CHAPTER 12

Biotechnology and Its Applications

12.1 Biotechnological Applications in Agriculture

1. Bt cotton variety that was developed by the introduction of toxin gene of *Bacillus thuringiensis* (Bt) is resistant to
(a) insect pests (b) fungal diseases
(c) plant nematodes (d) insect predators.
(NEET 2020)

2. What triggers activation of protoxin to active toxin of *Bacillus thuringiensis* in bollworm?
(a) Acidic pH of stomach
(b) Body temperature
(c) Moist surface of midgut
(d) Alkaline pH of gut *(NEET 2019)*

3. Which of the following is true for Golden rice?
(a) It has yellow grains, because of a gene introduced from a primitive variety of rice.
(b) It is vitamin A enriched, with a gene from daffodil.
(c) It is pest resistant, with a gene from *Bacillus thuringiensis*.
(d) It is drought tolerant, developed using *Agrobacterium* vector. *(NEET 2019)*

4. In RNAi, the genes are silenced using
(a) ds-RNA (b) ss-DNA
(c) ss-RNA (d) ds-DNA.
(Odisha NEET 2019)

5. Which part of the tobacco plant is infected by *Meloidogyne incognita*?
(a) Stem (b) Root
(c) Flower (d) Leaf *(NEET-I 2016)*

6. Golden rice is a genetically modified crop plant where the incorporated gene is meant for biosynthesis of
(a) omega 3 (b) vitamin A
(c) vitamin B (d) vitamin C. *(2015)*

7. In Bt cotton, the Bt toxin present in plant tissue as protoxin is converted into active toxin due to
(a) action of gut microorganisms
(b) presence of conversion factors in insect gut
(c) alkaline pH of the insect gut
(d) acidic pH of the insect gut. *(2015 Cancelled)*

8. The crops engineered for glyphosate are resistant/tolerant to
(a) insects (b) herbicides
(c) fungi (d) bacteria.
(2015 Cancelled)

9. Which of the following Bt crops is being grown in India by the farmers?
(a) Brinjal (b) Soybean
(c) Maize (d) Cotton *(NEET 2013)*

10. RNA interference involves
(a) synthesis of cDNA and RNA using reverse transcriptase
(b) silencing of specific *m*RNA due to complementary RNA
(c) interference of RNA in synthesis of DNA
(d) synthesis of *m*RNA from DNA.
(Karnataka NEET 2013)

11. Consumption of which one of the following foods can prevent the kind of blindness associated with vitamin 'A' deficiency?
(a) 'Flavr Savr' tomato (b) Canolla
(c) Golden rice (d) Bt-Brinjal *(2012)*

12. Tobacco plants resistant to a nematode have been developed by the introduction of DNA that produces (in the host cells)
(a) both sense and anti-sense RNA
(b) a particular hormone
(c) an antifeedant
(d) a toxic protein. *(Mains 2012)*

13. The process of RNA interference (RNAi) has been used in the development of plants resistant to
(a) nematodes (b) fungi
(c) viruses (d) insects. *(2011)*

14. *Bacillus thuringiensis* forms protein crystals which contain insecticidal protein. This protein
(a) binds with epithelial cells of midgut of the insect pest ultimately killing it
(b) is coded by several genes including the gene *cry*
(c) is activated by acid pH of the foregut of the insect pest
(d) does not kill the carrier bacterium which is itself resistant to this toxin. *(Mains 2011)*

15. Silencing of *m*RNA has been used in producing transgenic plants resistant to
(a) boll worms (b) nematodes
(c) white rusts (d) bacterial blights. *(Mains 2011)*

16. The genetically-modified (GM) brinjal in India has been developed for
(a) insect-resistance
(b) enhancing shelf life
(c) enhancing mineral content
(d) drought-resistance. *(2010)*

17. Some of the characteristics of Bt cotton are
(a) long fibre and resistance to aphids
(b) medium yield, long fibre and resistance to beetle pests
(c) high yield and production of toxic protein crystals which kill dipteran pests
(d) high yield and resistance to bollworms. *(2010)*

18. An improved variety of transgenic basmati rice
(a) does not require chemical fertilizers and growth hormones
(b) gives high yield and is rich in vitamin A
(c) is completely resistant to all insect pests and diseases of paddy
(d) gives high yield but has no characteristic aroma. *(2010)*

