3 BIOTECHNOLOGY AND ITS APPLICATION

SYNOPSIS

INTRODUCTION :

1. Biotechnology is a branch of biology which deals with the techniques of using live organisms, enzymes or biological processes to produce products and provide services for human welfare.
2. The new definition of modern bitechnology given by EFB (The European federation of Biotechnology) is that 'Biotechnology is the integration of natural science and organisms, cells, parts thereof and molecular analogues for products and services'.

3.2 Recombinant DNA technology :

1. Recombinant DNA technology is the technique of manipulating the genome of a cell or organism so as to change the phenotype desirably.
2. Recombinant DNA (rDNA) technology is a part of genetic engineering.
3. Genetic engineering involves the design, construct and manipulation of a genetic material towards a desired end and in a predetermined way.
4. Genetic engineering bypasses the restriction in the gene transfer mechanisms between unrelated organisms.

5. Steps involved in rDNA technology

Isolation of genomic DNA from donor

↓

Fragmentation of donor DNA by restriction endonucleases

↓

Screening for desired gene

↓

Inserting them into cloning vector

↓

Formation of rDNA

↓

Introducing recombinant vector into host cell

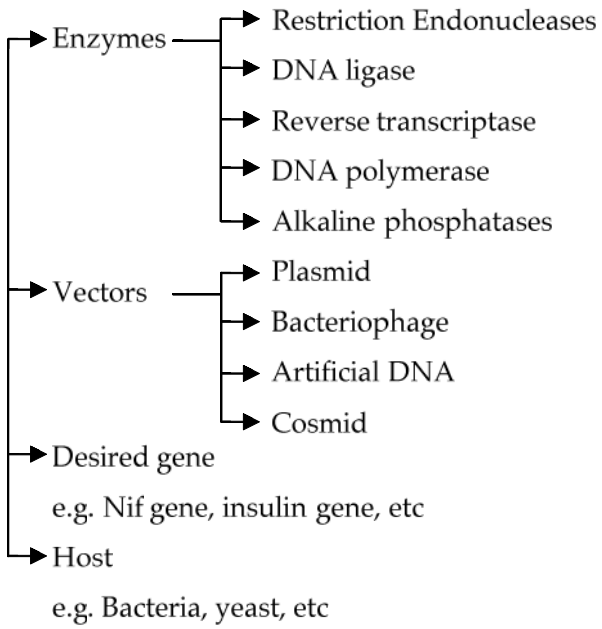
↓

Culturing the cells to obtain multiple copies

↓

Expression of desired gene to produce the desired protein.

6. Tools used in rDNA technology



7. Vectors or Vehicle DNA :

Vectors are defined as the DNA molecules capable of self replication and used as the carrier of DNA segment to be cloned (gene). Vectors are transferable genetic elements that are themselves DNA molecules.

(i) *Recombinant DNA*

Recombinant DNA is the vector carrying the desired gene in it. It is also called as 'hybrid DNA' or 'Chimeric DNA'

(ii) Cloning Vectors

Those which do not only allow multiplication (cloning) but may also be manipulated in such a way that the inserted gene may be expressed in the host.

(iii) A good vector must have :

a. Origin of replication (ori). So as to replicate autonomously, to generate its multiple copies within the host itself. As the vector replicates, the inserted DNA replicates too.

b. Small size or low molecular weight for enhanced stability.

c. Restriction sites for a large number of restriction enzymes.

d. Easy isolation and purification.

e. Easy tranformation of the host cells.

f. Marker Genes to permit the selection of transformed host cells. The marker enables the cell carrying the recombinant vector to get easily distinguished from those lacking vectors. Usually the genes encoding resistance to antibiotics such as ampicillin, chloramphenicol, tetracycline or kanamycin, etc., are use as selectable markers for *E. coli.*

The normal *E. coli* cells do not carry resistance against any of these antibiotics.

Transposons, Plasmids and Bacteriophages

1. Transposons :

(i) Jumping genes

Sequences of DNA that can move or transpose themselves to new positions within the genome of a single cell leading to phenotypically significant mutations and alteration of cell's genome size.

(ii) Discovery :

By Barbara Mcclintock in 1948 in *Zea mays* (maize) for which she was awarded Nobel prize in 1983.

About 50% of the total genome of maize consists of transposons.

(iii) Types of transpons

(a) Retrotranspons :

→ copy and paste method.

→ Enzyme involved is reverse transcriptase for reverse transcription.

(b) DNA transposons :

→ Cut and paste method.

→ Enzyme involved is transposase

2. Plasmids :

These are most widely used vectors. Plasmids are extrachromosomal, self - replicating, double-stranded closed and circular DNA found in bacterial cells. The size of plasmids ranges from 1 to 1000 kbp.

