NEET BIOLOGY · CLASS 12 · CHAPTER 10

Biotechnology and its Applications

From the lab to the farm, the clinic and the courtroom

Chapter 9 taught you how to move a gene. This chapter shows what that gives us: insect-proof crops, human insulin from bacteria, and a fight over rice.

9 diagrams | 14 worked questions | 20 quick-review cards | Fact sheet

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In short

- Bt crops make an insect toxin that only becomes active in the alkaline gut of the insect.
- RNA interference silences a pest's gene. Tobacco plants protected this way kill the nematode that feeds on them.
- Human insulin is now made in *E. coli*, as separate A and B chains joined later.
- The first gene therapy (1990) treated ADA deficiency. It was not a permanent cure.
- Transgenic animals help study disease, make medicines and test safety. Biopiracy and patents raise ethical questions.

0 How to Read This Set

- This chapter is a set of case studies. For each one, learn three things: the problem, the trick, and the catch.
- Many questions here hide one wrong word in a true-looking sentence. Read every statement to the end.
- Orange boxes are traps. Read every one.
- Questions after each section are NEET level. Try each one before reading the answer.
- Insulin and Bt crops gave nearly half the questions in our data. Learn those two sections best.

WHAT NEET 2026 ASKS FROM THIS CHAPTER

The NMC syllabus lists: "Application of Biotechnology in health and agriculture: Human insulin and vaccine production, gene therapy; Genetically modified organisms-Bt crops; Transgenic Animals; Biosafety issues-Biopiracy and patents."

- **Vaccine production** is not in NCERT Chapter 10. It appears in Chapter 7 (Human Health and Disease). Section 05 covers it.
- **Stem cell technology** appears in the CBSE board syllabus. But NCERT does not teach it, and the NEET 2026 syllabus does not list it. These notes skip it.
- **How genes are cut, copied and inserted** is Chapter 9. Read those notes first.

PYQ ANALYSIS **See how NEET tested this chapter from 2015 to 2025** →

In our analysis, two topics gave about 45% of this chapter's questions: insulin production and Bt crops. Since 2020, multi-statement and match-the-column questions have replaced many plain MCQs.

01 Biotechnology in Agriculture

IN NEET

Three ways to grow more food

- **Agro-chemical based agriculture:** uses fertilisers and pesticides.
- **Organic agriculture.**
- **Genetically engineered crop-based agriculture.**
- The Green Revolution tripled the food supply. But it was still not enough for a growing population.
- Agrochemicals are too costly for many farmers. More of them also harms the environment.
- So we need crops that need fewer chemicals.

Tissue culture: many plants from one

- Breeding could not keep pace with demand. So another technology, **tissue culture**, was developed.
- In the 1950s, scientists learnt that whole plants can be regenerated from **explants**.
- An explant is any part of a plant taken out and grown in a test tube. It grows under sterile conditions, in a special nutrient medium.
- The capacity to grow a whole plant from any cell or explant is called **totipotency**.
- The nutrient medium must provide:
  - a carbon source, such as sucrose
  - inorganic salts, vitamins and amino acids
  - growth regulators, like auxins and cytokinins.
- Producing thousands of plants this way, in a very short time, is called **micropropagation**.
- Each of these plants is genetically identical to the original plant. They are **somaclones**.
- Tomato, banana and apple have been produced on a commercial scale this way.

Virus-free plants

- Even if a plant is infected with a virus, its **meristem** (apical and axillary) is free of virus.
- So the meristem is removed and grown in vitro. This gives **virus-free plants**.
- Meristems of banana, sugarcane and potato have been cultured this way.

Somatic hybridisation

- Single cells are isolated from plants, and their cell walls are digested. This leaves naked **protoplasts**, surrounded only by the plasma membrane.
- Protoplasts from two different varieties, each with a desirable character, are fused. The hybrid protoplast grows into a new plant.
- These plants are **somatic hybrids**. The process is **somatic hybridisation**.
- Example: a tomato protoplast was fused with a potato protoplast. The result was the **pomato**.
- The pomato did not have all the desired characters for commercial use.



THINK IT THROUGH

SANITY CHECK

- Micropropagation makes identical copies, called somaclones. Somatic hybridisation joins two different plants. Do not swap the two.

Genetically modified organisms (GMOs)

- Plants, bacteria, fungi and animals whose genes have been changed by manipulation are called **GMOs**.
- GM plants have been useful in five ways:

1. More tolerance to **abiotic stresses**: cold, drought, salt and heat.
2. Less reliance on **chemical pesticides**, through pest-resistant crops.
3. Fewer **post-harvest losses**.
4. More efficient **mineral use** by plants. This stops early exhaustion of soil fertility.
5. Better **nutritional value**. Example: **Golden rice**, which is Vitamin A enriched rice.

- GM plants can also be tailor-made to supply industry with starches, fuels and medicines.



TRAP ALERT

TRAP ALERT

- Golden rice is enriched in **Vitamin A**. It is not a pest-resistant crop. Our data lists it as due for a return.

Q1 Counting

LEVEL 2

How many of the following are benefits of GM plants listed in NCERT?

Tolerance to drought and salt, reduced use of chemical pesticides, reduced post-harvest losses, more efficient use of minerals, Vitamin A enriched grain, a greater need for chemical fertilisers, a higher need for irrigation water

1. Four
2. Five
3. Six
4. Seven

Answer: 2

CORE PRINCIPLE NCERT lists five uses: abiotic stress tolerance, less pesticide, fewer post-harvest losses, better mineral use, and better nutrition.

TRAP The last two items are the opposite of what GM crops aim for. Option 4 counts everything listed. Option 3 counts one of the two false items.

02 Bt Crops

IN NEET REPEATS OFTEN *Bt crops, 6 questions*

Where the toxin comes from

- Bt toxin comes from the soil bacterium ***Bacillus thuringiensis*** (Bt for short).
- Its toxin gene is cloned and expressed in plants. The plants then resist insects without insecticides.
- In effect, the plant makes its own **bio-pesticide**.
- Examples: **Bt cotton**, Bt corn, rice, tomato, potato and soyabean.

Which insects it kills

- Some strains of *B. thuringiensis* make proteins that kill certain insects:
  - **Lepidopterans:** tobacco budworm, armyworm.
  - **Coleopterans:** beetles.
  - **Dipterans:** flies, mosquitoes.

How the toxin works

- At one stage of growth, *B. thuringiensis* forms **protein crystals**. These hold the toxic insecticidal protein.

- In the bacterium, the toxin exists as an **inactive protoxin**. So it does not kill the bacterium itself.
- An insect eats it.
- The **alkaline pH of the insect's gut** dissolves the crystals and converts the protoxin into its active form.
- The active toxin binds to the surface of the **midgut epithelial cells**.
- It creates **pores** in them. The cells swell and burst (lysis).
- The insect dies.