19. What is true about Bt toxin?
(a) Bt protein exists as active toxin in the *Bacillus*.
(b) The activated toxin enters the ovaries of the pest to sterilise it and thus prevent its multiplication.
(c) The concerned *Bacillus* has antitoxins.
(d) The inactive protoxin gets converted into active form in the insect gut. *(2009)*

20. Transgenic plants are the ones
(a) generated by introducing foreign DNA into a cell and regenerating a plant from that cell
(b) produced after protoplast fusion in artificial medium
(c) grown in artificial medium after hybridization in the field
(d) produced by a somatic embryo in artificial medium. *(2009)*

21. The bacterium *Bacillus thuringiensis* is widely used in contemporary biology as
(a) insecticide
(b) agent for production of dairy products
(c) source of industrial enzyme
(d) indicator of water pollution. *(2009)*

22. What is antisense technology?
(a) When a piece of RNA that is complementary in sequence is used to stop expression of a specific gene
(b) RNA polymerase producing DNA
(c) A cell displaying a foreign antigen used for synthesis of antigens
(d) Production of somaclonal variants in tissue cultures *(2009)*

23. *Cry* I endotoxins obtained from *Bacillus thuringiensis* are effective against
(a) nematodes (b) bollworms
(c) mosquitoes (d) flies. *(2008)*

24. A transgenic food crop which may help in solving the problem of night blindness in developing countries is
(a) Bt soybean (b) Golden rice
(c) Flavr Savr tomatoes (d) Starlink maize. *(2008)*

25. Main objective of production/use of herbicide resistant GM crops is to
(a) encourage eco-friendly herbicides
(b) reduce herbicide accumulation in food articles for health safety
(c) eliminate weeds from the field without the use of manual labour
(d) eliminate weeds from the field without the use of herbicides. *(2008)*

26. Golden rice is a promising transgenic crop. When released for cultivation, it will help in
(a) producing a petrol-like fuel from rice
(b) alleviation of vitamin A deficiency
(c) pest resistance
(d) herbicide tolerance. *(2006)*

27. *Bacillus thuringiensis* (Bt) strains have been used for designing novel
(a) biofertilizers
(b) bio-metallurgical techniques
(c) bio-mineralization processes
(d) bioinsecticidal plants. *(2005)*

28. Golden rice is a transgenic crop of the future with the following improved trait
(a) insect resistance
(b) high lysine (essential amino acid) content
(c) high protein content
(d) high vitamin-A content. *(2005)*

29. The first transgenic crop was
(a) tobacco (b) cotton
(c) pea (d) flax. *(1999)*

12.2 Biotechnological Applications in Medicine

30. Match the following columns and select the correct option.

	Column-I		**Column-II**
(A)	Bt cotton	(i)	Gene therapy
(B)	Adenosine deaminase deficiency	(ii)	Cellular defence
(C)	RNA*i*	(iii)	Detection of HIV infection
(D)	PCR	(iv)	*Bacillus thuringiensis*

	(A)	**(B)**	**(C)**	**(D)**
(a)	(iv)	(i)	(ii)	(iii)
(b)	(iii)	(ii)	(i)	(iv)
(c)	(ii)	(iii)	(iv)	(i)
(d)	(i)	(ii)	(iii)	(iv)

(NEET 2020)

31. Which of the following statements is not correct?
(a) In man insulin is synthesised as a proinsulin.
(b) The proinsulin has an extra peptide called C-peptide.
(c) The functional insulin has A and B chains linked together by hydrogen bonds.
(d) Genetically engineered insulin is produced in *E.Coli*. *(NEET 2020)*

32. Which kind of therapy was given in 1990 to a four-year-old girl with adenosine deaminase (ADA) deficiency?
(a) Gene therapy (b) Chemotherapy
(c) Immunotherapy (d) Radiation therapy
(NEET-II 2016)

33. The two polypeptides of human insulin are linked together by
(a) covalent bond
(b) disulphide bridges
(c) hydrogen bonds
(d) phosphodiester bond. *(NEET-I 2016)*

34. The first human hormone produced by recombinant DNA technology is
(a) insulin (b) estrogen
(c) thyroxin (d) progesterone. *(2014)*

