Session : 2025-26 **AS PER NEW NTA SYLLABUS**

Total Questions : 347

BIOLOGY (QUESTION BANK)

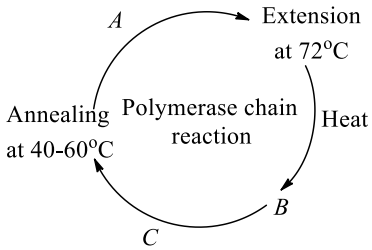
11.BIOTECHNOLOGY PRINCIPLES AND PROCESSES

Single Correct Answer Type

1. First hormone prepared by genetic engineering is:
   a) Insulin b) Oxytocin c) Adrenaline d) Somatotropin
2. Retroviruses in animals including humans are able to change normal cells into
   a) Germ cell b) Cancerous cells c) Cosmid d) Vector
3. The restriction enzyme responsible for the cleavage of following sequence is
   $5' - G - T - C - G - A - C - 3'$
   $3' - C - A - G - C - T - G - 5'$
   a) *Alu* I b) *Bam* HI c) *Hind* II d) *Eco* RI
4. pBR322 was the first artificial cloning vector developed in ...A... by ...B... and ...C... from *E. coli* plasmid. Here A, B and C can be
   a) A-1976, B-Boliver, C-Rodriquez b) A-1975, B-Tiselius, C-Rodriquez
   c) A-1977, B-Boliver, C-Rodriquez d) A-1978, B-HO Smith, C-KW Wileox
5. Transfer of any gene into a completely different organism can be done through
   a) Genetic engineering b) Tissue culture c) Transformation d) None of these
6. An environmental agent that triggers transcription from an operon is a:
   a) Depressor b) Inducer c) Regulator d) Controlling element
7. Recombinant DNA have integrated fragment of
   a) Antibiotic resistant gene b) Diseases resistant gene
   c) Allergy resistant gene d) All of these
8. In plants, the tumour inducing plasmid (Ti) of *Agrobacterium tumefaciens* is used as a cloning vector. This statement is
   a) True b) False
   c) Sometimes (a) and sometimes (b) d) Neither (a) nor (b)
9. If recombinant DNA carrying antibiotic resistance (*e. g.*, ampicillin) is transferred into *E. coli* cell, the host cell is transformed into ampicillin-resistant cells. The ampicillin resistant gene in this case is called a
   a) Vectors b) Plasmid c) Selectable marker d) Cloning sites
10. Boviene spongiform encephalopathy disease is equal to:
    a) Kala Azar b) Parkinson's disease
    c) Creutzfeldt-Jacob disease d) None of the above
11. Known sequence of DNA that is used to find complementary DNA strand is:
    a) Vector b) Plasmid c) DNA probe d) Recombinant DNA
12. Proteins are removed by treatment with
    a) Ribonuclease b) Chitinase c) Cellulase d) Protease
13. Which of the following key factors, makes plasmid, the vector in genetic engineering?
    a) It is resistant to antibiotics b) It is resistant to restriction enzymes
    c) Its ability to carry a foreign gene d) Its ability to cause infection in the host
14. I. *Ori* also controls the copy numbers of the linked DNA
    II. If a foreign DNA ligates at the *Bam* HI site of tetracycline resistance gene in the vector pBR322, the recombinant plasmid loses the tetracycline resistance due to insertion of foreign DNA
    Choose regarding the above statements

a) I is true, II is false b) II is true, I is false c) Both are true d) Both are false

15. When scientists make an animal superior by view of genotype, introducing some foreign genes in it, the phenomenon is called:
    a) Tissue culture b) Biotechnology c) Genetic engineering d) Immunisation
16. Many copies of a DNA molecule in a test tube are produced by:
    a) Polymerase chain reaction (PCR) b) Molecular chain reaction (MCR)
    c) Ephemeral chain reaction (ECR) d) All of them
17. Producing a 'giant mouse' in the laboratory was possible through:
    a) Gene mutation b) Gene duplication c) Gene synthesis d) Gene manipulation
18. Downstream process includes
    I. Separation of the product from the reactor
    II. Purification of the product
    III. Formation of the product with suitable preservatives
    IV. Quality control testing and clinical trials in case of drugs
    Which of the statements given above are correct?
    a) I, II and III b) I, II and IV c) II, III and IV d) I, II, III and IV
19. More advancement in genetic engineering is due to
    a) Restriction endonuclease b) Reverse transcription
    c) Protease d) Zymase
20. Plasmid are suitable vectors for gene cloning because
    a) These are small circular DNA molecules, which can integrate with host chromosomal DNA
    b) These are small circular DNA molecules with their own replication origin site
    c) These can shuttle between prokaryotic and eukaryotic cells
    d) These often carry antibiotic resistance genes
21. Polymerase chain reaction is useful in
    a) DNA synthesis b) DNA amplification
    c) Protein synthesis d) Amino acid synthesis
22. Study the following diagram and identify *A*, *B* and *C*



    a) A-*Taq* polymerase, B-Denaturation at 94°C, C-Primer
    b) A-Denaturation at 94°C, B-*Taq* polymerase, C-Primer
    c) A-Primer, B-Denaturation at 94°C, C-*Taq* polymerase
    d) A-*Taq* polymerase, B-Extension, C-Transformation
23. A bioreactor is
    a) Hybridoma b) Culture containing radioactive isotopes
    c) Culture for synthesis of new chemicals d) Fermentation tank
24. Which of the following techniques can be used to detect genetic disorders in human?
    a) Polymerase Chain Reaction (PCR) b) Gel electrophoresis
    c) Spectroscopy d) All of the above
25. Special sequence in the DNA recognized by restriction endonuclease is called
    a) Restriction nucleotide sequence b) Palindromic nucleotide sequence
    c) Recognition nucleotide sequence d) All of the above
26. Primers are

a) Small chemically synthesized oligonucleotides of about 10-18 nucleotides that are complementary to the region of template DNA
b) Chemically synthesized oligonucleotides of about 10-18 nucleotides that are not complementary to the region of template DNA
c) The double-stranded DNA that need to the amplified
d) Specific sequences present on recombinant DNA

27. This method of finding a gene is used when researchers very little about the gene they are trying to find. This process results in a complete gene library : a collection of copies of DNA fragments that represent the entire genome of an organism. Identify the method
a) Cloning b) Shotgun cloning c) Gene synthesis d) Cloning

28. Consider the following statement about PCR
I. Polymerase Chain Reaction (PCR) is a technique of synthesizing multiple copies of the desired gene in *vitro*
II. This technique was developed by Kary Mullis in 1985
III. A single PCR amplification cycle involves three basic steps; denaturation, annealing and extension
Which of the statement given above are correct?
a) I and II b) I and III c) II and III d) I, II and III

29. A somatic plant cell has potential to develop into a full plant. This is called:
a) Totipotency b) Gene cloning c) Tissue culture d) Regeneration

30. *Ori* is a DNA sequence that is responsible for initiating replication. This statement is
a) True b) False
c) Sometimes (a) and sometimes (b) d) Neither (a) nor (b)

31. Plasmids are autonomously replicating circular extrachromosomal DNA. This statement is
a) True b) False
c) Sometimes (a) and sometimes (b) d) Neither (a) nor (b)

32. Genetic engineering is possible because:
a) The phenomenon of transduction in bacteria is well understood
b) We can see DNA by electron microscope
c) We can cut DNA at specific sites by endonucleases like DNA ase I
d) Restriction endonucleases purified form bacteria can be used in vitro

33. A single PCR amplification cycle involves
a) Denaturation b) Annealing c) Extension d) All of these

34. DNA fingerprinting is related to:
a) Molecular analysis of profiles of DNA samples
b) Analysis of DNA samples using imprinting devices
c) Techniques used for molecular analysis of different specimens of DNA
d) Techniques used in identification of fingerprints of different persons

35. The basic of DNA fingerprinting is:
a) The double helix b) Errors in base sequence
c) Polymorphism in sequence d) DNA replication

36. In genetic engineering, the terms vector is applied for:
a) Plasmid b) Sources of DNA c) Cell which receives d) Virus

37. Which of the following are used to gene cloning?
a) Nucleoids b) Chromosomes c) Mesosomes d) Plasmid

38. The process that preserves the distribution of DNA fragments in the gel while creating replica on the filter is one of the following
a) Directed sequencing of BAC counting b) Random shotgun sequencing
c) Electrophoresis d) Southern blotting

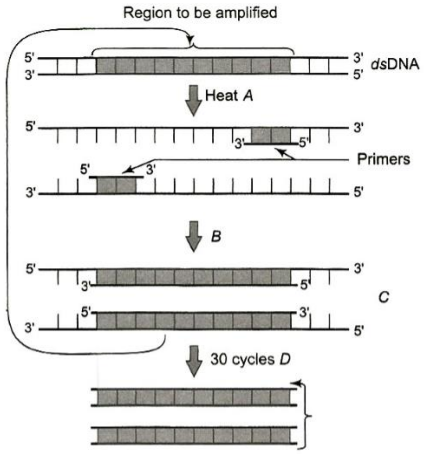
39. Two enzymes responsible for restricting the growth of bacteriophages in *E. coli* were isolated. One was methylase and other was restriction endonuclease. What is the significance of methylase?

a) Protection of host DNA from the action of restriction endonuclease by adding methyl group to one or two bases usually with in the sequence recognized by restriction enzyme
b) Able to ligate the two cohesive ends of DNA molecule
c) Able to remove the methyl group and hence, prevent the action of restriction endonuclease on host DNA
d) Able to cut the DNA of bacteriophage at specific sites

40. Single-stranded DNA molecules that can bind to and be used to detect other DNA molecules are called
a) Primer b) STRs c) RFLPs d) Probes

41. Which of the following enzyme is used in genetic engineering?
a) Translocase b) Topoisomerase
c) DNAse d) Restriction endonuclease

42. The below diagram refer to PCR. Identify the steps *A*, *B* and *C* and select the correct option



a) A-Denaturation of 94-96°C, B-Annealing of 40-60°C, C-Extension through *taq* polymerase at 72°C, D-Amplified
b) A-Annealing of 94-96°C, B-Denaturation of 40-60°C, C-Extension through *taq* polymerase at 72°C, D-Amplified
c) A-Extension through *taq* polymerase at 40-60°C, B-Amplified, C-Denaturation of 40-60°C, D-Annealing of 94-96°C
d) A-Annealing, B-Extension through *taq* polymerase at 40-60°C, C-Denaturation of 94-96°C, D-Annealing of 40-60°C

43. The controlled use of biological agents, such as microorganism, plants or animal cell, for beneficial use is called
a) Biochemistry b) Molecular biology c) Biotechnology d) Microbiology

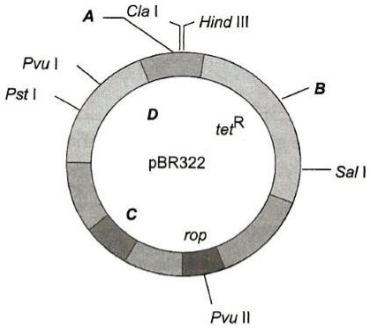
44. Humulin is a:
a) Pig insulin b) Human insulin c) Viral insulin d) Human clone

45. Find the incorrect statement:
a) Gene therapy is a genetic engineering technique used to treat disease at molecular level by replacing defective genes with normal genes
b) Calcitonin is a medically useful recombinant product in the treatment of infertility
c) Bt toxin is a biodegradable insecticide obtained from Bacillus thuringiensis
d) Trichoderma sp. is a biocontrol agent for fungal diseases of plants

46. Plasmids are extrachromosomal circular DNA molecules:
a) Which have their own point of replication and can replicate independently
b) Which have their own point of replication but cannot replicate independently
c) Which do not have their own point of replication and cannot replicate independent of bacterial of bacterial chromosomal DNA
d) None of the above

47. The genome map was produced under human genome project in:
a) 1992 b) 1994 c) 1996 d) 2000

48. Term hybridoma implies:
    a) DNA-RNA hybrid
    b) Recombination of DNA molecules
    c) Somatic hybridisation
    d) Genetic fusion
49. Which of the following is a difficulty in getting prokaryotic cells to express eukaryotic genes?
    a) The signals that control gene expression are different and prokaryotic promoter regions must be added to the vector
    b) The genetic code differs between the two because prokaryotes substitute the base uracil for thymine
    c) Prokaryotic cells cannot transcribe introns because their genes do not have them
    d) The ribosomes of prokaryotes are not large enough to handle long eukaryotic genes
50. In transgenics, the expression of transgene in the target tissue is known by:
    a) Enhancer
    b) Transgene
    c) Promoter
    d) Reporter
51. Identify A, B, C and D in the given diagram of $E.coli$ cloning vector pBR322



    a) A-*Eco* RI, B-*Bam* HI, C-Ori, D-amp^R
    b) A- amp^R, B- *Ori*, C-*Bam* HI, D-*Eco* RI
    c) A-*Ori*, B-*Bam* HI, C-*Eco* RI, D-amp^R
    d) A-*Bam* HI, B-*Eco* RI, C- amp^R, D-*Ori*
52. Consider the following statements
    I. In microinjection method foreign DNA is directly injected into the nucleus of animal cell or plant cell by using micro needles or micro pipettes
    II. Microinjection method is used in oocytes, eggs and embryo
    III. Electroporation is the formation of temporary pores in the plasma membrane of host cell by using lysozyme or calcium chloride
    IV. In chemical mediated gene transfer method certain chemicals such as CO_2 help foreign DNA to enter the host cell
    Which of the statements given above are correct?
    a) I and II
    b) I, II and III
    c) II, III and IV
    d) I, II, III and IV
53. The construction of the first recombinant DNA was done by using the native plasmid of:
    a) $E.coli$
    b) $Salmonella\ typhimurium$
    c) $B.thuringiensis$
    d) Yeast
54. Gene amplification using primers can be done by
    a) Microinjection
    b) ELISA
    c) Polymerase chain reaction
    d) Gene gun
55. Polyethylene glycol method is used for
    a) Biodiesel production
    b) Seedless fruit production
    c) Energy production from sewage
    d) Gene transfer without a vector
56. The enzymes, commonly used in genetic engineering are
    a) Restriction endonuclease and polymerase
    b) Endonuclease and ligase
    c) Restriction endonuclease and ligase
    d) Ligase and polymerase
57. Which one of the following techniques had helped to solve many mysteries involving murders, robberies and rapes?
    a) Gene splicing
    b) Computer technology
    c) DNA fingerprinting
    d) Gene cloning
58. Consider the following statements

I. Recombinant DNA technology popularly known as genetic engineering is a stream of biotechnology which deals with the manipulation of genetic material by man *in vitro*
II. pBR322 is the first artificial cloning vector developed in 1977 by Boliver and Rodriquez from *E. coli* plasmid
III. Restriction enzymes belongs to a class of enzymes called nucleases
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

59. What is C-DNA?
a) Circular DNA
b) Cloned DNA
c) DNA produced from reverse transcription of RNA
d) Cytoplasmic DNA

60. PCR was developed by …A… in …B… and for this he received Nobel Prize for chemistry in …C… . Here A, B and C can be recognized as
A B C
a) Kary Mulllis 1990 1997
b) Flemming 1985 1993
c) Kary Mullis 1985 1993
d) Flemming 1990 1997

61. Cutting of a piece of DNA from a plasmid was done with the help of …A… enzymes, popularly known as …B… . Here A and B can be
a) A-Tu ligases; B-Molecular glu
b) A-Restriction enzyme; B-Molecular scissors
c) A-Joining enzyme; B-Molecular glu
d) A-DNA polymerases; B-Synthesising enzymes

62. In a genetic engineering experiment, restriction enzymes can be used for
a) Bacterial DNA only
b) Viral DNA only
c) Any DNA fragment
d) Eukaryotic DNA only

63. The components of a bioreactor are
I. an agitator system
II. an oxygen delivery system
III. foam control system
IV. temperature control system
V. pH control system
VI. sampling ports to with draw cultures periodically
Choose the correct option
a) I, II, III, IV and V b) II, IV, V and VI c) I, II, III, IV and VI d) All of these

64. The minimum length of cistron in base pairs which synthesizes a polypeptide of 50 amino acids is:
a) 50 bp b) 100 bp c) 150 bp d) 200 bp

65. I. DNA being a hydrophilic molecule cannot pass through cell membranes
II. The bacteria should be made competent to accept the DNA molecule
The correct option regarding the above statements is
a) I is true, but II is false
b) II is true, but I is false
c) I and II are true
d) I and III are false

66. In cloning plasmid pBR322
p stands for …A…
B stands for …B…
R stands for …C…
Choose the correct option
a) A-plasmid, B-Boliver, C-Rodriquez
b) A-plasmid, B-bacteria, C-Rodriquez
c) A-prophage, B-bacteriophage, C-Rodriquez
d) A-prophage, B-Boliver, C-Rodriquez

