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CUET · BIOLOGY · CLASS XII · CODE 304

Biotechnology and its Applications

CUET unit: Biotechnology and its Applications -> Applications

By **UniDrill** · NCERT-grounded study material

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📌 Snapshot

- This chapter translates the rDNA toolkit of the previous chapter into real-world products: GM crops, recombinant pharmaceuticals, gene therapy and transgenic animals.
- Three critical research areas in biotechnology — best catalyst (improved organism/enzyme), engineered optimal conditions, and downstream processing (p. 177).
- Agriculture half centres on Bt crops (Bacillus thuringiensis), RNA interference against the nematode Meloidogyne incognita, and the broader GMO toolkit.
- Medicine half covers Eli Lilly's recombinant human insulin (1983), ADA gene therapy (1990), and molecular diagnosis via PCR/ELISA/DNA probes.
- Ethics half deals with GEAC oversight in India, biopiracy (Basmati, turmeric, neem) and the second amendment of the Indian Patents Bill — high-yield CUET territory.

📖 Detailed Notes

2.1 Core concepts

- Biotechnology essentially deals with industrial-scale production of biopharmaceuticals and biologicals using genetically modified microbes, fungi, plants and animals; its applications span therapeutics, diagnostics, GM crops for agriculture, processed food, bioremediation, waste treatment and energy production (NCERT §10 intro, p. 177).
- Three critical research areas of biotechnology are (i) providing the best catalyst in the form of an improved organism — usually a microbe or pure enzyme; (ii) creating optimal conditions through engineering for a catalyst to act; and (iii) downstream processing technologies to purify the protein/organic compound (NCERT §10 intro, p. 177).
- Three options exist for increasing food production — agro-chemical based agriculture, organic agriculture, and genetically engineered crop-based agriculture; the **Green Revolution** tripled food supply but was insufficient for growing demand. Increased yields were partly due to improved crop varieties but mainly due to better management practices and agro-chemicals (fertilisers and pesticides), which are often too expensive for farmers in the developing world (NCERT §10.1, p. 178).

- **Tissue culture** (developed in the 1950s) exploits **totipotency** — the capacity of any cell/explant to regenerate a whole plant. An **explant** is any part of a plant taken out and grown in a test tube under sterile conditions in special nutrient media containing a carbon source (sucrose), inorganic salts, vitamins, amino acids and growth regulators like auxins and cytokinins (NCERT §10.1, p. 178).
- **Micro-propagation** produces thousands of plants through tissue culture in very short durations; each plant is genetically identical to the original parent and is called a **somaclone**. Tomato, banana and apple have been produced on commercial scale by this method (NCERT §10.1, p. 178).
- Recovery of healthy plants from diseased plants is a second important application: even if a plant is infected with a virus, the **meristem** (apical and axillary) is free of virus; meristem culture yields virus-free banana, sugarcane and potato (NCERT §10.1, p. 178).
- **Somatic hybridisation** fuses naked **protoplasts** (cell walls digested, plasma membranes intact) of two different varieties — each having a desirable character — to make somatic hybrids. The tomato-potato fusion called **pomato** was achieved but lacked all the desired combination of characters for commercial use (NCERT §10.1, pp. 178-179).
- **Genetically Modified Organisms (GMOs)** are plants, bacteria, fungi or animals whose genes have been altered by manipulation. GM plants have been useful in many ways: (i) more tolerant to abiotic stresses (cold, drought, salt, heat); (ii) reduced reliance on chemical pesticides (pest-resistant crops); (iii) reduced post-harvest losses; (iv) increased efficiency of mineral usage (preventing early exhaustion of soil fertility); (v) enhanced nutritional value of food, e.g. golden rice — Vitamin 'A' enriched rice. GM has also created tailor-made plants supplying starches, fuels and pharmaceuticals (NCERT §10.1, p. 179).
- **Bt toxin:** Some strains of Bacillus thuringiensis produce proteins that kill insects such as lepidopterans (tobacco budworm, armyworm), coleopterans (beetles) and dipterans (flies, mosquitoes). B. thuringiensis forms protein crystals during a particular phase of growth; these crystals contain a toxic **insecticidal protein**. The toxin does not kill the Bacillus because it exists as an inactive **protoxin**; once an insect ingests it, the alkaline pH of the gut solubilises the crystals, the activated toxin binds midgut epithelial cells, creates pores that cause cell swelling and lysis, and the insect dies (NCERT §10.1, p. 179).
- Specific Bt toxin genes were isolated from Bacillus thuringiensis and incorporated into crop plants such as cotton (Figure 10.1). The choice depends on the crop and the targeted pest, as most Bt toxins are insect-group specific. The toxin is coded by a gene named cry: proteins encoded by cryIAc and cryIIAb control **cotton bollworms**, while cryIAb controls **corn borer** (NCERT §10.1, p. 180).
- **Pest-Resistant Plants by RNAi:** Several nematodes parasitise plants and animals. The nematode Meloidogyne incognita infects roots of tobacco plants and causes a great reduction in yield. **RNA interference (RNAi)** — a method of cellular defence