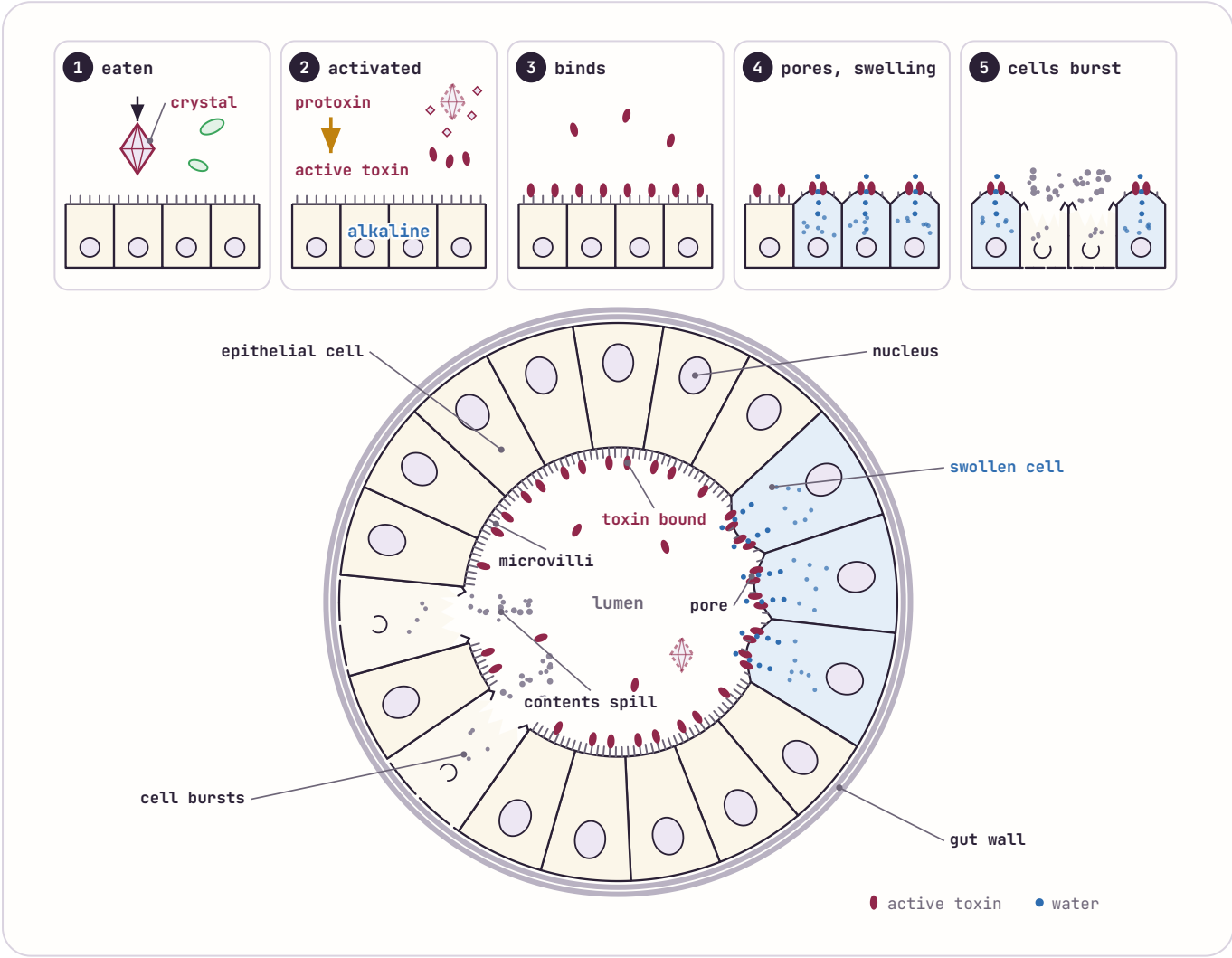


Fig 1 · Bt toxin in the insect gut. Harmless in the bacterium, deadly once the alkaline gut activates it.



HAVING DIFFICULTY PICTURING THE GUT CELLS BURSTING?

Play it.

This chapter is a set of short games in the Logic Bloom app.
logicbloom.co.in/download · Free to start.

SCAN



TRAP ALERT

TRAP ALERT

- The toxin is activated by **alkaline** pH, not acidic pH. Our data shows this exact fact tested 3 times. Options love to swap "alkaline" for "acidic".

The cry genes

- The Bt toxin gene is called ***cry***.
- Most Bt toxins are specific to one insect group. So the gene chosen depends on the crop and the pest.

GENE	CONTROLS
cryIAc and ***cryIIAb***	Cotton bollworms
cryIAb	Corn borer

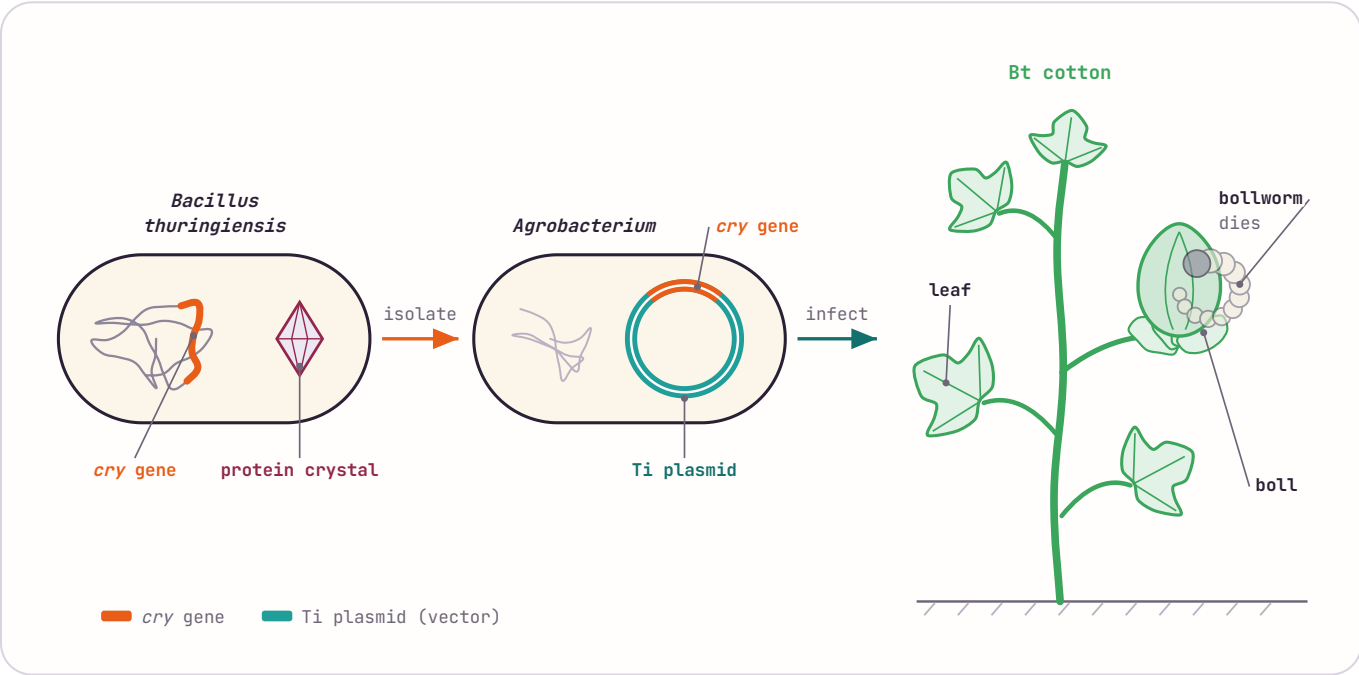


Fig 2 · Making Bt cotton. The plant now makes its own bio-pesticide.



THINK IT THROUGH

SANITY CHECK

- Lower-case italic *cry* is the gene. Capital, non-italic Cry is the protein it codes for. NCERT uses the same convention.

Q2 Assertion-Reason

LEVEL 2

Assertion (A): The Bt toxin does not kill *Bacillus thuringiensis*, the bacterium that makes it.

Reason (R): Inside the bacterium, the toxin exists as an inactive protoxin. It becomes active only in the alkaline gut of an insect.

