of Emphysema.

Trans. cow \rightarrow Human Lactoferrin gene \rightarrow Treatment of cystic fibrosis

Trans. cow \rightarrow Human Lactalbumin gene \rightarrow used in infant feeding.
(Rosie) \rightarrow produces nutritious milk rich in lactalbumin (2.4g/l)

Trans. goat \rightarrow TPA gene (Tissue plasminogen activator gene) \rightarrow used for the removal / dissolution of blood clot in heart / BV.
 \downarrow
Streptokinase

Trans. goat \rightarrow Spider gene \rightarrow Thread formed (used for clothes & pet. formation).
often products

Trans. pig \rightarrow Human Oritigen gene \rightarrow Their organs are used for transplant-ation.

Trans. sheep/pig/etc. → Human growth hormone → size ↑ ↑
cow/fishes used as food.

↳ These foods are known as GMF → food.

(2) For the study of normal physiology and development.

↳ study of gene expression and regulation
Transgenic mice are studied.

(3) ↳ For the study of diseases.

eg. Oncomouse → for cancer study

(4) For vaccine safety testing

eg. Transgenic mice had been used for safety testing of polio vaccine.

(5) For chemical safety / Toxicity Testing

In this sensitive transgenic organisms are developed by gene transfer and then they are used for safety testing.

TRANSGENIC MICROBES.

↳ max. in no.

① → having Human Insulin gene



Treatment of Diabetes

② → having human growth hormone



Treatment for Dwarfism

~~Trans~~ E. coli
Transgenic

Pgs 18
Module

- Transgenic E-Coli
- ③ having calcitonin gene → Treatment of Rickets
 - ④ having Interferon gene → For viral Resistance
 - ⑤ having antigen gene → For vaccine production

★ Pseudomonas putida (Superbug) → 1st Biopent
→ Developed by → Anand Mohan Chakravarty
↳ It can digest hydrocarbon / petroleum
↳ It is used to remove oil spills from oceans. Marine water pollution
control:

↳ an eg. of Bioremediation (use of living org. to remove pollution)

→ in this bacteria ④ types of genes / plasmids were transferred.

- ① OCT gene → octane digestion
- ② XYL gene → xylene digestion
- ③ CAM gene → camphor digestion
- ④ NAH gene → naphthalene digestion

GEAC

Basmati Rice

NEET
KOTA
JULY