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Biotechnology and Its Applications

TOPIC 1

Applications of Biotechnology in Agriculture

- 01** Match the organism with its use in biotechnology. [NEET (Sep.) 2020]

Column I	Column II
A. <i>Bacillus thuringiensis</i>	1. Cloning vector
B. <i>Thermus aquaticus</i>	2. Construction of first rDNA molecule
C. <i>Agrobacterium tumefaciens</i>	3. DNA polymerase
D. <i>Salmonella typhimurium</i>	4. Cry proteins

Select the correct option.

- | | | | |
|-------|---|---|---|
| A | B | C | D |
| (a) 4 | 3 | 1 | 2 |
| (b) 3 | 2 | 4 | 1 |
| (c) 3 | 4 | 1 | 2 |
| (d) 2 | 4 | 3 | 1 |

Ans. (a)

The correct option is (a). It can be explained as follows

Bacillus thuringiensis is a source of Cry proteins.

Thermus aquaticus is a source of thermostable DNA polymerase (*Taq* polymerase) used in PCR.

Agrobacterium tumefaciens is a cloning vector.

The construction of 1st recombinant DNA molecule was performed using native plasmid of *Salmonella typhimurium*.

- 02** RNA interference is used for which of the following purposes in the field of biotechnology? [NEET (Oct.) 2020]

- (a) to develop a plant tolerant to abiotic stresses
- (b) to develop a pest resistant plant against infestation by nematode
- (c) to enhance the mineral usage by the plant
- (d) to reduce post harvest losses

Ans. (b)

RNA interference is used to develop a pest resistant plant against infestation by nematode. RNA interference takes place in all eukaryotic organisms as a method of cellular defence. This method involves silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing).

- 03** *Bt* cotton variety that was developed by the introduction of toxin gene of *Bacillus thuringiensis* (*Bt*) is resistant to [NEET (Sep.) 2020]

- (a) fungal diseases
- (b) plant nematodes
- (c) insect predators
- (d) insect pests

Ans. (d)

The correct option is (d). It can be explained as follows

Bt cotton is resistant to cotton bollworm (insect pest). *cry I Ac* and *cry II Ab* genes have been introduced in cotton to protect it from cotton bollworm. This makes *Bt* cotton as biopestic.

- 04** If an agricultural field is liberally irrigated for a prolonged period of time, it is likely to face problem of [NEET (Odisha) 2019]

- (a) metal toxicity
- (b) alkalinity
- (c) acidity
- (d) salinity

Ans. (d)

Salinity of soil is a problem faced by farmers if they liberally irrigate agricultural field for a prolonged period of time.

Irrigation salinity is the accumulation of salts in the topsoil under irrigation. It is caused by over irrigation of agricultural land, inefficient water use, poor drainage and the irrigation of unsuitable and leaky soils.

- 05** Which part of the tobacco plant is infected by *Meloidegyn* *incognitia*? [NEET 2016, Phase II]

- (a) Leaf
- (b) Stem
- (c) Root
- (d) Flower

Ans. (c)

Meloidegyn incognitia is a nematode, which infects roots of tobacco plant and results in root knot disease.

- 06** Golden rice is a genetically modified crop plant where the incorporated gene is meant for biosynthesis of [CBSE AIPMT 2015]

- (a) vitamin-B
- (b) vitamin-C
- (c) omega 3
- (d) vitamin-A

Ans. (d)

Golden rice is a variety of rice produced through genetic engineering to biosynthesise β -carotene, a precursor of vitamin-A, in the edible parts of rice.

07 The introduction of tDNA into plants involves [CBSE AIPMT 2015]

- (a) infection of the plant by *Agrobacterium tumefaciens*
- (b) altering the pH of soil, heat-shocking the plants
- (c) exposing the plants to cold for a brief period
- (d) allowing the plant roots to stand in water

Ans. (a)

Agrobacterium tumefaciens, a pathogen of several dicot plants is able to deliver a piece of DNA known as tDNA to transform normal plant cells into a tumour and direct these tumour cells to produce the chemicals required by the pathogen.

08 Which of the following Bt crops is being grown in India by the farmers? [NEET 2013]

- (a) Maize
- (b) Cotton
- (c) Brinjal
- (d) Soyabean

Ans. (b)

In India Bt cotton is grown by farmers extensively. Bt toxin is produced by a bacterium called *Bacillus thuringiensis* (Bt). Examples of Bt crops are Bt cotton, Bt corn, rice, tomato, potato and soyabean, etc.