67. Blood stains are found at the site of murder. If DNA profiling technique is to be used for identifying the criminal, which of the following is ideal for use?
a) Serum b) Erythrocytes c) Leucocytes d) Platelets

68. The Ti plasmid used in genetic engineering is obtained from:
    a) *Bacillus thuringeinsis* b) *Agrobacterium rhizogenes*
    c) *Agrobacterium tumifaciens* d) *Escherichia coli*
69. Who got the Nobel prize in medicine for their discovery of 'G-proteins' and the role of these proteins in the cells:
    a) Robert and Philip Sharp b) Gilman and Rodbell
    c) Fischer and Krebs d) Ervin Nahar and Bert Sakmann
70. Which of the following is required to perform polymerase chain reaction?
    I. DNA template
    II. Primer
    III. *Taq* polymerase and *vent* polymerase
    Choose the correct option
    a) I, II and III b) I and II c) II and III d) II and III
71. The basis for DNA fingerprinting is:
    a) Occurrence of restriction fragment length polymorphism (RFLP)
    b) Phenotypic differences between individuals
    c) Availability of cloned DNA
    d) Knowledge of human karyotype
72. In genetic engineering, a DNA segment (gene) of interest, is transferred to the host cell through a vector. Consider the following four agents (I-IV) in this regard and select the correct option about which one or more of these can be used as a vector/vectors
    I. Bacterium
    II. Plasmid
    III. *Plasmodium*
    IV. Bacteriophage
    a) I, II and IV b) I only c) I and III d) II and IV
73. Transfer of any gene into a completely different organism can be done through
    a) Genetic engineering b) Tissue culture c) Transformation d) None of these
74. Thermostable enzymes '*taq*' and '*vent*' isolated from thermophilic bacteria are
    a) DNA polymerase b) DNA ligases
    c) Restriction endonucleases d) RNA polymerases
75. Due to chloramphenicol resistance gene, one is able to select a transformed cell in the presence of chloramphenicol. The chloramphenicol resistance gene in this case is called
    a) Origin of replication b) Selectable marker
    c) Cloning sites d) Insertional inactivation
76. GAATTC is the recognition site for the restriction endonuclease
    a) *Eco* RI b) *Hind* II c) *Eco* RII d) *Bam* HI
77. Plasmid is
    a) An autonomously replicating circular extrachromosomal DNA
    b) An autonomously replicating circular extrachromosomal RNA
    c) An circular protein molecules
    d) An autonomously replicating chromosomal DNA
78. The polymerase chain reaction is a technique that is used for
    a) *In vivo* replication of DNA
    b) *In vivo* synthesis of *m*RNA
    c) *In vitro* synthesis of *m*RNA
    d) *In vitro* replication of specific DNA sequence using thermostable DNA polymerase
79. Yeast has become important in genetic engineering because it:
    a) Has plasmids that can be genetically engineered
    b) Allows the study of eukaryotic gene regulation and expression

c) Grows readily and rapidly in the laboratory
d) All of the above

80. The genome of *Caenorhabditis elgans* consists of:
a) 3 billion base pairs and 30,000 genes
b) 12 million base pairs and 6,000 genes
c) 4.7 million base pairs and 4,000 genes
d) 97 million base pairs and 18,000 genes

81. 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) *Rhizobium* and *Diplococcus*

82. Gel electrophoresis is used for:
a) Isolation of DNA molecule
b) Cutting of DNA into fragments
c) Separation of DNA fragments according to their size
d) Construction of recombinant DNA by joining with cloning vectors

83. Then linking of antibiotic resistance gene with the plasmid vector became possible with:
a) DNA ligase
b) Exonucleases
c) Endonucleases
d) DNA polymerase

84. Restriction endonucleases are:
a) Present in mammalian cell for degradation of DNA when the cell dies
b) Synthesized by bacteria as part of their defence mechanism
c) Used for in vitro DNA synthesis
d) Both (B) and (C)

85. Which one of the following is related with genetic engineering?
a) Plasmids
b) Mitochondria
c) Mutations
d) Ribosomes

86. Enzyme that is used in PCR technology is
a) Ligase
b) Polymerase
c) Helicase
d) Reverse transcriptase

87. Genetic diagnosis by DNA testing:
a) Detects only mutant and normal alleles
b) Can be done only on eggs or sperms
c) Involves hybridization to ribosomal RNA
d) Utilizes restriction enzymes and a polymorphic site

88. An enzyme catalyzing the removal of nucleotides from the ends of DNA is
a) Endonuclease
b) Exonuclease
c) DNA ligase
d) *Hind* II

89. Inducible/lac operon system operates in:
a) Catabolic pathway
b) Anabolic pathway
c) Intermediate metabolism
d) All the above

90. Polymerase Chain Reaction (PCR) needs
a) DNA template
b) Primers
c) *Taq* polymerase
d) All of these

91. Consider the following statements
I. A soil inhabiting plant bacterium, *Agrobacterium tumefaciens*, a pathogen of several dicot plants is able to transfer a piece of DNA known as T-DNA
II. The T-DNA causes tumours
III. Tumour formation induced by Ti-plasmid
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

92. Restriction endonucleases are enzymes which
a) Make cuts at specific positions within the DNA molecule
b) Recognize a specific nucleotide sequence for binding of DNA ligase
c) Restrict the action of the enzyme DNA polymerase
d) Remove nucleotides from the ends of the DNA molecule

93. Restriction enzymes are used to cut

a) Single-stranded RNA b) Double-stranded DNA
c) Single-stranded DNA d) Double-stranded RNA

94. Restriction enzymes are isolated chiefly from:
a) Algae b) Fungi c) Protozoans d) Prokaryotes

95. Which of the following is correctly matched?
a) *Agrobacterium tumefaciens* – Tumour b) *Thermus aquaticus* – *Bt* gene
c) pBR322 – Enzyme d) Ligase – Molecular scissors

96. The Polymerase Chain Reaction (PCR) is a reaction in which amplification of specific DNA sequences is carried out *in vitro*. This statement is
a) True b) False
c) Sometimes (a) and sometimes (b) d) Neither (a) nor (b)

97. The total number of nitrogenous bases in human genome is estimated to be about:
a) 35 million b) 3.1 billion c) 3.5 million d) 35 thousand

98. Totipotency in cell is:
a) Flower in a culture medium
b) Development of fruit from a flower in a culture medium
c) Development of an organism from cell in culture medium
d) Development of all tissues of all kinds from a cell in a culture medium

99. Restriction enzymes was discovered by
a) Alexander Flemming b) Waksman
c) Berg d) Smith, Nathan and Arber

100. Identify the plasmid:
a) Alu I b) Hind III c) Eco RI d) pBR 322

101. Consider the following statements
I. Bioreactors are vessels of large volumes in which raw materials are biologically converted into specific products
II. One of the most commonly used bioreactors is of stirring type
III. Shake flasks are used for growing and mixing the desired materials on a small scale in the laboratory
IV. A large scale production of desired biotechnological product is done by using 'bioreactors'
a) I and II b) I and III c) I, II and III d) I, II, III and IV

102. The term 'Biotechnology' was given by
a) Craig Venter b) Robert Edward c) Karl Erkey d) Temin and Baltimore

103. A collection of organisms, usually viruses, bacteria or yeast, which have been transformed by the addition of extra genes from another species:
a) Gene replication b) Gene cloning c) Gene pool d) Gene library

104. Exonucleases cleaving nucleotides one at a time from the end of the polynucleotide chain are:
a) Specific for 5' end of RNA strand
b) Specific for 3' end of RNA strand
c) Specific for both 5' and 3' ends of nucleotide strands
d) Non-specific for 5' and 3' ends of nucleotide strand

105. The genetic recombinants obtained by insertion of plasmid into 1 phage genome is called:
a) Cosmid b) Phasmid c) Phagmid d) Foreign DNA

106. Which of the following statements is true?
a) In the historic cloning experiment of Dr. Wilmut, the transplanted nucleus was taken from an udder cell
b) Mammalian characters appeared first in dinosaurs
c) Heart of mammals is incapable of being in vitro
d) Pyramid of biomass is upright in pond ecosystem

107. Which of the following statement is not true?
I. DNA being a hydrophilic molecule cannot pass through cell membranes

II. *Agrobacterium tumefaciens* delivers a piece of DNA known as 'Z-DNA' in the Ti-plasmid which transforms normal plant cells into tumour cells to produce chemical against pathogens
III. Retrovirus, adenovirus, papillomavirus are also now used as cloning vectors in animal because of their ability to transform normal cells into cancerous cell.
IV. In genetic engineering, DNA from different sources are cut with the same restriction enzymes so that both DNA fragments have same kind of sticky ends
Choose the correct option

a) Only I b) Only II c) Only III d) Only IV

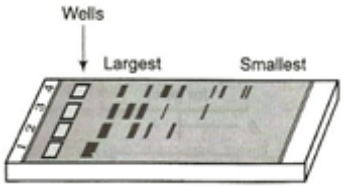
108. Which one of the following pairs is correctly matched?
a) RNA polymerase -RNA primer b) Restriction enzymes-Genetic Engineering
c) Central Dogma-codon d) Okazaki fragments-splicing
109. Bam HI, Eco RI, Sma H are the types of:
a) Restriction endooxidases b) Restriction endonucleases
c) Restriction exonucleases d) Restriction polymerases
110. PCR technique was invented by
a) Boyer b) Kary Mullis c) Cohen d) Sanger
111. Somaclonal variation can be obtained by:
a) Hybridization b) Tissue culture
c) Application of colchicine d) Irradiation with gamma rays
112. Ability to absorb foreign DNA is:
a) Sexduction b) Competence c) Hfr d) Transduction
113. Which of the following is specifically used in genetic engineering?
a) Ligase b) Gyrase
c) DNA polymerase d) Restriction endonuclease
114. The tumour inducing capacity of *Agrobacterium tumefaciens* is located in large extrachromosomal plasmids called
a) Ri-plasmid b) Lambda phage c) pBR322 d) Ti-plasmid
115. Who discovered recombinant DNA (rDNA) technology?
a) Har Gobind Khorana b) James D Watson
c) Stanley Cohen and Herber Boyer d) Walter Sutton and Avery
116. Which of the following is used in recombinant DNA technique?
a) Cell wall of virus b) Gene which produces capsid of virus
c) Virus d) Capsid of virus
117. There are special proteins that help to open up DNA double helix infront of the replication fork. These proteins are:
a) DNA gyrase b) DNA polymerase I c) DNA ligase d) DNA topoisomerase
118. Agarose extracted from sea weeds finds use in:
a) Spectrophotometry b) Tissue culture
c) Gel electrophoresis d) PCR
119. For selectable marker.
I. It helps to select the host cells which contain the vector and eliminate the non transformants
II. Genes encoding resistance to antibiotics like ampicillin, chloramphenicol, tetracycline or kanamycin, are useful selectable markers for $E.coli$
Which of the statements given above are correct?
a) Only I b) Only II c) I and II d) None of these
120. The first clone animal of the world is:
a) Molly sheep b) Polly sheep c) Dolly sheep d) Molly goat
121. Common bacterium used in genetic engineering is:
a) $E.coli$ b) *Diplococcus* c) *Rhizobium* d) *Spirillium*

122. Who discovered that restriction enzymes have the capability of cutting DNA strands in a particular fashion, which left what has became known as 'sticky ends' on the strands?
a) Ramdeo Mishra b) Stanley Cohen c) Herbert Boyer d) James D Watson

123. A restriction fragment containing a specific gene of interest can be identified by gel electrophoresis followed by transferring the DNA to a membrane as a solid support matrix using a procedure called
a) An allozyme
b) A southern blot
c) Identification of a gene
d) A restriction fragment length polymorphism

124. About gene gun method
I. This method is also known as biolistic technique
II. In this method cells are bombarded with high velocity micro-particles of gold or tungsten coated with DNA in plants
III. Important crop plants like maize, rice and wheat have now been transformed by this method
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

125. Identify the correct match for the given diagram



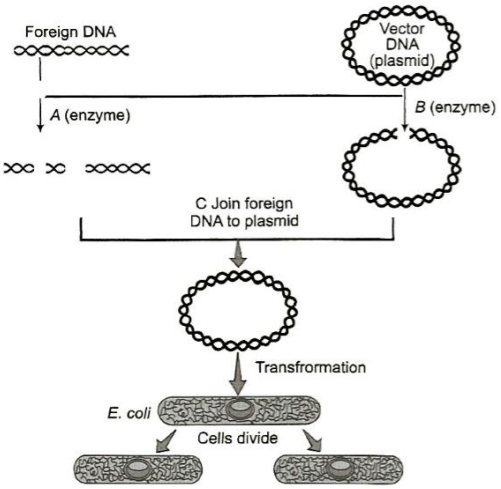
a) Electrophoresis – Migration of undigested and digested set of DNA fragments
b) Bioreactor – Raw materials are biologically converted into specific products
c) Microinjection – Technique of introducing foreign genes into a host cell
d) Gene cloning – Technique of obtaining identical copies of a particular DNA segment

126. In DNA fingerprinting which of the following is true?
a) VNTR is used as probes
b) Specific metabolic genes are used as probes
c) House keeping or luxury genes are use as probes
d) All of the above

127. The message from nuclear DNA for the synthesis of specific cytoplasmic protein is carried by:
a) mRNA b) t-RNA c) s-RNA d) r-RNA

128. The recent techniques used for separating fragments of DNA is:
a) Northern blotting b) Southern blotting c) Eastern blotting d) Western blotting

129. The flowchart given below represent the process of recombinant technology. Identify *A* and *D*



a) A-Restriction endonuclease, B-Restriction exonuclease, C-RNA ligase, D-Transformation
b) A-Restriction endonuclease, B-Restriction endonuclease, C-DNA ligase, D-Transformation
c) A-Restriction exonuclease, B-Restriction endonuclease, C-DNA polymerase , D-Transduction

d) A-Restriction endonuclease, B-Restriction endonuclease, C-DNA polymerase, D-Transformation

130. RNA is removed by the treatment with
a) Ribonuclease b) Protease c) Chitinase d) Cellulase

131. Which one of the following scientists developed the process of DNA fingerprinting?
a) Kary B. Mullis b) T.H. Morgan c) H.O. Smith d) Alec Jeffreys

132. Which of the following statement is not correct regarding *Eco* RI restriction endonuclease enzyme?
I. *Eco*. RI restriction endonuclease enzyme is isolated from *Escherichia coli* RY13
II. Its recognition sequence is 5'–GAATTC – 3'
3'–CTTAAG – 5'
↓
5' – G – A – A –T – T – C – 3'
III. Its site of cleavage is
3' – C – T – T – A – A – G – 5'
↑
a) I and II
b) I and III
c) I, II and III
d) None of the above

133. Process of formation of RNA from DNA is called
a) Transduction b) Transcription c) Transformation d) Translation

134. Which of the following would not be used in preparing recombinant DNA?
a) Plasmids b) Phages
c) Restriction enzymes d) DNA polymerase III

135. Which one of the following bacteria has found extensive use in genetic engineering work in plants?
a) *Agrobacterium tumefaciens* b) *Clostridium septicum*
c) *Xanthomonas citri* d) *Bacillus coagulens*

136. Which of the following components are used in gel electrophoresis?
I. Ethidium bromide
II. Restriction endonuclease
III. Agarose
IV. UV radiation
Choose the correct option
a) I and II b) I and III c) I, II and IV d) I, II, III and IV

137. What is the first step in Southern Blotting technique?
a) Isolation of DNA from a nucleated cell such as the one from the scene of crime
b) Denaturation of DNA on the gel for hybridization with specific probe
c) Production of group of genetically identical cells
d) Digestion of DNA by restriction enzyme

138. The most thoroughly studied of the known bacteria-plant interaction is the:
a) Plant growth simulation by phosphate-solubilising bacteria
b) Cyanobacterial symbiosis with some aquatic ferns
c) Gall formation on certain angiosperms by Agrobacterium
d) Nodulation of Sesbania stems by nitrogen fixing bacteria

139. Microorganisms can be grown in the bioreactor by
a) Support growth system b) Agitated growth system
c) Suspended growth system d) Both (a) and (b)

140. In Northern blotting RNAs are separated by gel electrophoresis and the RNA bands are transferred onto a membrane of:
a) Diazobenzyl oxymethyl b) Diazobenzene
c) Diazobromine d) None of the above

141. Which one of the following is commonly used in transfer of foreign DNA into crop plants?
a) *Trichoderma harzianum* b) *Meloidogyne incognitia*
c) *Agrobacterium tumefaciens* d) *Penicillium expansum*

