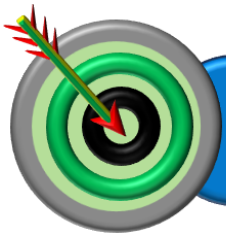
Chapter
10

Biotechnology & Its Applications



OBJECTIVES

- INTRODUCTION
- BIOTECHNOLOGICAL APPLICATIONS IN AGRICULTURE
- BIOTECHNOLOGICAL APPLICATIONS IN MEDICINE
- TRANSGENIC ANIMALS
- ETHICAL ISSUES

INTRODUCTION

- **Biotechnology essentially deals with industrial scale production of biopharmaceuticals and biologicals using genetically modified microbes, fungi, plants and animals.**
- **The applications of biotechnology include therapeutics, diagnostics, genetically modified crops for agriculture, processed food, bioremediation, waste treatment and energy production.**
- **Three critical research areas of biotechnology are:**
  i. Providing the best catalyst in the form of 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.

10.1 BIOTECHNOLOGICAL APPLICATIONS IN AGRICULTURE

There are three options to increase the food production:
(i) Agrochemical based agriculture;
(ii) Organic agriculture and;
(iii) Genetically engineered crop - based agriculture.

- The Green Revolution significantly increased food production, yet it was not enough to sustain the rapidly growing human population. Advancements in genetics can help enhance crop yields to meet this demand. It is essential to minimize the use of fertilizers and chemicals to reduce their harmful impact on the environment. One potential solution is the use of genetically modified crops. Through genetic manipulation, the genes of plants, bacteria, fungi, and animals have been altered, resulting in Genetically Modified Organisms (GMOs). The characteristics of a GMO depend on the nature of the transferred genes, as well as the traits of the host plant, bacterium, or animal.
- As traditional breeding techniques failed to keep pace with demand and to provide sufficiently fast and efficient systems for crop improvement, another technology called tissue culture got developed. What does tissue culture mean? It was learnt by scientists, during 1950s, that whole plants could be regenerated from explants, i.e., any part of a plant taken out and grown in a test tube, under sterile conditions in special nutrient media. This capacity to generate a whole plant from any cell/explant is called totipotency. You will learn how to accomplish this in higher classes. It is important to stress here that the nutrient medium must provide a carbon source such as sucrose and also inorganic salts, vitamins, amino acids and growth regulators like auxins, cytokinins etc. By application of these methods it is possible to achieve propagation of a large number of plants in very short durations. This method of producing thousands of plants through tissue culture is called micro-propagation. Each of these plants will be genetically identical to the original plant from which they were grown, i.e., they are somaclones. Many important food plants like tomato, banana, apple, etc., have been produced on commercial scale using this method. Try to visit a tissue culture laboratory with your teacher to better understand and appreciate the process.
- Another important application of the method is the recovery of healthy plants from diseased plants. Even if the plant is infected with a virus, the meristem (apical and axillary) is free of virus. Hence, one can remove the meristem and grow it in vitro to obtain virus-free plants. Scientists have succeeded in culturing meristems of banana, sugarcane, potato, etc.

Genetically modified crops

Genetically modified crop plants contain and express one or more beneficial foreign genes. The genes introduced into an organism's genome are known as transgenes, and plants that produce the desired traits from these transgenes are called transgenic plants.

- **Production of transgenic plants**
  The most commonly used vector for introducing new genes into plant cells is the Ti plasmid, derived from the soil bacterium Agrobacterium tumefaciens. This bacterium is often referred to as a "natural genetic engineer" because the genes carried by its plasmid can influence various parts of the plant.
- **Ti plasmid (Tumour inducing plasmid),** is so called because in nature, it induces tumor formation in broad Leafy plants such as tomato, tobacco, and soybean can be genetically modified using the Ti plasmid as a vector. To facilitate this, researchers have removed its tumor-causing properties while retaining its ability to transfer DNA into plant cells. The segment of the Ti plasmid that integrates into the plant's DNA is known as T-DNA.
- The T-DNA, with the desired DNA inserted into it, integrates into the chromosomes of the host plant, where it replicates by randomly moving between different chromosomal positions. These modified plant cells are then cultured, stimulated to multiply, and induced to differentiate into plantlets. Once transferred to the soil, the plantlets grow into mature plants that carry and express the foreign gene throughout their structure.
- **Transgenic Plants**
  Some examples of transgenic plants are as follows:
- **Insect resistant plants**
  The soil bacterium *Bacillus thuringiensis* produces proteins that are lethal to certain insects, including lepidopterans (such as tobacco budworm and armyworm), coleopterans (beetles), and dipterans (flies and mosquitoes). B. thuringiensis forms protein crystals that contain an insecticidal toxin. However, this toxin does not harm the bacterium itself because it remains in an inactive form known as a protoxin. When an insect ingests the protoxin, the alkaline pH of its digestive system converts it into an active toxin. The activated toxin binds to the midgut epithelial cells, creating pores that lead to cell swelling, lysis, and ultimately, the insect's death.
  Through genetic engineering, Bt toxin genes have been isolated from *Bacillus thuringiensis* and integrated into various crops, including Bt cotton, Bt rice, Bt corn, tomato, pomato, and soybean. The selection of genes depends on the crop and the target pest, as most Bt toxins are specific to certain insect groups.
  The toxin is encoded by a gene called cry. In cotton, two cry genes—cryIAc and cryIIAb—have been incorporated to protect against cotton bollworms, resulting in the genetically modified crop known as Bt cotton. Similarly, the cryIAb gene has been introduced into Bt corn to safeguard it against corn borer infestations.

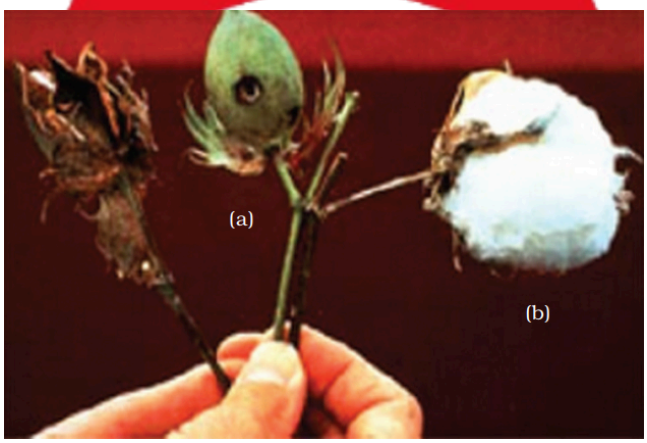


Fig. : Cotton boll: (a) destroyed by bollworms;
(b) a fully mature cotton boll

- **Pest resistant plants**

Many nematodes act as parasites in plants, animals, and even humans. One such nematode, Meloidogyne incognita, infects the roots of tobacco plants, significantly reducing their yield. To combat this infection, a novel approach was developed based on the mechanism of RNA interference (RNAi).

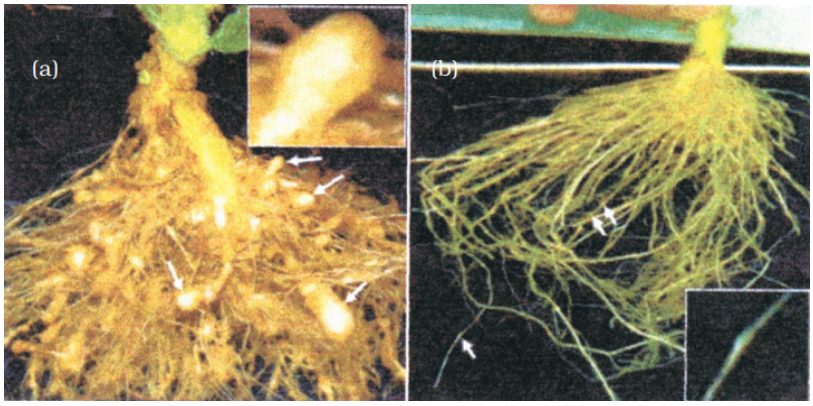


Fig.: Host plant-generated dsRNA triggers protection against nematode infestation: (a) Roots of a typical control plants; (b) transgenic plant roots 5 days after deliberate infection of nematode but protected through novel mechanism.

- **RNA interference (RNAi)** is a process that inhibits gene activity by producing RNA molecules that are complementary to messenger RNA (mRNA). Using Agrobacterium vectors, nematode-specific anti-sense genes are introduced into the host plant. This leads to the production of anti-sense RNA within the plant cells, which then pairs with the corresponding mRNA to form double-stranded RNA (dsRNA).
  Since these dsRNA molecules cannot be translated, the nematode infestation is effectively prevented in transgenic plants. The complementary anti-sense RNA blocks the translation of nematode mRNA, thereby silencing its gene expression. As a result, the transgenic plants gain protection against the parasite. RNAi serves as a natural defense mechanism in all eukaryotic organisms.