1. Both A and R are true and R is the correct explanation of A
2. Both A and R are true but R is not the correct explanation of A
3. A is true but R is false
4. A is false but R is true

Answer: 1

CORE PRINCIPLE The toxin is harmless until alkaline gut conditions activate it. That is exactly why the bacterium survives.

TRAP Option 2 is for students who see two true lines and stop checking the link.

Q3 Process ordering

LEVEL 2

Arrange these events in the correct order, after an insect eats a Bt cotton leaf.

(A) The cells of the midgut epithelium swell and burst

(B) The alkaline gut dissolves the crystals and activates the toxin

(C) The insect dies

(D) The active toxin binds to midgut epithelial cells and creates pores

1. (B), (A), (D), (C)
2. (D), (B), (A), (C)
3. (B), (D), (A), (C)
4. (A), (B), (D), (C)

Answer: 3

CORE PRINCIPLE Activate first, then bind, then make pores, then lysis, then death.

TRAP Option 1 puts the bursting before the binding. Option 2 has the toxin binding before it is even active.

Q4 Match the Column

LEVEL 2

COLUMN I	COLUMN II
A. *cryIAc* and *cryIIAb*	I. Beetles
B. *cryIAb*	II. Cotton bollworms
C. Coleopterans	III. Flies and mosquitoes
D. Dipterans	IV. Corn borer

Choose the correct answer from the options given below.

1. A-IV, B-II, C-I, D-III
2. A-II, B-IV, C-I, D-III
3. A-II, B-IV, C-III, D-I
4. A-II, B-I, C-IV, D-III

Answer: 2

CORE PRINCIPLE Two genes for cotton bollworms, one for corn borer. Coleopterans are beetles; dipterans are flies and mosquitoes.

TRAP Option 1 swaps the two gene rows. Option 3 swaps the two insect orders.

03 Pest-Resistant Plants: RNA Interference

IN NEET SEEN SEVERAL TIMES *4 questions*

The problem

- The nematode ***Meloidegyne incognitia*** infects the **roots of tobacco** plants.
- It causes a great fall in yield.

The trick: RNA interference (RNAi)

- RNAi happens in **all eukaryotic organisms**, as a method of cellular defence.
- It silences a specific **mRNA**.
- A complementary **double-stranded RNA (dsRNA)** binds to the mRNA and prevents its translation.
- The source of this complementary RNA can be:
  - an infection by viruses with RNA genomes, or
  - mobile genetic elements (**transposons**) that replicate through an RNA intermediate.

How it protects tobacco

- Nematode-specific genes were put into the host plant using ***Agrobacterium*** vectors.
- This produced **both sense and anti-sense RNA** in the host cells.
- The two RNAs are complementary. So they paired to form **dsRNA**.
- The dsRNA started RNAi and silenced the specific mRNA of the nematode.
- The parasite could not survive in a transgenic host that expressed this interfering RNA.

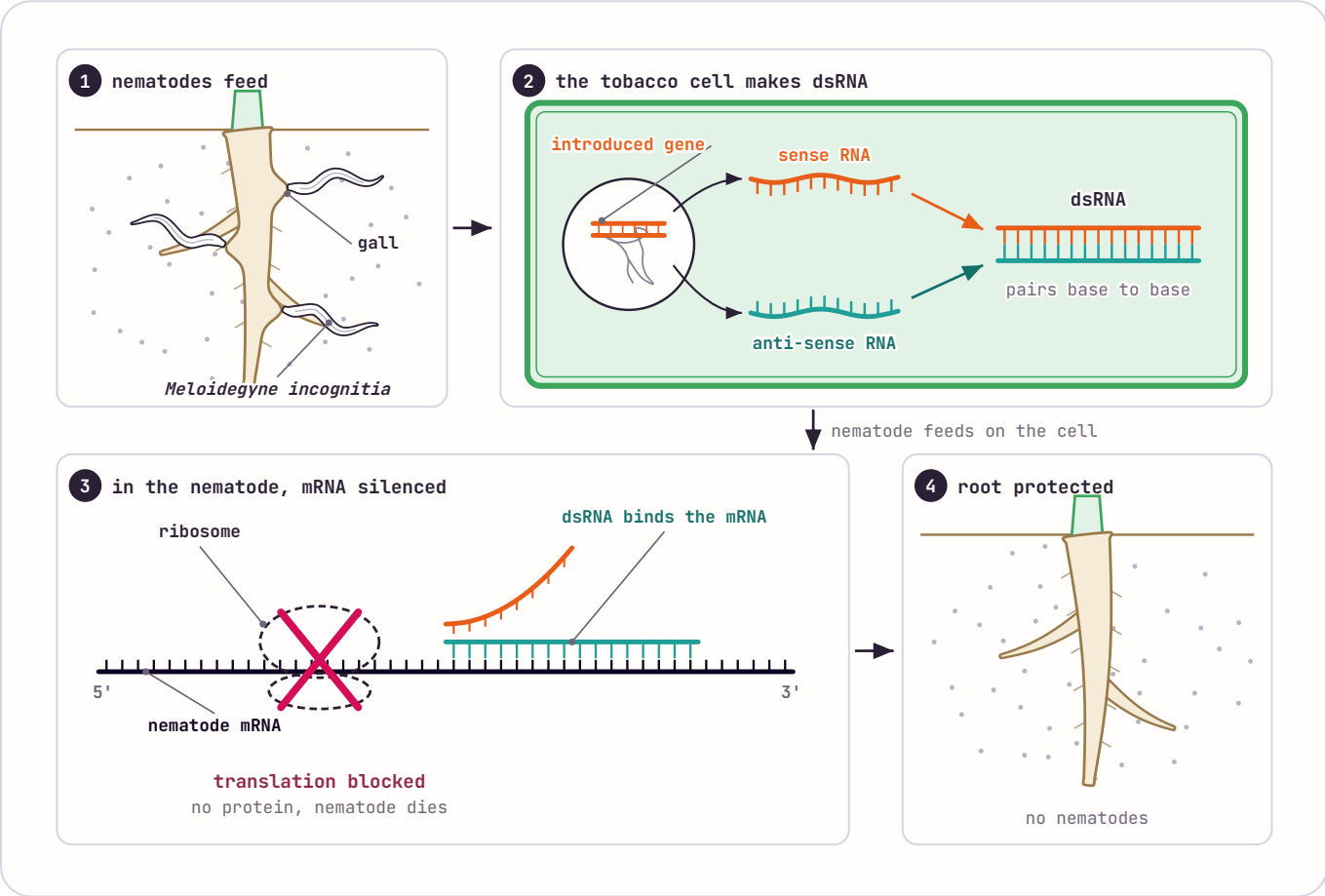


Fig 3 · RNA interference. Sense plus anti-sense makes dsRNA, which silences the pest's mRNA.



TRAP ALERT

TRAP ALERT

- The plant makes **both** sense and anti-sense RNA. A statement saying "only anti-sense RNA" is false. RNAi silencing by complementary dsRNA was tested 3 times in our data.

Q5 Multi-statement

LEVEL 2

Read these statements about the RNAi method used to protect tobacco.

(a) RNAi occurs in all eukaryotic organisms as a method of cellular defence.

(b) A complementary dsRNA binds to a specific mRNA and prevents its translation.

(c) The nematode *Meloidegyne incognitia* infects tobacco roots.

(d) Nematode-specific genes were introduced into the plant using *Agrobacterium* vectors.

(e) The host plant made only anti-sense RNA, which silenced the nematode's mRNA.

