Biotechnology and Its Applications

Class 12 Biology · 24 NEET MCQs with answers & explanations

Biotechnology and Its Applications covers genetically modified organisms (Bt cotton, Golden Rice), gene therapy, molecular diagnostics (PCR, ELISA), transgenic animals and bioethics. NEET questions test specific examples — which gene does what, which organism was modified for what purpose. Factual recall dominates, so a clean revision table is your best weapon.

Key Applications

Application	Key Fact
Bt cotton	cry genes (cry1Ac, cry2Ab) from Bacillus thuringiensis; Bt toxin kills bollworm larvae
Golden Rice	Engineered with beta-carotene biosynthesis genes for Vitamin A fortification
Gene therapy	ADA deficiency — first gene therapy; functional ADA gene introduced into lymphocytes
PCR (diagnostics)	Amplifies DNA; detects HIV, genetic mutations; uses Taq polymerase
ELISA	Antigen-antibody based; detects HIV antibodies, pathogen proteins
Transgenic animals	Used for vaccine testing, drug production (e.g. human protein α-1-antitrypsin in sheep)

Questions

Q1. An insect-resistant transgenic plant produces Bt protoxin. What condition in the insect gut is primarily responsible for converting the protoxin into its active insecticidal form?

(A) Acidic pH of the gut
(B) Alkaline pH of the gut
(C) Neutral pH of the gut
(D) High temperature of the gut

Q2. Golden Rice was developed primarily to address which nutrient-related deficiency problem?

(A) Vitamin C deficiency
(B) Vitamin B12 deficiency
(C) Provitamin A deficiency
(D) Iron deficiency

Q3. RNA interference (RNAi) primarily silences gene expression at which stage?

(A) Post-transcriptional level by mRNA degradation
(B) Pre-replication by blocking DNA unwinding
(C) Translational level by inhibiting ribosomes
(D) Transcriptional level by blocking RNA polymerase

Q4. Which structural feature of the RNA molecule introduced into engineered plants makes it capable of initiating RNAi?

(A) It is single-stranded with a 5' cap
(B) It is double-stranded with complementarity to target mRNA
(C) It is circular with no free ends
(D) It contains modified nucleotides blocking Dicer

Q5. Which biotechnology application specifically involves silencing a nematode gene rather than producing an insecticidal protein?

(A) RNAi in tobacco against Meloidogyne
(B) Bt cotton against bollworms
(C) Golden Rice beta-carotene production
(D) Recombinant insulin production

Q6. A DNA sequence from a pathogen is present in a patient sample in extremely small quantity. Which technique is most appropriate to amplify this specific sequence?

(A) ELISA
(B) PCR
(C) Western blot
(D) Southern blotting

Q7. Which genetically engineered organism was used by Eli Lilly to prepare human insulin?

(A) Genetically engineered Escherichia coli
(B) Bacillus thuringiensis for Bt toxin
(C) Agrobacterium tumefaciens for plant transformation
(D) Saccharomyces cerevisiae for fermentation

Q8. A genetically modified crop survives a herbicide that kills surrounding weeds. Which advantage is being demonstrated?

(A) Killing of insects through Bt protein
(B) Production of beta-carotene in seeds
(C) Silencing of nematode genes via RNAi
(D) Selective weed control through herbicide tolerance

Q9. Which technique amplifies specific DNA segments allowing detection of pathogens even when present in very low concentration?

(A) Polymerase Chain Reaction
(B) ELISA
(C) Gel electrophoresis
(D) Centrifugation

Q10. Which molecular diagnostic technique is based on antigen–antibody interaction?

(A) Southern blotting
(B) ELISA
(C) Northern blotting
(D) DNA sequencing

Q11. Which concept encompasses guidelines and practices ensuring safe development, use, and release of genetically modified organisms?

(A) Biosafety
(B) Biopiracy
(C) Bioprospecting
(D) Bioremediation

Q12. Which international protocol specifically regulates transboundary movement of living modified organisms?

(A) Kyoto Protocol
(B) Cartagena Protocol
(C) Montreal Protocol
(D) Paris Agreement

Q13. Which bacterium is the natural source of Cry genes used in Bt crops?

(A) Bacillus thuringiensis
(B) Agrobacterium tumefaciens
(C) Rhizobium leguminosarum
(D) Escherichia coli

Q14. Bt cotton was engineered primarily to resist which of the following?