in all eukaryotes — silences a specific mRNA via a complementary dsRNA molecule that binds and prevents translation. The source of the complementary RNA can be infection by RNA viruses or mobile genetic elements (transposons) replicating via an RNA intermediate (NCERT §10.1, p. 180).

- Using Agrobacterium vectors, nematode-specific genes were introduced into the host plant such that the DNA produced both **sense** and **anti-sense RNA** in host cells. The two complementary RNAs formed a **double-stranded RNA (dsRNA)** that initiated RNAi and silenced the specific mRNA of the nematode; the parasite could not survive in the transgenic host expressing specific interfering RNA (Figure 10.2) (NCERT §10.1, p. 180).
- The **recombinant DNA technological processes** have made immense impact in healthcare by mass-producing safe and more effective therapeutic drugs; recombinant therapeutics do not induce unwanted immunological responses common with products from non-human sources. At present, about **30 recombinant therapeutics are approved for human use worldwide; 12 are presently marketed in India** (NCERT §10.2, p. 181).
- **Genetically Engineered Insulin:** Adult-onset diabetes is managed by taking insulin at regular intervals. Insulin used earlier was extracted from the pancreas of slaughtered cattle and pigs, but animal-source insulin sometimes caused allergy or other reactions. Insulin consists of two short polypeptide chains — **chain A and chain B** — linked together by **disulphide bridges** (Figure 10.3) (NCERT §10.2.1, p. 181).
- In mammals, including humans, insulin is synthesised as a **pro-hormone** (like a pro-enzyme — it needs processing before becoming fully mature and functional) containing an extra stretch called the **C peptide**. The C peptide is not present in mature insulin and is removed during maturation. The main challenge for rDNA-based insulin was getting insulin assembled into a mature form. In **1983, Eli Lilly**, an American company, prepared two DNA sequences corresponding to chains A and B of human insulin and introduced them into plasmids of E. coli to produce insulin chains. Chains A and B were produced separately, extracted and combined by creating disulphide bonds to form human insulin (NCERT §10.2.1, p. 182).
- **Gene Therapy** is a collection of methods that allows correction of a gene defect diagnosed in a child/embryo. Genes are inserted into a person's cells and tissues to treat a disease, especially hereditary; correction involves delivery of a normal gene to take over the function of the non-functional gene (NCERT §10.2.2, p. 182).
- The **first clinical gene therapy** was given in **1990 to a 4-year-old girl with adenosine deaminase (ADA) deficiency**. ADA is crucial for immune-system function; the disorder is caused by deletion of the gene for adenosine deaminase. In some children ADA deficiency is cured by **bone marrow transplantation**; in others it is treated by **enzyme replacement therapy** (functional ADA injected) — but neither approach is completely curative. As a first step toward gene therapy, lymphocytes from the patient's blood are grown in culture outside the body; a

functional ADA cDNA (using a **retroviral vector**) is then introduced into these lymphocytes and they are returned to the patient. Because these cells are not immortal, the patient requires periodic infusion of such engineered lymphocytes. Introducing the gene isolate into cells producing ADA at **early embryonic stages** could give a permanent cure (NCERT §10.2.2, p. 182).