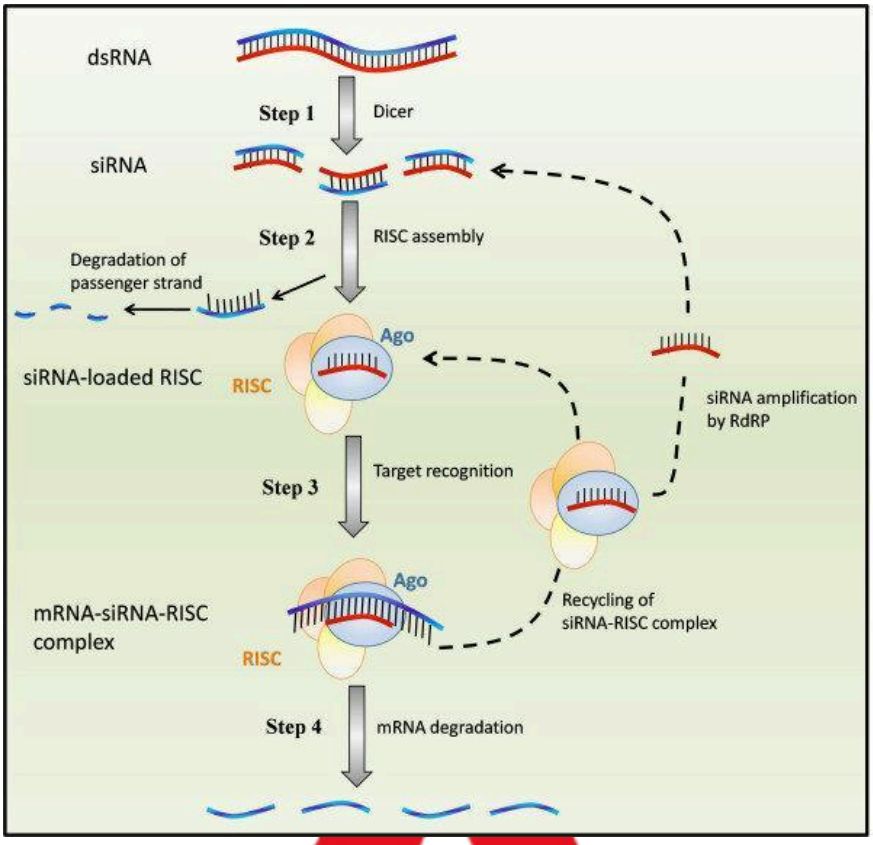


Fig.: Process of RNA Interference

In fact, recent evidence indicates that these RNA duplexes are often rapidly degraded in vivo. The source of this complementary RNA could be from an infection by viruses having RNA genomes or mobile genetic elements (transposons) that replicate via an RNA intermediate.

- **Nutritionally enhanced crops**

  Certain crops are genetically modified to enhance the nutritional value of the food they produce e.g., vitamin A enriched rice.

Clue Finder

It is a transgenic variety of rice (Oryza sativa) which contains good quantities of ß-carotene (provitamin A-inactive state of vitamin A). Since the grains (seeds) of the rice are yellow in colour due to ß-carotene, the rice is commonly called golden rice.

Critical Thinking

Reduction of post-harvest losses

Post harvest and over ripening losses have been reduced by introducing genes which prevent deterioration of harvested products.

The tomato variety 'Flavr Savr' present an example where expression of a native tomato gene has been blocked.

The gene codes for the enzyme polygalacturonase. This enzyme promotes fruit softening by degrading pectin. Fruits of this tomato variety remain fresh and retain their flavour for much longer than do the fruits of normal tomato varieties.

- **Applications of GM plants:** Due to genetic modification, GM plants have been useful in many ways.
  - **(i)** **Pest resistance crops:** Growing GM crops can help to reduce the use of chemical pesticides.
  - **(ii)** **Tolerance:** GM crops are more tolerant to abiotic stresses (cold, drought, salt, heat, etc.).
  - **(iii)** **Reduction in post - harvest losses:** They have helped to reduce post-harvest losses.
  - **(iv)** **Prevention of early exhaustion of fertility of soil:** Increased efficiency of mineral usage by plants prevents early exhaustion of fertility of soil.
  - **(v)** **Increasing nutritional value of food:** GM plants enhance nutritional value of food. e.g., vitamin A enriched rice.
  - **(vi)** **Herbicide resistance:** Herbicides (weed killers) do not harm the GM crops.
  - **(vii)** **Disease resistance:** There are many viruses, fungi and bacteria that cause plant diseases. Plant biologist are working to create plants with genetically engineered resistance to these diseases.
  - **(viii)** **Alternative resources to industries:** GM plants have been used to create alternative resources to industries in the form of starches, fuels and pharmaceuticals. Researchers are working to develop edible vaccines in tomatoes and potatoes.
  - **(ix)** **Phytoremediation:** Plants such as poplar trees have been genetically engineered to clean up heavy metal pollution from contaminated soil.
  - **(x)** Increased efficiency of mineral usage by plants (this prevents early exhaustion of fertility of soil).

TOPIC CENTRIC EXERCISE 01

Q1. **In Bt cotton, Bt stands for**

(a) Bacillus anthracis (b) Bacillus coagulans

(c) *Bacillus thuringiensis* (d) Bacillus subtilis.

Q2. **Which is a transgenic plant with vitamin A enrichment?**

(a) Soybean (b) Corn

(c) Golden rice (d) Cucumber

Q3. **Bt cotton is not**

(a) a GM plant (b) insect-resistant crop

(c) a bacterial gene expressing system (d) resistant to all pesticides.

Q4. **RNA interference (RNAi) is a process that inhibits gene activity by producing RNA molecules that are complementary to**

(a) mRNA (b) rRNA

(c) tRNA (d) DNA

Q5. **The process of RNA interference uses**

(a) dsRNA (b) ssRNA

(c) ssDNA (d) dsDNA.

10.2 BIOTECHNOLOGICAL APPLICATIONS IN MEDICINE

- Recombinant DNA technology has had a profound impact on healthcare by enabling the large-scale production of safe and more effective therapeutic drugs. Unlike similar products derived from non-human sources, recombinant therapeutics minimize the risk of unwanted immune responses.
- **Currently, around 30 recombinant therapeutic products have been approved for human use worldwide, with 12 of them being marketed in India.**

10.2.1 Genetically Engineered Insulin

- Management of adult-onset diabetes is possible by taking insulin at regular time intervals. If enough human insulin is not available, a diabetic patient would need to use insulin from other animals.
- However, insulin from animals may not be as effective as human insulin and could trigger an immune response in the body. The process becomes much simpler if bacteria can be used to produce human insulin. Large quantities of these bacteria can be grown, allowing for the production of as much insulin as needed.
- Insulin used for diabetes was earlier extracted from pancreas of slaughtered cattle and pigs. Insulin from an animal source, though caused some patients to develop allergy or other types of reactions to the foreign protein.
- Insulin consists of two short polypeptide chains: chain A and chain B, that are linked together by disulphide bridges.
- In mammals, including humans, insulin is synthesized as a pro-hormone (like a pro-enzyme, the pro-hormone also needs to be processed before it becomes a fully mature and functional hormone) which contains an extra stretch called the C peptide. This C peptide is not present in the mature insulin and is removed during maturation into insulin.
- The main challenge for production of insulin using rDNA techniques was getting insulin assembled into a mature form. In 1983, Eli Lilly an American company prepared two DNA sequences corresponding to A and B, chains of human insulin and introduced them in plasmids of E. coli to produce insulin chains. Chains A and B were produced separately, extracted and combined by creating disulfide bonds to form human insulin.

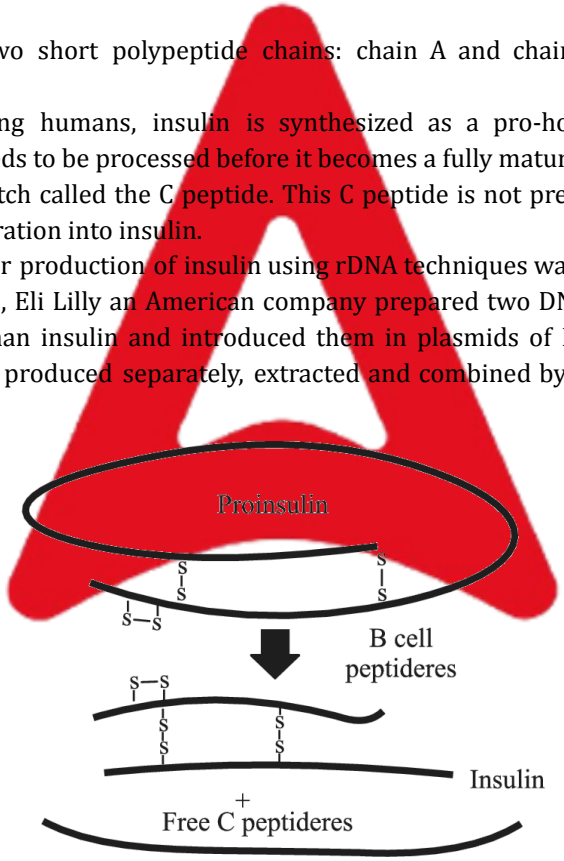


Fig. : Maturation of pro-insulin into insulin (simplified)

Clue Finder

- It is a protein-based hormone composed of 51 amino acids, organized into two polypeptide chains: A (21 amino acids) and B (30 amino acids), connected by disulfide (S-S) bonds.
- In 1916, Sir Edward Albert Sharpey Schafer was the first to observe that diabetes in some individuals resulted from the inability of certain pancreatic islets to produce a substance, which he named insulin (derived from the Latin word insula, meaning "island").

10.2.2 Gene Therapy :

- A new system of medicine gene therapy, may be used to treat some hereditary diseases such as SCID, haemophilia etc.
- 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 crucial for the immune system to function. The disorder is caused due to the deletion of the gene for adenosine deaminase.
- In some children ADA deficiency can be cured by bone marrow transplantation; in others it can be treated by enzyme replacement therapy, in which functional ADA is given to the patient by injection. But the problem with both of these approaches is that they are not completely curative.
- As a first step towards gene therapy, lymphocytes from the blood of the patient are grown in a culture outside the body.
- A functional ADA cDNA (using a retroviral vector) is then introduced into these lymphocytes, which are subsequently returned to the patient.
- However, as these cells are not immortal, the patient requires periodic infusion of such genetically engineered lymphocytes.
- **However, if the gene isolated from marrow cells producing ADA is introduced into cells at early embryonic stages, it could be a permanent cure.**

10.2.3 Medical Diagnosis of Disease (Molecular Diagnosis)

- You know that for effective treatment of a disease, early diagnosis and understanding its pathophysiology is very important. Using conventional methods of diagnosis (serum and urine analysis, etc.) early detection is not possible.
- Recombinant DNA technology, Polymerase Chain Reaction (PCR) and Enzyme Linked Immuno-sorbent Assay (ELISA) are some of the techniques that serve the purpose of early diagnosis.