09 Consumption of which one of the following foods can prevent the kind of blindness associated with vitamin-A deficiency? [CBSE AIPMT 2012]

- (a) *Flavr savr* tomato
- (b) Canolla
- (c) Golden rice
- (d) Bt brinjal

Ans. (c)

Golden rice is a variety of *Oryza sativa* (rice) produced through genetic engineering to biosynthesise beta-carotene, a precursor of vitamin-A in the edible part of rice (i.e. endosperm). The research that led to golden rice was conducted with the goal of helping children who suffer from vitamin-A deficiency. Because many children in countries where there is a dietary deficiency in vitamin-A rely on rice as a staple food, the genetic modification of rice to produce the vitamin-A precursor beta-carotene is seen as a simple and less expensive alternative to vitamin supplements.

10 The process of RNA interference has been used in the development of plants resistant to

- (a) nematodes
- (b) fungi
- (c) viruses
- (d) insects

[CBSE AIPMT 2011]

Ans. (a)

The process of RNA interference (RNAi) has been used in the development of plants resistant to nematodes like *Meloidogyne incognita*, which infects the roots of tobacco plants and causes a great reduction in yield. RNA interference takes place in all eukaryotic organisms as a method of cellular defense. This method involves silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing).

11 Continuous addition of sugars in 'fed batch' fermentation is done to [CBSE AIPMT 2011]

- (a) produce methane
- (b) obtain antibiotics
- (c) purify enzymes
- (d) degrade sewage

Ans. (c)

Continuous addition of sugars in fed batch fermentation is done to purify enzymes. A fed batch is a biotechnological batch process which is based on feeding of a growth limiting nutrient substrate to a culture.

12 The Genetically Modified (GM) brinjal in India has been developed for [CBSE AIPMT 2010]

- (a) insect-resistance
- (b) enhancing self life
- (c) enhancing mineral content
- (d) drought-resistance

Ans. (a)

The genetically modified brinjal or Bt brinjal has the same *cry lac* gene from *Bacillus thuringiensis* as cotton. The gene is supposed to make the plant tolerant to the shoot and fruit borer insect, which attacks it throughout its life cycle.

13 Some of the characteristics of Bt cotton are [CBSE AIPMT 2010]

- (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

Ans. (c)

Bacillus thuringiensis forms crystals containing a toxic insecticidal protein. Bt toxin protein exists as inactive protein but once an insect ingests the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the gut, which solubilise the crystals.

The activated toxin binds to the surface of midgut epithelial cells and creates pores that cause cell swelling and lysis and eventually cause death of the insect. Specific Bt toxin genes were isolated from *B. thuringiensis* and incorporated into the several plants such as cotton.

The toxin is coded by a gene named *cry*. There are a number of them, e.g. the proteins encoded by the genes *cry I Ac* and *cry II Ab* control the cotton bollworms, that of *cry I Ab* control corn borers.

14 A transgenic food crop which may help in solving the problem of night blindness in developing countries is [CBSE AIPMT 2008]

- (a) Bt soyabean
- (b) golden rice
- (c) *flavr savr* tomatoes
- (d) starlink maize

Ans. (b)

Vitamin-A deficiency causes night blindness among children. Vitamin-A deficiency often occurs where rice is the staple food since, rice grain does not contain β -carotene. Three transgenes providing phytoene synthase, phytoene desaturase, beta carotene desaturase and lycopene cyclase activities were transferred into rice by *Agrobacterium* mediated transformation. The resulting transgenic rice popularly called goldern rice contains good quantities of β -carotene.

Flavr savr is genetically modified tomato, which remains fresh and retain their flavour much longer than normal tomato due to the blocking of synthesis of fruit softening enzyme polygalacturonase.

15 Introduction of food plants developed by genetic engineering is not desirable because

- (a) economy of developing countries may suffer

- (b) these products are less tasty as compared to the already existing products
- (c) this method is costly
- (d) there is danger of introduction of viruses and toxins with introduced crop

Ans. (a)

It is difficult for developing countries to keep up and maintain genetically engineered crops. Therefore, introduction of food plants by genetic engineering is not desirable for developing countries.