(A) Fungal wilt pathogens
(B) Lepidopteran insect pests
(C) Bacterial blight
(D) Viral mosaic disease

Q15. Gene therapy is best defined as the technique of:

(A) Inserting functional gene to correct genetic defect
(B) Removing chromosomes from cells
(C) Destroying defective genes using chemicals
(D) Inducing random mutations in DNA

Q16. Adenosine deaminase deficiency primarily affects which physiological system?

(A) Digestive system
(B) Respiratory system
(C) Immune system
(D) Nervous system

Q17. Which recombinant product was the first therapeutic protein produced using recombinant DNA technology for medical use?

(A) Recombinant human insulin
(B) Recombinant interferon
(C) Recombinant vaccine antigen
(D) Recombinant growth hormone

Q18. Which microorganism was used by Eli Lilly to produce the first recombinant human insulin?

(A) Agrobacterium tumefaciens
(B) Escherichia coli
(C) Bacillus thuringiensis
(D) Saccharomyces cerevisiae

Q19. The Cartagena Protocol on Biosafety primarily regulates which biotechnology-related activity?

(A) Extraction of mineral resources internationally
(B) Transboundary movement of living modified organisms
(C) Trade of conventional agricultural fertilisers
(D) International distribution of medical vaccines

Q20. The Cartagena Protocol on Biosafety is a supplementary agreement under which international treaty?

(A) UN Framework Convention on Climate Change
(B) World Health Organization Constitution
(C) Convention on Biological Diversity
(D) International Treaty on Plant Genetic Resources

Q21. Which term refers to the legal rights granted to inventors over a biological invention developed through biotechnology?

(A) Biopatent
(B) Biosafety certificate
(C) Bioprospecting license
(D) Bioremediation permit

Q22. Which concept describes the unethical appropriation of biological resources or traditional knowledge without fair compensation?

(A) Bioprospecting
(B) Biopiracy
(C) Benefit sharing
(D) Biodiversity audit

Q23. Animals whose genomes contain a gene introduced from another organism through genetic engineering are called:

(A) Transgenic animals
(B) Hybrid animals
(C) Mutant animals
(D) Cloned animals

Q24. Which transgenic cow, mentioned in NCERT, produced milk enriched with human alpha-lactalbumin?

(A) Rosie
(B) Dolly
(C) Tracy
(D) Polly

Answer key

1-B	2-C	3-A	4-B	5-A	6-B	7-A	8-D
9-A	10-B	11-A	12-B	13-A	14-B	15-A	16-C
17-A	18-B	19-B	20-C	21-A	22-B	23-A	24-A

Answers with explanations

Q1 — Answer: (B) Alkaline pH of the gut
The Bt protein is produced as an inactive protoxin in the plant; the alkaline pH of the insect gut solubilises the crystals and converts the protoxin into its active insecticidal form. Acidic pH is the classic reversal trap and is characteristic of human gastric juice, not susceptible insect guts. Neutral pH and high temperature do not activate the protoxin.

Q2 — Answer: (C) Provitamin A deficiency
Golden Rice is genetically modified to produce beta-carotene, a precursor of vitamin A, in the edible part of rice. It was therefore developed to combat vitamin A (provitamin A) deficiency. Iron deficiency is a deliberately attractive nutrition-related distractor. Vitamins C and B12 are unrelated to the genetic modification incorporated in Golden Rice.

Q3 — Answer: (A) Post-transcriptional level by mRNA degradation
RNAi acts post-transcriptionally — the mRNA is transcribed normally but is subsequently degraded by the RISC complex guided by siRNA, preventing translation. It does not act on DNA or RNA polymerase directly.

Q4 — Answer: (B) It is double-stranded with complementarity to target mRNA
Double-stranded RNA (dsRNA) is the trigger for RNAi. Its complementarity to the target mRNA allows the antisense strand (after Dicer cleavage) to guide RISC to the correct mRNA for degradation.

Q5 — Answer: (A) RNAi in tobacco against Meloidogyne
RNA interference in tobacco plants silences specific genes of the nematode Meloidogyne incognita, as described in NCERT. Bt cotton uses Cry proteins (insecticidal protein production). Golden Rice involves beta-carotene biosynthesis. Recombinant insulin involves protein production in E. coli. None of B, C, D involves gene silencing in a nematode.

Q6 — Answer: (B) PCR
PCR uses repeated cycles of denaturation, primer annealing and extension to exponentially amplify a selected DNA sequence. ELISA detects antigen-antibody interactions and does not amplify DNA. Western blot detects proteins. Southern blotting detects specific DNA sequences but does not amplify them.