(i) PCR

- Presence of a pathogen (bacteria, viruses, etc.) is normally suspected only when the pathogen has produced a disease symptom. By this time the concentration of pathogen is already very high in the body. However, very low concentration of a bacteria or virus (at a time when the symptoms of the disease are not yet visible) can be detected by amplification of their nucleic acid by PCR.
- PCR is now routinely used to detect HIV in suspected AIDS patients. It is being used to detect mutations in genes in suspected cancer patients too.
- It is a powerful techqnique to identify many other genetic disorders.

(ii) Hybridisation using probe

- 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.
- The clone having the mutated gene will hence not appear on the photographic film, because the probe will not have complementarity with the mutated gene.

(iii) ELISA

- ELISA is based on the principle of antigen-antibody interaction.
- Infection by pathogen can be detected by the presence of antigens (proteins, glycoproteins, etc.) or by detecting the antibodies synthesised against the pathogen.

Clue Finder

PCR (Polymerase Chain Reaction) is used in the diagnosis and monitoring of AIDS (Acquired Immunodeficiency Syndrome) caused by the HIV (Human Immunodeficiency Virus). It helps in detecting the virus by amplifying its genetic material, even in very small amounts. PCR is especially useful for:
Early Detection: It can detect HIV soon after infection, even before antibodies develop.

TOPIC CENTRIC EXERCISE 02

Q1. Genetically engineered bacteria are being employed for production of which human hormone?
(a) Human insulin (b) Thyroxine
(c) Cortisol (d) Epinephrine

Q2. First gene therapy was given in year
(a) 1990 (b) 1985
(c) 1999 (d) 1981.

Q3. Which one of the following techniques is used in ELISA diagnosis?
(a) Southern blotting (b) RNA interference
(c) PCR (d) Both (a) and (b)

Q4. ELISA technique helps in the detection of infection caused by pathogen by the presence of
(a) antigen (b) DNA
(c) RNA (d) None of these.

Q5. Human insulin is being commercially produced from a transgenic species of
(a) Rhizobium (b) Saccharomyces
(c) Escherichia (d) Mycobacterium.

10.3 TRANSGENIC ANIMALS

Animals that have had their DNA manipulated to possess and express an extra (foreign) gene are known as **transgenic animals.**

Transgenic rats, rabbits, pigs, sheep, cows and fish have been produced, although over **95 percent** of all existing transgenic animals are **mice.**

Critical Thinking

Dolly the Sheep (1996) – The First Cloned Mammal from an Adult Cell

Dolly was the first mammal successfully cloned from an adult somatic cell using Somatic Cell Nuclear Transfer (SCNT).

Molly and Polly – The First Cloned Transgenic Mammals (1997)

Molly and Polly were the first transgenic cloned sheep, meaning they were genetically modified before being cloned. Scientists introduced a human gene into their DNA, enabling them to produce Factor IX in their milk.

Advantages of Transgenic animals

(i) **Normal physiology and development:** Transgenic animals can be specifically designed to allow the study of how genes are regulated and how they affect the normal functions of the body and its development, e.g., study of complex factors involved in growth such as insulin-like growth factor. By introducing genes from other species that alter the formation of this factor and studying the biological effects that result, information is obtained about the biological role of the factor in the body.

(ii) **Study of disease:** Many transgenic animals are designed to increase our understanding of how genes contribute to the development of disease. 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.

(iii) **Biological products:** Medicines required to treat certain human diseases can contain biological products, but such products are often expensive to make. Transgenic animals that produce useful biological products can be created by the introduction of the portion of DNA (or genes) which codes for a particular product such as human protein (α-1-antitrypsin) used to treat emphysema.
Similar attempts are being made for treatment of phenylketonuria (PKU) and cystic fibrosis.
In 1997, the first transgenic cow, Rosie, produced human protein-enriched milk (2.4 grams per litre).
The milk contained the human alpha-lactalbumin and was nutritionally a more balanced product for human babies than natural cow-milk.

(iv) **Vaccine safety:** 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. If successful and found to be reliable, they could replace the use of monkeys to test the safety of batches of the vaccine.

(v) **Chemical safety testing:** This is known as toxicity/ safety testing. The procedure is the same as that used for testing toxicity of drugs.
Transgenic animals are made that 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.

TOPIC CENTRIC EXERCISE 03

Q1. **Over 95% of all existing transgenic animals are**
(a) fish (b) mice
(c) cow (d) pig.

Q2. **Which of the following gene is used to treat emphysema?**
(a) β-lactase (b) α-lactalbumin
(c) permease (d) α-1-antitrypsin

Q3. **Which of the following transgenic animals are used in testing safety of polio vaccine before they are used on human?**

(a) Transgenic cow (b) Transgenic monkey
(c) Transgenic mice (d) Transgenic sheep

Q4. The milk produced by Rosie, a transgenic cow, is known to be rich in which of the following?
(a) Sugar (b) Protein
(c) Fat (d) Vitamin

10.4 ETHICAL ISSUES

- The manipulation of living organisms by the human race cannot go on any further, without regulation. Some ethical standards are required to evaluate the morality of all human activities that might help or harm living organisms.
- Going beyond the morality of such issues, the biological significance of such things is also important. Genetic modification of organisms can have unpredicatable results when such organisms are introduced into the ecosystem.
- Therefore, the Indian Government has set up organisations such as GEAC (Genetic Engineering Approval Committee), which will make decisions regarding the validity of GM research and the safety of introducing GM-organisms for public services.
- The modification/usage of living organisms for public services (as food and medicine sources, for example) has also created problems with patents granted for the same.
- There is growing public anger that certain companies are being granted patents for products and technologies that make use of the genetic materials, plants and other biological resources that have long been identified, developed and used by farmers and indigenous people of a specific region/country

BIO-PATENT

- A patent is a right granted by a government to an inventor to prevent others from commercial use of his invention. A patent is granted for –
  (a) An invention [including product]
  (b) An improvement in an earlier invention
  (c) The process of generating products and
  (d) A concept or design.
- There is growing public anger that certain companies are being granted patents for products and technologies that make use of the genetic materials, plants and other biological resources that have long been identified, developed and used by farmers and indigenous people of a specific region/country.
- Rice is an important food grain, the presence of which goes back thousands of years in Asia's agricultural history. There are an estimated 200,000 varieties of rice in India alone. The diversity of rice in India is one of the richest in the world. Basmati rice is distinct for its unique aroma and flavour and 27 documented varieties of Basmati are grown in India. There is reference to Basmati in ancient texts, folklore and poetry, as it has been grown for centuries.
- In 1997, an American 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 farmer's varieties. Indian Basmati was crossed with semi-dwarf varieties and claimed as an invention or a novelty. The patent extends to functional equivalents, implying that other people selling Basmati rice could be restricted by the patent.
- Several attempts have also been made to patent uses, products and processes based on Indian traditional herbal medicines, e.g., turmeric, neem. If we are not vigilant and we do not immediately counter these patent applications, other countries/individuals may encash on our rich legacy and we may not be able to do anything about it.

BIO-PIRACY

- Bio-piracy is the term used to refer to the use of bio-resources by multinational companies and other organisations without proper authorisation from the countries and people concerned without compensatory payment.
- Most of the industrialised nations are rich financially but poor in biodiversity and traditional knowledge. In contrast the developing and the underdeveloped world is rich in biodiversity and traditional knowledge related to bio-resources. Traditional knowledge related to bio-resources can be exploited to develop modern applications and can also be used to save time, effort and expenditure during their commercialisation.
- There has been growing realisation of the injustice, inadequate compensation and benefit sharing between developed and developing countries. Therefore, some nations are developing laws to prevent such unauthorised exploitation of their bio-resources and traditional knowledge.
- The Indian Parliament has recently cleared the second amendment of the Indian Patents Bill, that takes such issues into consideration, including patent terms emergency provisions and research and development initiative.

TOPIC CENTRIC EXERCISE 04

Q1. **Biopiracy is**
(a) illegitimate use of bio resources
(b) traditional knowledge related to bioresources
(c) related to biomolecules and genes discovered
(d) all of these.

Q2. **How many documented varieties of Basmati rice are grown in India?**
(a) 50 (b) 84
(c) 42 (d) 27

Q3. **Which of the following has estimated 200,000 varieties in India alone?**
(a) Triticum (b) Oryza
(c) Pisum sativum (d) Brassica

Q4. **The Indian parliament has recently cleared the 2nd amendment of the Indian Patents Bill that considers issues such as**
(a) emergency provisions (b) research
(c) development initiative (d) all of these.

Solved Examples

Ex: 1- **In following table, the bacterial gene and related target insects are given. Select the correct match.**

Gene	Target insect
A. cry I Ac	Cotton bollworm
B. cry II Ab	Corn borer
C. cry I Ab	Cotton bollworm

(a) A only (b) A and C only
(c) B and C only (d) A, B and C

Sol. **(a):** Gene cry IAc and cry II Ab target cotton bollworm insect while cry | Ab targets corn borer insect.

Ex: 2- **The detection of HIV in suspected AIDS patient is nowadays done by**
(a) PCR (b) serum analysis
(c) DNA recombinant technology (d) urine culture.

Sol. **(a):** Using PCR, the presence of HIV in suspected AIDS patient is detected. It is also used to detect mutations in gene in cancer patients.

Ex: 3- **Silencing of mRNA has been used in producing transgenic plants resistant to**
(a) bollworms (b) nematodes
(c) white rusts (d) bacterial blights.

Sol. **(b):** RNA silencing technique was used to produce nematode resistant transgenic tobacco. The introduced gene produces sense and antisense RNA which bind with mRNA and translation is blocked, thus nematode is killed.

Ex: 4- The group of crops where A. tumefaciens can be used to produce GM variety is

(a) tomato, sunflower (b) cotton, maize
(c) wheat, potato (d) soyabean, paddy.

Sol. **(a):** A. tumefaciens infects only dicot plants hence genetically modified varieties of dicot plants like tomato and sunflower can be developed.

Ex: 5- The principle of ELISA test for diagnosis of disease is

(a) presence of antigen in the patient
(b) detection of antibody against antigen
(c) antigen and antibody interaction
(d) none of these.