They are also called as replicons as they are capable of autonomous replication.

3. Bacteriophages :

(i) A bacteriophage is a virus that infects bacteria.

(ii) Used for cloning of larger DNA molecules.

(iii) Phage Lambda (λ) as vector :

(a) DNA $\Rightarrow$ 48.5 kb in length

(b) Cos sites or cohesive ends of 12 bp allow the DNA to be circularized in host cell.

(c) Infects *E. coli*

orientation of the reading is kept the same.

5^1 – ACC**GAATTC**GCA – 3^1

3^1 – TGG**CTTAAG**CGT – 5^1

4. *Cleavage pattern :*

(i) Restriction endonucleases require Mg^{2+} ions for their activity and give rise to sticky ends in restriction fragments.

(ii) They cut the DNA by hydrolysing the phosphodiester bonds.

(iii) Analysis of restriction fragments can be done with the help of Agarose Gel Electrophoresis.

Preparing and Cloning A DNA Library :

In molecular biology, a library is a collection of DNA fragments (specifically genes) from a particular species that is stored and propagated in a population of micro – organisms through the process of molecular cloning.

1 Genomic Library :

(i) It is the collection of all clones of DNA fragments that represent the complete genome of an organism.

2 cDNA Library :

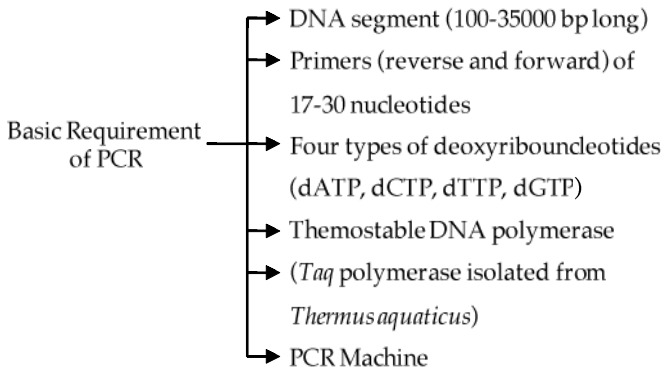
(i) cDNA is complementary DNA produced using mRNA by the process of reverse transcription.

(ii) A library having cDNA for each and every type of structural/functional protein can be constructed by inserting into a suitable vector and then cloning in proper host like *E. coli.*

Gene Amplification :

(i) Gene amplification is the process of obtaining multiple copies of a known DNA sequence that contains a gene.

(ii) Polymerase Chain Reaction (PCR) is an *in-vitro* technique of gene amplification.



4. Replication of Bacteriophages

Bacteriophages replicate via the lytic cycle, which comprises of the following steps

(i) Attachment : Attachment of 'Phage' to the host surface at specific receptors through random encounters with right receptors.

(ii) Penetration : Insertion of viral DNA into the host by contraction of tail fibres. Empty capsid remaining outside is termed as 'Ghost'.

(iii) Synthesis of proteins and Nuclic Acids : Host's normal synthesis of proteins and nucleic acids is disrupted and it is forced to manufacture viral DNA and proteins.

(iv) Virion Assemply : New viruses (virions) are assembled DNA is efficiently packed within the heads. Whole process takes 15 minutes.

(v) Release of Virions : Virions are released by lysis of the host cell with the help of enzyme 'Endolysin'. Visions can now infect new bacteria.

5. Cosmid

(i) Cosmid are plasmids with λ phage DNA fragments.

1. *Restriction fragments :*

(i) Restriction fragment : They are DNA fragments resulting from the cutting of the DNA strand by restriction enzyme, by a process called restriction.

(ii) **Types of Nucleases :**

(a) Exonucleases

(b) Endonucleases-

Type II Restriction Endonucleases are used in rDNA technology

2. Nomenclature of REN :

Named with particular reference to the bacteria from which they are isolated.

Ex. Eco RI

E → *Escherichia*

co → *coli*

R → Strain RY

I → First endonuclease to be discovered from *E coli*

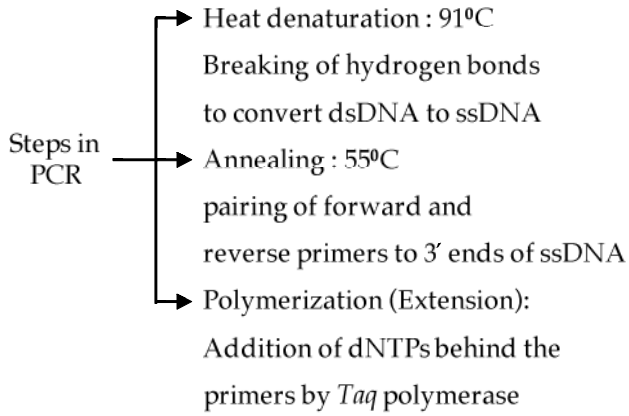
3. Recognition sequences or Restriction site

(i) Site where DNA is cut by restrction endonuclease.