35. Which one of the following vectors is used to replace the defective gene in gene therapy?
(a) Adenovirus (b) Cosmid
(c) Ri plasmid (d) Ti plasmid
(Karnataka NEET 2013)

36. The first clinical gene therapy was given for treating
(a) diabetes mellitus
(b) chicken pox
(c) rheumatoid arthritis
(d) adenosine deaminase deficiency. *(Mains 2012)*

37. Which one of the following is now being commercially produced by biotechnological procedures?
(a) Nicotine (b) Morphine
(c) Quinine (d) Insulin *(Mains 2010)*

38. The genetic defect–adenosine deaminase (ADA) deficiency may be cured permanently by
(a) administering adenosine deaminase activators
(b) introducing bone marrow cells producing ADA into cells at early embryonic stages
(c) enzyme replacement therapy
(d) periodic infusion of genetically engineered lymphocytes having functional ADA cDNA.
(2009)

39. Human insulin is being commercially produced from a transgenic species of
(a) *Rhizobium* (b) *Saccharomyces*
(c) *Escherichia* (d) *Mycobacterium*. *(2008)*

40. ELISA is used to detect viruses where the key reagent is
(a) alkaline phosphatase
(b) catalase
(c) DNA probe
(d) RNase. *(2004, 2003)*

41. Maximum application of animal cell culture technology today is in the production of
(a) insulin (b) interferons
(c) vaccines (d) edible proteins.
(2003)

42. The term 'humulin' is used for
(a) hydrolytic enzyme (b) powerful antibiotic
(c) human insulin (d) isoenzyme. *(1999)*

43. Hybridoma cells are
(a) only cells having oncogenes
(b) product of spore formation in bacteria
(c) nervous cells of frog
(d) hybrid cells resulting from myeloma cells.
(1999)

12.3 Transgenic Animals

44. Maximum number of existing transgenic animals is of
(a) fish (b) mice
(c) cow (d) pig. *(2011)*

45. Read the following four statements (A-D) about certain mistakes in two of them.
(A) The first transgenic buffalo, Rosie produced milk which was human alpha-lactalbumin enriched.
(B) Restriction enzymes are used in isolation of DNA from other macromolecules.
(C) Downstream processing is one of the steps of *r*DNA technology.
(D) Disarmed pathogen vectors are also used in transfer of *r*DNA into the host.
Which of the two statements have mistakes?
(a) B and C (b) C and D
(c) A and C (d) A and B *(Mains 2011)*

46. Genetic engineering has been successfully used for producing
(a) transgenic mice for testing safety of polio vaccine before use in humans
(b) transgenic models for studying new treatments for certain cardiac diseases
(c) transgenic cow-Rosie which produces high fat milk for making ghee
(d) animals like bulls for farm work as they have super power. *(2010)*

47. Production of a human protein in bacteria by genetic engineering is possible because
(a) the human chromosome can replicate in bacterial cell
(b) the mechanism of gene regulation is identical in humans and bacteria
(c) bacterial cell can carry out the RNA splicing reactions
(d) the genetic code is universal. *(2005)*

48. In transgenics, expression of transgene in target tissue is determined by
(a) enhancer (b) transgene
(c) promoter (d) reporter. *(2004)*

49. The transgenic animals are those which have
(a) foreign RNA in all its cells
(b) foreign DNA in some of its cells
(c) foreign DNA in all its cells
(d) both (a) and (b). *(1995)*

12.4 Ethical Issues

50. A 'new' variety of rice was patented by a foreign company, though such varieties have been present in India for a long time. This is related to
(a) Co-667 (b) Sharbati Sonora
(c) Lerma Rojo (d) Basmati. *(NEET 2018)*

51. In India, the organisation responsible for assessing the safety of introducing genetically modified organisms for public use is
(a) Indian Council of Medical Research (ICMR)
(b) Council for Scientific and Industrial Research (CSIR)
(c) Research Committee on Genetic Manipulation (RCGM)
(d) Genetic Engineering Appraisal Committee (GEAC). *(NEET 2018)*

52. Use of bioresources by multinational companies and organisations without authorisation from the concerned country and its people is called
(a) bio-infringement (b) biopiracy
(c) biodegradation (d) bioexploitation.
(NEET 2018)