Sol. **(c):** ELISA is based on antigen-antibody interaction. Even if pathogen is présent in very small quantity, the body

Ex: 6- The transgenic models exist for diseases such as

(a) cystic fibrosis (b) cancer
(c) Alzheimer's (d) all of these.

Sol. **(d):** Today transgenic models exist for many human diseases such as cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's.

Ex: 7- The illegal and unlawful development of biomaterials without payment to the inhabitants of their origin is called

(a) biopatent (b) biotechnology
(c) biowar (d) biopiracy.

Sol. **(d):** Bio-piracy is the term used to refer to the use of bio-resources by multinational companies and other organisations without proper authorisation from the countries and people concerned without compensatory payment.

Ex: 8- Animals that have had their DNA manipulated to possess and express a foreign gene are called

(a) transgenic animals (b) somatic hybrids
(c) somaclones (d) super animals.

Sol. **(a):** The animals which carry foreign genes are called transgenic animals. The foreign genes inserted into the genome of the animal using recombinant DNA technology are called transgenes.

Ex: 9- The Indian parliament has recently cleared which amendment of the Indian patents bill?

(a) 1st (b) 2nd
(c) 3rd (d) 4th

Sol. **(b):** The Indian parliament has recently cleared the 2nd amendment of Indian patents bill.

Ex: 10- Bt in popular crop Bt cotton stands for

(a) biotechnology (b) Bacillus tomentosa
(c) Bacillus thuringiensis (d) best type.

Sol. **(c):** BT stands for *Bacillus thuringiensis.*

Exercise-01 Level -01

1. Which one of the following can be produced by genetically modified E.coli?
   (a) Moulting hormone
   (b) Follicle stimulating hormone
   (c) Insulin
   (d) Antibiotics

2. 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.
3. The therapy used to cure ADA patient was
   (a) E.coli plasmid
   (b) enzyme replacement
   (c) insulin replacement
   (d) both (a) and (b).
4. Which of the following Bt crops is not being grown in India by the farmers?
   (a) Mango (b) Soybean
   (c) Maize (d) Cotton
5. In a diabetic patient, insulin is administered which is derived from the other animal source. The probable effect is
   (a) insulin from other animal may not be as effective as human insulin
   (b) insulin from other animal being a foreign protein may cause allergy
   (c) foreign insulin may generate autoimmune response
   (d) all of these.
6. Consumption of which one of the following foods can prevent the blindness associated with vitamin 'A' deficiency?
   (a) 'Flavr Savr' tomato
   (b) Canolla
   (c) Golden rice
   (d) Bt-Brinjal
7. Insulin is synthesised as a
   (a) a form of chitin
   (b) a new digestive enzyme
   (c) a powerful antibiotic
   (d) pro-hormone.
8. 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.
9. For effective treatment of a disease,
   (a) early diagnosis is required but understanding its pathophysiology is not required
   (b) early diagnosis is not required but understanding its pathophysiology is required
   (c) neither early diagnosis nor understanding of its pathophysiology is required
   (d) both early diagnosis and understanding of its pathophysiology are required.
10. The genetically-modified (GM) corn in India has been developed for
   (a) insect-resistance
   (b) enhancing shelf life
   (c) enhancing mineral content
   (d) drought-resistance.
11. Which technology was used to produce human insulin from E.coli?
   (a) Gene therapy
   (b) Recombinant DNA
   (c) Polymerase chain reaction
   (d) All of these
12. The main objective of producing pest resistant transgenic plant is to
   (a) encourage ecofriendly pesticides
   (b) eliminate pest from the fields with the use of pesticides
   (c) protect itself from the parasite
   (d) none of these.
13. What were the earlier sources of insulin?
   (a) Cattle and pig
   (b) Camel and pig
   (c) Cattle and dog
   (d) Goat and pig
14. Biotechnology essentially deals with the industrial scale production of
   (a) biopharmaceuticals
   (b) biologicals
   (c) restriction enzymes
   (d) both (a) and (b).
15. C-peptide of human insulin is
   (a) a part of mature insulin molecule
   (b) responsible for formation of disulphide bridges
   (c) removed during maturation into insulin
   (d) responsible for its biological activity.
16. Bt toxin is produced by
   (a) Bacillus subtilis
   (b) Pseudomonas putida
   (c) *Bacillus thuringiensis*
   (d) none of these.
17. In some children, ADA deficiency can be cured by
   (a) bone marrow transplantation
   (b) enzyme replacement therapy

(c) enzyme activation therapy
(d) both (a) and (b).

18. Which one of the followings is commonly used in the transfer of foreign DNA into dicot plants?
(a) Meloidogyne incognita
(b) Agrobacterium tumefaciens
(c) Penicillium expansum
(d) Trichoderma harizanum

19. Gene therapy can be initiated prior to birth too. What might be an advantage of beginning gene therapy prior to birth?
(a) It might impaired the development of embryo.
(b) It can be permanently cured.
(c) It makes the children immunocompromised.
(d) His/her body would reject the antigen.

20. Which one of the following is/are the application of biotechnology?
(a) Bioremediation, waste treatment and energy production.
(b) Nitrogen fixation, food processing and GM crops.
(c) Nuclear power production bioremediation
(d) Waste treatment and nitrogen fixation.

21. Why recombinant therapeutics drugs are considered as effective solution in health care?
(a) They are not able to induce unwanted immunological responses.
(b) They might decrease the immunological responses.
(c) They can alter the genome of the humans.
(d) None of these

22. Which part of the tobacco plant is infected by Meloidogyne incognita?
(a) Stem (b) Root
(c) Flower (d) Leaf

23. Transgenic plants are
(a) generated by introducing foreign DNA into a cell and regenerating a plant from that cell
(b) produced after protopalst fusion in artificial medium
(c) grown in artificial medium after hybridisation in the field
(d) produced by a somatic embryo in artificial medium.

24. Which of the following companies started selling human insuli in the year 1983?
(a) Eli Lilly (b) Genetech
(c) GEAC (d) None of these

25. Which gene controls the corn borers?
(a) cry l Ac (b) cry ll Ab
(c) cry 1 Ab (d) Both (b) and (c)

26. Gene therapy first used in the treatment of
(a) AIDS (b) PKU
(c) ADA deficiency (d) albinism.

27. infects the roots of tobacco plants reducing the production of tobacco.
(a) Nematode (Meloidogyne incognita)
(b) Coleopterans (beetles)
(c) Lepidopterans (armyworm)
(d) Dipterans (mosquitoes)

28. From which of the following techniques early detection of disease is not possible?
(a) Serum analysis
(b) PCR
(c) ELISA
(d) Recombinant DNA technology

29. Cultivation of Bt cotton has been much in news. The prefix "Bt" means
(a) "Barium-treated" cotton seeds
(b) "Bigger thread" variety of cotton with batter tensile strength
(c) Produced by "biotechnology" using restriction enzymes and ligases
(d) Carrying a Bt toxin gene from *Bacillus thuringiensis*.

30. Permanent cure for ADA (Adenosine Deaminase deficiency) is
(a) blood transfusion
(b) enzyme replacement therapy
(c) introduction of gene producing ADA in early embryo
(d) bone marrow transplantation.

31. 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.

32. In 1983 Which human hormone was produced by recombinant DNA technology is
(a) insulin (b) estrogen
(c) thyroxin (d) progesterone.

33. 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 and a GMO crop.
(c) It is pest resistant, with a gene from *Bacillus thuringiensis*.
(d) It is drought tolerant, developed using Agrobacterium vector.

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

35. Which one of the following is a correct statement?
(a) "Bt" in "Bt-cotton" indicates that it is a genetically modified organism produced through biotechnology.
(b) Classical plant breeding involves fusion of two somatic cells carrying desired genes.
(c) A nematode Meloidogyne incognita infects the root of tobacco plants and causes a great reduction in yield.
(d) Golden rice is a transgenic variety of rice rich in vitamin E.

36. What we will do when we study the normal physiology and development through DNA manipulation?
(a) Study of complex factors involved in growth
(b) Study the effect of altered gene
(c) Study the biological effect
(d) All of these.

37. Find the correct statement among the following.
(a) flavor savor is a variety of rice.
(b) In Bt-cotton, Bt stands for biologically treated cotton.
(c) Bt toxin is produced by *Bacillus thuringiensis*.
(d) Golden rice is GM crop rich in vitamin C.

38. Transgenic animal are useful in
(a) biomedical researches
(b) chemical safety tasting
(c) animal husbandry
(d) all of these

39. 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 antitoxin.
(d) The inactive protoxin gets converted into active form in the insect gut.

40. 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.

41. Golden rice is a promising transgenic crop because it will help in
(a) producing a petrol - like fuel from rice
(b) to overcome vitamin A deficiency
(c) pest resistance
(d) herbicide tolerance.

42. Organisms which can be genetically modified used to gain commercial benefits are called
(a) beneficial resources
(b) transgenic animals
(c) financial resources
(d) all of these.

43. Main objective of production/use of insecticides resistance GM crops is to
(a) encourage eco-friendly insecticides
(b) provide resistance to insects
(c) eliminate insects from the field without the use of manual labour
(d) eliminate weeds from the field without the use of herbicides.

44. Select the incorrect match.
(a) Transgenic mice - Polio vaccine
(b) Rosie cow - α lactalbumin gene
(c) ssDNA/RNA probe - Gene therapy
(d) PCR - Molecular diagnosis

45. cry II Ab and cry I Ab produce toxins that control
(a) cotton bollworms and corn borer respectively
(b) corn borer and cotton bollworms respectively
(c) tobacco budworms and nematodes respectively
(d) nematodes and tobacco budworms respectively.

Biotechnological Applications in Medicine

46. 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

47. What could be done if we want to convert proinsulin into mature insulin with the help of RDT?
(a) C-peptide is added
(b) C-peptide is removed

(c) B-peptide is added
(d) B-peptide is removed

48. A monopoly granted to a person who has invented a new and useful article, made improvement in an existing article or invented a new process of making an article is called
(a) bioethics
(b) patent
(c) biopiracy
(d) genetic recombination.