TOPIC 2

Applications of Biotechnology in Medicine

- 16** When gene targeting involving gene amplification is attempted in an individual's tissue to treat disease, it is known as [NEET 2021]
- (a) biopiracy
 (b) gene therapy
 (c) molecular diagnosis
 (d) safety testing

Ans. (b)

Gene therapy is a type of treatment designed to modify the expression of an individual's genes or to correct abnormal genes to treat a disease. Gene amplification is common in cancer cells, and some amplified genes may cause cancer cells to grow or become resistant to anticancer drugs. The presence of gene amplification can have a prognostic and a diagnostic value and can help in orienting therapy in specific tumour types.

- 17** With regard to insulin choose the correct options.
- I. C-peptide is not present in mature insulin.
 II. The insulin produced by rDNA technology has C-peptide.
 III. The pro-insulin has C-peptide.
 IV. A-peptide and B-peptide of insulin are interconnected by disulphide bridges.

Choose the correct answer from the options given below.

[NEET 2021]

- (a) II and IV (b) II and III
 (c) I, III and IV (d) I and IV

Ans. (c)

Statement I, III and IV are correct. Insulin consists of two short polypeptide chains A and B which are linked together by disulphide bridges. In mammals insulin is synthesised as pro hormone which contain an extra stretch called the C, peptide also called pro-insulin. C-peptide is removed during maturation into insulin and is not present in mature insulin.

Statement II is incorrect and be corrected as

It is challenging to produce insulin by using rDNA techniques because it is difficult to assemble insulin into its mature form using rDNA technique. Thus, C-peptide is absent in insulin produced by rDNA technology.

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

Ans. (b)

Statement in option (b) is incorrect because Insulin is composed of two peptide chains referred to as the A chain and B chain. A and B chains are linked together by two disulphide bonds, and an additional disulphide is formed within the A chain. Insulin molecules have a tendency to form dimers in solution due to hydrogen-bonding between the C-termini of B chains.

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

Ans. (d)

In India, **Genetic Engineering Approval Committee**, i.e., **GEAC** (NCERT) is

responsible for assessing the safety of introducing genetically modified organisms for public use. GEAC comes under the Ministry of Environment and Forests (MOE & F) while the **Review Committee on Genetic Manipulation** (RCGM) comes under Department of Biotechnology.

The **Council of Scientific and Industrial Research** (CSIR) is the largest research and development organisation in India. **The Indian Council of Medical Research** (ICMR) is the apex body in India for the formulation, coordination and promotion of biomedical research.

Note The name of GEAC is changed to **Genetic Engineering Appraisal Committee** from Genetic Engineering Approval Committee in 2010.

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

Ans. (c)

In humans, insulin is produced by β -cells of pancreas. It is synthesised as prohormone in which two polypeptides are synthesised with an extra stretch of 'C' polypeptide. During maturation extra stretch of 'C' polypeptide is separated and two polypeptide chains (A and B) are linked together by disulphide linkages (bridges).

- 21** Which kind of therapy was given in 1990 to a four-year-old girl with Adenosine Deaminase (ADA) deficiency? [NEET 2016, Phase II]
- (a) Gene therapy
 (b) Chemotherapy
 (c) Immunotherapy
 (d) Radiation therapy

Ans. (a)

The first clinical gene therapy was given in 1990 to a 4 years old girl with Adenosine Deaminase (ADA) deficiency.

ADA deficiency is a disorder caused due to the deletion of the gene for adenosine deaminase. Gene therapy is the technique of genetic engineering that allows correction of a gene defect that has been diagnosed in child/embryo. In this therapy a normal healthy functional gene is inserted and the faulty gene is replaced.

22 The first human hormone produced by recombinant DNA technology is
[CBSE AIPMT 2014]

- (a) insulin (b) estrogen
(c) thyroxin (d) progesterone

Ans. (a)

The first human hormone produced by recombinant DNA technology is insulin. It is peptide hormone, which controls the level of blood sugar. It is formed by joining of two polypeptide chain by disulphide bonds.

23 Human insulin is being commercially produced from a transgenic species of
[CBSE AIPMT 2008]

- (a) *Rhizobium* (b) *Saccharomyces*
(c) *Escherichia* (d) *Mycobacterium*

Ans. (c)

In 1983 an American company Eli Lilly produced the first genetically engineered insulin by first synthesising two DNA sequences corresponding to α and β insulin chains. The two DNA sequences or genes were made to fuse with plasmids of *Escherichia coli* and later allowed to form insulin chains.