- **Molecular Diagnosis:** Conventional methods (serum/urine analysis etc.) do not enable early detection. **Recombinant DNA technology, Polymerase Chain Reaction (PCR) and Enzyme Linked Immuno-Sorbent Assay (ELISA)** serve early diagnosis. A pathogen is usually suspected only after symptoms appear, by which time concentration is already high; very low concentrations of bacteria/viruses can be detected by **amplification of nucleic acid through PCR**. PCR is now routinely used to detect **HIV in suspected AIDS patients** and **mutations in suspected cancer patients**, and is a powerful technique to identify many genetic disorders (NCERT §10.2.3, pp. 182-183).
- A single-stranded **DNA or RNA tagged with a radioactive molecule (probe)** is allowed to hybridise to its complementary DNA in a clone of cells, followed by detection using **autoradiography**. A clone having the mutated gene will not appear on the photographic film because the probe will not have complementarity with the mutated gene. **ELISA** is based on the principle of **antigen-antibody interaction**; infection can be detected by presence of antigens (proteins, glycoproteins, etc.) or by detecting antibodies synthesised against the pathogen (NCERT §10.2.3, p. 183).
- **Transgenic Animals** are animals whose DNA has been manipulated to possess and express an extra (foreign) gene. Transgenic rats, rabbits, pigs, sheep, cows and fish have been produced, although **over 95 per cent of all existing transgenic animals are mice**. They serve five purposes (NCERT §10.3, pp. 183-184):
- **(i) Normal physiology and development** — e.g. study of complex factors like insulin-like growth factor by introducing genes that alter formation of the factor.
- **(ii) Study of disease** — models for human diseases such as cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's.
- **(iii) Biological products** — human protein **α-1-antitrypsin** for emphysema; attempts for phenylketonuria (PKU) and cystic fibrosis. In **1997, the first transgenic cow Rosie** produced human protein-enriched milk (**2.4 grams per litre**) containing human **alpha-lactalbumin**, nutritionally more balanced for human babies than natural cow milk.
- **(iv) Vaccine safety** — transgenic mice are being used to test the safety of the polio vaccine; if successful, they could replace monkeys.
- **(v) Chemical safety testing (toxicity testing)** — transgenic animals carrying genes that make them more sensitive to toxic substances yield results in less time.
- **Ethical Issues:** Manipulation of living organisms cannot go on without regulation; genetic modification can have unpredictable results when GMOs are introduced into the ecosystem. The Indian Government has set up the **GEAC (Genetic Engineering**

Approval Committee) to take decisions regarding the validity of GM research and the safety of introducing GM organisms for public services (NCERT §10.4, p. 184).

- **Biopiracy** is the use of bio-resources by multinational companies and other organisations without proper authorisation from the countries and people concerned and without compensatory payment. Industrialised nations are financially rich but poor in biodiversity and traditional knowledge; the developing world is the opposite. Cases include the **1997 US patent on Basmati rice** (the 'new' variety derived from Indian farmer varieties crossed with semi-dwarf varieties, with claims extending to functional equivalents), and patent attempts on **turmeric** and **neem**. The Indian Parliament has cleared the **second amendment of the Indian Patents Bill**, addressing emergency provisions, research and development (NCERT §10.4, pp. 184-185).