142. Which one among the following is just a cloning plasmid not an expression plasmid?
a) pBAD-18-Cam b) pBCSK c) pUC 18 d) pET

143. There …A… are the DNA molecules that can carry a foreign …B… segment into the host cell.
Here A and B refers to
A B
a) Vector RNA b) Vector DNA
c) Gene RNA d) Gene DNA

144. Probes, used in DNA fingerprinting are initially
a) Single-stranded RNA b) Mini satellite
c) 19 base long oligonucleotides d) All of the above

145. Application of PCR are
I. detection of pathogens
II. diagnosis of specific mutation
III. DNA fingerprinting
Choose the correct option
a) I and II b) I and III c) II and III d) I, II and III

146. A clone of sheep Dolly has been made by:
a) Gene transfer b) Somatic cell cloning
c) Nucleus transfer d) Germinal cell cloning

147. T_1-plasmid used in genetic engineering is obtained from
a) *Bacillus thuringiensis* b) *Agrobacterium rhizogenes*
c) *Agrobacterium tumefaciens* d) *Psedomonas syringae*

148. The role of DNA ligase in the construction of a recombinant DNA molecule is
a) Formation of phosphodiester bond between two DNA fragments
b) Formation of hydrogen bonds between sticky ends of DNA fragments
c) Ligation of all purine and pyrimidine bases
d) None of the above

149. Transgenic animals are produced by injecting foreign gene into the:
a) Egg b) Nucleus of unfertilized egg
c) Nucleus of fertilized egg d) Nucleus of sperm

150. Clonal cell lines can be obtained by:
a) Autoradiography b) Tissue culture c) Centrifugation d) Cell fractionation

151. Electroporation procedure involves:
a) Fast passage of food through sieve pores in phloem elements with the help of electric stimulation
b) Opening of stomatal pores during night by artificial light
c) Making transient pores in the cell membrane to introduce gene constructs
d) Purification of saline water with the help of a membrane system

152. Which of the following is associated with genetic engineering?
a) Plastids b) Plasmids c) Mutations d) Hybrid vigour

153. Biolistics (gene gun) is suitable for
a) Disarming pathogen vectors b) Transformation of plants cells
c) Construction recombinant DNA by joining with vectors d) DNA fingerprinting

154. Which of the following statements are correct for the enzyme *taq* polymerases?
I. *Taq* polymerase is thermally unstable
II. It requires primers for carrying out the process of polymerization
III. *Taq* polymerase is isolated from thermophilic bacterium, *Thermus aquaticus*

Choose the correct option

a) I and II b) I and III c) II and III d) I, II and III

155. EFB stands for

a) European Federation of Biotechnology b) Eurasian Federation of Biotechnology

c) East Asia Federation of Biotechnology d) Ethiopian Federation of Biotechnology

156. The commonly used DNA fingerprinting technique in forensic studies is simply a method involving

a) Southern blotting b) Northern blotting c) Eastern blotting d) Western blotting

157. *Cry* I endotoxins obtained from *Bacillus thruigiensis* are effective against

a) Nematodes b) Bollworms c) Mosquitoes d) Flies

158. In the naming of restriction enzymes the first letter is derived from …A… name and next two letters from the …B… and fourth letter from …C… of …D… where the enzymes are extracted

A to D in the statement can be

A B C D

a) Genus species strain bacteria b) Species genus strain bacteria

c) Genus species variety eukaryote d) Species genus variety eukaryote

159. Which of the following techniques is most commonly used to separate DNA molecules by size?

a) Chromatography b) PCR c) RFLP d) Gel electrophoresis

160. Which one of the following scientists got the Nobel Prize for his invention polymerase chain reaction (PCR)?

a) F. Sanger b) Paul Berg c) Alec Jeffreys d) Kary B. Mullis

161. Which is non-invasive technique of genetic counselling?

a) Amniocentesis b) Chorionic biopsy

c) Foetal blood sampling d) Ultrasonography

162. The colonies of recombinant bacteria appear white in contrast to blue colonies of non-recombinant bacteria because of:

a) Insertional inactivation of alpha-galactosidase in non-recombinant bacteria

b) Insertional inactivation of alpha-galactosidase in recombinant bacteria

c) Inactivation of glycosidase enzyme in recombinant bacteria

d) Non-recombinant bacteria containing beta-galactosidase

163. Which of the following steps are catalyzed by *taq* polymerase in a PCR reaction?

a) Denaturation of template DNA b) Annealing of primers to template DNA

c) Extension of primer end on the template DNA d) All of the above

164. I. In the process of recombinant DNA technology after several treatment the purified DNA is precipitated by adding chilled ethanol

II. The bacterial/plant, animal cell is broken down by enzymes to release DNA, along with RNA, proteins, polysaccharides and lipids

Choose the correct option for above statements

a) I is true, but II is false b) I is false, but II is true

c) I and II are true d) I and II are false

165. Which of the statements are correct about bioreactors?

I. It provides all the optimal conditions for achieving the desired product by providing optimal growth conditions like temperature, pH, substrate, salt, vitamin and oxygen

II. It is suited for large-scale production of microorganisms under aseptic conditions for a number of days

Correct option is

a) Only I b) Only II c) I and II d) None of the above

166. *Taq* polymerase enzyme used in PCR is isolated from

a) *Thermus aquaticus* b) *Thermococcus litoralis*

c) *Salmonelia typhimurium* d) None of the above

167. The first hormone artificially produced by culturing bacteria is:

a) Insulin b) Thyroxine c) Testosterone d) Adrenaline

168. A gene is made up of:
a) DNA b) RNA c) Either DNA or RNA d) Amino acids

169. The first restriction endonuclease type II …A…, was isolated by Smith, Wilcox and Kelley from …B… bacterium. It was formed to cut DNA molecules at a particular point by recognizing a specific sequence of six base pairs, known as the …C… . Here A, B and C can be

	A	B	C
a)	*Eco* RI	*Escherichia* RY 13	Restriction sequence
b)	*Eco* RII	*E. coli* R 245	Recognition sequence
c)	*Hind* II	*Haemophilus influenza*	Recognition sequence
d)	*Bam* HI	*Bacillus amyoliquefaciens*	Restriction sequence

170. In gel electrophoresis, the separated DNA fragments are visualized after staining the DNA with …A… followed by exposure to …B…
Here A and B refers to

	A	**B**		
a)	B-galactosidase	Infrared radiation	b) Ethidium bromide	UV radiation
c)	Ethidium nitrate	γ-rays	d) Ethidium chloride	Radiowave

171. In DNA fingerprinting:
a) A positive identification can be made
b) Multiple restriction enzyme digests/generate unique fragments
c) The polymerase chain reaction amplifies fewer DNA
d) The variability of repeated sequences between two restriction sites is evaluated

172. Cosmid is:
a) Extragenetic material in Mycoplasma
b) Circular DNA in bacteria
c) Extra DNA in bacteria
d) Fragment of DNA inserted in bacteria for forming copies

173. Following enzymes/chemical/technique are used in the process of gel electrophoresis
I. sample DNA is cut into fragments
II. restriction endonucleases
III. agarose gel
IV. ethidium bromide
V. UV-radiation
VI. elution
Mark the correct sequence of their use
a) I, II, III, VI, V and IV b) I, II, III, VI, V and IV c) IV, V, VI, I, II and III d) I, II, IV, V, VI and III

174. Improvement of genotype of an organism by addition of some foreign genes is:
a) Genetic diversity
b) Gene handling
c) Tissue culture
d) Genetic engineering

175. Which one is a true statement regarding DNA polymerase used in polymerase chain reaction?
a) DNA polymerase is responsible for DNA synthesis
b) It is isolated from Protozoa
c) It is serves as a selectable marker
d) It is used to ligate introduced DNA in recipient plant cell

176. Most sensitive technique to detect malignant cell in non-hodgkin's lymphoma is
a) Polymerase chain reaction
b) Gene therapy
c) Stem cell therapy
d) None of the above

177. Gene therapy involves:
a) Introducing of a normal genes in cell
b) Eliminating defective and useless genes
c) Treating of defective genes with radiations

d) Replacement of defective genes by normal ones

178. Human Genome project was the thought of:
a) Jean Dausset b) Watson c) Crick d) None of the above

179. Which conserved motifs are found in $E.coli$ genes?
a) TATA box b) CAAT box c) Pribnow box d) All of these

180. Given below is a sample of a portion of DNA strand giving the base sequence on the opposite strands. What is so special shown in it?
5'_____GAATTC_____3'
3'_____CTTAAG_____5'
a) Replication completed b) Deletion mutation
c) Start codon at the 5' end d) Palindromic sequence of base pairs

181. The DNA used as a carrier for transferring a fragment of foreign DNA into a suitable host is called
a) Cloning vector b) Vehicle DNA c) Gene carrier d) All of these

182. The nuclease enzyme, which beings its attack from free end of a polynucleotide, is?
a) Exonuclease b) Kinase c) Polymerase d) Endonuclease

183. Genetically engineered bacterium used in production of:
a) Thyroxine b) Human insulin c) Epinephrine d) Cortisol

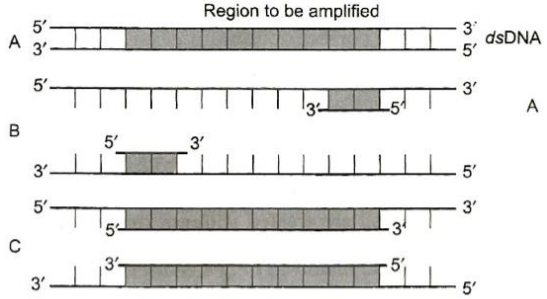
184. In Southern blotting…… is separated by gel electrophoresis:
a) DNA b) m-RNA c) t-RNA d) Protein

185. Taq polymerase enzyme is found in:
a) $Thermus\ aquatecus$ b) $E.coli$ c) $Pseudomonas$ d) $Agrobacterium$

186. The process used for separation of protein in polyacrylamide gel is called:
a) Southern blotting b) Northern blotting c) Western blotting d) Eastern blotting

187. Which of the following methods(s) is used to introduce foreign DNA into host cells?
a) Gene gun method b) Gel electrophoresis c) Elution d) Extension

188. The figure shown three steps (A, B, C) of Polymerase Chain Reaction PCR. Select the option giving correct identification together with what represents?



a) B-denaturation at a temperature of about 98°C separating the two DNA strands
b) A-denaturation at a temperature of about 50°C
c) C-extension in the presence of heat stable DNA polymerase
d) A-annealing with three sets of primers

189. DNA fingerprinting method is very useful for:
a) DNA tests for identity and relationships b) Forensic studies
c) Polymorphism d) All of the above

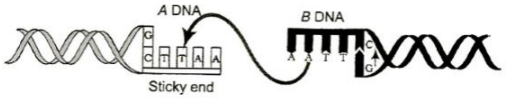
190. Restriction endonucleases are used as:
a) Molecular build up at nucleotides
b) Molecular degradation to DNA breakup
c) Molecular knives for cutting DNA at specific sites
d) Molecular cement to combine DNA sites

191. After completion of the biosynthetic stage in the bioreactors, the product undergoes. Separation and purification processes, collectively termed as
a) Transformation b) Transduction

c) Downstream processing d) Upstream processing

192. Which of the following should be choosen for best yield if one has to produce a recombinant protein or enzyme on a large scale, using microbial plants/anima/human cell?
a) Stirred-tank bioreactor b) Electrophoresis
c) Laboratory flask of largest capacity d) All of the above

193. Go through the figure and select the option for C and D. Here A and B are taken as vector/plasmid DNA and foreign DNA respectively



Restriction enzyme recognizing palindrome *C*	**Enzyme joining the sticky ends *D***		
a) *Eco* RI	DNA ligase	b) DNA ligase	*Eco* RI
c) Exonuclease	DNA ligase	d) DNA ligase	Exonuclease

194. Which of the following is known as molecular scissors of DNA?
a) Ligase b) Polymerases
c) Restriction endonucleases d) Transcriptase

195. A kind of biotechnology involving manipulation of DNA is
a) DNA replication b) Genetic engineering c) Denaturation d) Renaturation

196. Harris and J.F. Watkins in 1965 first time reported the fusion of following cell lines to form hybrids:
a) Mouse and man b) Mouse and hamster
c) Mouse and click erythrocytes d) Mouse and *Drosophila*

197. Polymerase chain reaction employs
a) Primers and DNA ligase b) DNA ligase only
c) DNA polymerase d) Primer and DNA polymerase

198. An antibiotic resistance gene in a vector usually helps in the selection of
a) Competent cells b) Transformed cells c) Recombinant cells d) None of these

199. The collection of bacteria with gDNA is called:
a) DNA clones b) DNA library
c) Genomic DNA library d) cDNA library

200. Which of the following statements are correct with respect to a bioreactor?
I. It can process small volume of culture
II. It provides optimum temperature, pH, salt, vitamins and oxygen
III. Sparged stirred-tank bioreactor is a stirred type reactor in which air is bubbled
Choose the correct option
a) I and II b) I and II c) II and III d) I, II and III

201. PCR and Restriction Fragment Length Polymorphism are the methods for:
a) Genetic transformation b) DNA sequencing
c) Genetic fingerprinting d) Study of enzymes

202. Restriction enzymes may be used for:
a) Making recombinant DNA b) Gene mapping
c) Diagnosis of genetic diseases d) All the above

203. *Vent* polymerase enzyme used in PCR is isolated from
a) *Thermococcus litoralis* b) *Thermus aquaticus*
c) *E. coli* d) *Salmonella typhimurium*

204. Genetically bacteria have been successfully used in the commercial production of:
a) Human insulin b) Testosterone c) Thyroxine d) Melatonin

205. DNA fingerprinting method is very useful for:
a) DNA tests for identity and relationships b) Forensic studies
c) Polymorphism d) All of the above

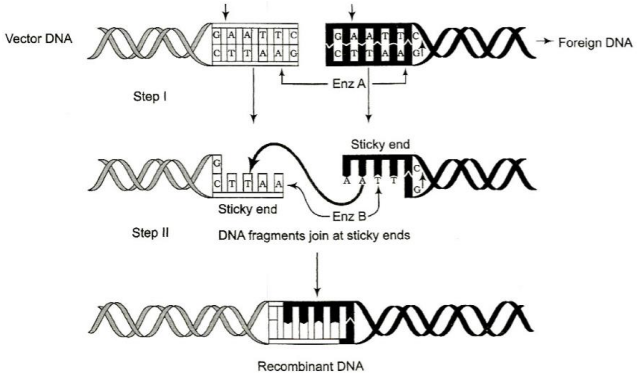
206. Plasmids are autonomously replicating mini chromosomes found in:
    a) Bacteriophage lambda
    b) *Leishmania donovani*
    c) *Escherichia coli*
    d) *Paramecium caudatum*
207. Production of a human protein in bacteria in genetic engineering is possible because:
    a) Bacterial cell can carry out the RNA splicing reactions
    b) The human chromosome can replicate in bacterial cell
    c) The mechanism of gene regulation is identical in humans and bacteria
    d) The genetic code is universal
208. Reverse transcriptase:
    a) Disintegrates host DNA
    b) Translates host DNA
    c) Transcribes viral RNA to DNA
    d) Polymerises host DNA
209. An example of gene therapy is:
    a) Production of injectable Hepatitis B vaccine
    b) Production of vaccines in food crops like potatoes which can be eaten
    c) Production of test tube babies by artificial insemination and implantation of fertilized eggs
    d) Introduction of gene for adenosine deaminase in persons suffering from Severe Combined Immuno-Deficiency (SCID)
210. Synthetic DNA or sDNA is:
    a) DNA synthesized in lab without any template
    b) DNA synthesized in the cell without any template
    c) DNA synthesized in the lab, without any nucleotide
    d) DNA synthesized in the cell without any nucleotide
211. Stirred-tank bioreactors have advantages over shake flasks because they
    a) Provide high temperature and pH
    b) Provide better aeration and mixing properties
    c) Do not allow the entry of CO_2
    d) Are easy to operate
212. During 'gene cloning' which is called a gene taxi?
    a) Vaccine b) Plasmid c) Bacteria d) Protozoa
213. TATAATG sequence near the RNA start point of prokaryotic promoter is:
    a) Nicks b) DNA marker c) Pallindrome d) Pribnow box
214. I. Copy number is defined as the number of copies of plasmid present in a cell
    II. It varies from 15-100 copies per cell
    Choose regarding the above statements
    a) I is true, II is false b) II is true, I is false c) Both are true d) Both are false
215. Which one of the following hydrolyses internal phosphodiester bonds in a polynucleotide chain?
    a) Lipase b) Protease c) Exonuclease d) Endonuclease
216. What does Bt stand for the popular crop Bt cotton?
    a) Best b) Best type c) Biotechnology d) Bacillus thuringiensis
217. Which of the following statement is incorrect?
    a) Cosmid contains gene coding for viral protein
    b) Cosmid replicates like plasmids
    c) Cosmid has antibiotic resistant marker gene
    d) *Cos* site has 12 bases helping to join complete genome to make it circular
218. An attenuated virus:
    a) Is a virus that is non-pathogenic
    b) In an elongated viral particle
    c) Can transfer recombinant DNA to other viruses
    d) Will not produce an immune response
219. Which of the following has popularized the PCR (polymerase chain reaction)?