Choose the correct answer from the options given below.

1. (a), (b) and (e) only
2. (b), (c), (d) and (e) only
3. (a), (c) and (d) only
4. (a), (b), (c) and (d) only

Answer: 4

CORE PRINCIPLE The host made sense and anti-sense RNA. Together they formed the dsRNA that silenced the pest's mRNA.

TRAP (e) drops the sense strand. Options 1 and 2 include it. Option 3 misses (b), the core mechanism.

READ NEXT how *Agrobacterium* delivers genes →

04 Biotechnology in Medicine: Human Insulin

IN NEET | REPEATS OFTEN | *insulin production, 7 questions, the most tested topic here*

Why recombinant medicines

- rDNA technology makes safe and more effective drugs in large amounts.
- Recombinant drugs do not cause unwanted immune responses, unlike similar products taken from animals.
- About 30 recombinant therapeutics have been approved worldwide. In India, 12 are being marketed.

The old way and its problem

- Adult-onset diabetes is managed by taking insulin at regular intervals.
- Earlier, insulin came from the pancreas of slaughtered cattle and pigs.
- In some patients, this foreign protein caused allergy or other reactions.

The structure of insulin

- Insulin has **two short polypeptide chains**, **chain A** and **chain B**.
- They are linked together by **disulphide bridges**.
- In mammals, including humans, insulin is made as a **pro-hormone**, like a pro-enzyme.
- The pro-hormone has an extra stretch called the **C peptide**.
- The **C peptide is removed** during maturation. Mature insulin does not have it.
- So the hard part was getting insulin assembled into its mature form.

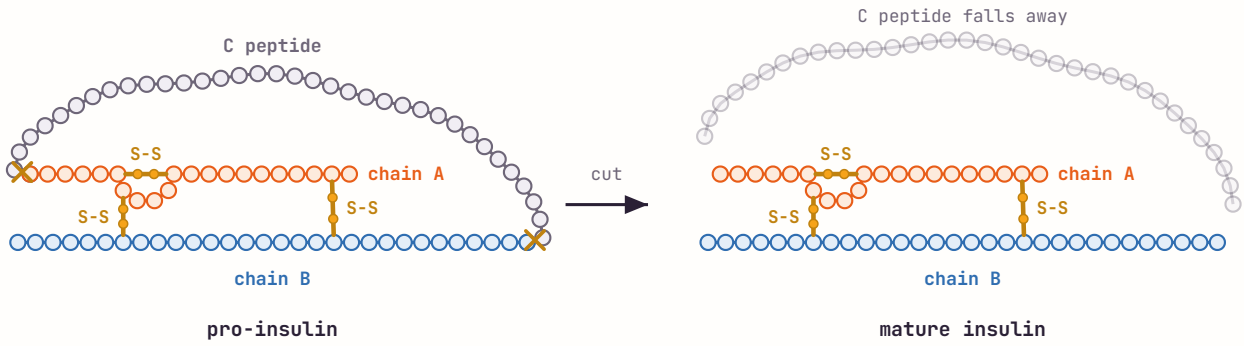


Fig 4 · From pro-insulin to mature insulin. Cut out the C peptide; the bridges hold A and B together.

The Eli Lilly solution (1983)

- In **1983**, **Eli Lilly**, an American company, prepared two DNA sequences.
- One matched **chain A** of human insulin. The other matched **chain B**.
- Each was introduced into **plasmids of *E. coli***.
- The bacteria made chains A and B **separately**.
- The chains were extracted and **combined by creating disulphide bonds**. This formed human insulin.
- Because the chains were made separately, there was **no C peptide** to remove.

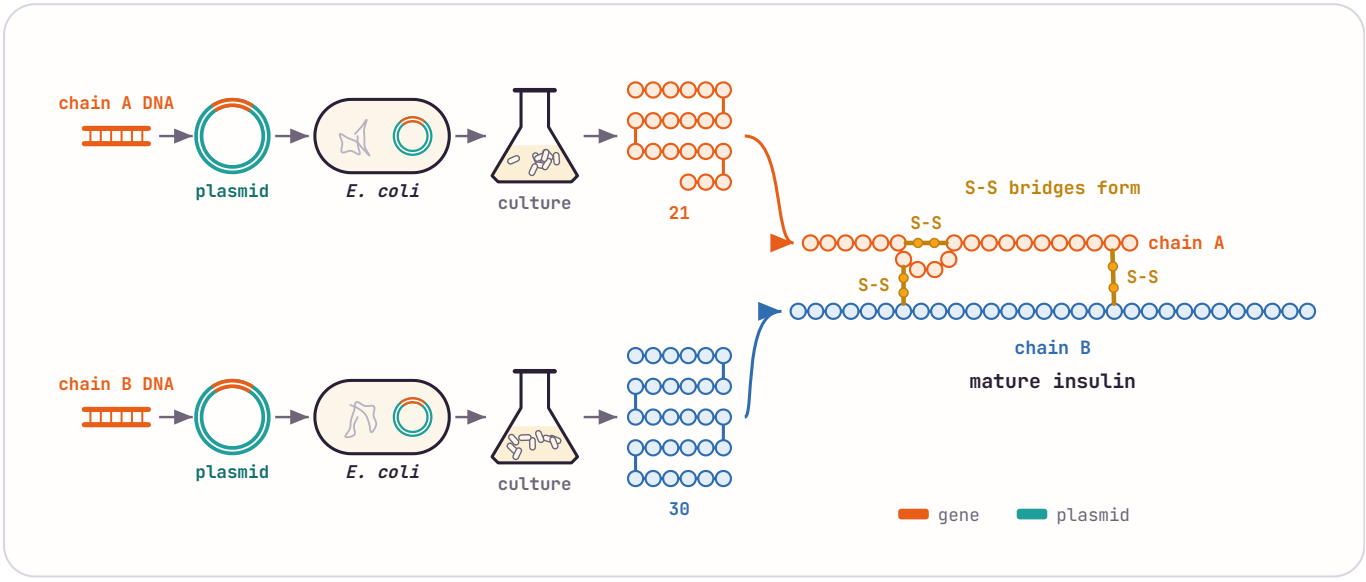


Fig 5 · The Eli Lilly method. Two genes, two cultures, joined outside the cell.



WAIT, REALLY?

MYTH

Eli Lilly put the whole pro-insulin gene into *E. coli* and let the bacterium cut out the C peptide.

SCIENCE

Bacteria cannot do that maturation step. So the A and B chains were made separately and joined outside the cell.



TRAP ALERT

TRAP ALERT

- Two facts were each tested 3 times in our data. The C peptide is **removed**. And chains A and B are joined by **disulphide** bridges, not peptide or hydrogen bonds. The host, *E. coli*, was tested 2 times.

Q6 Multi-statement

LEVEL 2

Read these statements about human insulin.

(a) It has two polypeptide chains, A and B, linked by disulphide bridges.

(b) In humans, it is first made as a pro-hormone with an extra C peptide.

(c) The C peptide stays in the mature insulin molecule.

(d) In 1983, Eli Lilly introduced DNA for chains A and B into plasmids of *E. coli*.

(e) The two chains were produced separately and then joined by disulphide bonds.

Choose the correct answer from the options given below.

1. (a), (b) and (c) only
2. (b), (c), (d) and (e) only
3. (a), (b), (d) and (e) only
4. (a), (c) and (e) only

Answer: 3

CORE PRINCIPLE The C peptide is cut out during maturation. All the other statements are NCERT lines.