49. Which of the following statements is not correct?
(a) In man insulin is synthesised as a pro hormone.
(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.

50. The example of biopiracy related plants in India is
(a) Sorghum (b) maize
(c) rose (d) neem.

Exercise-02 Level -02

1. Choose the correct statement w.r.t. the characteristics of Bt cotton.
(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.

2. An improved variety of transgenic golden 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.

3. Which technology is used to purify the protein or organic compound?
(a) Upstream processing
(b) Downstream processing
(c) Forward processing
(d) Reverse processing

4. Bacillus thruingiensis (Bt) strains have been used for designing novel
(a) bio-fertilisers
(b) bio-insecticidal plants
(c) bio-mineralisation process
(d) bio-metallurgical techniques.

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

6. Choose the correct set of statements regarding the critical gresearch areas of biotechnology.
(I) Provides the best catalyst in the form of improved organism usually a microbe or impure enzyme.
(II) Creates optimal conditions through engineering for a catalyst to act.
(III) Downstream processing technologies to purify the protein/organic compound.
(a) I only (b) II and III
(c) III only (d) I, II and III.

7. Which one of the following statement is correct?
(a) The proteins encoded by the genes cryl Ac and cryll Ab control cotton bollworms.
(b) Protein encoded by cryl Ab controls corn borer.
(c) Proteins encoded by cry IAc and cry IAb control dipterans
(d) Both (a) and (b)

8. Which one of the following is not a true solution for increasing food production?
(a) Pesticide based agriculture
(b) Organic agriculture
(c) Genetically engineered crop-based agriculture
(d) Agro-chemical based agriculture

9. Which of the following factor(s) is/are responsible for the increase in crop yield?-
(a) Better management practices
(b) Use of agrochemicals (fertilisers and pesticides)
(c) Improved crop varieties
(d) All of these

10. Important objective of biotechnology in agriculture section is
(a) to produce pest resistant varieties of plants
(b) to decrease the nitrogen content
(c) to decrease the seed number
(d) to increase the plant weight.

11. Consider the following statements.

I. Specific Bt toxin gene have been isolated from *Bacillus thuringiensis*
II. Bt toxin is coded by a gene named cry.
III. Bt toxin protein exists as inactive protoxins.
Which of the statements given above are correct?
(a) I, II and III (b) I and II
(c) I and III (d) II and III

12. Choose the correct set of statements w.r.t. golden rice.
1. It is a transgenic variety of rice.
II. It contains a good quality of vitamin-A.
III. It is a principal source of vitamin-B.
IV. The grains of the rice are yellow in colour so the rice is commonly called golden rice.
(a) I, II and III (b) II, III and IV
(c) I, III and IV (d) I, II and IV

13. Consider the following statements about transgenic cotton plant.
I. Transgenic cotton plants contains a gene from a bacterium, *Bacillus thuringiensis*
II. Bt toxin is an insecticidal protein which damages the inner lining of the insects midgut and kills it.
III. cry II Ab control corn borer.
Which of the statements given above are correct?
(a) I and II (b) I and III
(c) II and III (d) I, II and III

14. Genetic modification has
I. reduced reliance on chemical pesticides
II. reduced post-harvest losses
III. increased efficiency of minerals used by the plants
IV. enhanced nutritional value of the food
Which of the statements given above are correct?
(a) I, II, III and IV (b) I, II and III
(c) II, III and IV (d) III and IV

15. Biotechnology commercially deals with
(a) industrial scale production of biopharmaceutical
(b) biological use of genetically modified microbes, fungi, plants and animals
(c) transfer of a gene from parents to offspring.
(d) Both (a) and (b).

16. The most likely reason for the development of resistance against pesticides in
(a) Reduced reliance on chemical pesticides
(b) genetic recombination
(c) induced mutations
(d) acquired heritable changes.

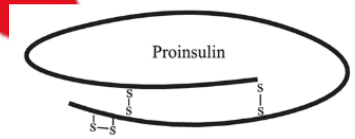
17. Which one of the following is now being commercially produced by biotechnological procedures?
(a) Nicotine (b) Morphine
(c) Quinine (d) Insulin

18. 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.

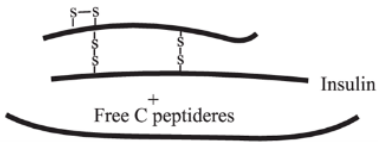
19. Which of the following statement is incorrect?
(a) Insulin used for diabetic patients.
(b) Human insulin is being commercially produced from a transgenic species of Agrobacterium tumefaciens.
(c) Rosie, the first transgenic cow, produced human protein enriched milk.
(d) CrylAb endotoxins obtained from *Bacillus thuringiensis* is effective against corn borers.

20. Genetic engineering aims at
(a) destroying wild gene
(b) preserving defective gene
(c) curing human disease by introducing new gene
(d) all of these.

21. Two stages of insulin (Stage P and stage Q) are shown in the 2 diagram. Select the correct statement?



Stage P



Stage Q

(a) Stage P is earlier and active stage of insulin.
(b) Stage Q is functional and earlier stage of insulin.
(c) Stage Q is referred as proinsulin.
(d) Stage P is an non-functional stage.

22. Read the following four statements (A-D).
(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) Transgenic mice are being used to test the safety of the polio vaccine.
(d) Toxicity testing in transgenic animals will allow us to obtain result in less time.
Which of the two statements are incorrect?
(a) b and c (b) c and d
(c) a and c (d) a and b

23. 'Rosie' cow known to produce a type of milk which has all the following characteristics
I. protein content of 2.4 g/L
II. human α-lactalbumin
III. more nutritionally balanced for human babies than natural cow milk
Which of the above statements are correct?
(a) I and II (b) I and III
(c) II and III (d) I, II and III

24. Consider the following statements about the responsibility of GEAC.
I. GEAC make decisions regarding research. the validity of the GM
II. It checks the safety of introducing GM organisms for the public services for their large scale use.
III. It was established by the government of USA.
Which of the statements given above is/are correct?
(a) Only I (b) Only II
(c) I and II (d) None of these

25. Select the unrelated pair.
(a) Genetically modified rice - Vitamin A rich
(b) Bt cotton - Pest resistance
(c) cry lAb-Control cotton bollworms
(d) Meloidogyne incognita - Pathogen to tobacco plants

26. Which of the following genes were introduced in cotton to protect it from cotton bollworms?
(a) cryll Ac and cryl Ab
(b) Bt Ac and Bt Ab
(c) cry I Ac and cry II Ab
(d) Nif genes

27. Which of the following statements are considered as the advantages of biotechnology?
I. Enhanced efficiency of mineral used by plants food.
II. Production of pest resistant crops.
III. Plants yielding more nutritious and tastier fruits.
IV. Production of new types of medicine to fight with dangerous diseases.
Choose the correct option.
(a) Only IV (b) I and III
(c) I, II and III (d) I, II, III and IV

28. Which of the following is/are considered as application(s) of biotechnology?
I. Waste treatment
II. Energy production Bioremediation
III. Processed food
IV. Genetically modified crops for agriculture
V. Diagnostics
VI. Therapeutics
Choose the correct option.
(a) I, II, III, IV and V
(b) III, V, II and VI
(c) I, II, III, V and VI
(d) All of these

29. Which of the following statement is incorrect?
(i) Recombinant DNA technology is used to improve crop plants by increasing their productivity, by making them more nutritious and by developing disease resistant.
(ii) Bt cotton is resistant to bollworm infestation.
(iii) *Bacillus thuringiensis* form cry protein during any phase of their growth.
(iv) *Bacillus thuringiensis* is not harmed by self cry protein because of its occurrence as (inactive) protoxin.
(v) Protoxin cry protein is changed into active cry protein in the stomach of insects due to alkaline pH.
(a) (i) and (iii) (b) (i) and (iv)
(c) Only (iii) (d) All of these

30. Bt toxin gene have been expressed in plants in order to provide resistance against
I. tobacco budworm and armyworm
II. beetles
III. flies and mosquitoes
Choose the correct option.
(a) I and II (b) I and III
(c) II and III (d) I, II and III

31. Which one of the following statements is correct w.r.t advantage of Bt cotton?
(a) Resistant to beetle pests and medium yield.

(b) Smaller thread variety of cotton with better tensile strerigth.
(c) Resistance to aphids.
(d) High yield and resistance to bollworms.

32. Choose the correct set of statement w.r.t pest resistance in, tobacco plant against the nematode.
(I) To prevent the nematode infestation is host plant, the novel strategy of DNA interference is used.
(II) In this plant, Thermus aquaticus is used as a vector.
(III) It induces the formation of ds DNA complex to initiate RNA induced gene silencing of specific mRNA of nematode.
(IV) By using the DNA mediated interference, the parasite could not be able to survive in a transgenic plant.
Of the above given statements
(a) I, II and III are correct.
(b) II, III and IV are correct.
(c) I, III and IV are correct.
(d) None of these.

33. Plants, bacteria, fungi and animals whose genes have been altered by manipulation are called
(a) genetically modified organisms
(b) hybrid organisms
(c) pest resistant organisms
(d) insect resistant organisms.

34. Match column I with column II and choose the correct option.

Column I		Column II	
A.	Bt toxin	I.	Silencing of mRNA
B.	RNA interference	II.	ADA CDNA
C.	Recombinant DNA technology	III.	cry gene
D.	Gene therapy	IV.	DNA or RNA probe

(a) A-I, B-III, C-II, D-IV
(b) A-III, B-I, C-II, D-IV
(c) A-III, B-I, C-IV, D-II
(d) A-II, B-I, C-III, D-IV

35. The correction of a genetic defect involves the
(a) delivery of a normal gene into the embryo or individual
(b) delivery of a non-functional gene into the embryo or individual
(c) delivery of a mutated gene into the embryo or individual
(d) delivery of a pseudogene into the embryo or individual.