53. Which body of the Government of India regulates GM research and safety of introducing GM organisms for public services?
(a) Genetic Engineering Approval Committee
(b) Research Committee on Genetic Manipulation
(c) Bio-safety committee
(d) Indian Council of Agricultural Research
(2015 Cancelled)

ANSWER KEY

1.	(a)	**2.**	(d)	**3.**	(b)	**4.**	(a)	**5.**	(b)	**6.**	(b)	**7.**	(c)	**8.**	(b)	**9.**	(d)	**10.**	(b)
11.	(c)	**12.**	(a)	**13.**	(a)	**14.**	(a)	**15.**	(b)	**16.**	(a)	**17.**	(d)	**18.**	(b)	**19.**	(d)	**20.**	(a)
21.	(a)	**22.**	(a)	**23.**	(b)	**24.**	(b)	**25.**	(c)	**26.**	(b)	**27.**	(d)	**28.**	(d)	**29.**	(a)	**30.**	(a)
31.	(c)	**32.**	(a)	**33.**	(b)	**34.**	(a)	**35.**	(a)	**36.**	(d)	**37.**	(d)	**38.**	(b)	**39.**	(c)	**40.**	(a)
41.	(c)	**42.**	(c)	**43.**	(d)	**44.**	(b)	**45.**	(d)	**46.**	(a)	**47.**	(d)	**48.**	(d)	**49.**	(c)	**50.**	(d)
51.	(d)	**52.**	(b)	**53.**	(a)														

Hints & Explanations

1. (a): Bt cotton is resistance to cotton bollworm infestation. The genes *cry* I *Ac* and *cry* II*Ab* control cotton bollworms, thus acts as bio-pesticide.

2. (d): Some strains of *Bacillus thuringiensis* produce proteins that kill certain insects such as lepidopterans and dipterans. *B. thuringiensis* forms protein crystals during a particular phase of their growth. These crystals contain a toxic insecticidal protein which exists as inactive protoxins but once an insect ingest the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the gut which solubilise the crystals.

3. (b): Rice is a staple food in many countries, particularly in Asia, but does not contain vitamin A or its immediate precursors. By inserting two genes from daffodil and one gene from a bacterial species into rice plants, Swiss researchers have produced rice capable of synthesising β-carotene, the precursor of vitamin A. Vitamin A is required by all individuals as it is present in retina of eyes. Deficiency of vitamin A causes night blindness and skin disorders. This rice is called 'Golden rice' because of yellow colour of rice grains due to the presence of β-carotene.

4. (a)

5. (b): *Meloidogyne incognita* is a nematode which infects the roots of the tobacco plants and causes a great reduction in the yield.

6. (b): Golden rice is a transgenic variety of rice (*Oryza sativa*) which contains good quantities of β-carotene (provitamin A - inactive state of vitamin A). β-carotene is a principal source of vitamin A. Since the grains of this rice is yellow in colour due to β-carotene, it is commonly called golden rice.

7. (c): Soil bacterium *Bacillus thuringiensis* produces proteins that kill certain insects like lepidopterans (tobacco budworm, armyworm), coleopterans (beetles) and dipterans (flies, mosquitoes). *B. thuringiensis* forms some protein crystals. These crystals contain a toxic insecticidal protein. This toxin does not kill the *Bacillus* (bacterium) because it exists as inactive protoxins in them. But, once an insect ingests it, it is converted into an active form of toxin due to the alkaline pH of the alimentary canal. The activated toxin binds to the surface of midgut epithelial cells and create pores that cause swelling and lysis and finally cause death of the insect.

8. (b): Glyphosate is a broad spectrum herbicide which especially kills broad leaved herbs. Crop plants may also get affected by the herbicide, thus now crop plants are genetically engineered for glyphosate resistance. So, when glyphosate herbicide is applied, only weeds and no crop plants get harmed.

9. (d): Bt toxin genes were isolated from *Bacillus thuringiensis* and incorporated into the several crop plants such as cotton. The choice of genes depends upon the crop and targeted pest, as most Bt toxins are insect-group specific. The toxin is coded by a gene named *cry*. There are numerous genes. Two *cry* genes *cry* I Ac and *cry* II Ab have been incorporated in cotton. The genetically modified crop is called Bt cotton as it contains Bt toxin genes against cotton bollworms.