a) Easy availability of DNA template
b) Availability of synthetic primers
c) Availability of cheap deoxyribonucleotides
d) Availability of 'Thermostable' DNA polymerase

220. Choose the correct statement with reference to 'Dolly':
a) She was created by taking nucleus from unfertilized eggs and cytoplasm from unfertilized eggs
b) She was created by taking nucleus from under udder cells and cytoplasm from unfertilized eggs
c) She was created by taking cytoplasm from udder cell and nucleus from unfertilized eggs
d) She was created by taking cytoplasm from udder cell and nucleus from fertilized eggs

221. The first recombinant DNA was constructed by
a) Stanley Cohen
b) Herbert Boyer
c) Both (a) and (b)
d) Temin and Baltimore

222. Study the given diagram and identify the enzymes A and B involves in steps I and II



	Step I	Step II
a)	*Eco* RI	DNA ligase
b)	*Alu* I	DNA ligase
c)	*Hind* II	DNA polymerase
d)	Restriction endonuclease	DNA polymerase

223. 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) Somatic hybridization involves fusion of two complete plant cells carrying desired genes
c) The anticoagulant hirudin is being produced from transgenic *Brassica napus* seeds
d) "Flavr Savr" variety of tomato has enhanced the production of ethylene which improves its taste

224. The transgenic animals are those which have:
a) Foreign RNA in all its cell
b) Foreign DNA in all its cells
c) Foreign DNA in some of its cells
d) Both 'A' and 'C'

225. Which of the following is not correctly matched for the organism and its cell wall degrading enzyme?
a) Plant cells-Cellulase
b) Algae-Methylase
c) Fungi-Chitinase
d) Bacteria-Lysozyme

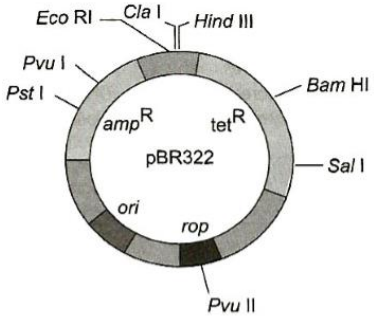
226. Petroleum-lysing bacteria are being engineering for the removal of oil spills. What is the most realistic danger of these bacteria to the environment?
a) Mutations leading to the production of a strain pathogenic to humans
b) Extinction of natural microbes due to the competitive advantage of the "petro-bacterium"
c) Destruction of natural oil deposits
d) Poisoning of the food chain

227. c-DNA probes are copied from the messenger RNA molecules with the help of:
a) Restriction enzymes
b) Reverse transcriptase
c) DNA polymerase
d) Adenosine deaminase

228. Mishandling of genetic engineering may cause:
a) Genetic erosion
b) Green revolution
c) Silver revolution
d) White revolution

229. Gene for cloning may be chemically synthesized:
a) When the exact sequence of nucleotides is known
b) Through the use of restriction enzymes and gel electrophoresis to separate restriction fragments
c) By the Sanger method
d) By making complementary DNA from genes without introns

230. Source of *taq* polymerase used in PCR is a
    a) Thermophilic fungus
    b) Mesophilic fungus
    c) Thermophilic bacterium
    d) Halophilic bacterium
231. Genetic engineering has been successfully used for producing:
    a) Transgenic models for studying new treatment for certain cardiac diseases
    b) Transgenic Cow-Rosie which produces high fat milk for making ghee
    c) Animals like bulls for farm work as they have super power
    d) Transgenic mice for testing safety of polio vaccine before sue in humans
232. Which of the following is used as a best genetic vector in plants?
    a) *Bacillus thuringiensis*
    b) *Agrobacterium fumefaciens*
    c) *Pseudomonas putida*
    d) None of the above
233. Plants in comparison to animals are more rapidly manipulated by genetic engineering. Select out the most probable reason for this
    a) Totipotency shown by plant cells
    b) Single somatic cell can regenerate a whole plant body
    c) Genetic engineering is supplemented with plant tissue culture techniques
    d) All of the above
234. Which of the following pairs is correctly matched?
    a) Central dogma-Codon
    b) Okazaki fragments-Splicing
    c) RNA polymerase-RNA primer
    d) Restriction enzymes-Genetic engineering
235. Recombinant DNA technology is related with:
    a) Stanley Cohen and Harbert Boyer
    b) Bateson and Punnet
    c) Huxley and Harvey
    d) Schleiden and Schwann
236. Western blotting technique was developed by:
    a) Alwin
    b) Edwin
    c) Towbin
    d) Thomas
237. In recombinant DNA technique, the term vector refers to a
    a) Donor DNA, it is identified and picked up through electrophoresis
    b) Plasmid, transfers DNA into living cell
    c) Collection of entire genome in form of plasmid
    d) Enzyme, cuts the DNA at specific sites
238. Complete transduction is:
    a) Transfer of whole genome with the help of virus
    b) Picking up of one or more genes by a phage and transfer it to second host
    c) Integration of gene brought by viral particle into genome of new host
    d) Both B and C
239. The function of polymerase chain reaction (PCR) is:
    a) Translation
    b) Transduction
    c) DNA amplification
    d) None of these
240. The steps involved in the Southern blot test are as follows
    I. X-ray film
    II. Electrophoresis
    III. Digestion with restriction enzyme
    IV. Ethidium bromide
    V. Radioactive probe
    Choose the option having correct sequential order of these events
    a) III, II, IV, V and I
    b) III, IV, II, V and I
    c) III, II, V, IV and I
    d) II, IV, III, V and I
241. The given figure is the diagrammatic representation of the *E. coli* vector pBR322. Which one of the given options correctly identifies its certain component(s)?



a) *Ori*-original restriction enzymes b) *Rop*-reduced osmotic pressure
c) *Hind* III, Eco RI-selectabel markers d) amp^R, tet^R-antibiotic resistances genes

242. The restriction enzyme(s) used in recombinant DNA technology that make staggered cuts in DNA leaving sticky ends is/are
a) *Eco* RI b) Hind II c) *Bam* HI d) All of the above

243. RNA processing is:
a) An event that occurs after RNA transcribed b) The rejection of old, worn-out RNA
c) An event that occurs before RNA is transcribed d) Both (A) and (C)

244. Find out the wrong statements
a) Mobile genetic elements, transposons were visualized by Barbara McClintock
b) Udder cell and somatic cell is used to produce the cloned sheep by nuclear transplantation method
c) In pedigree analysis, a person immediately affected by and action is called propositus
d) DNA ligases are used to cleave a DNA molecule

245. Widely used tool in genetic engineering of crop plants is:
a) Protoplast fusion b) Transposon
c) Microinjection d) Agrobacterium mediation

246. DNA fingerprinting method is very useful for:
a) DNA tests for identity and relationships b) Forensic studies
c) Polymorphism d) All of the above

247. Who among the following discovered the enzyme restriction endonuclease?
a) Hamilton Othanel Smith b) Sir Godfrey Hounsfield
c) F. Jacob d) Andre Lwoff

248. The mobile genetic element is
a) Transposons b) Mutation c) Endonuclease d) Variation

249. The enzyme used for cutting DNA segment in genetic engineering is:
a) ATP-ase b) Ligase
c) DNA polymerase d) Restriction endonuclease

250. When the number of genes increases in response to some signal, the effect is called:
a) Gene dosage b) Gene pool c) Gene amplification d) Gene frequency

251. Identify the palindromic sequence in the following
a) $\frac{GAATTC}{CTTUUG}$ b) $\frac{GGATCC}{CCTAGG}$ c) $\frac{CCTGGA}{GGACCT}$ d) $\frac{CGATAC}{GCTAAG}$

252. Colony hybridization procedure for identification of plasmid clones is called:
a) Southern blotting b) Grunstein-Hogness assay
c) DNA probes d) Molecular assay

253. The different basic steps of genetic engineering are given below randomly
I. Identification of DNA with desirable genes
II. Gene transfer
III. Maintenance of DNA in host and gene cloning
IV. Introduction of DNA into host to from recombinant DNA
Which of the following represents the correct sequence of steps?
a) I, II, III and IV b) I, IV, III and II c) III, IV, II and I d) I, III, IV and II

254. Which of the following steps are involved in the process of recombinant biotechnology? Arrange in correct order
I. Extraction of the desired gene product
II. Amplification of the gene of interest
III. Isolation of a desired DNA fragment
IV. Ligation of the DNA fragment into a vector
V. Insertion of recombinant DNA into the host
Correct order is
a) I, II, III, IV and V b) III, II, IV, V and I c) II, IV, V, III and I d) I, IV, V, III and II

255. In bacteria, genes for antibiotic resistance are usually located in:
a) Chromosomal DNA b) Cytoplasm c) Mitochondria d) Plasmids

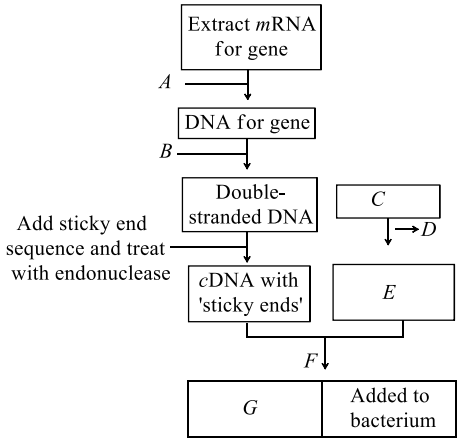
256. Natural genetic engineer is:
a) *Bacillus subtillis* b) *Pseudomonas spp*
c) *Escherichia coli* d) *Agrobacterium tumefaciens*

257. A number of bacteria with recombinant DNA of same type form:
a) Clone library b) Gene library c) Gene pool d) Gene frequency

258. I. …A… is the ability of a cell to take up foreign DNA
II. The cell is treated with specific concentration of a divalent cation such as …B… to increase pore size in cell wall
III. In ….C… method recombinant DNA is directly injected into the nucleus of an animal cell
The most appropriate option regarding A, B and C is
a) A-Competency, B-Calcium, C-gene gun method
b) A-Transformation, B-Sodium, C-microinjection method
c) A-Competency, B-Calcium, C-microinjection method
d) A-Transformation, B-Sodium, C-gene gun method

259. T_1 plasmid is used for making transgenic plants. It is obtained from:
a) Azotobacter b) Agrobacterium
c) Rhizobium in leguminous root d) Yeast

260. Identify and match the labelled items A, B, C, D, E, F and G in the diagram below from the list I-VII given with components



I. DNA polymerase
II. plasmid
III. plasmid with 'sticky ends'
IV. DNA ligase
V. restriction endonuclease
VI. recombinant DNA
VII. reverse transcriptase
The correct components are
A B C D E F G

a) VII I II V III IV VI
b) VII VI V IV III II I
c) VII V III I II IV VI
d) I II IV VI III V VII

261. A technology which has found immense use in solving cases of disputed parentage is:
a) DNA fingerprinting
b) Polymerase chain reaction
c) Recombinant DNA technology
d) Monoclonal antibody production

262. The most important feature in a plasmid to be used as a vector is
a) Origin of replication
b) Presence of a selectable marker
c) Presence of sites for restriction endonuclease
d) Its size

263. DNA gyrase, the enzyme that participates in the process of DNA replication is a type of
a) DNA ligase
b) DNA polymerase
c) DNA topoisomerase
d) Reverse transcriptase

264. Abnormal gene is replaced by normal gene through:
a) Gene therapy
b) Medicines
c) Cloning
d) Radiation

265. The key tools required for the recombinant DNA technology are
I. restriction enzymes II. Polymerase enzymes
III. host organism ligases IV. Vectors
V. host organisms
Select the correct option
a) I, II and III
b) I, III, IV and V
c) I, II, III and V
d) I, II, III, IV and V

266. A tumour inducing plasmid widely used in the production of transgenic plants in that of:
a) *Escherichia coli*
b) *Bacillus thuringiensis*
c) *Staphylococcus aureus*
d) *Agrobacterium tumefaciens*

267. Which one of the following palindromic base sequences in DNA can be easily cut at about the middle by some particular restriction enzyme?
a) 5'_____GATATG_____3'
3'_____CTACTA_____5'
b) 5'_____GAATTC_____3'
3'_____CTTAAG_____5'
c) 5'_____CACGTA_____3'
3'_____CTCAGT_____5'
d) 5'_____CGTTCG_____3'
3'_____ATGGTA_____5'

268. Which of the following infection (s) can be diagnosed by the use of polymerase chain reaction?
a) HIV-1 and HIV-2 viruses
b) Hepatitis-B virus
c) *Mycobacterium tuberculosis*
d) All of the above

269. Agarose is extracted from
a) Sea weeds
b) Blue-green algae
c) *Ephedra*
d) *Sargassam*

270. Which one is a true statement regarding DNA polymerase used in PCR?
a) It is used to ligate introduced DNA in recipient cell
b) It serves as a selectable marker
c) It is isolated from a virus
d) It remains active at high temperature

271. DNA fragments generated by the restriction endonucleases in a chemical reaction can be separated by:
a) Polymerase chain reaction
b) Electrophoresis
c) Restriction mapping
d) Centrifugation

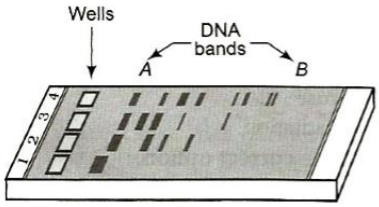
272. The two main techniques that gave birth to modern biotechnology are
I. chemical engineering
II. genetic engineering
III. human genome engineering
IV. molecular biology
Choose the correct option
a) I and II
b) I and III
c) II and IV
d) II and III

273. Stirred-tank bioreactors have been designed for
    a) Purification of the product
    b) Addition of preservatives to the product
    c) Availability of oxygen throughout the process
    d) Ensuring anaerobic conditions in the culture vessel
274. First biochemical to be produced commercially by microbial cloning and genetic engineering is:
    a) Interferon b) Penicillin c) Human insulin d) Fertility factors
275. Which is incorrect statement?
    a) *Taq* DNA polymerase is important for PCR
    b) *Taq* DNA polymerase is not thermostable
    c) In PCR two nucleotide primers are used
    d) *Taq* DNA polymerase, isolated from bacterium *Thermus aquaticus*
276. A genetically engineered micro-organism used successfully in bioremediation of oil spills is a species of:
    a) *Trichoderma* b) *Xanthomonas* c) *Bacillus* d) *Pseudomonas*
277. There is a restriction endonuclease called *Eco*RI. What does "co" part in it stand for?
    a) Coli b) Coelom c) Coenzyme d) Colon
278. Which of the following would have the highest oxygen transfer rate characteristics?
    a) A sparged stirred tank bioreactor being stirred at 200 RPM
    b) A non-sparged stirred tank bioreactor being stirred at 200 RPM
    c) A shake flask being mixed at 200 RPM
    d) All of the above would have equivalent oxygen transfer rate characteristics
279. Enzymes breaking nucleic acids into nucleotides are called:
    a) Hydrolases b) Amylases c) Nucleic acidases d) Nucleases
280. Palaeontologists unearthed a human skull during excavation. A small fragment of the scalp tissue was still attached to it. Only little DNA could be extracted from it. If the genes of the ancient man need to be analysed, the best way of getting sufficient amount of DNA from this extract is
    a) By hybridizing the DNA with a DNA probe
    b) By subjecting the DNA to polymerase chain reaction
    c) By subjecting the DNA to gel electrophoresis
    d) By treating the DNA with restriction endonucleases
281. Transgenic organisms are produced by:
    a) Deleting sex chromosomes b) Inducing gene mutations
    c) Introducing foreign genes d) Arresting spindle fibre formation
282. Manipulation of gene and genetic material by man is a fast emerging branch of science which started with the formation of recombinant DNA molecules. This branch of science is named as
    a) Recombinant DNA technology b) Genetic engineering
    c) DNA manipulation biotechnology d) All of the above
283. Ligases catalyse the formation of bonds between
    a) C = C b) P = O c) C – C d) H – H
284. The characteristics of a molecular probe are
    I. very long molecule
    II. double-stranded
    III. DNA or RNA
    IV. complementary to a part of desired gene
    The correct pair is
    a) I and II b) II and III c) III and IV d) IV and I
285. VNTR analysis involves
    a) Analyzing specific loci for two base repeating units usually less then 100 bp in size
    b) Analyzing specific loci for 2-4 bp repeating units
    c) PCR amplification of specific genes

d) Cutting DNA with restriction enzyme and analyzing the banding pattern of fragments