Q7 — Answer: (A) Genetically engineered Escherichia coli
Eli Lilly used genetically engineered E. coli for production of human insulin. DNA sequences corresponding to the A and B chains were introduced separately into E. coli and the two chains were later combined through disulphide bonds. Bacillus thuringiensis is associated with Bt crops, whereas Agrobacterium is used in plant genetic engineering.

Q8 — Answer: (D) Selective weed control through herbicide tolerance
The genetically modified crop is engineered to tolerate the herbicide, allowing weeds to be eliminated while the crop survives. Bt resistance targets insects, Golden Rice addresses nutritional improvement and RNAi can silence specific pest genes.

Q9 — Answer: (A) Polymerase Chain Reaction
PCR exponentially amplifies specific DNA sequences using thermostable Taq polymerase, enabling pathogen detection even from minute quantities. ELISA detects proteins, not nucleic acids. Gel electrophoresis and centrifugation only separate molecules, they do not amplify.

Q10 — Answer: (B) ELISA
ELISA (Enzyme-Linked Immunosorbent Assay) relies on specific antigen–antibody binding for detection. Southern and Northern blotting detect DNA and RNA respectively using nucleic acid hybridization, not antigen-antibody reactions.

Q11 — Answer: (A) Biosafety
Biosafety refers to policies and procedures ensuring that biotechnology research and GMO release do not harm human health or the environment. The other options relate to IP exploitation, resource exploration, and pollution cleanup respectively.

Q12 — Answer: (B) Cartagena Protocol
The Cartagena Protocol on Biosafety (2000) regulates the safe transfer, handling, and use of LMOs across national borders. Kyoto and Paris deal with climate change; Montreal addresses ozone depletion.

Q13 — Answer: (A) Bacillus thuringiensis
Cry genes originate from Bacillus thuringiensis, a gram-positive soil bacterium that produces insecticidal crystalline proteins during sporulation. Agrobacterium is a vector, not a Cry gene source.

Q14 — Answer: (B) Lepidopteran insect pests
Bt cotton expresses Cry1Ac protein targeting lepidopteran larvae such as bollworms. It has no engineered resistance to fungal, bacterial, or viral pathogens.

Q15 — Answer: (A) Inserting functional gene to correct genetic defect
Gene therapy corrects genetic disorders by introducing a functional gene copy into target cells, compensating for the defective one. Options B, C, D describe destructive or unrelated processes not aligned with gene therapy principles.

Q16 — Answer: (C) Immune system
ADA deficiency causes accumulation of toxic deoxyadenosine in lymphocytes, severely impairing immune function. The immune system — not digestive, respiratory, or nervous — is the primary target of ADA enzyme activity.

Q17 — Answer: (A) Recombinant human insulin
Recombinant human insulin, produced by Eli Lilly using E. coli, was the first commercially available therapeutic protein made via recombinant DNA technology. Interferon and growth hormone came later in the recombinant protein timeline.

Q18 — Answer: (B) Escherichia coli
E. coli was genetically engineered with synthetic DNA sequences coding for human insulin A and B chains separately, then the chains were combined chemically. Agrobacterium is used in plant transformation; Bacillus thuringiensis produces Bt toxin.

Q19 — Answer: (B) Transboundary movement of living modified organisms
The Cartagena Protocol specifically governs the safe transboundary movement, handling, and use of living modified organisms (LMOs) that may affect biodiversity. It does not regulate fertilisers, vaccines, or mineral extraction.

Q20 — Answer: (C) Convention on Biological Diversity
The Cartagena Protocol was adopted under the Convention on Biological Diversity (CBD) — it operationalises the CBD's biosafety provisions. The UNFCCC governs climate; WHO constitution governs health — neither is the parent treaty of the Cartagena Protocol.

Q21 — Answer: (A) Biopatent
A biopatent confers exclusive legal ownership over biological inventions or processes, incentivising innovation. Biosafety, bioprospecting, and bioremediation are separate concepts unrelated to IP ownership.

Q22 — Answer: (B) Biopiracy
Biopiracy involves exploiting biological resources or traditional knowledge of indigenous communities without authorization or equitable benefit sharing. Bioprospecting is legal exploration; benefit sharing is the ethical remedy.

Q23 — Answer: (A) Transgenic animals
Transgenic animals carry a foreign gene stably integrated into their genome via genetic engineering. Hybrid animals arise from interspecific crosses; cloned animals are genetically identical copies — neither involves deliberate foreign gene insertion.

Q24 — Answer: (A) Rosie
Rosie was the first transgenic cow whose milk contained human alpha-lactalbumin, making it nutritionally superior for human infants. Dolly was a cloning experiment; Tracy (a sheep) produced alpha-1-antitrypsin — not alpha-lactalbumin.

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