10. (b): RNA interference (RNAi) is the phenomenon of inhibiting activity of a gene through production of both sense and antisense RNA. RNAi takes place in all eukaryotic organisms as a method of cellular defense. This method involves a specific *m*RNA silencing. It is due to a complementary RNA molecule which binds to and prevents translation of the *m*RNA causing its silencing.

11. (c)

12. (a): Many nematodes live in plants and animals including human beings. A nematode *Meloidogyne incognita* infests the roots of tobacco plants and causes a great reduction in yield. A novel strategy was adopted to prevent this infection that was based on the process of RNA interference (RNAi). RNA interference (RNAi) is the phenomenon of inhibiting activity of a gene by synthesis of RNA molecules complementary to the *m*RNA. The normal (*in vivo* synthesized) *m*RNA of a gene is said to be "sense" because it carries the codons that are "read" during translation. Normally, the complement to the *m*RNA "sense" strand will not contain a sequence of codons that can be translated to produce a functional protein; thus, this complementary strand is called "anti-sense RNA". The anti-sense RNA and *m*RNA molecules will anneal to form duplex RNA molecules (or double stranded RNA) and the duplex RNA molecules can not be translated. Thus, the presence of anti-sense RNA will block translation of the *m*RNA of the affected gene.

13. (a)

14. (a): *B. thuringiensis* forms some protein crystals. These crystals contain a toxic inactive insecticidal protein. When an insect ingests it, it is converted into an active form of toxin. The activated toxin binds to the surface of midgut epithelial cells and create pores that cause swelling and lysis and finally cause death of the insect.

15. (b)

16. (a): The genetically modified (GM) Bt brinjal in India has been developed mainly for insect resistance. Through genetic engineering Bt toxin genes were isolated from *Bacillus thuringiensis* and incorporated into the several crop plants such as cotton, brinjal, etc.

17. (d): Bt toxin genes were isolated from *Bacillus thuringiensis* and incorporated into cotton plant. The genetically modified crop is called Bt cotton. Bt cotton has the following useful characteristics: pest resistance, herbicide tolerance, high yield and resistance to boll worm infestation.

18. (b) **19. (d)**

20. (a) : The plants produced through genetic engineering contain gene or genes usually from an unrelated organism. Such genes are called transgenes and the plants having transgenes are called transgenic plants. Recombinant DNA techniques are being used to improve crop plants by increasing their productivity, by making them more nutritious and by developing disease resistance. Transgenic plants may have resistance to herbicides, pests and abiotic stresses.

21. (a) : Some strains of *Bacillus thuringiensis* produce proteins that kill certain insects such as lepidopterans and dipterans.

22. (a) : *Refer to answer 12.*

23. (b) **24. (b)**

25. (c) : Genetic engineering has helped to develop such transgenic crop plants which are resistant to herbicides so that they are not damaged when farmers spray herbicides in the fields. Herbicide resistant plants have been developed in such a way that they continue to produce normal crop yield and at the same time remain unaffected by the activity of herbicides. These plants also reduces the use of weeding labour, farmer's cost and increases yield.

26. (b) : Golden rice is a transgenic variety of rice (*Oryza sativa*) which contains good quantities of β-carotene. β-carotene is a principal source of vitamin A, so it will help in alleviation of vitamin A deficiency.

27. (d) : *Bacillus thuringiensis* strains have been used for designing bio-insecticidal plants. A gene from this bacteria have insecticidal property which is transferred to cotton plants to produce Bt cotton which is resistant to bollworm insect which is a major pest of cotton. Similarly, insects affecting maize; cabbage, sunflower, etc., are also controlled by mutant strains of *Bacillus thuringiensis* bacteria.

28. (d) : Golden rice is a transgenic crop rice with high vitamin A content. It has been developed by transferring beta carotene synthesizing gene into the transgenic rice. Beta carotene is the precursor of vitamin A. This transgenic rice has been crossed with the already adapted varieties of rice to make them grow well in a particular area. It is very useful for the people suffering from vision impairment due to vitamin A deficiency.