286. Manipulation of DNA in genetic engineering became possible due to the discovery of
a) Restriction endonuclease b) DNA ligase
c) Transcriptase d) Primase

287. Study the given figure carefully and select the correct statements regarding this



I. It represents typical agarose gel electrophoresis which showing differential migration of DNA fragments
II. Lane 1 contains undigested DNA fragments
III. Lanes 2 to 4 contains digested DNA fragment
IV. Smallest DNA bands are present at (*A*) position and largest DNA bands are present at (*B*) position
a) I, II and III b) I, II and IV c) II and III d) III and IV

288. Matching sequence of DNA between two evidences, one of the criminal with the suspect is known as:
a) DNA fingerprinting b) DNA amplification c) Gene mapping d) DNA resolution

289. Alec Jeffreys developed the DNA fingerprinting technique. The probe he used was
a) Ribozyme b) Sex chromosomes c) SNP d) VNTR

290. In addition to *taq* polymerase enzyme which other thermostable DNA polymerases have been isolated to be used in Polymerase Chain Reaction (PCR)?
a) *Vent* polymerase b) *Pfu* polymerase c) Both (a) and (b) d) None of these

291. PCR proceeds in three distinct steps governed by temperature. They are in order of
a) Denaturation, synthesis (polymerization), annealing
b) Annealing, synthesis (polymerization), denaturation
c) Synthesis (polymerization), annealing, denaturation
d) Denaturation, annealing, synthesis (polymerization)

292. One of the following is transgenic of organisms:
a) Holly sheep and Flavr savr tomato b) Holly sheep and Cotton Bt
c) Dolly sheep and Cotton Ct d) Flavr savr tomato and Cotton Bt

293. Name of the drug used in cancer treatment produced by using biotechnology is:
a) HGH b) TSH c) Insulin d) Interferon

294. What is the function of Restriction endonuclease?
a) Restricts the synthesis of DNA inside the nucleus
b) Synthesizes DNA
c) Cuts the DNA molecule randomly
d) Cuts the DNA molecule at specific sites

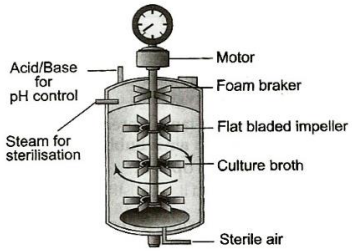
295. I. Bacteriophages are …A… nfectecting …B… .
II. …C… are hybrid vectors derived from plasmids which contain or site of λ phage
A, B and C in above statements refers to

	A	B	C
a)	Protozoa	Bacteria	Cosmid
b)	Plasmid	Virus	Cosmid
c)	Bacteria	Virus	Cosmid
d)	Virus	Bacteria	Cosmid

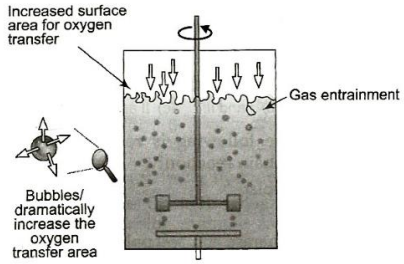
296. In gel electrophoresis, the separated bands of DNA are cut out and extracted from the gel piece. This step is called
a) Elution b) Origin replication c) Competency d) Transformation

297. Nif genes is a group of proteins:
a) 15 genes b) 15 nucleotides c) 15 proteins d) 10 genes

298. Identify the following diagrams *A* and *B* and select the correct option



A



B

a) A-Simple stirred-tank bioreactor, B-Sparged stirred-tank bioreactor
b) A-Sparged stirred-tank bioreactor, B-Complex stirred-tank bioreactor
c) A-Sparged stirred-tank bioreactor, B-Simple stirred-tank bioreactor
d) A-Simple stirred-tank bioreactor, B-Complex stirred-tank bioreactor

299. Genetic engineering is helpful in:
a) Gene regulation b) Gene translation c) Gene therapy d) Alcohol production

300. Significance of heat shock method in bacterial transformation is facilitate
a) Binding of DNA to the cell wall
b) Uptake of DNA through membrane transport proteins
c) Uptake of DNA through transient pores in the bacterial cell wall
d) Expression of antibiotic resistance gene

301. A technique used to make numerous copies of a specific segment of DNA quickly and accurately:
a) Ligase chain reaction
b) Transcription
c) Polymerase chain reaction
d) Translation

302. Two microbes found to be very useful in genetic engineering are:
a) Diplococcus sp. and Pseudomonas sp.
b) Crown gall bacterium and Caenorhabditis elegans
c) Escherichia coli and Agrobacterium tumefaciens
d) Vibrio cholerae and a tailed bacteriophage

303. Minisatellite or Variable Number Tendem Repeat (VNTR) are used in
a) Gene therapy b) Gene mapping c) DNA fingerprinting d) Restriction enzymes

304. Having become an expert on gel electrophoresis, you are asked to examine a gel for a colleague. Where would you find the smallest segment of DNA?
a) Near the positive electrode, farthest away from the wells
b) Near the negative electrode, close to the wells
c) Near the top, near the negative pole
d) Near the middle they tend to slow-down after the first few minutes

305. Improvement of genotype of an organism by addition of some foreign genes is:
a) Genetic diversity b) Gene handling c) Tissue culture d) Genetic engineering

306. The structure involved in genetic engineering is
a) Codon b) Anticodon c) Vector d) Plasmid

307. In agarose gel electrophoresis, DNA molecules are separated on the basis of their
a) Charge only b) Size only c) Charge to size ratio d) All of these

308. In gel electrophoresis, the sample DNA is cut into fragments by

a) Restriction endonucleases
b) Exonuclease
c) Endonuclease
d) Anhydro L-galactose

309. Molecular scissors, which cut DNA at specific site:
a) Ligase
b) Cellulase
c) Pectinase
d) Polymerase

310. PCR stands for:
a) Polymerase Cyclic Reaction
b) Polymerase Chain Reaction
c) Polyethyl Cytosine Reaction
d) Polymerization Chain Reaction

311. In case of polymerase chain reaction, temperature, required for the steps
A. Denaturation
B. Annealing
C. Extension
a) A-94°C, B-40°C, C-72°C
b) A-40°C, B-72°C, C-94°C
c) A-72°C, B-94°C, C-40°C
d) A-94°C, B-72°C, C-40°C

312. DNA can be introduced into any cell by:
a) Injection
b) Being complexed with calcium salts
c) Being placed along with the cell into a gene gun
d) Gel electrophoresis

313. An improved variety of transgenic basmati rice:
a) Gives high yield and is rich in Vitamin A
b) Is completely resistant to all insect pests and diseases of paddy
c) Gives high yield but has no characteristic aroma
d) Does not require chemical fertilizers and growth hormones

314. Which of the following organelles is associated with genetic engineering?
a) Plastids
b) Plasmids
c) Chloroplast
d) Mitochondria

315. Human genome contains about:
a) 10,000 nucleotides
b) 10,000 genes
c) 6 billion nucleotides
d) 6 billion genes

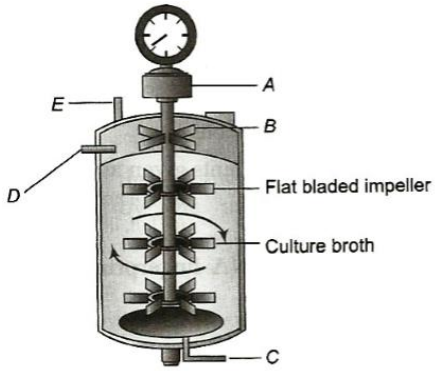
316. An artificial process of infecting cells with naked viral DNA is:
a) Translation
b) Transduction
c) Transfection
d) Transgenic

317. Match the correct one:
a) RNA Polymerase-RNA primer
b) Respiration-Lysosome
c) Restriction enzyme-genetic engineering
d) Central dogma-DNA structure

318. For transformation, microparticles coated with DNA are to be bombarded with gene gun are made up of:
a) Platinum or Zinc
b) Silicon or Platinum
c) Gold or Tungsten
d) Silver or Platinum

319. You are attempting to introduce a gene that imparts larval moth resistance to bean plants. Which of the following vectors are you most likely to use?
a) Phage DNA
b) Bacterial plasmid
c) Ti plasmid
d) Yeast plasmid

320. Simple stirred-tank bioreactor is given below. Identify A,B,C,D and E



A	*B*	*C*	*D*	*E*

a)

Motor	Foam braker	Sterile air	Steam for sterilization	Acid/Base of pH control

b)

Foam braker	Sterile air	Steam for sterilization	Acid/ Base of pH control	

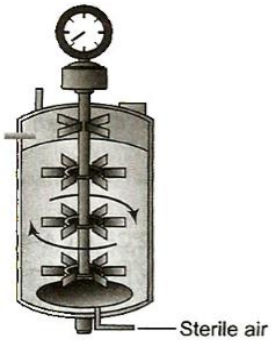
c)

Acid/ Base of pH control	Motor	Foam braker	Sterile air	Steam for sterilization

d)

Sterile air	Steam for sterilization	Foam braker	Motor	Acid/Base of pH control

321. Protein engineering is used to study the proteins to compare the catalytic properties of:
   a) Normal and mutated form of enzyme
   b) Normal form of enzyme
   c) Mutated form of enzyme
   d) Normal and mutated form of proteins
322. Genes that are involved in turning on or off the transcription of a set of structural genes are called:
   a) Polymorphic genes b) Operator genes c) Redundant genes d) Regulatory genes
323. The experimental manipulation of DNA of different species, producing recombination DNA is known as
   a) Gel electrophoresis
   b) Transformation
   c) Genetic engineering
   d) Replication technology
324. Plasmid is used as carrier because:
   a) It has both ends with replicating points
   b) It has no free ends
   c) It is circular DNA with a capacity of binding with equkaryotic DNA
   d) All of the above
325. Which of the following statement is correct in the context of observing DNA separated by agarose gel electrophoresis?
   a) DNA can be seen in visible light
   b) DNA can be seen without staining in visible light
   c) Ethidium bromide stained DNA can be seen in visible light
   d) Ethidium bromide stained DNA can be seen under exposure to UV light
326. Nitrogen fixing genes are called:
   a) '*Nif*' genes b) Plasmid genes c) *Leg* genes d) *Cos* genes
327. The genetically-modified (GM) brinjal in India has been developed for:
   a) Enhancing shelf life
   b) Enhancing mineral content
   c) Drought-resistance
   d) Insect-resistance
328. Variable number of tendem repeats (VTNRs) in the DNA molecule are highly useful in:
   a) Monoclonal antibody production
   b) DNA fingerprinting
   c) Recombinant DNA technology
   d) Stem cell culture
329. Protoplasts of two different species are fused in:
   a) Clona propagation
   b) Organography
   c) Micropropagation
   d) Somatic hybridization
330. Identify the correct match for the given diagram



Apparatus function

a) Gene gun - Vectorless direct gene transfer
b) Electrophoresis - Differential migration of DNA fragments

c) Bioreactor - Raw materials are biologically converted into specific products
d) Respirometer - Finding out rate of respiration

331. DNA fingerprinting technique was first developed by:
a) Jeffreys, Wilson and Thein
b) Schleiden and Schwann
c) Edward and Steptoe
d) Boysen and Jensen

332. Using recombinant technology, genes from a donor cell can be transplanted into a bacterium for DNA replication and protein synthesis. The kinds of cells that can be used as a donor in this technology are
a) Bacteria
b) Either yeast or bacteria
c) Eukaryotic cells
d) Any kind of cell

333. Transformation is defined as the procedure by which a piece of …A… is introduced into a …B… host. Here A and B refers to

	A	B
a)	RNA	Virus
b)	DNA	Bacteria
c)	RNA	Bacteria
d)	DNA	Virus

Session : 2025-26 **AS PER NEW NTA SYLLABUS**

Total Questions : 347

BIOLOGY (QUESTION BANK)

11.BIOTECHNOLOGY PRINCIPLES AND PROCESSES

: ANSWER KEY :

1)	a	2)	b	3)	c	4)	c	149)	c	150)	b	151)	c	152)	b
5)	a	6)	b	7)	a	8)	a	153)	b	154)	c	155)	a	156)	a
9)	c	10)	c	11)	c	12)	d	157)	b	158)	a	159)	d	160)	d
13)	c	14)	c	15)	c	16)	a	161)	d	162)	c	163)	c	164)	c
17)	d	18)	d	19)	a	20)	b	165)	c	166)	a	167)	a	168)	c
21)	b	22)	a	23)	d	24)	a	169)	c	170)	b	171)	d	172)	d
25)	b	26)	a	27)	b	28)	d	173)	b	174)	a	175)	a	176)	a
29)	a	30)	a	31)	a	32)	d	177)	d	178)	a	179)	c	180)	d
33)	d	34)	a	35)	c	36)	a	181)	d	182)	a	183)	b	184)	a
37)	d	38)	d	39)	a	40)	d	185)	a	186)	c	187)	a	188)	c
41)	d	42)	a	43)	c	44)	b	189)	d	190)	c	191)	c	192)	a
45)	b	46)	a	47)	b	48)	c	193)	a	194)	c	195)	b	196)	a
49)	a	50)	d	51)	a	52)	a	197)	d	198)	b	199)	a	200)	c
53)	b	54)	c	55)	d	56)	c	201)	d	202)	d	203)	a	204)	a
57)	c	58)	d	59)	b	60)	c	205)	d	206)	c	207)	d	208)	c
61)	b	62)	c	63)	d	64)	c	209)	d	210)	a	211)	b	212)	b
65)	c	66)	a	67)	c	68)	c	213)	d	214)	c	215)	d	216)	d
69)	b	70)	a	71)	a	72)	d	217)	a	218)	a	219)	d	220)	b
73)	a	74)	a	75)	b	76)	a	221)	c	222)	a	223)	c	224)	b
77)	a	78)	d	79)	d	80)	d	225)	b	226)	c	227)	d	228)	a
81)	b	82)	c	83)	a	84)	d	229)	a	230)	c	231)	d	232)	b
85)	a	86)	b	87)	a	88)	b	233)	d	234)	b	235)	a	236)	c
89)	a	90)	d	91)	d	92)	a	237)	b	238)	c	239)	c	240)	a
93)	b	94)	d	95)	a	96)	a	241)	d	242)	d	243)	a	244)	d
97)	b	98)	c	99)	d	100)	d	245)	d	246)	d	247)	a	248)	a
101)	d	102)	c	103)	d	104)	c	249)	b	250)	c	251)	b	252)	b
105)	b	106)	a	107)	b	108)	b	253)	b	254)	b	255)	d	256)	d
109)	b	110)	b	111)	b	112)	b	257)	b	258)	c	259)	b	260)	a
113)	d	114)	d	115)	c	116)	c	261)	a	262)	a	263)	c	264)	a
117)	a	118)	c	119)	c	120)	a	265)	d	266)	d	267)	b	268)	d
121)	a	122)	c	123)	b	124)	d	269)	a	270)	d	271)	b	272)	a
125)	a	126)	a	127)	a	128)	b	273)	c	274)	c	275)	b	276)	d
129)	b	130)	a	131)	d	132)	d	277)	a	278)	a	279)	d	280)	b
133)	b	134)	d	135)	a	136)	d	281)	c	282)	d	283)	b	284)	c
137)	d	138)	c	139)	d	140)	a	285)	d	286)	a	287)	a	288)	a
141)	a	142)	c	143)	b	144)	b	289)	d	290)	c	291)	d	292)	d
145)	d	146)	c	147)	c	148)	a	293)	d	294)	d	295)	c	296)	a

297)	**a**	**298)**	**a**	**299)**	**c**	**300)**	**c**	**321)**	**a**	**322)**	**b**	**323)**	**c**	**324)**	**c**
301)	**c**	**302)**	**c**	**303)**	**c**	**304)**	**a**	**325)**	**d**	**326)**	**a**	**327)**	**d**	**328)**	**b**
305)	**d**	**306)**	**d**	**307)**	**b**	**308)**	**a**	**329)**	**d**	**330)**	**c**	**331)**	**a**	**332)**	**d**
309)	**c**	**310)**	**b**	**311)**	**a**	**312)**	**b**	**333)**	**b**						
313)	**a**	**314)**	**b**	**315)**	**c**	**316)**	**c**								
317)	**c**	**318)**	**c**	**319)**	**c**	**320)**	**a**								

BIOLOGY (QUESTION BANK)

11.BIOTECHNOLOGY PRINCIPLES AND PROCESSES

: HINTS AND SOLUTIONS :

2 **(b)**
Retroviruses in animals including humans are able to change normal cells into cancerous cell

4 **(c)**
pBR322 vector was the first artificial cloning vector constructed in 1977 by Boliver and Rodriquez. It is widely used in gene cloning experiments in pBR322
p – Denotes that it is plasmid
BR – stands for Boliver and Rodriquez who constructed this plasmid
322 is a number given to distinguish this plasmid from others developed in the same laboratory

5 **(a)**
Genetic engineering is defined as the modification of genetic information of living organism by direct manipulation of their DNA. Thus, a gene of known function (economic importance) can be transferred from its normal location into a cell *via* a suitable mobile genetic element called vector such as plasmid, phage, etc.