24 Production of a human protein in bacteria by genetic engineering is possible because
[CBSE AIPMT 2005]

- (a) bacterial cell can carry out the RNA splicing reactions
(b) the human chromosome can replicate in bacterial cell
(c) the mechanism of gene regulation is identical in humans and bacteria
(d) the genetic code is universal

Ans. (d)

Production of human protein in bacteria by genetic engineering is possible because the genetic code is universal as a codon codes for the same amino acid in all the organisms.

25 The genetic defect-Adenosine Deaminase (ADA) deficiency may be cured permanently by
[CBSE AIPMT 2009]

- (a) periodic infusion of genetically engineered lymphocytes having functional ADA cDNA
(b) administering adenosine deaminase activators
(c) introducing bone marrow cells producing ADA into cells at early embryonic stages
(d) enzyme replacement therapy

Ans. (a)

Severe Combined Immuno Deficiency (SCID) caused by Adenosine Deaminase Deficiency (ADA) is the first genetic disorder to be treated with gene therapy. T-cell directed gene transfer was useful in the treatment of ADA-SCID, whereas the retroviral-mediated gene transfer to haematopoietic stem cells was insufficient for achievement of clinical benefits.

26 ELISA is used to detect viruses where the key reagent is
[CBSE AIPMT 2004, 03]

- (a) alkaline phosphatase
(b) catalase
(c) DNA probe
(d) RNase

Ans. (a)

Alkaline phosphate is the key reagent used during detection of virus in ELISA test. The test work by detecting antibodies/substances or protein which are produced in blood when virus is present. The reagents are used to provide antibody-antigen complex in a specialised ELISA plate.

TOPIC 3 Transgenic Organisms and Ethical Issues

27 The laws and rules to prevent unauthorised exploitation of bioresources are termed as
[NEET (Oct.) 2020]

- (a) biopatenting
(b) bioethics
(c) bioengineering
(d) biopiracy

Ans. (b)

Bioethics are sets of laws and rules to prevent unauthorised exploitation of bioresources.

Biopiracy is the use of bioresources by multinational companies and other organisations without proper authorisation from the countries and people concerned without compensatory payment. Biopatenting is patent granted on biological products, organisms processes or bioresources.

Bioengineering is the application of the life sciences, physical sciences, mathematics and engineering principles to define and solve problems in biology, medicine, health care and other fields.

28 Exploitation of bioresources of a nation by multinational companies without authorisation from the concerned country is referred to as
[NEET (Odisha) 2019]

- (a) bioweapon (b) biopiracy
(c) bioethics (d) biowar

Ans. (b)

Exploitation of bioresources of a nation by multinational companies without authorisation from concerned country is referred to as biopiracy. For example, a patent granted in USA covers the entire basmati rice germplasm of our country.

29 Exploration of molecular, genetic and species level diversity for novel products of economic importance is known as
[NEET (Odisha) 2019]

- (a) biopiracy (b) bioenergetics
(c) bioremediation (d) bioprospecting

Ans. (d)

Exploration of molecular, genetic and species level diversity for novel products of economic importance is known as bioprospecting. Biopiracy refers to illegal use of bioresources.

Bioremediation is use of organisms to clean up contamination during waste treatment. Bioenergetics deals with energy metabolism in living organisms.

30 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
[NEET 2018]

- (a) Lerma Rojo
(b) Sharbati Sonora
(c) Co-667
(d) Basmati

Ans. (d)

In 1997, an American company got patent rights on Basmati rice through the US Patent and Trademark office. This 'new' variety of Basmati had actually been derived from Indian farmer's varieties. This 'new' variety was produced by crossing Indian Basmati with semi-dwarf varieties.

Lerma Rojo and Sharbati Sonora are high yielding varieties of wheat. Co-667 is a variety of soyabean.

31 Use of bioresources by multinational companies and organisations without authorisation

from the concerned country and its people is called [NEET 2018]

- (a) biodegradation
- (b) biopiracy
- (c) bio-infringement
- (d) bioexploitation

Ans. (b)

Biopiracy is referred to the use of bioresources by multinational companies and other organisations without proper authorisation from the countries and people concerned without compensatory payment. Bio-infringement is the commission of a prohibited act with respect to a patented invention without permission from the patent holder. Bio-exploitation means taking advantage of biological resources of other country without permission. Biodegradation is biological breakdown of organic material by bacteria, fungi, etc.