(ii) 4 – 8 nucleotide palindromic sequence.

(iii) Palindromes are groups of letters that form the same word when read forward or backword, ex. MALAYALAM.

(iv) Palindrome in DNA is a sequence of base pairs that reads the same on the two strands when



(iii) PCR works on principle of thermal cycling leading to exponential amplification of DNA

(iv) One cycle of PCR takes 3-5 minutes.

Application of Biotechnology in Agricuture:

1 Bacillus thuringiensis (Bt) :

(i) Soil bacterium that produces protein with insecticidal properties.

(ii) *Bt* toxin occurs as inactive prototoxins which gets converted into active form due to the alkaline pH of the insect gut.

(iii) The protein is crystalline in nature and the gene coding for the toxin is *'cry'* gene.

(iv) This gene is inserted in plant genomes to induce insect resistance in plants.

Examples : *Bt* cotton, *Bt* corn, *Bt* rice, *Bt* tomato, *Bt* potato and *Bt* soyabean.

2 Agrobacterium tumefaciens :

(i) A soil bacterium that causes crown gall tumours in dicolyledonous plants.

(ii) The gall producing gene T-DNA- occurs in a large plasmid - Tumour inducing (Ti) plamid

(iii) Thus, *Agrobacterium tumefaciens* is used for gene transfer in higher plants, where T-DNA becomes the marker gene.

Examples : Flavr savr. Tomato, Golden Rice

Donor organism	Donor gene	Vector organism	Vector DNA	Host	Transgenic variety
Bacillus thuringensis	*Bt* toxin (gene) crystal/cry (Protein)	*Agrobacterium tumefaciens*	Tumor inducing plasmid (Ti plasmid)	Dicotely-denons plants	Insect resistant plant : *Bt* cotton *Bt* tobacco *Bt* maize *Bt* corn

Biosafety issues :

(i) Biosafety issues are the issues related to the commercialitzation of transgenic crops and their impact on agriculture, human health and environment.

(ii) Genetic modifications of organisms can have beneficial as well as harmful and unpredictable effects when such organisms are released into the ecosystem.

(iii) GEAC or Genectic Engineering Approval committee has been set-up by the Government of India to take decisions regarding the validity of GM research and safety of introducing GM products for products and services.

2. Biopatent

(i) A biopatent is the patent granted by the government to the inventor of biological entities, processes and products.

(ii) A patent gives the owner exclusive rights to use the resource, process or market the product and earn porfits.

3. Biopiracy

(i) Biopiracy is the unlawful biopatenting of the bioresource of other nation without proper permisson of the concerned nation or unlawful exploitation of the bioresource without giving compensation.

(ii) Developed countries have been enjoying immense profits by patenting the knowledge and bioresources of underdeveloped countries.

Multiple Choice Questions

CLASSWORK - I

3.1 INTRODUCTION:

(1) _____ are produced by microbes and harvested using sophisticated biotechnological process.

(a) Vitamins (b) Minerals

(c) Antibiotics (d) Both a and c

(2) Plant tissue culture has enabled plant breeders to cultivate crops with qualities like

(a) Rapid growth

(b) Less fertilizers requirement

(c) Thriving in poor soil conditions

(d) All of these

(3) EFB stands for

(a) European Formulation of Biotechnology

(b) European Facilitation of Biotechnology

(c) European Federation of Biotechnology

(d) European Formation of Biotechnology

3.2 Recombinant DNA Technology

(4) In rDNA technology, the fragment with desired genes are inserted in

(a) Recombinant vector

(b) Cloning vector

(c) Replication vector

(d) Regeneration vector

(5) The cloning vector carrying the desired genes is known as _____ vector

(a) Recombined (b) Recombination

(c) Recombinant (d) Recopied

(6) The cell that receives the recombinant vector is called _____ cell

(a) Ghost (b) Host

(c) Recombinant (d) Cloning

(7) Insertion of cloning vector in eukaryotic cells is called

(a) Transfection (b) Transduction

(c) Transformation (d) None of these

CLASSWORK - II

3.3 Transposons, plasmids and Bacteriophages

(8) _____ % of the total genome of maize consists of transposons

(a) 25 (b) 130 (c) 50 (d) 45

(9) Transposons in Humans are called

(a) *Alo* sequences (b) *Alu* sequences

(c) *Aul* sequences (d) *Ace* sequences

(10) DNA transposons transpose themselves by _____ mechanism

(a) Cut and paste (b) Control and paste

(c) Copy and paste (d) Complete and paste

(11) Because of their capability of autonomous replication within a suitable host, plasmids are considered as