7 **(a)**
Recombinant DNA having integrated fragment of antibiotic resistant gene

8 **(a)**
True. In plants, the tumour inducing plasmid (T_i) of *Agrobacterium tumefaciens* is used as a cloning vector

9 **(c)**
Gene encoding resistance to antibiotics like ampicillin, chloramphenicol, tetracycline or Kanamycin, are useful selectable markers for *E.coli.* The normal *E.coli* cells do not carry resistance against any of these antibiotics

12 **(d)**
Proteins are removed by treatment with protease

13 **(c)**
Plasmids, cosmids or bacteriophages can be used as vector in genetic engineering. Plasmids are most widely used circular, extrachromosomal DNA segments seen in the bacterial cells. They carry a foreign gene or desired gene to the host. The size of plasmids ranges from 1×10^6 to 200×10^6 daltons

14 **(c)**
Both are true, *Ori* also controls the copy numbers of the linked DNA
If a foreign DNA ligates at the *Bam* HI site tetracycline resistance gene in the vector pBR322, the recombinant plasmid loses the tetracycline

18 **(d)**
After the formation of the product in the bioreactors, it undergoes through some processes before a finished product to be ready for marketing. *The processes include* (i) separation and (ii) purification of product which are collectively called the downstream processing
The product is subjected to quality control testing and kept in suitable preservatives. If drugs are to be manufactured such formulation has to undergo through clinical trials. A proper quality control testing for each product is also needed. The downstream processing and quality control test are different from product to product

19 **(a)**
Endonucleases are enzymes that produce internal cuts called cleavage DNA molecule. A class of endonucleases cleavage DNA only within or near those sites which have specific base sequences, such endonucleases are known as restriction endonucleases and sites recognized by them are called recognition sites. Restriction endonucleases have major role in genetic engineering

20 **(b)**

Plasmid is an extrachromosomal genetic of DNA that is capable of replicating independently of host chromosome. It forms the basis of many cloning vectors used in genetic engineering

21 **(b)**
PCR was discovered by Kary Mullis. In Polymerase Chain Reaction (PCR), a segment of DNA is amplified. *Taq* DNA polymerase enzyme is used PCR, this enzyme is temperature resistant

22 **(a)**
A-*Taq* polymerase, B-Denaturation (air), C-Prime

23 **(d)**
Bioreactors (fermenters) are considered as vessel in which raw material are biologically converted into specific products by microbes, plant and animal cells and/or their enzymes

24 **(a)**
By using PCR phenylketonuria, muscular cystrophy, sickle-cell anaemia, hepatitis, chlamydia and tuberculosis can be diagnosed

26 **(a)**
Primers are small chemically synthesized oligonucleotides of about 10-18 nucleotides long that are complementary to the sequences present at the 3' ends of the target DNA segment

27 **(b)**
Shotgun cloning involves cutting the DNA of the entire genome into pieces with restriction enzyme, inserting these pieces or fragments into bacteria or yeast with plasmids or viruses and allowing the organism to reproduce making copies or clones of the DNA fragments

28 **(d)**
The Polymerase Chain Reaction or PCR, as it is commonly called, was originally invented by Kary Mulllis in 1985. Kary Mulllis shared the Nobel Prize with Michael Smith in Chemistry in 1993. PCR is best defined as the DNA replication *in vitro.* A single PCR amplification cycle involves three basis steps; denaturation, annealing and extension (polymerization)

30 **(a)**
True, *Ori* is a DNA sequence that is responsible for initiating replication. Any piece of DNA, which linked to this sequence can replicated with in the host cells

31 **(a)**
True. Plasmids are autonomously replicating circular extra-chromosomal DNA

33 **(d)**
PCR is carried out in the following three steps
Denaturation, Annealing and Extension

37 **(d)**
Plasmid which is extra chromosomal DNA molecule and help in gene cloning

38 **(d)**
A restriction fragment containing a specific gene of interest can be identified by gel electrophoresis followed by transferring of DNA to a membrane as a solid support matrix using a procedure called a Southern blot

39 **(a)**
Protection of host DNA from the action of restriction endonuclease by adding methyl group to one or two bases usually with in the sequence recognized by restriction enzyme

40 **(d)**
Single stranded DNA molecules that can bind to and be used to detect other DNA molecule are called probes

42 **(a)**
Principle of PCR The purpose of a PCR (Polymerase Chain Reaction) is to make a huge number of copies of a gene. This is necessary to have enough starting template for sequencing There are three major steps in a PCR, which are repeated for 30 or 40 cycles. This is done on an automated cyclers, which can heat and cool the tubes with the reaction mixture in a very short time
(i) **Denaturation at 95**°C During the denaturation, the double-strand melts open to single-stranded DNA, all enzymatic reactions stop (for example : the extension from a previous cycle)
(ii) **Annealing at 54**°C The primers are jiggling around, caused by the Brownian motion. Ionic bonds are constantly formed and broken between the single-stranded primer and the single-stranded template. The more stable bounds last a little bit longer (primers that fit exactly) and on that little piece of double-stranded DNA (template and primer), the polymerase can attach and starts copying the template. Once there are a few bases built in, the ionic bond is so strong between the template and the primer, that it does not break anymore
(iii) **Extension at 72**°C This is the ideal working temperature for the polymerase. The primers, where there are a few bases built in, a already

have a stronger ionic attraction to the template than the forces breaking these attractions. Primers, that are on positions with no exact match, get loose again (because of the higher temperature) and don't give an extension of the fragament

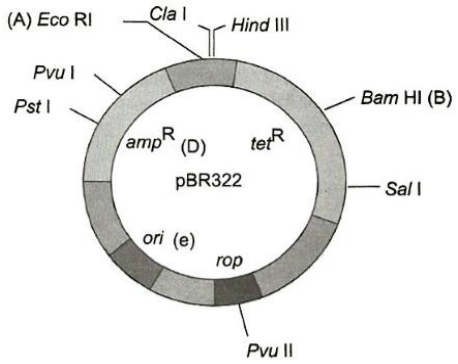
The bases (complementary to the template) are coupled to the primer on the 3' side (the polymerase adds *d*NTPs from 5' to 3', reading the template from 3' to 5' side, bases are added complementary to the template)

43 **(c)**

The controlled use of biological agents, such as microorganism, plants or animal cell, for beneficial use is called biotechnology. This technology involves cutting and pasting of desired DNA fragments into the specified hosts for the benefits of human beings

51 **(a)**

Eco RI.



52 **(a)**

Microinjection DNA is directly injected into plant protoplasts or cells (specifically into the nucleus or cytoplasm) using fine tipped (0.5-1.0 micrometer diameter) glass needle or micropipette. This method of gene transfer is used to introduce DNA into large cells such as oocytes, eggs, and the cells of early embryo

Electroporation It involves a pulse of high voltage applied to protoplasts/cells/tissues to make transient (temporory) pores in the plasma membranes which facilitates the uptake of foreign DNA

The cells are place in a solution containing DNA and subjected to electrical shock to cause holes in the membranes. The foreign DNA fragments enter through the holes into the cytoplasm and then to nucleus

Chemical Mediated Gene Transfer *Chemicals like Polyethylene Glycol (PEG) and sulphate induce DNA uptake into plant protoplasts. Calcium phosphate is also used to transfer DNA into cultured cells*

55 **(d)**

Polyethylene glycol method is used for gene transfer without a vector. It is a chemical method for direct gene transfer to protoplast

56 **(c)**

Restriction endonucleases and ligase are commonly used enzymes in genetic engineeering

57 **(c)**

DNA fingerprinting is a modern technique that compares sets of DNA by locating identical sequences of nucleotides. It is oftening used to solve many mysteries involving murders, robberies and rapes

58 **(d)**

Genetic engineering is a branch of biotechnology, which deals with the manipulation of genetic material by man. The technique of genetic engineering includes

(i) formation of 'recombinant DNA'

(ii) use of gene cloning

(iii) gene transfer

1. pBR 322 was the first artificial cloning vector constructed in 1977 by Boliver and Rodriguer. It is widely used in gene cloning experiments

2. Restriction enzymes belongs to a class of enzymes called nucleases

60 **(c)**

A – Key Mullis

B – 1985

C – 1993

61 **(b)**

Cutting of piece of DNA from a plasmid was done with the help of restriction enzyme, popularly known as molecular scissors

62 **(c)**

Different kinds of specific enzymes are used in genetic engineering, *e.g.,* cleaving enzymes → These enzymes are used to break DNA molecules

They are of three types

(i) Exonucleases

(ii) Endonucleases

(iii) Restriction endonucleases

63 **(d)**

Components of a bioreactors

An agitator system
An oxygen delivery system
Foam control system
Temperature control system
pH control system
sampling ports to withdraw culture periodically

65 **(c)**
Both are true

66 **(a)**
A-plasmid, B-Boliver, C-Rodriquez.
pBR322 vector was the first artificial cloning vector constructed in 1977 by Boliver and Rodriquez. It is widely used in gene cloning experiments in pBR322
p – Denotes that it is plasmid
BR – stands for Boliver and Rodriquez who constructed this plasmid
322 is a number given to distinguish this plasmid from others developed in the same laboratory

67 **(c)**
DNA fingerprinting is a technique to identify a person on the basis of person's DNA specificity. The technique is based upon the fact that the DNA constitution of an individual carries some specific sequence of nucleotides, which do not carry any information for protein synthesis
From the given options, leucocytes are to be used for identifying the criminal because they are nucleotide, whereas erythrocytes are enucleated

70 **(a)**
The basic requirements of a PCR reaction are the following
DNA Template Any source that contains one or more target DNA molecules to be amplified can be taken as template
Two Nucleotide Primers Primers, which are oligonucleotides, that hybridise to the target DNA region, one to each strand of the double helix
Enzyme *Taq* polymerase and *vent* polymerase

72 **(d)**
Circular plasmid DNA which is used as a vector, can be cleaved at one site with the help of enzyme to give a linear DNA molecule. A foreign DNA segment can now be inserted, by joining the ends of broken circular DNA to the two ends of foreign DNA, thus regenerating a bigger circular DNA molecule that can now be separated by gel electrophoresis on the basis of its size
Bacteriophages provide another source of cloning vectors. Since, usually, a phage has a linear DNA molecule, a single break will generate two fragments, which are later joined together with foreign DNA to generate a chimeric phage particle

73 **(a)**
Genetic engineering is defined as the modification of genetic information of living organisms by direct manipulation of their DNA
Thus, a gene of known function (or economic importance) can be transferred from its normal location into a cell *via* a suitable mobile genetic element called vector such as plasmid phage, etc.

74 **(a)**
Thermostable enzymes '*Taq* and *Vent'* isolated from thermophilic bacteria are DNA polymerase *Taq* polymerase, isolated from a *Thermophilic bacterium, Thermus aquaticus* and *vent* polymerase, isolated from a thermophilic bacterium *Thermococcus litoralis*

75 **(b)**
Due to chlorophenicol resistance gene, one is able to select a transformed cell in the presence of chloramphenicol. The chloramphenicol resistance gene in this case is called selectable marker

76 **(a)**
The restriction endonuclease *Eco* RI is obtained from *Esherichia coli* RY 13. The recoginition sequence for this is GAATTC, CTTAAG

77 **(a)**
Autonomously replicating circular extrachromosomal DNA.
Manipulation of gene and genetic material by man is a fast emerging branch of science, which started with the formation of recombinant DNA molecule. This branch of science is named as recombinant DNA technology, genetic engineering and DNA manipulation technology, genetic engineering and DNA manipulation technology. This technology involves cutting and pasting of desired DNA fragments into the specified hosts for the benefits of human beings

78 **(d)**
The polymerase chain reaction is a technique that is used for *in vitro* replication of specific DNA sequence using thermostable DNA polymerase. The polymerase chain reaction or PCR, was originally invented by Kary Mullis in 1985. Kary Mullis shared the Nobel Prize with Michael Smith in chemistry in 1993

86 **(b)**

The Polymerase Chain Reaction (PCR) is a technique by which small samples of DNA can be quickly amplified. The repeated amplification is achieved by the use of thermostable DNA polymerase (*i.e., taq* polymerase isolated from a bacterium, *Thermus aquaticus*) which remain active during the high temperature induced denaturation of double-stranded DNA

88 **(b)**
Exonucleases remove nucleotides from the terminal ends (either 5' or 3') of DNA in one strand of duplex

90 **(d)**
PCR is a technique of synthesizing multiple copies of the desired gene or (DNA) *in vitro. The basic requirement of PCR* are DNA template, two nucleotide primers and enzyme (DNA polymerase)

91 **(d)**
Agrobacterium tumefaciens (soil inhabiting plant bacterium) is a pathogen of several dicot plants. It delivers a piece of DNA known as 'T-DNA' in the Ti-plasmid which transforms normal plant cells into tumour cells to produce chemicals against pathogens

92 **(a)**
Restriction endonuclease recognize a specific DNA base sequence (recognition sequence, recognisation site, restriction sequence or restriction site having palindromic sequence) and cleaves both the strands of DNA at or near that site. The enzyme cuts the DNA, generating restriction fragments with overhanging ends or blunt ends

95 **(a)**
Agrobacterium tumefaciens (updated scientific name *Rhozobium radiobacter*) is the casual agent of crown gall disease (the formation on tumour) in over 140 species of dicot. It is a rod-shaped, Gram negative, soil bacterium (Smith, *et. al* 1907). Symptoms are caused by the insertion of a small segment of DNA, known as T-DNA (transfer DNA) into the plant cell, which is incorporated at a semi-random location into the plant genome

96 **(a)**
True, the polymerase chain reaction is a reaction in which amplification of specific DNA sequences is carried out in *vitro*

99 **(d)**
Restriction enzyme are known as molecular knives or molecular scissors and are used to cut DNA at specific sites of DNA. These were first discovered by Smith, Nathan and Arber

101 **(d)**
Small volume cultures are usually employed in laboratories for research and production of less quantities of products. *e.g.,* in shake flasks. However, large scale production of the products is carried out in 'bioreactor'
Bioreactors are large vessels (having a volume of 100 to 1000 L) which are used for biological conversion of raw materials into specific products. The most commonly used bioreactors are of stirring type

102 **(c)**
The term 'Biotechnology' was given in 1917 by a Hungarian Engineer, Karl Erkey, to describe a process or large scale production of pigs

107 **(b)**
Agrobacterium tumefaciens delivers a piece of DNA known as 'T-DNA' in the Ti-plasmid which transforms normal plant cells into tumour cells to produce chemical against pathogens

110 **(b)**
Kary Mullis
Gene encoding resistance to antibiotics like ampicillin, chloramphenicol, tetracycline or Kanamycin, are useful selectable markers for *E.coli.* The normal *E.coli* cells do not carry resistance against any of these antibiotics

114 **(d)**
Ti-plasmid is found in *Agrobacterium tumefaciens,* which produces crown gall (tomour) in a large number of dicot species. *A. tumefaciens* is a Gram negative soil bacterium that infects a wide range of plants and causes crown galls

115 **(c)**
The science of recombinant technology took birth when Cohen and Boyer (1972) were able to introduce a piece of antibiotic resistance gene containing foreign DNA into plasmid of *Salmonella typhimurium.* This modified plasmid was them inserted into *E. coli* to get clones of recombinant DNA. Thus, Cohen and Boyer discovered recombinant technology

116 **(c)**
In recombinant DNA technology, a desired segment of DNA or a gene is made to combine with the DNA of an organism where it will

multiply and produce it copies. Plasmids and viruses are the most commonly used cloning vectors in recombinant DNA technology

119 **(c)**

Selectable marker helps to select the host cells which contain the vector and eliminate the non-transformants. Genes encoding resistance to antibiotics like ampicillin, chloramphenicol, tetracycline or kanamycin are useful selectable markers of *E.coli*. The normal *E.coli* cells do not carry resistance against any of these antibiotics

122 **(c)**

Herbert Boyer discovered that restriction enzymes have the capability of cutting DNA strands in a particular fashion, which left what has became known as sticky ends on the strands

123 **(b)**

A Southern blot.