TRAP (c) is the false one. Options 1, 2 and 4 all keep it.

Q7 Statement I / Statement II

LEVEL 2

Statement I: Eli Lilly made human insulin by expressing the complete pro-insulin gene in *E. coli*.

Statement II: Mature human insulin does not contain the C peptide.

1. Both Statement I and Statement II are true
2. Both Statement I and Statement II are false
3. Statement I is true but Statement II is false
4. Statement I is false but Statement II is true

Answer: 4

CORE PRINCIPLE Eli Lilly used two separate DNA sequences, one for each chain. The C peptide is never part of mature insulin.

TRAP Option 1 is for students who assume the natural pro-hormone route was copied.

READ NEXT **Biomolecules notes: proteins and peptide bonds** →

05 Recombinant Vaccines (from NCERT Chapter 7)

IN NEET

This short section comes from NCERT Chapter 7, Human Health and Disease. The NEET 2026 syllabus names "vaccine production" under this chapter, so it belongs here too.

- rDNA technology lets us make the **antigenic polypeptides** of a pathogen in **bacteria or yeast**.
- Vaccines made this way can be produced on a large scale. So more people can be immunised.
- Example: the **hepatitis B vaccine is produced from yeast**.



THINK IT THROUGH

SANITY CHECK

- The vaccine contains a protein of the pathogen, not the pathogen. The yeast only acts as the factory.

Q8 Statement I / Statement II

LEVEL 2

Statement I: The hepatitis B vaccine is produced from yeast using recombinant DNA technology.

Statement II: A recombinant vaccine contains live, weakened hepatitis B viruses grown inside yeast.

1. Both Statement I and Statement II are true
2. Both Statement I and Statement II are false
3. Statement I is true but Statement II is false
4. Statement I is false but Statement II is true

Answer: 3

CORE PRINCIPLE The yeast makes an antigenic polypeptide of the pathogen. No virus is present.

TRAP Option 1 confuses a recombinant vaccine with a weakened-pathogen vaccine.

06 Gene Therapy

IN NEET | SEEN SEVERAL TIMES | *4 questions*

What it is

- Gene therapy is a set of methods to correct a gene defect diagnosed in a child or embryo.
- Genes are inserted into a person's cells and tissues to treat a disease.
- A normal gene is delivered to take over the job of the non-functional gene.

The first case (1990)

- The first clinical gene therapy was given in **1990**.
- The patient was a **4-year-old girl** with **adenosine deaminase (ADA) deficiency**.
- ADA is an enzyme crucial for the **immune system** to work.
- The disorder is caused by **deletion of the gene for ADA**.

Earlier treatments

- Some children were cured by **bone marrow transplantation**.
- Others got **enzyme replacement therapy**: injections of functional ADA.
- Neither treatment is completely curative.

How the gene therapy worked

1. **Lymphocytes** were taken from the patient's blood and grown in culture outside the body.
2. A functional **ADA cDNA** was put into these lymphocytes using a **retroviral vector**.
3. The lymphocytes were returned to the patient.

The catch

- Lymphocytes are **not immortal**. So the patient needs **periodic infusions** of engineered lymphocytes.
- A **permanent cure** may be possible. The ADA gene from marrow cells would be put into cells at **early embryonic stages**.

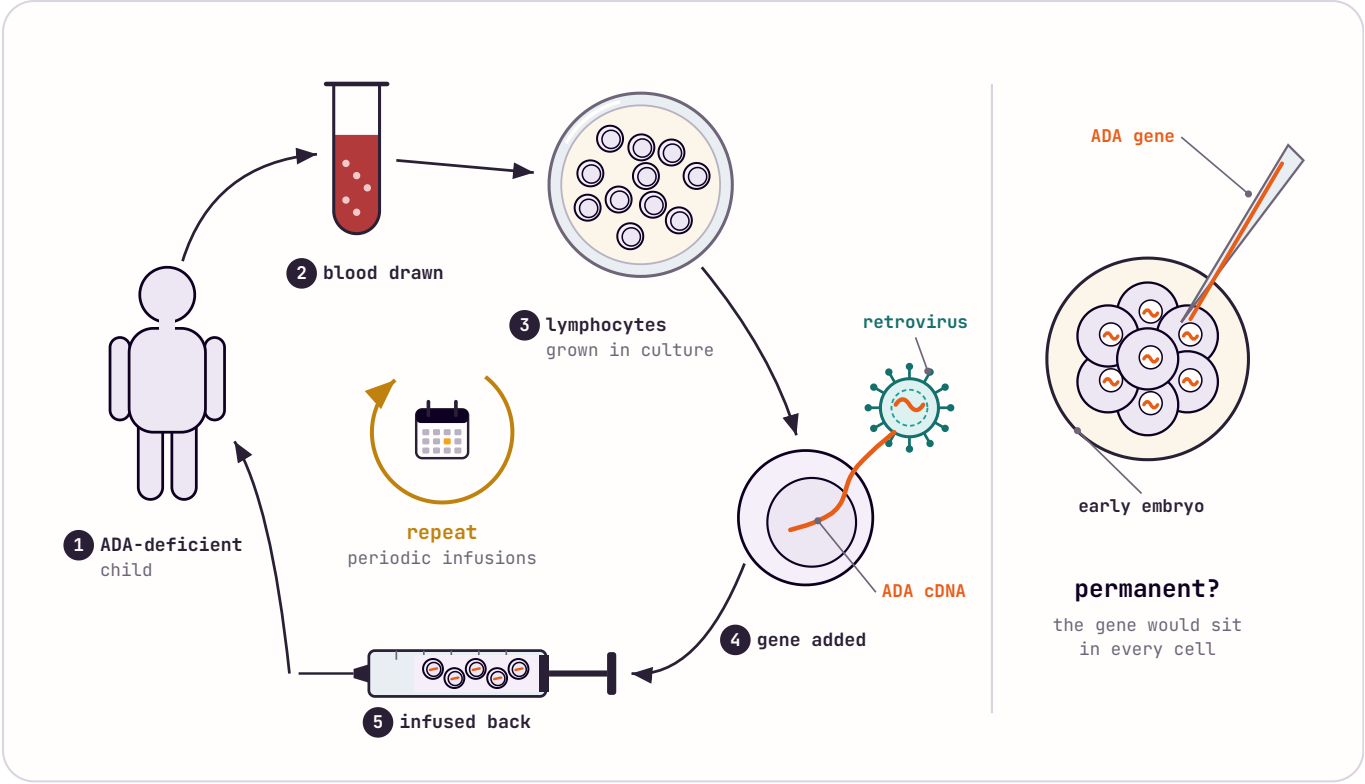


Fig 6 · ADA gene therapy. Engineered lymphocytes die out, so the treatment must be repeated.



TRAP ALERT

TRAP ALERT

- The vector is a **retrovirus**, not *Agrobacterium* (that is for plants). And the therapy is not permanent, because lymphocytes die. Our data tested this limitation 2 times.

Q9 Multi-statement

LEVEL 2

Read these statements about the first clinical gene therapy.

(a) It was given in 1990 to a 4-year-old girl with ADA deficiency.

(b) ADA deficiency is caused by deletion of the gene for adenosine deaminase.

(c) Functional ADA cDNA was put into the patient's lymphocytes using a retroviral vector.

(d) The engineered lymphocytes gave a permanent cure after a single infusion.

(e) Bone marrow transplantation and enzyme replacement are not completely curative.

Choose the correct answer from the options given below.