(a) Multicons (b) Replicons

(c) Repliclones (d) None of these

(12) The genetic material in bacteriophages can be

(a) Circular (b) Linear

(c) Both (a) and (b) (d) None of these

(13) The packing of recombinant DNA in viral particles is done

(a) *in vitro* (b) *in vivo*

(c) *in ovo* (d) None of these

(14) On a lawn of bacterial cells, lysis of bacterial cells after infection with bacteriophages gives rise to _____

(a) Plaques (b) Plates

(c) Holes (d) Inhibition zones

3.4 Restriction Fragments

(15) The process of cutting DNA with restriction enzymes is called

(a) Restriction (b) Cutting

(c) Multiplication (d) fragmentation

(16) The roman numerical in the name of the restriction enzyme stands for

(a) Number of times it has been used

(b) Order of discovery

(c) Number of experiments carried out to discover it

(d) Number of organism from which it is isolated

(17) Restriction endonucleases recognise sites which are _____ in nature

(a) Inverted (b) Palindromic

(c) Ambigramatic (d) epigrammatic

CLASSWORK - III

3.5 Preparing and Cloning ADNA Library

(18) Collection of all clones of DNA fragments representing the complete genome of an organisms is

(a) cDNA library

(b) Genomic library

(c) Molecular library

(d) Gene pool

(19) How many DNA fragments are inserted into each host cell while constructing a genomic library?

(a) 1 (b) 2 (c) 10 (d) 50

(20) Which RNA is used for producing cDNA library?

(a) tRNA (b) rRNA

(c) snRNA (d) mRNA

(21) Non-coding and coding regions are seen in genes of which organisms?

(a) Bacteria (b) Yeast

(c) Prokaryotes (d) Eukaryotes

(22) mRNA for construction of cDNA library are isolated from_____ at different times and phases of the life cycle of an organism what part of the organism can be chosen as an efficient source?

(a) Cells (b) Tissues

(c) Organs (d) All of these

(23) Production of human proteins such as interferon, insulin and blood clotting factor VIII can be done using

(a) Genomic Library

(b) cDNA

(c) PCR

(d) Gel electrophoresis

3.6 Gene Amplification(PCR)

(24) Primers contain _____ nucleotides

(a) 10 – 12 (b) 17 – 30

(c) 25 – 50 (d) 15 – 40

(25) The thermostable DNA polymerase used in PCR is known as

(a) *Tuq* polymerase (b) *Baq* polymerase

(c) *Eco* polymerase (d) *Taq* polymerase

(26) Alternate heating and cooling of PCR sample is termed as

(a) Thermal cycling (b) Thermal recycling

(c) Heat Denaturation (d) Primer Annealing

(27) Heat denaturation is carried out at

(a) 55^0C (b) 98^0C (c) **91^0C** (d) 72^0C

CLASSWORK - IV

3.7 Applications of Biotechnology in Agriculture

(28) Usage of bio fertilizers in agriculture for increase of food production is called

(a) Inorganic farming

(b) Organic farming

(c) Traditional farming

(d) Modern farming

(29) Already produced transgenic plants exhibit which traits?

(a) Disease resistance

(b) Insect resistance

(c) Herbicide resistance

(d) All of these

(30) Why are insect resistant crops / Bt crops produced?

(a) To increase the dependence of farmers on agrochemicals

(b) To decrease the independence of farmers on agrochemicals

(c) To decrease the dependence of farmers on agrochemicals

(d) None of these

(31) *Bt* stands for

(a) Bacterium T – DNA

(b) *Bacillus thuringiensis*

(c) *Bacillus thioparans*

(d) *Bacillus thermoamylovorans*

(32) What activates the Bt toxin in the gut of the insect?

(a) Alkaline pH

(b) Acidic pH

(c) Neutral pH

(d) Amphoteric conditions

(33) Nitrogen fixation gene is

(a) *nif* gene (b) *nf* gene

(c) N_2 gene (d) *nfx* gene

(34) Golden rice has high content of

(a) Vitamin A (b) Pro-vitamin A

(c) Beta carotene (d) Both (b) and (b)

3.8 Biosafety issues

(35) Bio piracy is concerned with

(a) Bio patenting of bio resources of other nations

(b) Unlawful exploitation and use of bio-resources of other nations

(c) Giving no compensation to the nations whose bio resources are being exploited

(d) All of these

(36) _____ rice grown in India is known for it unique aroma and flower.