29. (a) : Transgenic plants are those plants in which a foreign gene has been introduced and stably integrated into host DNA. The first transgenic plants were produced in tobacco (*Nicotiana tabacum*). A gene resistant to PPT (L-phosphinothricin), an active ingredient of herbicide 'Basta', was isolated from *Medicago sativa*. It inhibits the enzyme GS (glutamine synthase) which is involved in ammonia assimilation. This gene resistant to PPT was incorporated into tobacco, as a result of which transgenic tobacco was produced which was resistant to PPT.

30. (a)

31. (c) : Insulin consists of two short polypeptide chains : Chain A and chain B, that are linked together by disulphide bridges.

32. (a) : Gene therapy is a technique of genetic engineering which involves replacement of a faulty/ disease causing gene by a normal healthy functional gene. The first clinical gene therapy was given in 1990 to a 4-year old girl with adenosine deaminase (ADA) deficiency. This enzyme is very important for the immune system to function. The deficiency of this enzyme can lead to severe combined immune deficiency (SCID).

33. (b) : Human insulin is made up of 51 amino acids arranged in two polypeptide chains. Chain A has 21 amino acids and chain B has 30 amino acids. The two polypeptide chains are interconnected by disulphide bridges or S-S-linkages.

34. (a) : The recombinant DNA technological processes have made great impact in the area of health care by mass production of safe and more effective therapeutic drugs. In 1983, Eli Lily, an American company, first prepared two DNA sequences corresponding to A and B chains of human insulin and introduced them in plasmids of *Escherichia coli* to produce insulin chains. Chains A and B were produced separately, extracted and combined by creating disulphide bonds to form human insulin (humulin).

35. (a) : Gene therapy is a corrective therapy that is given to patients with diseases caused by some gene defects. Here, genes are inserted into a person's cells and tissues to treat disease by replacing the defective gene. The normal gene delivered into the individual or embryo takes over the function and compensate for the non-functional gene. Viral vectors like adenovirus are generally used to deliver the normal gene.

36. (d) : Gene therapy is a collection of methods that allows correction of a gene defect that has been diagnosed in a child/embryo. Here genes are inserted into a person's cells and tissues to treat a disease. Correction of a genetic defect involves delivery of a normal gene into the individual or embryo to take over the function of and compensate for the non-functional gene. The first clinical gene therapy was given in 1990 to a 4 - year old girl with adenosine deaminase (ADA) deficiency. This enzyme is very important for the immune system to function. SCID is caused due to defect in the gene for the enzyme adenosine deaminase. In some children ADA deficiency can be cured by bone marrow transplantation. Here, the isolated gene from bone marrow cells producing ADA is introduced into cells at early embryonic stages; it can be a permanent cure.

37. (d) : Insulin is now being commercially produced by genetic engineering. Insulin consists of two short polypeptide chains: chain A and chain B, that are linked together by disulphide bonds. Insulin, in mammal is synthesised as a prohormone which contains an extra stretch called the C-peptide. During maturation this C-peptide is removed. The major problem for production of insulin using *r*DNA technique was getting insulin assembled in mature form. This problem was solved in 1988 by Eli Lilly, an American company which prepared functionable insulin from two DNA sequences corresponding to A and B chains of human insulin and introduced them in plasmids of *E.coli* to produce insulin chains. In this way, chains A and B were produced separately which was extracted and combined by creating disulphide bonds to get human insulin.

38. (b): ADA deficiency can be permanently cured if the isolated gene from bone marrow cells producing ADA is introduced into cells at early embryonic stages.

39. (c): Insulin is now being commercially produced by genetic engineering with the help of *E.coli* bacteria.

40. (a): ELISA (enzyme linked immunosorbent assay) screening test is the initial test to diagnose AIDS. The test works by detecting antibodies/substances or protein which are produced in the blood when virus is present. Alkaline phosphatase and peroxidases are commonly used enzymes as key reagent to perform the ELISA test. These enzymes are used to provide antibody-antigen complex in a specialised ELISA plate or tray. In ELISA test for detecting a particular antigen, its antibody is buffered and a drop of serum (supernatant of centrifuged blood) poured over it. If the latter contains antigen, it will produce antigen-antibody complex. A second enzyme labelled antibody is added. It forms enzyme-antigen-antibody complex, if the antigen is present. Substrate is now added. It produces a stain if the antigen is present.