1. (a), (b), (c) and (e) only
2. (a), (b) and (d) only
3. (b), (c), (d) and (e) only
4. (a), (c) and (d) only

Answer: 1

CORE PRINCIPLE Lymphocytes are not immortal. So the infusions must be repeated.

TRAP (d) is false. Options 2, 3 and 4 all include it.

07 Molecular Diagnosis

IN NEET WATCH LIST *molecular diagnostics is named "due for a return" in our data*

Why we need it

- Conventional methods, like **serum and urine analysis**, cannot detect disease early.
- A pathogen is usually suspected only after it causes symptoms.
- By then, the pathogen's concentration in the body is already very high.

The tools

- **PCR:** detects very low concentrations of a bacterium or virus, before symptoms show. It does this by amplifying the pathogen's nucleic acid.
  - PCR is now routinely used to detect **HIV** in suspected AIDS patients.
  - It is used to detect **mutations in genes** in suspected cancer patients.
  - It helps identify many other genetic disorders.
- **Probe and autoradiography:** a single-stranded DNA or RNA, tagged with a radioactive molecule, is called a **probe**.
  - It is allowed to hybridise (pair) with its complementary DNA in a clone of cells.
  - Then the clone is detected using **autoradiography**.
  - A clone with a **mutated gene will not appear** on the photographic film. The probe cannot pair with the mutated gene.
- **ELISA:** based on the principle of **antigen-antibody interaction**.
  - Infection is detected by finding the pathogen's antigens (proteins, glycoproteins).
  - Or by finding the antibodies made against the pathogen.

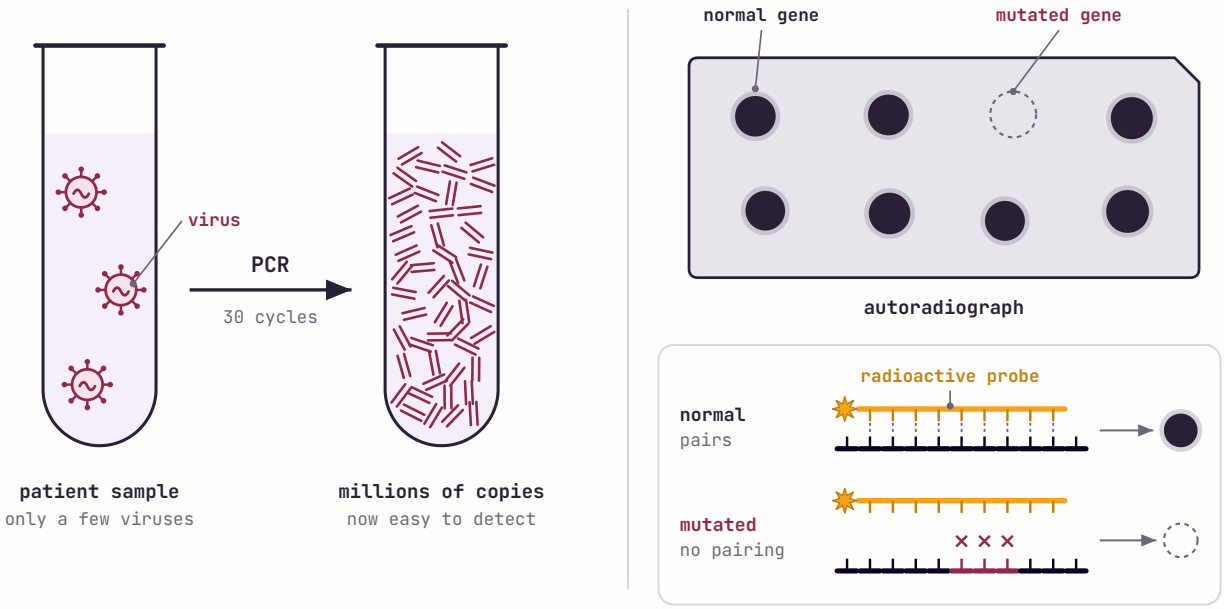


Fig 7 · Molecular diagnosis. PCR finds tiny amounts; a probe pairs only with the normal sequence.

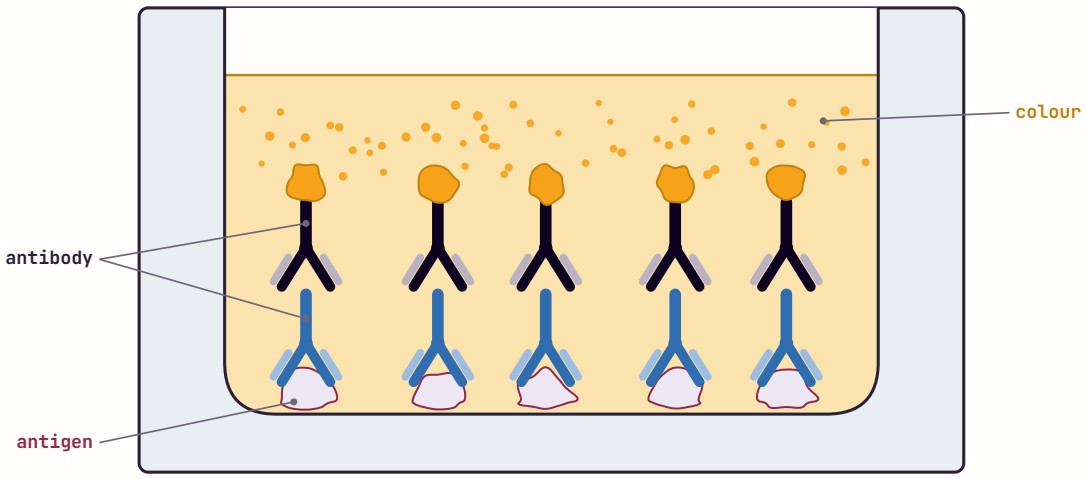


Fig 8 · ELISA principle. A colour change shows that antibody found antigen.



THINK IT THROUGH

SANITY CHECK

- On an autoradiograph, a missing spot is the result that matters. No pairing means no signal, and no signal means a mutation.

Q10 Concept application

LEVEL 2

A probe made for the **normal** form of a gene is radioactively tagged. It is added to two clones of cells. Clone X has the normal gene. Clone Y has a mutated form of the gene. What does the autoradiograph show?

1. Both clones appear as dark spots
2. Clone X appears; clone Y does not
3. Clone Y appears; clone X does not
4. Neither clone appears

Answer: 2

CORE PRINCIPLE The probe pairs only with its complementary sequence. It pairs with the normal gene but not the mutated one.

MATH X: probe binds, so a spot appears. Y: no pairing, so no spot.

TRAP Option 3 assumes a probe "finds the fault". It finds the match. Option 1 ignores that pairing needs complementarity.

Q11 Match the Column

LEVEL 2

COLUMN I	COLUMN II
A. PCR	I. Antigen-antibody interaction
B. ELISA	II. Cannot detect disease early
C. Radioactive probe	III. Amplifies a pathogen's nucleic acid before symptoms show
D. Serum and urine analysis	IV. Fails to pair with a mutated gene

Choose the correct answer from the options given below.

1. A-I, B-III, C-IV, D-II
2. A-III, B-I, C-II, D-IV
3. A-III, B-I, C-IV, D-II
4. A-IV, B-I, C-III, D-II

Answer: 3

CORE PRINCIPLE PCR copies nucleic acid. ELISA uses antibodies. A probe needs a perfect match. Conventional tests come too late.

TRAP Option 1 swaps PCR and ELISA. Option 2 swaps the last two rows.