(a) Texmati (b) Basmati

(c) Kolam (d) None of these

(37) Texmati is cross between Basmati and _____ variety of rice

(a) Dwarf variety (b) Tall variety

(c) Semi draft variety (d) Semi –tall variety

(38) Manipulation of gene or genetic engineering has been made possible because of

(a) Discovery of restriction enzyme

(b) Development of method for construction of DNA having desirable genes

(c) Both a and b

(d) None of the above

(39) Introduction of one or more genes into an organism which normally does not possess them comes under

(a) Molecular biology

(b) Genetic hybridisation

(c) Cytogenetics

(d) Genetic engineering

(40) In genetic engineering term vector is applied for

(a) Plasmid (b) Sources of DNA

(c) Cell which receive (d) Virus

Multiple Choice Questions

HOMEWORK - I

3.1 Introduction

(1) _____ is the oldest form of biotechnology.

(a) Vitamin production

(b) Fermentation

(c) Tissue culture

(d) DNA manipulation

(2) Techniques in biotechnology are

(a) *In vitro* fertilization

(b) Correction of defective gene

(c) Synthesizing a gene

(d) All of these

(3) Biotechnology is the integration of _____ for products and services

(a) Natural science and organisms

(b) Cells and their parts

(c) Molecular analogues

(d) All of these

3.2 Recombinant DNA Technology

(4) Vectors or carriers used to carry recombinant DNA in genetic engineering are

(a) Plasmids

(b) Bacteriophages

(c) Plant and animal viruses

(d) All of these

(5) DNA fragments with sticky ends are not allowed to undergo self – ligation by

(a) Alkaline phospatase

(b) Gyrase

(c) Unwindase

(d) Helicase

(6) Which of the following properties make plasmids suitable vectors for gene cloning

(a) Plasmids are small circular DNA molecules that can integrate with host chromosomal DNA

(b) Plasmids are small circular DNA molecules with their own replication origin site

(c) Plasmids can shuttle between prokaryotic and eukaryotic cells

(d) Plasmids often carry antibiotic resistance gene

(7) Genetically engineered bacteria have been used in commercial production of

(a) thyroxine (b) testosterone

(c) human insulin (d) helicase

(8) An enzyme that joins the ends of two stands of nucleic acid is

(a) polymerase (b) ligase

(c) synthetase (d) helicase

HOMEWORK - II

3.3 Transposons, Plasmids & Bacteriophages

(9) Significant phenotypic mutations and alteration of genome size can occur naturally due to

(a) Transposition (b) Transfer

(c) Transalteration (d) None of these

(10) Retro transposons transpose themselves by _____ mechanism

(a) Cut and paste (b) Control and paste

(c) Copy and paste (d) Complete and paste

(11) Which enzyme is involved in the transposition of DNA transposons?

(a) Restriction Endonuclease

(b) Transposase

(c) Ligase

(d) Both b) and c)

(12) The term plasmid was introduced by

(a) Peter Lobban (b) Stanley Cohen

(c) Kary Mullis (d) Joshua Lederberg

(13) Lambda phage DNA is _____ kb in length

(a) 4.85 (b) 48.5

(c) 485.0 (d) 0.485

(14) The 12bp ends in the lambda phage DNA are known as _____

(a) Sine sites (b) Tan sites

(c) Cos sites (d) Cosec sites

(15) Newly formed viruses are called

(a) Virusoids (b) Viroids

(c) Virions (d) Viriods

3.4 Restriction Fragments

(16) The first ever restriction end nucleases were isolated from

(a) *Haemophilius influenza*

(b) *Klebsiella pneumonia*

(c) *Salmonella typhimurium*

(d) Escherichia coli

(17) The nucleases that remove nucleotides from the end of DNA are known as

(a) Endonucleases

(b) Endoproteases

(c) Exonucleases

(d) Exoproteases

(18) The nucleases that make cuts at specific positions within the DNA are as known as

(a) Endophosphatases

(b) Exonucleases

(c) Exophosphatases

(d) Endonucleases

(19) How many types of restriction end nucleases are present?