A restriction fragment containing a specific gene of interest can be identified by gel electrophoresis followed by transferring of DNA to a membrane as a solid support matrix using a procedure called a Southern blot

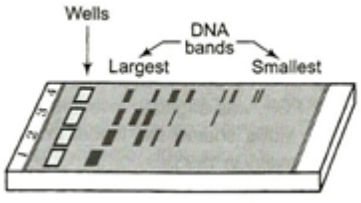
124 **(d)**

In biolistic or gene gun method, cells are a high velocity micro-particles of gold or tungsten coated with DNA in plants. Important crop plants like maize, rice and wheat have now been transformed by this method

125 **(a)**

Electrophoresis.

A molecule of DNA can be cut into fragments by the enzyme restriction endonucleases. These fragments of DNA can be separated by a technique of gel electrophoresis. In this process the smallest segment of DNA travel towards anode (+ ve electrode), farthest away from the wells



130 **(a)**

RNA is removed by treatment with ribonuclease

132 **(d)**

All statements are correct

Restriction Enzymes	Source	Recognition Sequence and Site of Cleavage	Product
Eco RI	*Escherichia coli* RY 13	5'-G↓A-A-T-T-C-3' 3'-C-T-T-A-A↑G-5'	G A-A-T-T-C C-T-T-A-A G Sticky ends

133 **(b)**

During annealing two oligonucleotide primers hybridise to each of single stranded template DNA in presence of excess of synthetic oligonucleotides

136 **(d)**

In gel electrophoresis a molecule of DNA can be cut into fragments by the enzyme restriction endonuclease. DNA fragments move towards the anode according to their molecular size through the agarose gel

The separated DNA fragments can be observed only after staining them with a solution of ethidium bromide. The bright orange coloured bands of DNA can be seen only under UV light. These bands of DNA fragments are cut out from the gel and extracted by using convenient technique. This step is called elution

139 **(d)**

Microorganisms can be grown in the bioreactors by support growth system and suspended growth system

141 **(a)**

Escherichia coli and *Agrobacterium tumefaciens* are the microbes found to be very useful in genetic engineering. *E.coli* is a motile, Gram negative, rod-shaped bacterium which is a normal inhabitant of human colon. It is most extensively used in bacterial genetic and molecular biology *Agrobacterium tumefaciens* is a soil bacterium. It has Ti-plasmid (tumour inducing plasmid) and it can be used for the transfer of a desired gene in dicot plants

142 **(c)**

pUC 18 is a plasmid cloning vector commonly used with *E. coli.* The vector length is 2686 bp and is isolated from *E. coli* strain DH5α by standard procedures

143 **(b)**

A – Vector; B-DNA

144 **(b)**

The probes used for DNA fingerprinting are usually prepared from minisatellite or microsatellite DNA

145 **(d)**

In recent times, PCR is being used in the detection of HIV (virus of AIDS) mutation are related to genetic disease. By using PCR phenylketonuria, muscular dystrophy, sickle-cell anaemia, hepatitis, chlamydia and tuberculosis can be diagnosed. PCR is also used in DNA fingerprinting

147 **(c)**
Ti-plasmid is a plasmid present in *Agrobacterium tumefaciens*. It is used in genetic engineering in plants, *e*. *g*., as a vector in gene transfer to dicot plants

148 **(a)**
The role of DNA ligase in the construction of a recombinant DNA molecule is formation of phosphodiester bond between two DNA fragments. DNA ligase help in sealing gaps in DNA fragments
Therefore, they act as a molecular glue. In 1969 Har Govind Khorana discovered DNA ligase in T_4-bacteriophage

153 **(b)**
In gene gun or biolistic method tungsten or gold particles, coated with foreign DNA are bombarded into target cells at a very high velocity
Although this method is suitable for plants yet this technique is also used to insert genes into animal that promote tissue repair into cells (particularly cancer of mouth) near wounds

154 **(c)**
The final step in PCR is extension (polymerization), where in *Taq* DNA polymerase synthesizes the DNA region between the primers using deoxynucleotide triphosphates and Mg^{2+}. It means the primers are extended towards each other so that the DNA segment lying between the two primer is copied. The optimum temperature for this polymerization step is 72°C
Taq polymerase is thermostable enzyme, isolated from Thermophilic bacterium, Thermus aquaticus

155 **(a)**
EFB – European Federation of Biotechnology
A definition of biotechnology which covers both traditional views and modern molecular biotechnology has been given by European Federation of Biotechnology. According to EFB "Biotechnology is the integrated use of biochemistry, microbiology and engineering sciences in order to achieve technological application of the capabilities of microorganisms, cultured tissues/cells and part there of"

156 **(a)**
A technique developed by EM Southern in 1975 for detection of a specific DNA sequences (gene or other) in a large, complex sample of DNA (*e*. *g*., cellular DNA). It is also used to determine the molecular weight of a restriction fragment and to measure relative amounts in different sample
Uses Southern blots are used in gene discovery and mapping, evolution and development studies, diagnostics and forensics
In regards to genetically modified organisms, Southern blotting is used as a definitive test to ensure that a particular section of DNA of known genetic sequence has been successfully incorporated into the genome of the host organism

157 **(b)**
Cry I endotoxins obtained from *Bacillus thuringiensis* are effective against bollworm larvae

158 **(a)**
In the naming of restriction enzymes the first letter is derived from genus name and next two letters from the species name of the prokaryotic cell from where the enzymes are extracted

159 **(d)**
A molecule of DNA can be cut into fragments by the enzyme restriction endonucleases. These fragments of DNA can be separated by a technique of gel electrophoresis. It is a technique used for the separation of substances of different ionic properties

163 **(c)**
During extension, the enzymes *Taq* polymerase synthesizes the DNA segment between the primers. The two primers extend towards each other in order to copy the DNA segment typing between the two primers
This step requires presence of deoxynucleoside triphosphate (*d*NTPs) and Mg^{2+} and occurs at 72°C

164 **(c)**
Both are true in the process for the isolation of DNA, after several treatments the purified DNA is precipitated by adding chilled ethanol. The bacterial/plant, animal cell is broken down by enzymes to release DNA, along with RNA, proteins, polysaccharide and lipids

165 **(c)**

Bioreactors are vessels of large volumes (100-1000 litres) in which raw materials are biologically converted into specific products. It provides all the optimal conditions for achieving the desired product by providing optimal growth conditions like temperature, pH, substrate, salts vitamins and oxygen. Stirred-tank bioreactors are commonly used bioreactors. There are cylindrical with curved base to facilitate proper mixing of the contents. The stirrer mixes the contents and makes oxygen available throughout the bioreactor

166 **(a)**

Thermus aquaticus.

DNA polymerase which is stable at high temperature (>90°C) is required to carry out the synthesis of new DNA. The DNA polymerase like *Taq* polymerase is generally used in PCR reactions which is isolated from a bacterium *Thermus aquaticus*

169 **(c)**

The first restriction endonuclease type II was isolated by Smith, Wilcox and Kelley from *Haemophilus influenza* bacterium. It was formed to cut DNA molecules at a particular point of recognizing a specific sequence of six base pairs, known as the recognition sequence

170 **(b)**

In gel electrophoresis, the separated DNA fragments are visualized after staining the DNA with ethidium bromide followed by exposure to UV radiation

173 **(b)**

In gel electrophoresis a molecule of DNA can be cut into fragments by the enzyme restriction endonuclease. DNA fragments move towards the anode according to their molecular size through the agarose gel

The separated DNA fragments can be observed only after staining them with a solution of ethidium bromide. The bright orange coloured bands of DNA can be seen only under UV light. These bands of DNA fragments are cut out from the gel and extracted by using convenient technique. This step is called elution

175 **(a)**

DNA polymerase which is stable at high temperature (>90°C) is required to carry out the synthesis of new DNA. The DNA polymerase like *Taq* polymerase is generally used in PCR reactions which is isolated from a bacterium *Thermus aquaticus*

176 **(a)**

Most sensitive technique to detect malignant cell in non-hodgkins lymphoma is polymerase chain reaction. In recent times, PCR is being used in the detection of HIV (Virus of AIDS)

179 **(c)**

The Pribnow box (also known as the Pribnow – Schaller box) is the sequence TATAAT of six nucleotides that is an essential part of a promoter site on DNA for transcription to occur in bacteria

187 **(a)**

Gene gun method was first developed by Prof. Stanford and coworkers at Cornell University, USA in 1987. This method is used to introduce foreign DNA into host cell

188 **(c)**

During extension, the enzyme DNA polymerase synthesizes the DNA segment between the primers. DNA polymerase is a heat stable enzyme

191 **(c)**

After the formation of the product in the bioreactors, it undergoes through some processes before a finished product to be ready for marketing. The processes include (i) separation and (ii) purification of products, which are collectively called the downstream processing

192 **(a)**

The stirred-tank bioreactor is well suited for large-scale production of protein of enzyme by using microbial plant/animal/human cells

193 **(a)**

A-DNA is vector/plasmid DNA and B-is foreign DNA.

C-The restriction enzyme that recognizes this palindrome-*Eco* RI

D-The enzyme that can link these two DNA fragment-DNA ligase

194 **(c)**

Restriction endonuclease was isolated for the first time by W Arber in 1962 in bacteria. They are called molecular scissors or biological scissors. In 1978 Arber, Smith and Nathan were awarded the Nobal Prize for the discovery of restriction endonuclease

195 **(b)**

In genetic engineering *r*DNA technology is applied to several biotechnological processes for

obtaining particular biochemical improvement of genetic make up of an organism and fighting genetic defects

197 **(d)**
Primer and DNA polymerase.
PCR is a technique of synthesizing multiple copies of the desired gene or (DNA) *in vitro. The basic requirement of PCR* are DNA template, two nucleotide primers and enzyme (DNA polymerase)

198 **(b)**
An antibiotics resistance gene in a vector usually helps in the selection of transformed cell

200 **(c)**
Bioreactors are considered as vessels in which raw materials are biologically converted into specific products by microbes, plant and animal cells and or their enzymes. Small volume cultures can not give large quantities of the products. Large scale production (100-1000 L) of the products is carried out in bioreactors. A bioreactor provides the optimal conditions for obtaining the desired product by providing optimum growth conditions such as temperature, pH, substrate, vitamins, oxygen and salts. In the sparged stirred tank bioreactor, sterile air bubbles are sparged. The surface area for oxygen transfer is increased

203 **(a)**
Vent polymerase enzyme used in PCR is isolated from *Thermococcus litoralis*

211 **(b)**
A stirred-tank bioreactor is more advantageous, than shake flasks. It has an agitator system to mix the contents properly, an oxygen delivery system to make availability of oxygen, a foam control system, a temperature control system, a pH control system and a sampling port to withdraw the small volumes of the culture periodically

212 **(b)**
During gene cloning plasmid is called gene taxi. Molecular biologists add desired gene desired gene to plasmids, then insert the new plasmid with the added gene into a living bacterium

214 **(c)**
Both are true. Copy number is defined as the number of copies of vectors present in a cell. It varies from 1-100 copies per cell

219 **(d)**
Availability of thermostable DNA polymerase.
DNA polymerase which is stable at high temperature (>90°C) is required to carry out the synthesis of new DNA. The DNA polymerase like *Taq* polymerase is generally used in PCR reactions which is isolated from a bacterium *Thermus aquaticus*

221 **(c)**
Stanley Cohen and Herbert Boyer generated first recombinant DNA molecule by combining a gene from a bacterium with plasmid of *Escherichia coli*

230 **(c)**
Thermophilic bacterium.
Thermostable enzymes '*Taq* and *Vent'* isolated from thermophilic bacteria are DNA polymerase *Taq* polymerase, isolated from a *Thermophilic bacterium, Thermus aquaticus* and *vent* polymerase, isolated from a thermophilic bacterium *Thermococcus litoralis*

232 **(b)**
Agrobacterium tumefaciens is used as a best genetic vector in plants

233 **(d)**
Plants in comparison to animals are more rapidly manipulated by genetic engineering reasons are
(i) Totipotency (having the ability to differentiate into all cell types) shown by plant cells
(ii) Single somatic cell can regenerate a whole plant body
(iii) Genetic engineering is supplemented with plant tissue culture techniques

237 **(b)**
Vector is a plasmid or virus DNA used to introduce genes into a host cell, where the genes may be amplified (gene cloning) or otherwise manipulated

240 **(a)**
Digestion with restriction enzyme
↓
Electrophoresis
↓
Ethidium bromide
↓
Radioactive probe
↓
X-ray film

241 **(d)**

amp^R (amplification resistance gene) and tet^R (tetracycline resistance gene) are antibiotic resistance genes

244 **(d)**

Restriction endonucleases cleave DNA molecules only at specific nucleotide sequence called restriction sites. DNA ligase enzymes is used to joins bits of DNA

248 **(a)**

Mobile genetic element is broadly any genetic element capable of moving itself, with or without duplication, from one site in a genome to another. Mobile genetic elements include plasmids, viruses, transposable genetic elements (transposons), short interspread elements, pathogenicity islands and so on. The term 'transposon' was introduced **RW Hedges** and **AE Jacob** in 1974, 'controlling elements' or jumping genes, discovered by **Barbara McClintock** (1950) in maize

251 **(b)**

Special sequence in the DNA recognized by restriction endonuclease is called palindromic nucleotide sequence.

Restriction endonuclease recognizes palindromic sequences in DNA and cuts them

The palindromes in DNA are base pair sequences that are the same when read forward (left to right) or backward (right to left) from a central axis of symmetry

For example

(i) 5' – G A A T T C – 3'
3' – C T T A A G – 5'

(ii) 5' – G G A T C C -3'
3' – C C T A G G -5'

253 **(b)**

Identification of DNA with desirable gene
↓
Introduction of DNA into host to form recombinant DNA
↓
Maintenance of DNA in host and gene cloning
↓
Gene transfer

254 **(b)**

Recombinant DNA technology involved the following steps

(i) Isolation of DNA

(ii) Fragmentation of DNA by restriction endonucleases

(iii) Isolation of a desired DNA fragment

(iv) Amplification of the gene of interest

(v) Ligation of the DNA fragment into a vector

(vi) Insertion of recombinant DNA into the host

(vii) Culturing the host cells on a suitable medium at a large scale

(viii) Extraction of the desired gene product

(ix) Downstream processing of the products as finished product, ready for marketing

258 **(c)**

A - Competency

B - Calcium

C - microinjection method

262 **(a)**

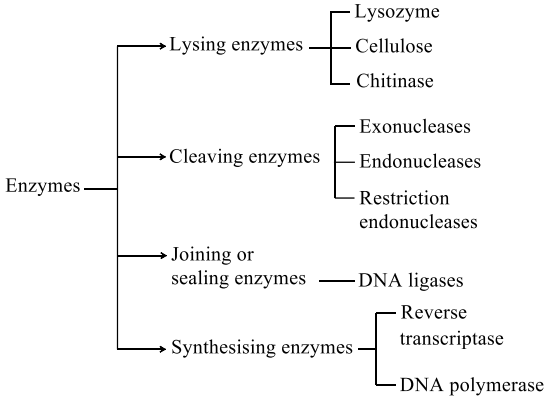
The most important feature in a plasmid to be used as a vector is origin of replication (*Ori*). Origin of replication is a specific sequence of DNA bases which is responsible for initiating replication. A prokaryotic DNA has a single origin of replication while eukaryotic DNA may have more than one origin of replication

263 **(c)**

DNA gyrase, the enzyme that participates in the process of DNA replication is a type of DNA topoisomerase

265 **(d)**

Three types of 'biological tool' are used in the formation of recombinant DNA



(ii) Cloning vectors (vehicle vectors)

(iii)Complementary host (for transformation with recombinant DNA)

268 **(d)**

In recent times PCR is being used in the detection of HIV (Virus of AIDS). By using PCR phenylketonuria, muscular dystrophy, sickle-cell anaemia, hepatitis, chlamydia and tuberculosis also can be diagnosed

269 **(a)**

Agarose is extracted from sea weeds. It is a polysaccharide. In gel electrophoresis, DNA fragments separate according to size through the pores of agarose gel

270 **(d)**
DNA polymerase remains active at high temperature. Usually *Taq* DNA polymerase, isolated from a thermophilic bacterium *Thermus aquaticus,* is used in most of the cases

272 **(a)**
The science of biotechnology is based mainly on two core technologies
(i) **Genetic engineering**, which is the manipulation of genes by man. It includes techniques to alter the nature of genetic material (DNA and RNA), to introduce these into host organisms and thus, change the phenotype of the host organism
(ii) **Biochemical engineering**, *i.e.,* processes that help the growth of desired microbe/eukaryotic cell in large quantities in a sterile medium for the manufacture and multiplication of biotechnological product