36. Consider the following statements about insulin.
I. Human insulin is made up polypeptide chains. of amino acids arranged in two chains.
II. The two polypeptide chains are interconnected by two disulphide bridges.
III. In mammals including humans, insulin is synthesised as a pro-hormone, which contains an extra stretch called the C-peptide.
IV. C-peptide is not present in the mature insulin.
Which of the statements given above are correct?
(a) I, II and III (b) I, III and IV
(c) II, III and IV (d) I, II, III and IV

37. When a person with defective Adenosine Deaminase (ADA) was treated, which of the following steps were performing for gene therapy?
I. Lymphocytes were extracted from the bone marrow of the patient.
II. Lymphocytes were grown in a culture outside the body.
III. Lymphocytes were transfected with the normal ADA genes.
IV. A functional ADA cDNA is introduced into lymphocytes using a retroviral vector.
(a) I, II and III (b) I, III and IV
(c) II, III and IV (d) I, II, III and IV

38. Gene therapy involves
(a) introduction of normal gene in cell
(b) treating of defective genes with radiation
(c) replacement of defective genes with normal gene
(d) eliminating defective and useless genes.

39. The ADA deficiency arise because of the
(a) addition of the gene for adenosine deaminase
(b) base substitution of the gene for adenosine deaminase
(c) deletion of the gene for adenosine deaminase
(d) transversion of the gene for adenosine deaminase

40. Amino acids of mature insulin are arranged in
(a) single polypeptide chains
(b) two polypeptides chains

(c) three polypeptides chains
(d) four polypeptides chains.

41. When will be the presence of pathogen is suspected in our body?
(a) When its concentration is very low.
(b) When it is not able to replicate in our body.
(c) When it has produced a disease symptom.
(d) None of these

42. Which of the following statements about transgenic animals is/ gare false?
(i) Transgenic animals are designed to study how genes are regulated.
(ii) They are specially made to serve as models for human diseases.
(iii) Transgenic cow Rosie was created to produce the human protein a-1-antitrypsin.
(iv) Transgenic mice are used to test the safety of vaccines.
(a) (iii) only (b) (i) and (iii) only
(c) (ii) only (d) (iii) and (iv) only

43. Genetic engineering has been successfully used for producing
(a) transgenic dog 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 protein milk
(d) animals like bulls for farm work as they have super power.

44. Today, transgenic models have been developed for many human diseases, which includes
I. rheumatoid arthritis
II. Alzheimer's disease
III. cancer
IV. Cystic fibrosis
Choose the correct option
(a) I and II (b) II and IV
(c) I, II and IV (d) I, II, III and IV

45. Consider the following statements about 'Rosie'.
I. Rosie is a first transgenic cow.
II. Rosie produced human protein enriched milk.
III. The milk contained the human x-lactalbumin and was nutritionally a more balanced product for human babies than natural cow-milk.
Which of the statements given above are correct?
(a) I and II (b) I and III
(c) II and III (d) I, II and III

46. Which of the following correctly defines a transgenic animal?
(a) An animal which has foreign DNA and RNA in some of its cells because of an injection of DNA and RNA into the nucleus of the zygote from which it is developed.
(b) An animal which has foreign DNA in all its cells because of an injection of DNA into the nucleus of the zygote from which it is developed.
(c) An animal which has foreign DNA in some of its cells because of an injection of DNA into the nuclei of some of the cells of the blastocyst.
(d) An animal which has foreign DNA in all its cells because of an injection of DNA into the nuclei of some of the cells in adulthood.

47. Which of the following is/are correct?
(i) Transgenic animal - Animal that have had their DNA manipulated to possess and express an extra gene.
(ii) GEAC-Genome Engineering approval Committee.
(iii) Biopiracy
Exploitation of bioresources of the nations without proper authorisation:
(a) Only (ii) (b) Only (i)
(c) (i) and (ii) (d) (i) and (iii)

48. Choose the correct options about Basmati rice.
I. In 1997, an American company got patent rights for Basmati rice through the US Patent and Trademark office and was allowed to sell a 'new variety' in US and abroad.
II. This new variety of Basmati was derived from Chinese farmer's varieties.
III. Indian Basmati was crossed with semi-dwarf varieties and claimed as an invention or a novelty.
Which of the above statements are correct?
(a) I and II (b) I and III
(c) II and III (d) I, II and III

Exercise-03 Level -03

Assertion & Reason Based Questions

1. **Assertion (A):** B. thuringiensis forms protein crystals during a particular phase of their growth.
Reason (R): Cry proteins are soluble in alkaline environment of midgut of insect.
(a) Both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.
(b) Both Assertion and Reason are True but Reason is not a correct explanation of the Assertion.
(c) Assertion is True but the Reason is False.
(d) Assertion is False but the Reason is True.

2. **Assertion (A):** PCR is routinely used for early diagnosis of HIV in suspected AIDS patients
Reason (R): It is a powerful techqnique to identify many other genetic disorders
(a) If both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are true but Reason is not a correct explanation of the Assertion
(c) If Assertion is true but the Reason is false
(d) If both Assertion and reason are false

3. **Assertion (A):** The first clinical gene therapy was given in 1990 to a 4-year old girl with adenosine deaminase (ADA) deficiency.
Reason (R): The functional adenosine deaminase (ADA) is introduced into monocytes for the immune system to function.
(a) Both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.
(b) Both Assertion and Reason are True but Reason is not a correct explanation of the Assertion.
(c) Assertion is True but the Reason is False.
(d) Assertion is False but the Reason is True.

4. **Assertion (A):** GM plants are more useful than normal plants
Reason (R): Golden rice is rich in *vitamin A*
(a) If both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are true but Reason is not a correct explanation of the Assertion
(c) If Assertion is true but the Reason is false
(d) If both Assertion and reason are false

5. **Assertion (A):** We can produce transgenic bacteria to yield desired products.
Reason (R): Human insulin can be produced by bacteria.
(a) Both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.
(b) Both Assertion and Reason are True but Reason is not a correct explanation of the Assertion.
(c) Assertion is True but the Reason is False.
(d) Assertion is False but the Reason is True.

6. **Assertion (A):** The Green Revolution succeeded in tripling the food supply. It was not enough to feed the growing human population.
Reason (R): Increased yields have partly been due to the use of improved crop varieties, but mainly due to the use of better management practices and use of agrochemicals.
(a) Both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.
(b) Both Assertion and Reason are True but Reason is not a correct explanation of the Assertion.
(c) Assertion is True but the Reason is False.
(d) Assertion is False but the Reason is True.

7. **Assertion (A):** Basmati rice is distinct for its unique aroma and flavour
Reason (R): Almost 37 documented varieties of Basmati are grown in India
(a) If both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are true but Reason is not a correct explanation of the Assertion
(c) If Assertion is true but the Reason is false
(d) If both Assertion and reason are false

8. **Assertion (A):** Eli Lilly prepared four DNA sequences corresponding to A and B chains of

human insulin and introduced them in the plasmid of E.coli to produce polypeptide chains of insulin.
Reason (R): Chains A and B were produced separately, extracted and combined by creating disulphide bonds to form human insulin.
(a) Both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.
(b) Both Assertion and Reason are True but Reason is not a correct explanation of the Assertion.
(c) Assertion is True but the Reason is False.
(d) Assertion is False but the Reason is True.

9. **Assertion (A):** ELISA test is based on antigen-antibody interactions.
Reason (R): Infection by pathogen can be detected by the presence of antigen.
(a) If both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are true but Reason is not a correct explanation of the Assertion
(c) If Assertion is true but the Reason is false
(d) If both Assertion and reason are false.

10. **Assertion (A):** Bt toxin is not toxic for *Bacillus* itself.
Reason (R): Bt toxin is synthesized by *cry* gene.
(a) If both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are true but Reason is not a correct explanation of the Assertion
(c) If Assertion is true but the Reason is false
(d) If both Assertion and reason are false

11. **Assertion (A):** PCR is widely used for the detection of infectious diseases like AIDS
Reason (R): ELISA is based on antigen antigen reaction.
(a) If both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are true but Reason is not a correct explanation of the Assertion
(c) If Assertion is true but the Reason is false
(d) If both Assertion and reason are false

12. **Assertion (A):** While performing autoradiography, the clone of cells having mutated gene will not appear on the photographic film.
Reason (R): The probe will not have complementarity with the mutated gene.
(a) Both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.
(b) Both Assertion and Reason are True but Reason is not a correct explanation of the Assertion.
(c) Assertion is True but the Reason is False.
(d) Assertion is False but the Reason is True.

13. **Assertion (A):** There are an estimated 200,000 varieties of rice in India.
Reason (R): Basmati rice is distinct for its unique aroma and flavour and 27 documented varieties of Basmati are grown in India.
(a) Both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.
(b) Both Assertion and Reason are True but Reason is not a correct explanation of the Assertion.
(c) Assertion is True but the Reason is False.
(d) Assertion is False but the Reason is True.

14. **Assertion (A):** Transgenic animals are useful for production of biological products for human welfare.
Reason (R): α-1-antirypsin produced by recombinant DNA technology is used to treat cystic fibrosis.
(a) If both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are true but Reason is not a correct explanation of the Assertion
(c) If Assertion is true but the Reason is false
(d) If both Assertion and reason are false

15. **Assertion (A):** RNAi takes place in all eukaryotic organisms as a method of cellular defence.
Reason (R): RNAi involves silencing of a specific mRNA due to a complementary dsRNA molecule.
(a) Both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.

(b) Both Assertion and Reason are True but Reason is not a correct explanation of the Assertion.
(c) Assertion is True but the Reason is False.
(d) Assertion is False but the Reason is True.

16. **Assertion (A):** GEAC makes decisions regarding the validity of GM research and the safety of introducing GM-organisms for public services.
Reason (R): Genetic modification of organisms can not have unpredicatable results when such organisms are introduced into the ecosystem.
(a) Both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.
(b) Both Assertion and Reason are True but Reason is not a correct explanation of the Assertion.
(c) Assertion is True but the Reason is False.
(d) Assertion is False but the Reason is True.