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

(20) Which type of endonucleases are utilized for recombinant DNA technology

(a) Type I (b) Type II

(c) Type III (d) All of these

(21) In *Eco*RI, R Stands for

(a) Genus of the bacterium

(b) Species of the bacterium

(c) Strain of the bacterium

(d) Order of discovery of the enzyme

(22) Restriction enzyme *Hind*III is isolated from

(a) *Haemophilius parainfluenzae*

(b) *Haemophilius ducreyi*

(c) *Haemophilius aegyptius*

(d) *Haemophilius influenza*

(23) Restriction site consists of _____ number of nucleotides

(a) 4 – 8 (b) 4 – 10

(c) 3 – 8 (d) 5 – 9

(24) Which of the following is a palindromic sequence?

(a) 5^1 – TAACCG - 3^1

3^1 – ATTGGC - 5^1

(b) 5^1 – GCATAT - 3^1

3^1 – CGTATA - 5^1

(c) 5^1 – GAATTC- 3^1

3^1 – CTTAAG - 5^1

(d) 5^1 – ATGCTT- 3^1

3^1 – TACGAA - 5^1

(25) Restriction endonucleases cleave the DNA molecules by bringing about the _____ of phosphodiester bonds

(a) Hydrolysis (b) Oxidation

(c) Ligation (d) Reduction

(26) The single stranded extensions of DNA obtained on double stranded restriction fragments are called as

(a) Pokey ends (b) Blunt ends

(c) Gluey ends (d) Sticky ends

(27) Restriction endonucleases cut

(a) Double stranded DNA

(b) Single stranded DNA

(c) Single stranded RNA

(d) Double stranded RNA

(28) A plasmid is

(a) Genetic material of a virus

(b) Extra – chromosomal DNA in a bacterial cell

(c) Smallest bacterium

(d) Slime mould

(29) Which of the following is a plasmid?

(a) pBR322 (b) *Bam*HI

(c) *Hind*III (d) *Eco*RI

(30) The mobile genetic element is

(a) transposon (b) mutation

(c) endonuclease (d) variation

(31) Cosmid is _____

(a) Extragenetic material in mycoplasma

(b) Circular DNA in bacteria

(c) Extra DNA in bacteria

(d) A plasmid carring 'cos' sites from λ-phage DNA

HOMEWORK - III

3.5 Gene Amplification (PCR)

(32) Who discovered the process of reverse transcription?

(a) Werner Arber and Steward Linn

(b) Peter Lobban and A.Dale Kaiser

(c) Temin and Baltimore

(d) Stanley Cohen and Herbert Boyer

(33) PCR is a _____ reaction

(a) *in vitro* (b) *in vivo*

(c) *in situ* (d) *ex situ*

(34) PCR was developed by

(a) Stanley Cohen (b) Barbara Mellintock

(c) Kary Mullis (d) Peter Lobban

(35) The enzyme used in polymerase chain reaction is

(a) *Taq* polymerase (b) RNA polymerase

(c) Ribonuclease (d) Endonuclease

(36) Gene amplication using primers can be done by

(a) Microinjection

(b) ELISA

(c) Polymerase chain reaction

(d) Gene gun

(37) Which of the following radioisotope is not suitable for DNA labelling based studies?

(a) H^3 (b) P^{32} (c) N^{15} (d) S^{35}

(38) The function of Polymerase Chain Reaction (PCR) is

(a) Translation

(b) Transduction

(c) DNA amplification

(d) None of these

HOMEWORK - IV

3.6 Application of Biotechnology in Agriculture

(39) To increase food production, which of the following technique can be used?

(a) Use of chemical fertilizers and pesticides

(b) Use of bio – pesticides and bio – fertilizers

(c) Use of genetically engineered crops

(d) All of these

(40) *Bt* toxin occurs as _____

(a) Active toxin

(b) Active proto toxin

(c) Inactive prototoxin

(d) Inactive toxin

(41) _____ is available in India to control the disease affecting cotton balls.

(a) *Bt* cotton (b) Transgenic cotton

(c) *Bt* spray (d) None of these

(42) The dependence on insecticides has been brought down by cloning and introducing _____ in many plants

(a) *Bt* toxin gene (b) *cry* gene

(c) *nif* gene (d) Both (a) and (b)

(43) Ti stands for

(a) Transfer induction

(b) Transfection induction

(c) Tumour inducing

(d) None of these

(44) The gall producing gene is known as

(a) C-DNA (b) G-DNA

(c) A-DNA (d) T-DNA

(45) The gall producing gene is found in _____ of Agrobacterium tumefaciens.

(a) Ti plasmid (b) At plasmid

(c) Bi plasmid (d) Ai plasmid

(46) Golden Rice and Flavr Savr Tomato have been produced by genetic modifications using

(a) *Bacillus thuringiensis*

(b) *Thermus aqauticus*

(c) *Agrobacterium tumefaciens*

(d) *Rhizobium*

(47) In Flavr Savr Tomato, additional copy of polygalacturonase gene has been inserted in _____ orientation.