2.2 Definitions to memorise

Term	Definition	Page
Biotechnology	Industrial-scale production of biopharmaceuticals/biologicals using GM microbes, fungi, plants and animals	177
Downstream processing	Technologies to purify the protein/organic compound after fermentation	177
Green Revolution	Movement that tripled food supply through improved varieties, management practices and agro-chemicals	178
Tissue culture	Growing whole plants from explants on sterile nutrient medium	178
Explant	Any part of a plant taken out and grown in a test tube under sterile conditions	178
Totipotency	Capacity to generate a whole plant from any cell/explant	178
Micro-propagation	Producing thousands of plants through tissue culture in very short durations	178
Somaclones	Genetically identical plants produced via tissue culture from a single parent	178
Meristem culture	Culturing apical/axillary meristem (virus-free) to recover virus-free plants	178
Protoplasts	Naked plant cells surrounded by plasma membranes, obtained by digesting cell walls	178
Somatic hybrids	Plants regenerated from fused protoplasts of two different varieties	178-179
Somatic hybridisation	Process of fusing protoplasts of two different plant varieties	178-179
Pomato		179

Term	Definition	Page
	Tomato-potato somatic hybrid lacking commercially desirable traits	
GMO	Plants, bacteria, fungi or animals whose genes have been altered by manipulation	179
Golden rice	Vitamin 'A' enriched rice (example of GM nutritional enhancement)	179
Bt toxin	Insecticidal protein produced as inactive protoxin crystals by Bacillus thuringiensis	179
Cry genes	Genes encoding Bt toxins (cryIAc, cryIIAb for bollworms; cryIAb for corn borer)	180
RNA interference (RNAi)	Cellular defense that silences a specific mRNA via complementary dsRNA	180
C peptide	Extra stretch in proinsulin, removed during maturation to mature insulin	182
Gene therapy	Insertion of genes into a person's cells/tissues to treat (especially hereditary) disease	182
PCR	Polymerase Chain Reaction — amplifies nucleic acid for early detection	183
ELISA	Enzyme Linked Immuno-Sorbent Assay — based on antigen-antibody interaction	183
DNA probe	Single-stranded DNA/RNA tagged with a radioactive molecule used for hybridisation + autoradiography	183
Transgenic animals	Animals whose DNA has been manipulated to possess and express a foreign gene	183
GEAC	Genetic Engineering Approval Committee — Indian regulator for GM research/release	184
Biopiracy	Use of bio-resources by MNCs/organisations without authorisation or compensation	185

2.3 Diagrams / processes to remember

- **Figure 10.1 (p. 180): Cotton boll** — (a) destroyed by bollworms vs. (b) a fully mature cotton boll. Visual demonstration of crop loss prevented by introducing cryIAc/cryIIAb into cotton to make Bt cotton.
- **Figure 10.2 (p. 181): RNAi-protected tobacco roots** — (a) roots of typical control plants vs. (b) transgenic plant roots **5 days after deliberate infection of nematode** but protected through the novel RNAi mechanism. Shows clean, healthy transgenic roots despite challenge.

- **Figure 10.3 (p. 182): Maturation of pro-insulin into insulin (simplified)** — single proinsulin ring shows chain A + chain B + C peptide held together by disulphide bridges; cleavage releases the **free C peptide** plus mature insulin where chains A and B remain joined by S-S bonds. The B peptide and A peptide labels with disulphide cross-links are diagnostic for figure-based MCQs.
- **Bt toxin activation pathway (p. 179):** inactive crystalline **protoxin** in bacterium -> ingestion by insect -> **alkaline gut pH** solubilises crystals -> active toxin -> binds **midgut epithelial cells** -> creates **pores** -> cell swelling and lysis -> insect death.
- **RNAi flowchart (p. 180):** Agrobacterium vector delivers nematode-specific DNA into host -> host transcribes both **sense and anti-sense RNA** -> the two pair to form **dsRNA** -> dsRNA initiates RNAi -> nematode mRNA silenced -> parasite cannot survive -> transgenic plant protected.
- **Recombinant insulin assembly (p. 182):** two DNA sequences for chains A and B prepared -> inserted separately into plasmids of E. coli -> chains A and B produced separately -> extracted -> combined via disulphide bonds -> mature human insulin (identical to natural molecule).
- **ADA gene therapy steps (p. 182):** lymphocytes drawn from patient -> cultured outside the body -> functional ADA cDNA introduced using a **retroviral vector** -> engineered lymphocytes returned to the patient -> periodic infusion required (lymphocytes are not immortal) -> permanent cure would require gene introduction at early embryonic stage.