17. **Assertion (A):** PCR is routinely used to detect HIV in suspected AIDS patients and is being used to detect mutations in genes in suspected cancer patients.
Reason (R): PCR cannot identify other genetic disorders.
(a) Both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.
(b) Both Assertion and Reason are True but Reason is not a correct explanation of the Assertion.
(c) Assertion is True but the Reason is False.
(d) Assertion is False but the Reason is True.

18. **Assertion (A):** Insulin consists of two short polypeptide chains: chain A and chain B.
Reason (R): Insulin is used for diabetic patients
(a) If both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are true but Reason is not a correct explanation of the Assertion
(c) If Assertion is true but the Reason is false
(d) If both Assertion and reason are false

19. **Assertion (A):** The Green Revolution succeeded in tripling the food supply
Reason (R): it was not enough to feed the growing human population
(a) If both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are true but Reason is not a correct explanation of the Assertion
(c) If Assertion is true but the Reason is false
(d) If both Assertion and reason are false

20. **Assertion (A):** The first clinical gene for ADA therapy was given to cure SCID.
Reason (R): The normal gene was delivered into the patients Cells using retroviral vector.
(a) If both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are true but Reason is not a correct explanation of the Assertion
(c) If Assertion is true but the Reason is false
(d) If Assertion is false but the Reason is true

Statement Based Questions

21. **Statement I:** The proteins encoded by the genes cryIAc and cryIIAb control the cotton bollworm
Statement II: cryIAb controls corn borer
(a) Both the statements are correct
(b) Statement I is correct but statement II is incorrect
(c) Statement II is correct but statement I is incorrect
(d) Both the statements are incorrect

22. **Statement I:** Plants produced by micro-propagation are different from their parent plant
Statement II: Each of these plants produced by microprpagation are genetically different to the original plant from which they were grown, i.e., they are somaclones
(a) Both the statements are correct
(b) Statement I is correct but statement II is incorrect
(c) Statement II is correct but statement I is incorrect
(d) Both the statements are incorrect

23. **Statement-I:** Human insulin is produced by protozoa.

Statement-II: Insulin from different animals causes allergic reactions in humans.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct

24. **Statement-I:** In some children ADA deficiency can be cured by bone marrow transplantation
Statement-II: If the gene isolate from marrow cells producing ADA is introduced into cells at early embryonic stages, it could be a permanent cure.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct

25. **Statement-I:** Insulin used for diabetes was earlier extracted from pancreas of slaughtered cattle and pigs
Statement-II: Insulin is synthesised as a pro-hormone, which has an extra stretch called the C peptide.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct

26. **Statement-I:** The proteins encoded by the genes crylAc A and cryllAb control the corn borer and that crylAb controls cotton bollworms.
Statement-II: Bt toxins are insect group specific.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct

27. **Statement-I:** Several nematodes parasitise a wide variety of plants and animals including human beings
Statement-II: A novel strategy was adopted to prevent nematode infestation which was based on the process of RNA interference (RNAi).
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct

28. **Statement-I**: ELISA is based on the principle of antigen-antibody interaction.
Statement-II: Infection by pathogen can not be detected by detecting antibodies synthesised against the pathogen.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct

29. **Statement-I:** The milk of transgenic cow, 'Rosie', is not better than natural cow milk.
Statement-II: Rosie produces human alpha-lactalbumin enriched milk.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct

30. **Statement-I:** *Bacillus thuringiensis* is not killed by its own toxin.
Statement-II: Bt toxin proteins exist as inactive protoxins.
(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct

31. **Statement I:** Gene therapy is a collection of methods that allows correction of a gene defect that has been diagnosed in a child/embryo

Statement II: Correction of a genetic defect involves delivery of a defected gene into the individual or embryo

(a) Both the statements are correct
(b) Statement I is correct but statement II is incorrect
(c) Statement II is correct but statement I is incorrect
(d) Both the statements are incorrect

32. **Statement I:** B. thuringiensis forms protein crystals during a particular phase of their growth
Statement II: Bt toxin gene has been cloned from the fungi and nematode and been expressed in plants to provide resistance to insects

(a) Both the statements are correct
(b) Statement I is correct but statement II is incorrect
(c) Statement II is correct but statement I is incorrect
(d) Both the statements are incorrect

33. **Statement-I:** Chemical safety testing is also known as toxicity or safety testing.
Statement-II: Transgenic animals are made that carry genes which make them less sensitive to toxic substances than non-transgenic animals.

(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct

34. **Statement-I:** The capacity to generate whole plant from ex plants its called totipotency
Statement-II: The mammalian gametes is also known to possess totipotent traits.

(a) Both Statement-I and Statement-II are correct.
(b) Both Statement-I and Statement-II are incorrect.
(c) Statement-I is correct & Statement-II is incorrect.
(d) Statement-I is incorrect & Statement-II is correct

Match up Based Questions

35. Match column I containing transgenic organisms with their specific characteristic in column II and select the correct option from the given codeiv.

Column I		Column II	
A.	GEAC	(i)	Human alpha lactalbumin
B.	95 % transgenic animals	(ii)	Genetic engineering approval committee
C.	Rosie cow	(iii)	Transgenic mice

(a) A-iii, B-i, C-ii (b) A-ii, B-iii, C-i
(c) A-ii, B-i, C-iii (d) A-i, B-iii, C-ii

36. Select the correct match

Column I		Column II	
A.	Mature insulin	(i)	C peptide
B.	Prohormone	(ii)	A and B chain
C.	Adenosine deaminase	(iii)	Function of immune system

(a) A-iii, B-i, C-ii (b) A-ii, B-iii, C-i
(c) A-ii, B-i, C-iii (d) A-i, B-iii, C-ii

37. Select the correct match

Column I		Column II	
A.	ELISA	(i)	27
B.	Largest chain of proinsulin	(ii)	C peptide
C.	Documented varieties of basmati grown in India	(iii)	Antigen antibody reaction

(a) A-iii, B-ii, C-i (b) A-ii, B-iii, C-i
(c) A-ii, B-i, C-iii (d) A-i, B-iii, C-ii

38. Match the columns.

Column-I		Column-II	
(a)	Gene modification	(i)	Vitamin A enriched rice
(b)	Gene therapy	(ii)	Chemical safety testing

(c)	Transgenic animals	(iii)	ADA deficiency treatment
(d)	Bt toxin	(iv)	Cry gene

(a) (a)-(i), (b)-(iii), (c)-(ii), (d)-(iv)
(b) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)
(c) (a)-(i), (b)-(ii), (c)-(iii),(d)-(iv)
(d) (a)-(iv), (b)-(ii), (c)-(iii), (d)-(i)

39. Match the Column I with Column II

	Column – I		**Column – II**
A.	Cry-I AC	(i)	Transgenic animal
B.	Green revolution	(ii)	Corn borer
C.	Rosie	(iii)	Tripling of food supply

(a) A-iii; B-i; C-ii
(b) A-ii; B-i; C-iii
(c) A-ii; B-iii; C-I
(d) A-i; B-ii; C-iii

40. Match the columns.

Column-I		**Column-II**	
(a)	Bt toxin	(i)	Silencing of m-RNA
(b)	RNA interference	(ii)	ADA CDNA
(c)	RDT	(iii)	cry gene
(d)	Gene Therapy	(iv)	DNA or RNA probe

(a) (a)-(i), (b)-(iii), (c)-(ii), (d)-(iv)
(b) (a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)
(c) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)
(d) (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)

41. Match the column I and column II and find out the correct combination:

	Column – I		**Column – II**
A.	Bt toxin	(i)	Meloidogyne incognita
B.	RNAi	(ii)	Insecticide
C.	Gene therapy	(iii)	Routine test for AIDS
D.	PCR	(iv)	ADA deficiency

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

42. Match the columns and choose the correct option.

Column-I		**Column-II**	
(a)	PCR	(i)	Emphysema
(b)	Insulin	(ii)	Eli Lilly
(c)	α-1 antitrypsin	(iii)	AIDS diagnosis
(d)	α-lactalbumin	(iv)	Cow milk

(a) (a)-(iii), (b)-(ii), (c)-(i), (d)-(iv)
(b) (a)-(ii), (b)-(iii), (c)-(i), (d)-(iv)
(c) (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)
(d) (a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)

43. Match the columns accordingly.

Column-I		**Column-II**	
(a)	Gene therapy	(i)	Use of bioresources without proper authorisation from the concerned authority
(b)	Probe	(ii)	Correction of a gene defect
(c)	Biopiracy	(iii)	A right granted by the government to an inventor to prevent thers from using the invention commercially
(d)	Biopatent	(iv)	DNA or RNA with radioactive molecule

(a) (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)
(b) (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)
(c) (a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)
(d) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)

44. Match the columns and find out the correct combination:

Column-I		**Column-II**	
(a)	Cry 1 Ac	(i)	Escherichia coli
(b)	Cry 1 Ab	(ii)	Agrobacterium

(c)	Ti-plasmid	(iii)	Control Cotton bollworms
(d)	RNA I	(iv)	Control Corn borer
		(v)	Meloidogyne incognita

(a) (a)-(ii), (b)-(iii), (c)-(i), (d)-(v)
(b) (a)-(iii), (b)-(ii), (c)-(iv), (d)-(v)
(c) (a)-(i), (b)-(ii), (c)-(iii), (d)-(v)
(d) (a)-(iii), (b)-(iv), (c)-(ii), (d)-(v)

45. Match the column I and Column II and find out the correct combination

	Column – I		**Column – II**
A.	Bio patent	(i)	Genetic engineering approved committee
B.	ADA deficiency	(ii)	Gene therapy
C.	Treatment of emphysema	(iii)	Transgenic animals

(a) A-iii; B-i; C-ii (b) A-i; B-ii; C-iii
(c) A-iii; B-i; C-ii (d) A-i; B-iii; C-ii

46. Match the columns and find out the correct combination:

Column-I		**Column-II**	
(a)	Bt	(i)	*Bacillus thuringiensis*
(b)	Rosie	(ii)	Human alpha-lactal bumin rich milk
(c)	Golden rice	(iii)	Emphysema
(d)	Insulin	(iv)	Use for diabetes
		(v)	Vitamin A rich