273 **(c)**
Each bioreactor has a cylindrical stirred-tank to facilitate the mixing of contents. The stirrer provides facility of mixing the contents as well as availability of oxygen throughout the process

275 **(b)**
Taq DNA polymerase is a thermostable enzyme, isolated from a *Thermophilic bacterium, Thermus aquaticus*

278 **(a)**
A sparged stirred-tank bioreactor being stirred at 200 RPM

280 **(b)**
The Polymerase Chain Reaction (PCR) is a technique by which small samples DNA can be quickly amplified. Starting with only one gene sized pieces of DNA, this technique is used to make literally billions of copies in only a few hours

283 **(b)**
Ligase catalyse the formation of bonds between P = O

284 **(c)**
A probe is radioactively labelled (P^{32}) nucleic acid (20-40 nucleotide long) with a short sequence complementary to at least one part of the desired DNA gene

285 **(d)**
VNTRs were an important sources of RFLP genetic markers used in linkage analysis of genomes. VNTRs have become essential to forensic crime investigations, *via* DNA fingerprinting

286 **(a)**
Isolation of restriction endonucleases by **Nathans** and **Smith** (1970) made it possible to cut DNA at specific sites. Restriction enzyme can cut both strains of DNA when foreign nucleotides are introduced in the cell. They cleave DNA to generate a nick with a 5' phosphoryl and 3' hydroxyl terminus

287 **(a)**
Largest DNA bands will be at (A) and smallest DNA bands will be at (B) because in this DNA is move according to their size in agarose small DNA fragment will have small resistant so this fragment move to long distance as compared to large DNA fragment

289 **(d)**
The technique of fingerprinting was initially developed by Alec Jeffreys. He used a satellite DNA as probe that shows very high degree of polymorphism. It was called as Variable Number of Tendem Repeats (VNTRs)

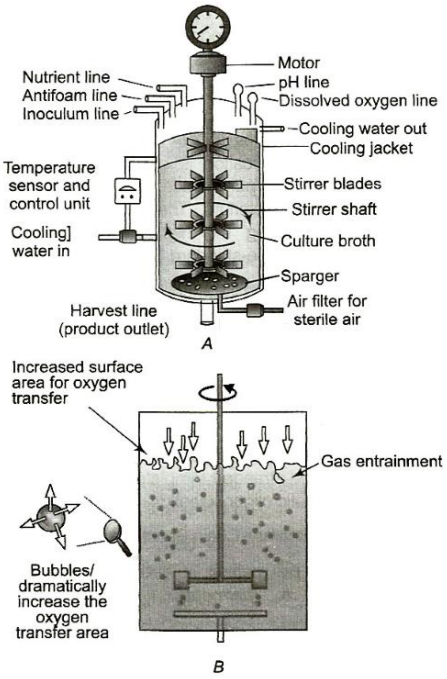
290 **(c)**
Vent polymerase and *pfu* polymerase both

291 **(d)**
A single PCR amplification cycle involves three basic steps; denaturation, annealing and extension (polymerization)
Denaturation – Melting of target DNA
Annealing – Join
Extension – Polymerisation

295 **(c)**
A-Bacteria, B-Virus, C-Cosmid

296 **(a)**
The DNA fragments are seen as orange coloured bands. The separated bands of DNA are cut out and extracted from the gel piece. This step is called elution

298 **(a)**
Simple stirred-tank bioreactor, sparged stirred-tank.



A-Simple stirred-tank bioreactor for continuous culture.

B-Sparged stirred-tank bioreactor through, which sterile (free from any germs) air bubbles are sparged

Bioreactor (fermenters) Bioreactors are considered as vessels in which raw materials are biologically converted into specific products by microbes, plant and animal cells and/or their enzymes. Small volume cultures cannot give large quantities of the products. Large scale production (100-1000 L) of the products in carried out in **bioreactors.** A bioreactor provides the optimal condition for obtaining the desired product by providing optimum growth conditions such as temperature, Ph, substrate, vitamins, oxygen and salts

Types of Bioreactors The most commonly used bioreactors are of **stirring type**. Stirring type bioreactors are (i) **Simple stirredtank bioreactors** and (ii) **Sparged stirred-tank bioreactor** as shown in figure. In the sparged stirred-tank bioreactor, sterile air bubbles are sparged. The surface area for oxygen transfer is increased

300 **(c)**

DNA being a hydrophilic molecule can not pass through cell membranes. Therefore, the bacteria should be made competent to accept the DNA molecule

In this case the cell is treated with specific concentration of a divalent cation such as calcium to increase pore size in cell wall

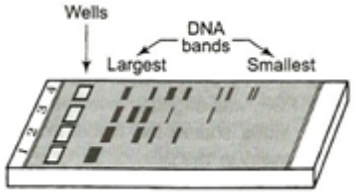
The cells are incubated with recombinant DNA on ice, followed by placing them briefly at 42°C and them putting it back on ice. This is called heat shock treatment. The bacteria now takes up the recombinant DNA

303 **(c)**

DNA fingerprinting technique is very useful in solving disputed parentage cases and forensic cases. DNA fingerprinting are obtained from RFLP and VNTR (satellite DNA) analysis of blood, hair or other material found the place of crime

304 **(a)**

A molecule of DNA can be cut into fragments by the enzyme restriction endonucleases. These fragments of DNA can be separated by a technique of gel electrophoresis. In this process the smallest segment of DNA travel towards anode (+ ve electrode), farthest away from the wells



306 **(d)**

The structure involved in genetic engineering is plasmid. Plasmids were discovered by William Hays and Joshua Lederberg (1952). These are extrachromosomal, self-replicating usually circular, double-stranded DNA molecules found naturally in many bacteria and also in some yeast

307 **(b)**

After the cutting of DNA by restriction enzymes fragments of DNA are formed. Separation of DNA fragments according to their size or length is done by a technique called gel electrophoresis developed by **A Tiselius** in 1937

308 **(a)**

In gel electrophoresis, the sample DNA is cut into fragments by restriction endonucleases

311 **(a)**

A-Denaturation - 94°C

B-Annealing - 40° – 60°C

C-Extension - 72°C

323 **(c)**

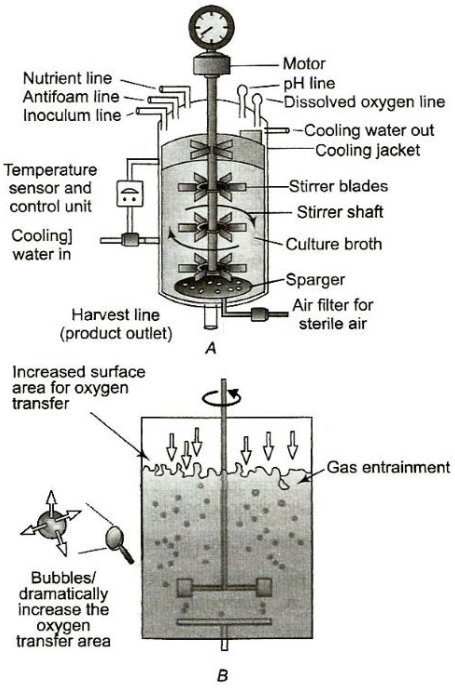
Genetic engineering

325 **(d)**

The separated DNA fragments can be seen only after staining the DNA with a compound known as

ethidium bromide (E + Br) followed by exposure to UV radiation as bright orange coloured bands

330 **(c)**



A-Simple stirred-tank bioreactor for continuous culture.

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332 **(d)**

A variety of cell types are used as a donor in recombinant DNA technology

333 **(b)**

A-DNA; B-Bacteria

BIOLOGY (QUESTION BANK)

11.BIOTECHNOLOGY PRINCIPLES AND PROCESSES

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 1 to 0. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

1

Statement 1: All endonuclease cut DNA at specific sites

Statement 2: Endonucleases are found in viruses

2

Statement 1: Restriction endonucleases are also called 'molecular scissors'

Statement 2: When fragments generated by restriction endonucleases are mixed, they join together due to their sticky ends

3

Statement 1: *Agrobacterium tumefaciens* is popular in genetic engineering because this bacterium is associated with roots of all cereals and pulse crops

Statement 2: A gene incorporated in the bacterial chromosomal genome gets automatically transferred to the crop with which the bacterium is associated

4

Statement 1: In recombinant DNA technology, human genes are often transferred into bacteria or yeast

Statement 2: Both bacteria and yeast multiply very fast to form huge population which expresses the desired gene

Session : 2025-26 **AS PER NEW NTA SYLLABUS**

Total Questions : 347

BIOLOGY (QUESTION BANK)

11.BIOTECHNOLOGY PRINCIPLES AND PROCESSES

: ANSWER KEY :

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

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BIOLOGY (QUESTION BANK)

11.BIOTECHNOLOGY PRINCIPLES AND PROCESSES

: HINTS AND SOLUTIONS :

1 **(d)**
Restriction endonuclease is a type of endonuclease which cut DNA at specific sites not all endonuclease cut DNA at specific sites. These are not found in virus. These were discovered from bacteria

2 **(b)**
Restriction endonucleases are molecular scissors, which cut a DNA molecule within certain specific site called restriction site. Common restriction endonucleases are *Eco* RI, *Bam* II, *Hind* III, etc.

When the DNA fragments are mixed, they join to each other due to free 5' phosphate group 3' OH group. To prevent joining, the phosphate group is removed from 5' end of DNA segments

3 **(d)**
Agrobacterium tumefaciens insects certain plants, in which T_i-plasmid (not chromosomal genome) causes the formation of tumour like growth called a crown gall. *Agrobacterium* does not infect grasses (*i.e.,* cereals)

4 **(a)**
Recombinant DNA is the DNA whose nucleotide sequence has undergone alteration as a result of incorporation or exchange with another DNA strand. In recombinant DNA technology, human genes are often transferred into bacteria or yeast because both bacteria and yeast multiply very fast to form huge population, which express the desired gene

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Total Questions : 347

BIOLOGY (QUESTION BANK)

11.BIOTECHNOLOGY PRINCIPLES AND PROCESSES

Matrix-Match Type

This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II**.

1. Match the following columns

Column-I	**Column- II**
(A) Bacterial cell is treated with	(1) Lysozyme
(B) Plant cell is treated with	(2) Cellulose
(C) Fungal cell is treated with	(3) Chitinase

CODES :

	A	**B**	**C**	**D**
a)	3	2	1	
b)	2	3	1	
c)	1	2	3	
d)	3	1	2	

2. Match the following and choose the correct combination from the options given:

Column-I	**Column- II**
(A) *Escherichia coli*	(1) 'nif' gene
(B) *Rhizobium meliloti*	(2) Digestion of hydrocarbons of crude oil
(C) *Bacillus thuringiensis*	(3) Human insulin production
(D) *Pseudomonas putida*	(4) Biocontrol of fungal disease
	(5) Biodegradable insecticide

CODES :

	A	B	C	D
a)	3	1	5	4
b)	1	2	3	4
c)	2	1	3	4
d)	4	3	1	2

3. Match the following column

Column-I	**Column- II**
(A) PCR	(1) Join of hybridise
(B) Denaturation	(2) Polymerization
(C) Annealing	(3) Melting of target DNA
(D) Extension	(4) Kary Mullis

CODES :

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

4. Match the following columns

Column-I	**Column- II**
(A) Polymerase Chain Reaction (PCR)	(1) *Thermus aquaticus*
(B) Bioreactor	(2) *Thermococcus litoralis*
(C) *Taq* polymerase	(3) Large scale culture
(D) *Vent* polymerase	(4) Amplification of gene

CODES :

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

5. Match the following columns

Column-I	Column- II
(A) Plasmids	(1) Natural polymer of D-galactose
(B) Bacteriophages	(2) Hybrid vector derived from plasmids
(C) Cosmids	(3) Virus infecting bacteria
(D) Agarose	(4) Circular extrachromosomal DNA

CODES :

	A	**B**	**C**	**D**
a)	2	1	3	4
b)	4	3	2	1
c)	3	2	1	4
d)	1	4	3	2

6. Match the following columns

Column-I	Column- II
(A) Recombinant DNA	(1) Sea weeds
(B) Gel electrophoresis	(2) DNA staining
(C) Ethidium bromide	(3) Plasmid DNA that has incorporated human DNA
(D) Agarose	(4) Process by which DNA fragments are separated based on their size

CODES :

	A	**B**	**C**	**D**
a)	3	4	2	1
b)	3	2	1	4
c)	2	1	4	3
d)	3	4	1	2

7. Match column I with column II with respect to the nomenclature of enzyme *Eco* RI and select the correct answer from codes given below

Column-I	Column- II
(A) *E*	(1) Ist in order of identification
(B) *co*	(2) Name of genus
(C) R	(3) Name of species

(D) I

(4) Name of strain

CODES :

	A	**B**	**C**	**D**
a)	3	4	1	2
b)	2	3	4	1
c)	2	1	4	3
d)	2	3	1	4

8. Match the following columns

Column-I	**Column- II**
(A) Arber, Nathan and Hamilton Smith	(1) Term biotechnology
(B) Paul berg	(2) First recombinant DNA
(C) Herbert Boyer and Stanley Cohen	(3) Father of genetic engineering
(D) Karl Erkey	(4) Isolated first restriction endonuclease from bacteria

CODES :

	A	**B**	**C**	**D**
a)	1	4	3	2
b)	3	2	1	4
c)	4	3	2	1
d)	4	3	1	2

9. Match the following columns

Column-I	**Column- II**
(A) Gel electrophoresis technique	(1) Har Govind Khorana
(B) Father of genetic engineering	(2) Dr. Lalji Singh
(C) Father of India DNA fingerprinting	(3) Paul Berg
(D) DNA ligase in T_4 –bacteriophage	(4) A Tiselius

CODES :

	A	**B**	**C**	**D**
a)	3	2	1	4
b)	4	3	2	1

c)	2	4	3	1
d)	4	3	1	2

10. Match the following columns

Column-I	**Column- II**
(A) *Eco* RI	(1) *E. coli* R 245
(B) *Hind* III	(2) *Bacillus armyloliquefaciens*
(C) *Bam* HI	(3) *Haemophilus influenza*
(D) *Eco* RII	(4) *Escherichia coli* RY13

CODES :

	A	**B**	**C**	**D**
a)	1	2	3	4
b)	3	2	1	4
c)	4	3	2	1
d)	4	2	3	1

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BIOLOGY (QUESTION BANK)

11.BIOTECHNOLOGY PRINCIPLES AND PROCESSES

: ANSWER KEY :

1)	**c**	**2)**	**d**	**3)**	**d**	**4)**	**c**	**9)**	**b**	**10)**	**c**
5)	**b**	**6)**	**a**	**7)**	**b**	**8)**	**c**				

BIOLOGY (QUESTION BANK)

11.BIOTECHNOLOGY PRINCIPLES AND PROCESSES

: HINTS AND SOLUTIONS :

1 **(c)**
Bacterial cell is treated with enzyme lysozyme.
Plant cell is treated with enzyme cellulose. Fungal cell is treated with enzyme chitinase

3 **(d)**
PCR – Kary Mullis
Denaturation – Melting of target DNA
Annealing – Join or hybridise
Extension – Polymerisation

4 **(c)**
PCR – Amplification of gene
Bioreactor – Large scale culture
Taq polymerase – *Thermus aquaticus*
Vent polymerase – *Thermococcus litoralis*

5 **(b)**
Plasmid Circular extrachromosomal DNA
Bacteriophages Virus infecting bacteria
Cosmids Hybrid vector derived from plasmids
Agarose Natural polymer of D-galactose

6 **(a)**
Recombinant DNA – Plasmid DNA that has incorporated
Human DNA
Gel electrophoresis – Process by which DNA fragments are separated
Based on their size
Ethidium bromide – DNA staining
Agarose – Sea weeds

7 **(b)**
E – Name of genus
co – Name of species
R – Name of strain
I – Ist in order of identification

8 **(c)**
Arber, Nathan and Hamilton - Isolated first restriction
Smith endonuclease from bacteria
Paul Berg – Father of genetic engineering
Herbert Boyer and Stanley Cohen – First recombinant DNA
Karl Erkey – Term biotechnology

9 **(b)**
A-Gel electrophoresis technique – A Tiselius
B-Father of genetic engineering – Paul Berg
C-Father of India DNA fingerprinting – Dr. Lalji Singh
D-DNA ligase in T_4-bacteriophage – Har Govind Khorana

10 **(c)**
Eco RI – *Escherichia coli* RY 13
Hind II – *Haemophilus influenza*
Bam HI – *Bacillus amyloliquefaciens*
Eco RII – *E. coli* R 245