READ NEXT **how PCR copies DNA** →

08 Transgenic Animals

IN NEET | SEEN SEVERAL TIMES | *3 questions*

What they are

- **Transgenic animals** have had their DNA manipulated to have and express an extra (foreign) gene.
- Transgenic rats, rabbits, pigs, sheep, cows and fish have been made.
- But **over 95%** of all existing transgenic animals are **mice**.

Why they are made

1. **Normal physiology and development:** to study how genes are regulated and how they affect normal body functions. Example: studying insulin-like growth factor.
2. **Study of disease:** as models for human diseases. Examples: cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's.
3. **Biological products:** some medicines are costly to make. Transgenic animals can make them.

   Example: **α-1-antitrypsin**, a protein used to treat **emphysema**.

   Attempts are also being made for phenylketonuria (PKU) and cystic fibrosis.

   In **1997**, the first transgenic cow, **Rosie**, produced milk enriched with human protein, at **2.4 grams per litre**.

   The milk contained human **alpha-lactalbumin**. It was nutritionally more balanced for human babies than natural cow milk.
4. **Vaccine safety:** transgenic mice test the safety of vaccines before use on humans. Example: **polio vaccine**.
5. **Chemical safety testing:** transgenic animals are made more sensitive to toxic substances. So results come faster.

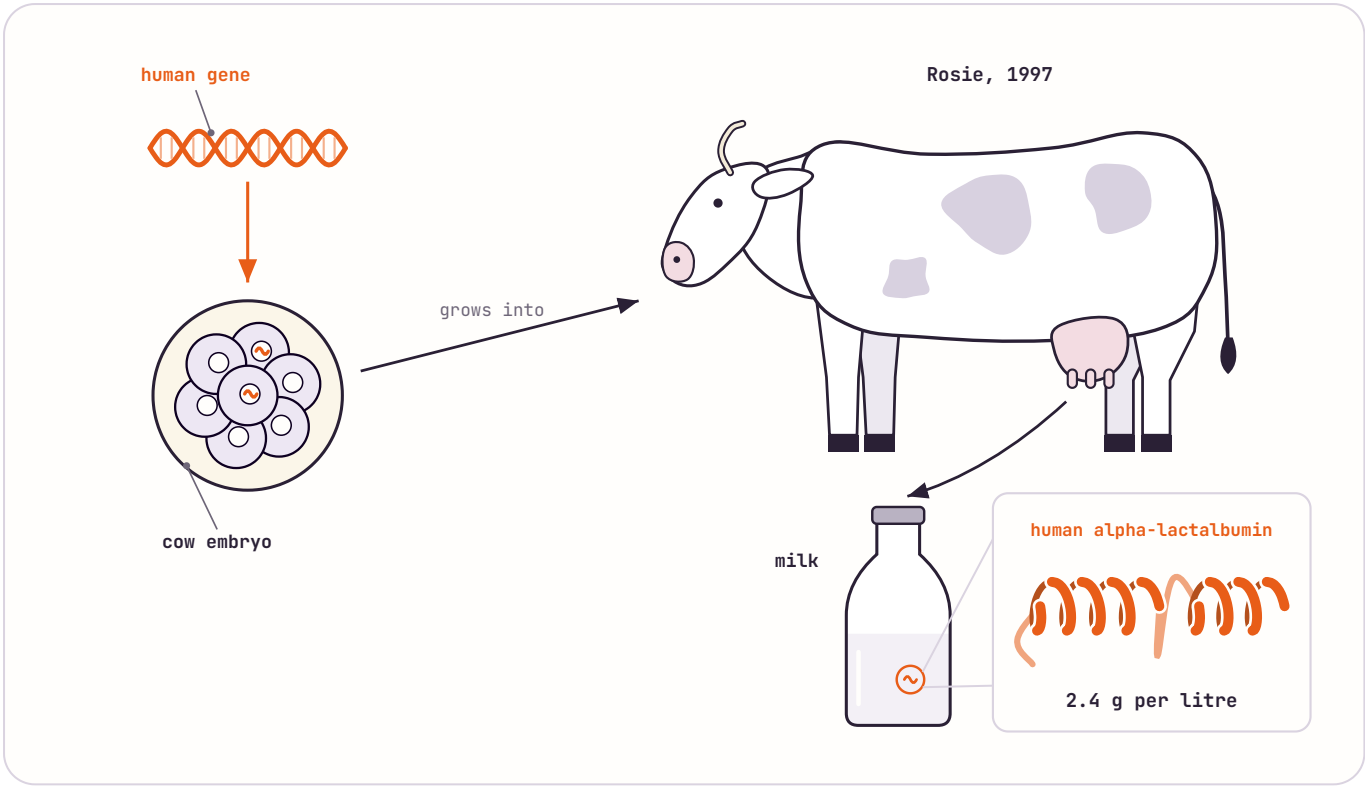


Fig 9 · Rosie the transgenic cow. A human gene, a cow's udder, a better milk for babies.



TRAP ALERT

TRAP ALERT

- Rosie's milk had human **alpha-lactalbumin**, not insulin and not α-1-antitrypsin. Our data shows Rosie tested 2 times.

Q12 Multi-statement

LEVEL 2

Read these statements about transgenic animals.

(a) Over 95% of all existing transgenic animals are mice.

(b) Rosie, the first transgenic cow (1997), gave milk with human alpha-lactalbumin.

(c) α-1-antitrypsin from transgenic animals is used to treat emphysema.

(d) Transgenic mice are used to test the safety of the polio vaccine.

(e) Rosie's milk contained human insulin at 2.4 grams per litre.

Choose the correct answer from the options given below.

1. (a), (b) and (e) only
2. (b), (c), (d) and (e) only
3. (a), (c) and (d) only
4. (a), (b), (c) and (d) only

Answer: 4

CORE PRINCIPLE Rosie's milk carried human alpha-lactalbumin at 2.4 g per litre. Everything else is a direct NCERT line.

TRAP (e) keeps the right number but swaps in the wrong protein. Options 1 and 2 include it.

Q13 Match the Column

LEVEL 2

COLUMN I (REASON)	COLUMN II (EXAMPLE)
A. Study of disease	I. Polio vaccine
B. Biological products	II. Insulin-like growth factor
C. Vaccine safety	III. Alzheimer's model
D. Normal physiology	IV. α-1-antitrypsin

Choose the correct answer from the options given below.

1. A-III, B-IV, C-I, D-II
2. A-IV, B-III, C-I, D-II
3. A-III, B-IV, C-II, D-I
4. A-II, B-IV, C-I, D-III

Answer: 1

CORE PRINCIPLE Match each NCERT reason to the example NCERT gives for it.

TRAP Option 2 swaps disease models with products. Option 3 swaps vaccine safety with physiology.

09 Ethical Issues

IN NEET | SEEN SEVERAL TIMES | *bioethics and GEAC 2, biopiracy and patents 2*

Who decides

- Genetic changes to organisms can have unpredictable results when they enter an ecosystem.
- The Indian Government set up bodies such as the **GEAC (Genetic Engineering Approval Committee)**.
- GEAC decides on the **validity of GM research** and the **safety of introducing GM organisms** for public use.

Patents

- People were angry when some companies got patents for products using genetic materials, plants and other bio-resources.
- These resources had long been identified, developed and used by **farmers and indigenous people**.
- **Rice** is an example.
  - There are an estimated **200,000 varieties of rice** in India alone.
  - There are **27 documented varieties of Basmati** grown in India.
- In **1997**, an **American company** got patent rights on **Basmati rice** through the US Patent and Trademark Office.
- This let the company sell a "new" variety of Basmati in the US and abroad.
- But this "new" variety came from Indian farmers' varieties. Indian Basmati had been crossed with semi-dwarf varieties and claimed as an invention.
- Other Indian products patented this way include **turmeric** and **neem**.