2.4 Common confusions / NTA trap points

- crylAc **vs.** cryllAb **vs. *crylAb** — the first two control cotton bollworms; crylAb (single l, single A, lowercase b) controls corn borer*. NTA loves to swap these in matching items.
- Bt toxin is not lethal to Bacillus itself because it exists as an **inactive protoxin in crystalline form** — not because the bacterium is "resistant" (Exercise option a) or "encloses it in a special sac" (Exercise option d), and not because the toxin is "immature" (option b).
- The first ADA gene therapy patient (1990) was a **4-year-old girl**; her treatment is **not curative** because lymphocytes are not immortal — periodic infusion is needed. **Embryonic-stage introduction** is the suggested permanent cure.
- Eli Lilly produced insulin chains A and B **separately** in E. coli plasmids and joined them via disulphide bonds — NCERT does not say the proinsulin/C-peptide gene was cloned as one unit, nor that yeast was used.
- **Rosie the cow (1997)** produced milk with **human alpha-lactalbumin at 2.4 g/L**, not human insulin and not ADA. **α-1-antitrypsin** treats **emphysema**, not PKU; PKU and cystic fibrosis are listed as targets being attempted.
- **GEAC** stands for **Genetic Engineering Approval Committee** — not "Appraisal", not "Authority", not "Agency".

- **Pomato** is the **tomato-potato** somatic hybrid; it failed commercially because it lacked the desired combination of characters — NCERT does not say it was infertile or banned.
- **Meristem** (apical and axillary) is virus-free, hence used for virus-free banana/ sugarcane/potato — not for somatic hybridisation. NTA may swap "meristem culture" with "protoplast fusion".
- **Probe-autoradiography logic is inverted**: the clone with the **mutated gene** does **not** appear on the film because the probe is complementary to the normal gene. Many students wrongly mark "the mutated clone glows".
- **30 recombinant therapeutics worldwide; 12 in India** — exact numbers are frequently asked. Do not confuse with "12 worldwide".
- **Golden rice = Vitamin A enriched rice**, not iron or protein enriched.
- **Basmati patent** was granted by the **US Patent and Trademark Office in 1997**; the variety was derived by crossing Indian Basmati with **semi-dwarf varieties** — not "American long-grain".

2.5 Key processes / classifications

#	Process / Item	Organism / Agent	Purpose / Result	Page
1	Tissue culture	Any explant on nutrient medium	Whole plant via totipotency	178
2	Micro-propagation	Tomato, banana, apple	Thousands of identical somaclones	178
3	Meristem culture	Banana, sugarcane, potato	Virus-free plants	178
4	Somatic hybridisation	Tomato + potato protoplasts	Pomato (no commercial value)	179
5	Bt cotton	cryIAc, cryIIAb	Resistance to cotton bollworms	180
6	Bt corn	cryIAb	Resistance to corn borer	180
7	RNAi tobacco	Agrobacterium-delivered sense + anti-sense RNA	Resistance to Meloidogyne incognita	180
8	Golden rice	GM rice	Vitamin A enrichment	179
9	Recombinant insulin (1983)	E. coli — Eli Lilly	Chains A + B joined by S-S bonds	182
10	ADA gene therapy (1990)	Retroviral vector in lymphocytes	Treatment of ADA deficiency	182
11	PCR	Nucleic acid amplification	HIV detection, cancer mutation, genetic disorders	183