(a) Missense (b) Antisense

(c) Nonsense (d) Sense

(48) Indian government was set up _____ for taking decision regarding the validity of GM research and safety of introducing GM products for public service.

(a) GEAC (b) GCAE

(c) GACE (d) GAEC

(49) Texas based company obtained patent for Basmati through which office?

(a) US patent and Trademark Office

(b) US department of energy

(c) National institute of health

(d) Foods and Drug administration

(50) Unlawful patents have been granted for

(a) Basmati (b) Turmeric

(c) Margosa (d) All of these

(51) _____ would help in better understanding of the opportunities and risks associated with rDNA technology.

(a) Genetic literacy movements in schools & colleges

(b) Genetic illiteracy movement in school & colleges

(c) Gene library in schools and colleges

(d) None of these

(52) _____ countries are rich in biodiversity and traditional knowledge .

(a) Developed (b) Developing

(c) Undeveloped (d) Both (b) and (c)

(53) Tumour inducing (Ti) plasmid transforms

(a) Animals (b) Plants

(c) Bacteria (d) Fungi

(54) *Bacillus thuringinesis* (*Bt*) strains have been used for designing novel

(a) Bioinsecticidal plants

(b) Bio-mineralization processes

(c) Biofertilizers

(d) Bio-metallurgical techniques

(55) Transgenic plants are developed by

(a) Introducing foreign genes

(b) Introducing gene mutations

(c) Deleting certain chromosomes parts

(d) Stopping spindle formation

(56) 'Golden rice' or 'Miracle rice' is transgenic rice rich in

(a) Vitamin B and iron

(b) Vitamin A and iron

(c) Vitamin A and Vitamin B

(d) Pro-vitamin A

(57) *Bt* cotton is resistant to

(a) *Boll worms* (b) Butterfly

(c) Grasshopper (d) Worm

(58) Cultivation of *Bt* cotton has been much in the news. The prefix *Bt* means

(a) 'Barium treated' cotton seeds

(b) 'Bigger thread' variety of cotton with better tensile strength

(c) Prodced by 'biotechnology' using restriction enzymes and ligases

(d) Carrying a prototoxin producing gene from *Bacillus thuringiensis*

(59) Main objective of production/use of herbicide resistant GM crops is to

(a) Encourage eco-friendly herbicides

(b) Reduce the dependence of farmers on chemical herbicides

(c) Eliminate weeds from the field without the use of manual labour

(d) Eliminate weeds from the field without the use of herbicides

(60) 'Flavr Savr' and Endless Summer' are transgenic

(a) Tomatoes (b) Potatoes

(c) Squash (d) Canolas

(61) Increased flavourful shelf life of tomato has been achieved by

(a) Enhancing epidermal growth factor

(b) Reducing activity of enzyme polygalacturonase

(c) Promoting activity of enzyme polygalacturonase

(d) Developing between storage facilities

(63) Specific gene transfer in plants is mostly done with

(a) *Bacillus radicicola*

(b) *Agrobacterium tumefaciens*

(c) *Plant and animal viruses*

(d) *Bacillus megatherium*

(64) Ti-plasmid used for introducing genes in plants is obtained from

(a) *Escherichia coli*

(b) *Agrobacterium tumefaciens*

(c) *Agrobacterium rhizogenes*

(d) *Klebsiella*

(65) There is a restriction endonuclease called *Eco* RI. What does '*co*' part in it stand for?

(a) *coelom* (b) *coenzyme*

(c) *coli* (d) *colon*

(66) Which of the following is correctly matched?

(a) *Agrobacterium tumefaciens* – Tumour

(b) *Thermus aquaticus* –*Bt* gene

(c) pBR322 – Enzyme

(d) Ligase – Molecular scissors

(67) Microbes found to be very useful in genetic engineering are

(a) *Escherichia coli and Agrobacterium tumefaciens*

(b) *Vibrio cholerae* and a tailed bacteriophase

(c) *Diplococcus sp.* And *Pseudomonas sp.*

(d) Crown gall bacterium and *Caenorhabditis elegans*

(68) Introduction of foreign gene for improving genotype is called

(a) Tissue culture (b) Vernalization

(c) Transgenesis (d) Eugenics

EVALUATION PAPER - BIOTECHNOLOGY : PROCESS AND APPLICATION

Time : 30 Min. **Marks : 25**

(1) The main technique involved in agricultural biotechnology is called
(a) tissue culture (b) transformation
(c) amplification (d) DNA replication

(2) Biotechnology deals with
(a) prokaryotes only (b) microorganisms
(c) plant and animal cells (d) both (a) and (b)