Biopiracy

- **Biopiracy** is the use of bio-resources by companies and other organisations without proper authorisation. It also involves no compensatory payment.
- The authorisation and payment are owed to the countries and people concerned.
- Most industrialised nations are rich financially but poor in biodiversity and traditional knowledge.
- Developing and underdeveloped nations are rich in biodiversity and traditional knowledge about bio-resources.
- So there is a growing need for fair benefit-sharing.
- The Indian Parliament has cleared the **second amendment of the Indian Patents Bill**. It covers patent terms, emergency provisions and research and development initiatives.



TRAP ALERT

TRAP ALERT

- The Basmati patent was granted in **1997** to an **American** company. Rosie the cow was also **1997**. Questions sometimes mix the two events. Biopiracy is in our "due for a return" list.

Q14 Multi-statement

LEVEL 2

Read these statements about ethical issues in biotechnology.

(a) GEAC decides on the validity of GM research and the safety of releasing GM organisms.

(b) In 1997, an American company got a patent on Basmati rice.

(c) India has 27 documented varieties of Basmati.

(d) Biopiracy is the authorised use of bio-resources with fair payment to the people concerned.

(e) Turmeric and neem are other Indian products that were patented this way.

Choose the correct answer from the options given below.

1. (a), (b) and (d) only
2. (a), (b), (c) and (e) only
3. (b), (c), (d) and (e) only
4. (a), (d) and (e) only

Answer: 2

CORE PRINCIPLE Biopiracy is use **without** authorisation and **without** payment.

TRAP (d) flips the definition. Options 1, 3 and 4 all keep it.

10 Quick Review: What NEET Repeats

Use this in the last week. Each card shows how often NEET repeats it, the topic and the question. The answer and the reason it recurs come next.

REPEATS OFTEN — INSULIN

How are chains A and B of insulin joined?

By disulphide bridges.

Why it recurs: Tested 3 times.

REPEATS OFTEN — INSULIN

What happens to the C peptide?

It is removed during maturation.

Why it recurs: Tested 3 times.

REPEATS OFTEN — INSULIN

Which host did Eli Lilly use, and in what year?

***E. coli*; 1983.**

Why it recurs: Host tested 2 times.

REPEATS OFTEN — INSULIN

Why did animal insulin cause problems?

It is a foreign protein; some patients got allergies.

Why it recurs: The "why" behind the whole section.

REPEATS OFTEN — BT CROPS

What activates the Bt toxin?

The alkaline pH of the insect's gut.

Why it recurs: Tested 3 times.

REPEATS OFTEN — BT CROPS

Why doesn't the toxin kill the bacterium?

It exists there as an inactive protoxin.

Why it recurs: A favourite assertion-reason pair.

REPEATS OFTEN — BT CROPS

Which genes control cotton bollworms? Corn borer?

***cryIAc* and *cryIIAb*; *cryIAb*.**

Why it recurs: Classic match-the-column.

REPEATS OFTEN — BT CROPS

Why are Bt toxins pest-specific?

Most are insect-group specific, so genes are chosen by crop and pest.

Why it recurs: Tested 2 times.

SEEN SEVERAL TIMES — RNAI

What silences the mRNA in RNAi?

A complementary dsRNA.

Why it recurs: Tested 3 times.

SEEN SEVERAL TIMES — RNAI

Which RNAs did the transgenic tobacco make?

Both sense and anti-sense RNA.

Why it recurs: The usual one-word trap.

SEEN SEVERAL TIMES — RNAI

Which pest and which crop?

***Meloidegyne incognitia*; tobacco roots.**

Why it recurs: Names get swapped in options.

SEEN SEVERAL TIMES — GENE THERAPY

Why is ADA gene therapy not permanent?

Lymphocytes are not immortal.

Why it recurs: Tested 2 times.

SEEN SEVERAL TIMES — GENE THERAPY

Which vector carried the ADA cDNA?

A retroviral vector.

Why it recurs: Swapped with Agrobacterium in options.

SEEN SEVERAL TIMES — GENE THERAPY

What would make it a permanent cure?

Putting the gene into cells at early embryonic stages.

Why it recurs: The NCERT "future" line.

SEEN SEVERAL TIMES — TRANSGENIC ANIMALS

What did Rosie's milk contain?

Human alpha-lactalbumin, 2.4 g per litre.

Why it recurs: Tested 2 times.

SEEN SEVERAL TIMES

TRANSGENIC ANIMALS

What share of transgenic animals are mice?

> **Over 95%.**

Why it recurs: A clean number to test.

SEEN SEVERAL TIMES

ETHICS

What does GEAC do?

> **Decides on GM research validity and the safety of releasing GM organisms.**

Why it recurs: Tested 2 times.

WATCH LIST

BIOPIRACY

What is biopiracy?

> **Using bio-resources without authorisation or compensatory payment.**

Why it recurs: Due for a return in our data.

WATCH LIST

AGRICULTURE

What is golden rice?

> **Vitamin A enriched rice.**

Why it recurs: Due for a return in our data.

WATCH LIST

DIAGNOSIS

Why are PCR and ELISA better than serum and urine tests?

> **They detect infection early, at low pathogen levels.**

Why it recurs: Due for a return in our data.

★ Biotechnology and its Applications · Fact Sheet

One page for the night before the exam.

AGRICULTURE

GM plant benefits: stress tolerance, less pesticide, fewer post-harvest losses, better mineral use, nutrition (golden rice, Vitamin A)

Tissue culture: explant, totipotency · micropropagation gives somaclones · meristem culture gives virus-free plants · protoplast fusion gives somatic hybrids (pomato)
Bt = *Bacillus thuringiensis* · protoxin crystals · activated by alkaline gut · pores in midgut epithelial cells
Kills lepidopterans (tobacco budworm, armyworm), coleopterans (beetles), dipterans (flies, mosquitoes)
cryIAc, *cryIIAb*: cotton bollworms · *cryIAb*: corn borer
RNAi: *Meloidegyne incognitia* on tobacco roots · *Agrobacterium* vector · sense + anti-sense = dsRNA

MEDICINE

Insulin: chains A and B, disulphide bridges · pro-hormone with C peptide (removed)

Eli Lilly, 1983: A and B chain DNA in *E. coli* plasmids, chains joined later
About 30 recombinant therapeutics worldwide; 12 marketed in India
Hepatitis B vaccine: made from yeast (NCERT Chapter 7)
Gene therapy: 1990, 4-year-old girl, ADA deficiency · retroviral vector · lymphocytes · periodic infusions
Diagnosis: PCR (HIV, cancer mutations) · radioactive probe + autoradiography · ELISA (antigen-antibody)

TRANSGENIC ANIMALS

Over 95% are mice

α-1-antitrypsin for emphysema · polio vaccine safety on mice
Rosie (1997): human alpha-lactalbumin, 2.4 g per litre

ETHICS

GEAC · Basmati patent 1997 (American company)

200,000 rice varieties, 27 Basmati varieties
Turmeric, neem · biopiracy = no authorisation, no payment · Indian Patents Bill second amendment

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★ STILL MIXING UP THE CASE STUDIES?

Play it. Then practice it.

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SCAN → DO · READ · VERIFY