(a) (a)-(ii), (b)-(iii), (c)-(i), (d)-(iv)
(b) (a)-(iii), (b)-(ii), (c)-(i), (d)-(iv)
(c) (a)-(i), (b)-(ii), (c)-(v), (d)-(iv)
(d) (a)-(v), (b)-(iii), (c)-(i), (d)-(iv)

47. Match the columns and find out the correct combination:

Column-I		**Column-II**	
(a)	Biopatent	(i)	E. coli
(b)	Human insulin	(ii)	Gene therapy
(c)	Pest resistant tobacco plants	(iii)	Genetic engineering approval committee
(d)	ADA deficiency	(iv)	Transgenic animals
		(v)	RNA interference

(a) (a)-(iii), (b)-(i), (c)-(v), (d)-(ii)
(b) (a)-(i), (b)-(iii), (c)-(iv), (d)-(v)
(c) (a)-(iii), (b)-(iv), (c)-(v), (d)-(ii)
(d) (a)-(v), (b)-(ii), (c)-(i), (d)-(iii)

48. Match the column I and column II and find out the correct combination.

	Column – I		**Column – II**
A.	First transgenic cow	(i)	m-RNA silencing
B.	Safety test of polio vaccine	(ii)	Rice
C.	Resistance from nematode	(iii)	Rosie
D.	Vitamin 'A' enriched crop	(iv)	Transgenic mice

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

49. Match the column – I and column – II and find out the correct combination.

	Column – I		**Column – II**
A.	Bt-cotton	i.	Insecticide
B.	Approved recombinant therapeutics	ii.	12

C.	Marketed recombinant therapeutics in india	iii.	30

(a) A-ii; B-i; C-iii
(b) A-iii; B-i; C-ii
(c) A-i; B-iii; C-ii
(d) A-i; B-ii; C-iii

50. Match the column and select the correct option

Column – I		Column – III	
A.	Genetic modified organism	i.	Bone marrow transplantation
B.	Adenosine deaminase deficiency	ii.	Organism whose genes have been manipulated
C.	DNA/RNA tagged	iii.	Autoradiography
	with radioactive molecule		

(a) A-ii; B-i; C-iii (b) A-iii; B-ii; C-i
(c) A-i; B-ii; C-iii (d) A-ii; B-i; C-iii

51. Match the following columns and select the correct option

Column I		Column II	
A.	Transposon	(i)	Retroviral vector
B.	Functional cDNA	(ii)	Mobile genetic element
C.	Eli lilly	(iii)	Human insulin

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

Exercise-04 Previous Year Questions

1. Match List I with List II : **(2024)**

List I		List II	
A.	α −1 antitrypsin	I.	Cotton bollworm
B.	Cry IAb	II.	ADA deficiency
C.	Cry IAc	III.	Emphysema
D.	Enzyme replacement therapy	IV.	Corn-borer

Choose the correct answer from the options given below:
(a) A-III, B-I, C-II, D-IV
(b) A-III, B-IV, C-I, D-II
(c) A-II, B-IV, C-I, D-III
(d) A-II, B-I, C-IV, D-III

2. Give below are two statements :
Statements I : Bt toxins are insects group specific and coded by a gene cry 1Ac.
Statements II : Bt toxins exists as inactive protoxin in B. thuringiensis. However, after ingestion by the insect the inactive protoxin gets converted into active from due to acidic pH of the insect gut.
In the light of the above statements, choose the correct answer from the options given below:
(2024)
(a) Both statement I and statement II are false
(b) Statement I is true but statement II is false
(c) Statement I is false but statement II is true
(d) Both Statement I and Statement II are true

3. The capacity to generate a whole plant from any cell of the plant is called: **(2024)**
(a) Micropropagation
(b) Differentiation
(c) Somatic hybridization
(d) Totipotency

4. Which of the following are fused in somatic hybridization involving two varieties of plants? **(2024)**
(a) Somatic embryos (b) Protoplasts
(c) Pollens (d) Callus

5. Which of the following can act as molecular scissors? **(2023)**
(a) Restriction enzymes
(b) DNA ligase
(c) RNA polymerase
(d) DNA polymerase

6. Match List-I with List-II: **(2023)**

List-I		List-II	
A.	Gene therapy	(i)	Separation of DNA fragments
B.	RNA interference	(ii)	Diagnostic test for AIDS
C.	ELISA	(iii)	Cellular defence
D.	Gel Electrophoresis	(iv)	Allows correction of a gene defect

Choose the correct answer from the options given below:
(a) A-(iv), B-(i), C-(ii), (iii)
(b) A-(iv), B-(ii), C-(iii), D-(i)
(c) A-(iv), B-(iii), C-(ii), D-(i)
(d) A-(iv), B-(iii), C-(i), D-(ii)

7. During the purification process for recombinant DNA technology, addition of chilled ethanol precipitates out **(2023)**
(a) DNA (b) Histones
(c) Polysaccharides (d) RNA

8. In gene gun method used to introduce alien DNA into host cells, microparticles of _____ metal are used **(2023)**
(a) Zinc (b) Tungsten or gold
(c) Silver (d) Copper

9. Main steps in the formation of Recombinant DNA are given below. **(2023)**
A. Insertion of recombinant DNA into the host cell
B. Cutting of DNA at specific location by restriction enzyme
C. Isolation of desired DNA fragment
D. Amplification of gene of interest using PCR
Choose the correct answer from the options given below:
(a) C, A, B, D (b) C, B, D, A
(c) B, D, A, C (d) B, C, D, A

10. Milk of transgenic 'Cow Rosie' was nutritionally more balanced product for human babies than natural cow milk because it contained: **(2022)**
(a) Human enzyme Adenosine Deaminase (ADA)
(b) Human protein ✔ -1-antitrypsin
(c) Human alpha-lactalbumin
(d) Human insulin-like growth factor

11. In the following palindromic base sequences of DNA, which one can be cut easily by particular restriction enzyme? **(2022)**
(a) $5'GATACT3'; 3'CTATGA5'$
(b) $5'GAATTC3'; 3'CTTAAG5'$
(c) $5'CTCAGT3'; 3'GAGTCA5'$
(d) $5'GRATTC3'; 3'CATAAG5'$

12. In gene therapy of Adenosine Deaminase (ADA) deficiency, the patient requires periodic infusion of genetically engineered lymphocytes because : **(2022)**
(a) Retroviral vector is introduced into these lymphocytes
(b) Gene isolated from marrow cells producing ADA is introduced into cell s at embryonic stages
(c) Lymphocytes from patient's blood are growth in culture, outside the body
(d) Genetically engineered lymphocytes are not immortal cells

13. Statements related to human Insulin are given below. **(2022)**
Which statements is/are correct about genetically engineered Insulin?
A. Pro-hormone insulin contain extra stretch of C-peptide.
B. A-peptide and B-peptide chains of insulin were produced separately in E.coli, extracted and combined by creating disulphide bond between them.
C. Insulin used for treating Diabetes was extracted from Cattles and Pigs.
D. Pro-hormone Insulin needs to be processed for converting into a mature and functional hormone.
E. Some patients develop allergic reactions to the foreign insulin.
Choose the most appropriate answer from the options given below:

(a) A, B and D only (b) B only
(c) C and D only (d) C, D and E only

14. When gene targeting involving gene amplification is attempted in an individual's tissue to treat disease, it is known as **(2021)**
(a) Gene therapy
(b) Molecular diagnosis
(c) Safety testing
(d) Biopiracy

15. Adenosine deaminase deficiency results into **(2021)**
(a) Parkinson's disease
(b) Digestive disorder
(c) Addison's disease
(d) Dysfunction of Immune system

16. Which of the following statement is not correct? **(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

17. Match the following columns and select the correct option **(2020)**

Column - I		Column - II	
1.	Bt cotton	(i)	Gene therapy
2.	Adenosine deaminase deficiency	(ii)	Cellular defense
3.	RNAi	(iii)	Detection of HIV infection
4.	PCR	(iv)	*Bacillus thuringiensis*

1 2 3 4
(a) (iii) (ii) (i) (iv)
(b) (ii) (iii) (iv) (i)
(c) (i) (ii) (iii) (iv)
(d) (iv) (i) (ii) (iii)

18. Bt cotton variety that was developed by the introduction of toxin gene of *Bacillus thuringiensis* (Bt) is resistant to **(2020)**
(a) Fungal diseases
(b) Plant nematodes
(c) Insect predators
(d) Insect pests

19. The laws and rules to prevent unauthorised exploitation of bio-resources are termed as **(2020 Covid Re-NEET)**
(a) Bioethics (b) Bioengineering
(c) Biopiracy (d) Biopatenting

20. RNA interference is used for which of the following purposes in the field of biotechnology? **(2020 Covid Re-NEET)**
(a) To develop a pest resistant plant against infestation by nematode
(b) To enhance the mineral usage by the plant
(c) To reduce post harvest losses
(d) To develop a plant tolerant to abiotic stresses

Answer keys

TOPIC CENTRIC EXERCISE 01 Answer Key

1. (c)	2. (c)	3. (d)	4. (a)	5. (a)

TOPIC CENTRIC EXERCISE 02 Answer Key

1. (a)	2. (a)	3. (c)	4. (a)	5. (c)

TOPIC CENTRIC EXERCISE 03 Answer Key

1. (b)	2. (d)	3. (c)	4. (b)

TOPIC CENTRIC EXERCISE 04 Answer Key

1. (a)	2. (d)	3. (b)	4. (d)

Exercise-01 Level -01 Answer Key

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

Exercise-02 Level -02 Answer Key

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

Exercise-03 Level -03 Answer Key

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

Exercise-04 Previous Year Questions

1. (b)	3. (d)	5. (a)	7. (a)	9. (d)	11. (b)	13. (a)	15. (d)	17. (d)	19. (d)
2. (b)	4. (b)	6. (c)	8. (b)	10. (c)	12. (d)	14. (a)	16. (b)	18. (d)	20. (a)