(3) Tool/s used by Stanley Cohen and Herbert Boyer in rDNA technology was/were
(a) antibiotic resistance gene (b) plasmid of *Salmonella*
(c) *E. coli* (d) all of these

(4) Recombinant DNA is also called is
(a) chimeric DNA (b) rDNA (c) cDNA (d) both (a) and (b)

(5) The chemical knives of DNA are
(a) ligases (b) polymerases (c) endonucleases (d) transcriptase

(6) The human hormone produced by recombinant DNA technique is
(a) Lysozyme (b) Relaxin (c) α–Interferon (d) Factor VII

(7) 'Alu' sequence is a
(a) plasmid (b) cosmid (c) transposon (d) phage

(8) Commonly used bacteriophages as cloning vectors are
(a) T_3 phage (b) T_4 phage
(c) M_{13} and lambda phage (d) both T_3 and T_4 phage

(9) Restriction endonuclease requires which of the following ions for cleavage
(a) Na^{++} (b) Mg^{++} (c) K^{+} (d) H^{+}

(10) Band pattern characteristics of original DNA molecule can be developed by
(a) lytic cycle (b) agarose gel electrophoresis
(c) denaturation (d) gene amplification

(11) Screening of desired gene during construction of genomic library is done through
(a) complementation (b) probes
(c) electrophoresis (d) both (a) and (b)

(12) For annealing, temperature required is about _____
(a) 55^0C (b) 75^0C (c) 90^0C (d) 25^0C

(13) Technique used in forensic sciences is
(a) DNA fingerprinting (b) tissue culture
(c) cloning (d) teminism

(14) Two bacteria found to be very useful in genetic engineering experiments are
(a) *Nitrosomonas* and *Klebsiella* (b) *Escherichia* and *Agrobacterium*
(c) *Nitrobacter* and *Azotobacter* (d) *Rhizohium* and *Diplococcus*

(15) Recombinant DNA technique can be
(a) harmful (b) useful
(c) both, harmful and useful (d) neither harmful nor useful

(16) The pre – requisites for biotechnological production of antibiotics is
(a) to search an antibiotic producing micro – organism.
(b) to isolate the antibiotic gene.
(c) to join antibiotic gene with a suitable cloning vector.
(d) all of these.

(17) In rDNA technology, tranformed bacterial colony can be identified using
(a) vectors (b) marker (c) stain (d) plasmid

(18) Which phenomenon can create mutation ?
(a) Transduction (b) Transfection (c) Transposition (d) Transformation

(19) Which of the following statements is correct ?
(a) During insertion of DNA molecules in bacteriophage, capsid is removed.
(b) During insertion of DNA molecules in bacteriophage, viral portion is retained.
(c) During insertion of DNA molecules in bacteriophage, viral portion is removed.
(d) None of the above.

(20) Which is not true about restriction endonuclease ?
(a) Restriction endonuclease cuts the DNA at specific points.
(b) They are used as tools for gene cloning.
(c) While naming restriction endonuclease, the first word indicates name of scientist who isolated it.
(d) Most restriction sites are palindromes.

(21) In genetic engineering, the same endonuclease are used to cut vector DNA and donor DNA as
(a) they have identical restriction sites
(b) they give identical sticky ends.
(c) joining of two DNA strands is easy due to complementary base pairing
(d) all of these

(22) Which committee has been set to keep check on GM research and GM product ?
(a) GEAC (b) IARI (c) IRRI (d) GMFAC

(23) Which vector can clone only a small fragment of DNA ?
(a) Bacterial atificial chromosome (b) Yeast artificial chromosome
(c) Plasmid (d) Cosmid

(24) Golden rice is a transgenic crop of the future with the following improved trait
(a) High lysine (essential amino acid) content (b) Insect resistance
(c) High protein content (d) High pro–vitamin A content

(25) In *Bt* cotton. the *Bt* toxin present in plant tissue as pro – toxin is converted into active toxin due to :
(a) alkaline pH of the insect gut
(b) acidic pH of the insect gut.
(c) action of gut micro – organisms
(d) presence of conversion factors in insect gut.

EVALUATION PAPER - BIOTECHNOLOGY PROCESS AND APPLICATION ANSWER KEY

1 **a**	2 **d**	3 **d**	4 **d**	5 **c**	6 **b**	7 **c**	8 **c**	9 **b**	10 **b**
11 **d**	12 **a**	13 **a**	14 **b**	15 **c**	16 **d**	17 **b**	18 **c**	19 **c**	20 **c**
21 **d**	22 **a**	23 **c**	24 **d**	25 **a**					

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