32 Maximum number of existing transgenic animals is of [CBSE AIPMT 2011]

- (a) fish
- (b) mice
- (c) cow
- (d) pig

Ans. (b)

Over 95% of all existing transgenic animals are mice. Animals that have their DNA manipulated to possess and express an extra (foreign) gene are known as transgenic animals, e.g. rats, rabbits, pig, sheep, cows, fish, etc.

33 Genetic engineering has been successfully used for producing [CBSE AIPMT 2010]

- (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

Ans. (a)

Genetic engineering has been successfully used for producing transgenic mice which are being developed for use in testing the safety of vaccines before they are used on humans. Transgenic mice are being used for testing toxicity of drugs. Transgenic animals are made to carry genes, which make them more sensitive to toxic substances than non-transgenic animals.

They are then exposed to the toxic substances and the effects studied.

Toxicity testing in such animals will allow us to obtain results in less time.

34 An improved variety of transgenic basmati rice [CBSE AIPMT 2010]

- (a) does not require chemical fertilisers 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

Ans. (b)

Golden rice (transgenic basmati rice) is a variety of *Oryza sativa* produced through genetic engineering to biosynthesise beta-carotene, a precursor of provitamin-A in the edible parts of rice. The research that led to golden rice was conducted with the goal of helping children who suffer from vitamin-A deficiency in poor countries. Golden rice has been bred to be especially disease-resistant, resulting in better crop yields.

35 Transgenic plants are the ones [CBSE AIPMT 2009]

- (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 hybridisation in the field
- (d) produced by a somatic embryo in artificial medium

Ans. (a)

The plants obtained through genetic engineering contain a gene or genes usually from an unrelated organism, such genes are called transgenes and the plants containing transgenes are known as transgenic plants. These plants are often called as genetically modified or GM crops, e.g. *Flavr savr* tomatoes, golden rice. Plants are made transgenic for identification, expressing the gene activity in time, to produce several chemicals like fatty acids, sugars, cellulose, rubber, etc.

36 In transgenics, expression of transgene in target tissue is determined by [CBSE AIPMT 2004]

- (a) enhancer
- (b) transgene
- (c) promoter
- (d) reporter

Ans. (d)

In transgenics, expression of transgene in target tissue is determined by reporter.

Reporter genes or screenable genes are a number of marker genes which are commonly used in plant transformation, e.g. cat, lux, npt II, gus, etc.

37 The Ti plasmid, is often used for making transgenic plants. This plasmid is found in [CBSE AIPMT 2004]

- (a) *Azotobacter*
- (b) *Rhizobium* of the roots of leguminous plants
- (c) *Agrobacterium*
- (d) Yeast as a 2 µm plasmid

Ans. (c)

A segment (T-DNA) of tumour-inducing plasmid (T₁) can be transformed from the bacterium *Agrobacterium* to plant cells at a wound site. This Ti-plasmid is often for developing transgenic plants.

38 Producing a giant mouse in the laboratory was possible through [CBSE AIPMT 2000]

- (a) gene mutation
- (b) gene manipulation
- (c) gene synthesis
- (d) gene duplication

Ans. (b)

Transgenic mice (of much larger size than the normal) have been produced in the laboratory by gene manipulation (transfer of genes to fertilised eggs as well as to stem cells).

39 The first successfully cloned mammals (animal) that gained worldwide publicity was [CBSE AIPMT 2000]

- (a) Molly (a sheep)
- (b) Polly (a sheep)
- (c) Chance (a bull)
- (d) Dolly (a sheep)

Ans. (d)

Dolly (a sheep) was the first successfully cloned mammal that gained worldwide publicity.

40 The transgenic animals are those which have [CBSE AIPMT 1995]

- (a) foreign DNA in some of its cells
- (b) foreign DNA in all its cells
- (c) foreign RNA in all its cells
- (d) DNA and RNA both in the cells

Ans. (b)

Transgenic animals have foreign DNA in all its cells. The animals which carry foreign genes are called transgenic animals. The foreign genes are inserted into the genome of animals using recombinant DNA technology or gene manipulation.