41. (c): Maximum application of animal cell culture technology is in the production of vaccines. Vaccines are chemical substances prepared from the proteins of other animals which confer immunity to a particular virus. Some of the vaccines synthesized biologically through genetic engineering are vaccines for hepatitis-B virus, vaccines for rabies virus, vaccines for poliovirus and vaccines for small pox virus, etc.

42. (c): Human insulin (humulin) is the first therapeutic product produced by means of recombinant DNA technology by Eli lilly and Co. on July 5, 1983.

43. (d): Hybridoma is hybrid cell resulting from the artificial fusion of an antibody-producing lymphocyte and a myeloma cell from a lymphoid tumour. Such cells can produce a clone that may be maintained in tissue culture and used for the continuing production of monoclonal antibody.

44. (b)

45. (d): In 1997, the first transgenic cow, Rosie, produced human protein enriched milk. The milk contained the human alpha-lactalbumin and was nutritionally a more balanced product for human babies than natural cow-milk. Isolation of DNA from other macromolecule is achieved by treating the bacterial cells/plant or animal tissue with enzymes such as lysozyme (bacteria), cellulase (plant cells), chitinase (fungus).

46. (a): Many transgenic animals are designed to increase our understanding of how genes contribute to the development of diseases. These are specially made to serve as models for human diseases so that investigation of new treatments for diseases is made possible. Today transgenic models exist for many human diseases such as cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's. Transgenic mice are being developed for use in testing the safety of vaccines before they are used on humans. Transgenic mice are being used to test the safety of the polio vaccine.

47. (d): Genetic code may be defined as the sequence of nucleotides in polynucleotide chain which determines the sequence of amino acids in a polypeptide chain. The genetic code is universal. It means that each codon codes for the same amino acid in all organisms including bacteria, plants and animals.

48. (d): The plants, in which a functional foreign gene has been incorporated by any biotechnological methods that generally is not present in plant, are called transgenic plants. When plant cell are transformed by any of the transformation methods it is necessary to isolate the transformed cells/tissue. There are certain selectable marker genes present in vectors that facilitate the selection process. In transformed cells the selectable marker genes are introduced through vector. There is a number of marker genes which are commonly described as reporter genes screenable genes. Some of the reporter genes which are most commonly used in plant transformation are : cat, gus, lux, nptII., etc.

49. (c): Transgenic organism is one that has become transformed following the introduction of novel genes into its genome. It is most frequently achieved by integration of cloned DNA sequences following their injection into the fertilized egg. This fertilized egg divides mitotically to form the whole organism so that all the cells of the organism will carry the transferred gene. The transferred genes are known as transgenes. Transgenesis can be done by microinjection and somatic cell nuclear transfer or cloning. Transgenic animals produced by this technology include mice, *Drosophila*, *Xenopus* and some of the fish species.

50. (d): In 1997, a Texas company got patent rights on Basmati rice through the US Patent and Trademark Office. This allowed the company to sell a 'new' variety of Basmati, in the US and abroad. This new variety of Basmati had actually been derived from Indian farmers' varieties. Indian Basmati was crossed with semi-dwarf varieties and claimed as an invention or a novelty. It caused a brief diplomatic crisis between India and United States with India threatening to take the matter to WTO (World Trade Organisation) as a violation of TRIPS (Trade Related Aspects of Intellectual Property Rights). Both voluntarily and due to review decisions by United States patent office, Rice Tec lost most of the claims of the patent.

51. (d): Indian government has set up organisation such as GEAC (Genetic Engineering Appraisal Committee) which makes decisions regarding the validity of GM research and safety of introducing GM organisms for public services.

52. (b): Some organisations and multinational companies exploit or patent biological resources or bioresources of other nations without proper authorisation from the countries concerned. This is called biopiracy.

53. (a): Genetic modification of organisms can have unpredictable results, when such organisms are introduced into the ecosystem. Therefore, the Indian Government has set up organizations such as GEAC (Genetic Engineering Approval Committee), (now, changed as Genetic Engineering Appraisal Committee) which makes decisions regarding the validity of GM research and the safety of introducing GM-organisms for public services.

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