#	Process / Item	Organism / Agent	Purpose / Result	Page
12	DNA probe	Radioactive ssDNA/RNA + autoradiography	Detect mutated gene clones	183
13	ELISA	Antigen-antibody interaction	Pathogen antigens / antibodies	183
14	Transgenic mice (>95%)	Mouse model	Normal physiology, disease modelling	183
15	Insulin-like growth factor study	Transgenic animals	Study of normal physiology and development	183
16	Disease models	Transgenic mice	Cancer, cystic fibrosis, rheumatoid arthritis, Alzheimer's	183
17	α-1-antitrypsin	Transgenic animals	Treatment of emphysema	184
18	Rosie the cow (1997)	First transgenic cow	Milk with 2.4 g/L human alpha-lactalbumin	184
19	Polio vaccine testing	Transgenic mice	Replace monkeys for vaccine safety	184
20	Toxicity testing	Transgenic animals	Faster chemical safety results	184
21	GEAC	Indian Government body	Validity of GM research, GM release safety	184
22	Basmati patent (1997)	US Patent & Trademark Office	Biopiracy case based on Indian farmer varieties	185
23	Turmeric / Neem patents	MNCs	Other biopiracy cases	185
24	2nd amendment, Patents Bill	Indian Parliament	Addresses patent terms, emergency, R&D	185

🎯 Practice MCQs

Q1. The Bt toxin crystals do not kill the *Bacillus thuringiensis* that produces them because:

A. the bacterium is genetically resistant to the toxin

B. the toxin exists as an inactive protoxin in the bacterium

C. the bacterium encloses the toxin in a special protective sac

D. the toxin is degraded by bacterial proteases before it can act

Q2. Which of the following Cry gene-pest pairs is correctly matched?

A. *crylAc* — corn borer

B. *cryIIAb* — corn borer

C. *crylAb* — cotton bollworm

D. *crylAc* — cotton bollworm

Q3. The nematode used in NCERT to illustrate RNAi-based pest resistance in tobacco is:

A. *Ascaris lumbricoides

B. *Wuchereria bancrofti

C. *Meloidogyne incognita

D. *Caenorhabditis elegans

📊 PYQ Alignment

Biotechnology and its Applications is one of the most heavily tested chapters in CUET Biology — typically yielding 12-15 MCQs per paper across CUET 2023-25. Recurrent question patterns include Bt toxin mechanism and cry-gene specificity, RNAi against Meloidogyne incognita, recombinant insulin (Eli Lilly, chains A/B, C peptide), the 1990

ADA gene therapy case (retroviral vector, lymphocytes), molecular diagnostic techniques (PCR, ELISA, probes), Rosie the cow and other transgenic-animal uses, and the Basmati/ turmeric/neem biopiracy cases together with GEAC.

CUET 2025 — Actual PYQs from this chapter

Q.35 (CUET 2025) Transgenic animals help to study diseases such as:

- A) Cholera and typhoid
- B) Leptospirosis and ringworm
- C) Cancer and cystic fibrosis
- D) Pneumonia and kala-azar

Tests: aligns with §2 (biotech applications) Answer: Not in extracted key — verify against official NTA key

Q.36 (CUET 2025) Genetically modified plants are useful in:

- A) Increasing crop yield
- B) Making crops tolerant to stresses
- C) Reducing mineral nutrient use
- D) Decreasing post-harvest losses

Tests: aligns with §2 (applications of GM plants) Answer: Not in extracted key — verify against official NTA key

CUET 2024 — Actual PYQs from this chapter

Q.12 (CUET 2024) Arrange steps of DNA fingerprinting in sequence: (A) Digestion with restriction enzyme (B) Isolation of DNA (C) Hybridisation with labelled VNTR probe (D) Blotting onto membrane

- A) [option not extracted — see source]
- B) [option not extracted — see source]
- C) [option not extracted — see source]
- D) [option not extracted — see source]

Tests: aligns with §2 (DNA fingerprinting — VNTR & applications) Answer: Not in extracted key — verify against official NTA key

Q.30 (CUET 2024) Which statements are true? (A) Milk from Rosie is more balanced (B) Biopiracy refers to using bioresources without authorization (C) GEAC decides validity of GMOs (D) Transgenic animals help study disease genes

- A) [option not extracted — see source]
- B) [option not extracted — see source]
- C) [option not extracted — see source]
- D) [option not extracted — see source]

Tests: aligns with §2 (biotech applications) Answer: Not in extracted key — verify against official NTA key

Q.31 (CUET 2024) Match transgene with its use/product. α-1 antitrypsin, crylAc, Antisense RNA, crylAb.

- A) [option not extracted — see source]
- B) [option not extracted — see source]
- C) [option not extracted — see source]
- D) [option not extracted — see source]

Tests: aligns with §2 (biotech applications) Answer: Not in extracted key — verify against official NTA key

Q.32 (CUET 2024) Expand GEAC.

- A) Genetic and Environmental Advisory Committee
- B) Gene Establishment Approval Committee
- C) Genetic Engineering Advisory Committee
- D) Genetic Engineering Approval Committee

Tests: aligns with §2 (biotech applications) Answer: Not in extracted key — verify against official NTA key

Q.33 (CUET 2024) When insect feeds on Bt plant it dies due to activation of toxin in:

- A) Alkaline pH of gut
- B) Acidic pH of gut
- C) Acidic saliva
- D) Alkaline saliva

Tests: aligns with §2 (biotech applications) Answer: Not in extracted key — verify against official NTA key

CUET 2023 — Actual PYQs from this chapter

Q.21 (CUET 2023) Which crop was made resistant to yellow mosaic virus and powdery mildew by mutation breeding?

- A) Cowpea
- B) Flat bean
- C) Mung bean
- D) Brassica

Tests: aligns with §2 (mutation breeding for crop resistance) Answer: Not in extracted key — verify against official NTA key

Q.22 (CUET 2023) Match List-I with List-II List-I (A) Sterilized plant part (B) Genetically similar plants (C) Meristem (D) Somatic hybrids List-II (I) Tomato (II) Virus free culture (III) Somaclones (IV) Explants

- A) [option not extracted — see source]

- B) [option not extracted — see source]
- C) [option not extracted — see source]
- D) [option not extracted — see source]

Tests: aligns with §2 (tissue culture, somatic hybridisation, somaclones) Answer: Not in extracted key — verify against official NTA key

Q.23 (CUET 2023) Sonalika and Ratna are HYV varieties of:

- A) Wheat and Rice
- B) Rice and Wheat
- C) Maize and Rice
- D) Wheat and Millet

Tests: aligns with §2 (HYV varieties — green revolution) Answer: Not in extracted key — verify against official NTA key

Q.30 (CUET 2023) Identify the gene which is not effective against cotton bollworms:

- A) crylAc
- B) crylAb
- C) cryllAb
- D) Both (2) and (3)

Tests: aligns with §2 (Bt cotton — cry genes against bollworms) Answer: Not in extracted key — verify against official NTA key

Q.31 (CUET 2023) RNA interference in tobacco plant was used to develop resistance against:

- A) Viruses
- B) Fungi
- C) Nematodes
- D) Insects

Tests: aligns with §2 (RNA interference — pest resistance in tobacco/cotton) Answer: Not in extracted key — verify against official NTA key

Q.32 (CUET 2023) Unauthorized use of bio-resources without compensation is called:

- A) Bioinformatics
- B) Biopiracy
- C) Biopatenting
- D) Biological theft

Tests: aligns with §2 (biopiracy — ethical/IPR issues) Answer: Not in extracted key — verify against official NTA key