

DBT JRF Programme**Biotechnology Eligibility Test (BET) – 2019**

As per the advertisement, question paper and answer key for BET-2019 is available below from **15.04.2019 to 25.04.2019**.

Candidates can go through the question paper and answer key and write to jrf.dbt@gov.in in case of any query/discrepancy found as per below format.

S.No	Particular	Description
1	Candidate Name	
2	Application Sequence ID	
3	Question Number	
4	Question	
5	Options	
6	Query	
7	Reference (<i>to substantiate your query</i>)	

Sd/-
Co-ordinator
DBT JRF Programme

PART A

- The major difference between hormones that have intracellular receptors and those that have cell membrane receptors is that the former is usually:
 - Charged
 - Hydrophilic
 - Glycosylated
 - Hydrophobic
- A patient suffering from allergy has been advised to take anti-histamine drugs. Which one of the following biological processes is most likely to be the reason for the allergy?
 - Mast cell degranulation
 - Thymocyte maturation
 - Somatic hypermutation
 - Bystander lysis
- Which one of the following statements is **NOT TRUE** for an enhancer element?
 - it can be downstream of the gene it regulates
 - it can only regulate a nearby gene
 - it can be upstream of the gene it regulates
 - it can be within the intron of the gene
- Which one of the following statements about alleles is **NOT TRUE**?
 - They may occupy different loci in the same chromosome
 - There may be several at one locus
 - One may be dominant over another
 - They may show co-dominance
- Allele 'A' is dominant over allele 'a' and results in dark skin pigmentation. In a mating of Aa with Aa, if 6 offspring are produced, the probability of all having dark pigment is:
 - 0.18
 - 0.75
 - 0.24
 - 0.12
- A bacterial culture grown in a medium containing radioactive sulphur would incorporate the radiolabel in the tetra-peptide:
 - serine-cysteine-tyrosine-methionine.
 - threonine-lysine-aspartic acid-glutamic acid.
 - alanine-proline-histidine-glycine.
 - tryptophan-phenylalanine-valine-isoleucine
- Of the dsDNA sequences given below, the sequence that is expected to have a higher melting temperature is:
 - ATGACATTATTACATTAGTG
 - GCGCGTGCATGCCCGATGCC
 - ATTATTATACGTATTTATAT
 - CGCGATCGGGATTACGAGC
- A peptide of sequence -SHELRL- is isolated from bacteria. Which one of the following options lists the possible phosphorylation site in this peptide?
 - H
 - L
 - R
 - E

9. Competitive inhibition of an enzyme can be reduced by:
 - a. Reducing the amount of the substrate
 - b. Increasing the amount of the substrate
 - c. Decreasing the amount of the enzyme
 - d. Diluting the reaction mixture
10. The sequence of first strand of DNA obtained after reverse transcription of a bacterial mRNA is the same as:
 - a. Anti-sense DNA strand
 - b. Sense DNA strand
 - c. mRNA
 - d. Anti-sense RNA
11. Statins inhibit biosynthesis of:
 - a. Prostaglandins
 - b. Leukotrienes
 - c. Serotonin
 - d. Cholesterol
12. A fetus with which one of the following karyotypes will **NOT** survive at birth?
 - a. 45, Y
 - b. 47, XY+13
 - c. 45, X
 - d. 47, XY+21
13. If a cell carries 21 pairs of chromosomes just after completion of mitotic telophase, how many chromatids will be there in metaphase?
 - a. 21
 - b. 42
 - c. 84
 - d. 168
14. Molecular mass of a protein **CANNOT** be determined by:
 - a. MALDI-TOF
 - b. Gel filtration Chromatography
 - c. Chromatofocusing
 - d. SDS-PAGE
15. Lack of reactivity to self HLA is known as?
 - a. Autoimmunity
 - b. Complement fixation
 - c. Clonal selection
 - d. Tolerance
16. The frequency of two alleles in a population is 0.19 (B) and 0.81(b). If the population is in Hardy-Weinberg equilibrium, what will be the percentage of heterozygous individuals in the population?
 - a. 62%
 - b. 38%
 - c. 31%
 - d. 19%

17. Which one of the following intermediate filament proteins is present in the nucleus?
- Vinculin
 - Lamin
 - Nestin
 - Laminin
18. All the DNA strands of a cell containing 4 chromosomes are labelled. After one division how many chromosomes in the daughter cell will have labelled DNA?
- 1
 - 2
 - 4
 - 8
19. Which one of the following statements is **INCORRECT** about facilitated diffusion?
- Its rate is higher than simple diffusion.
 - The partition coefficient of the solute is irrelevant for it.
 - It can be saturated at high concentration of the solute.
 - It works against the concentration gradient.
20. Variable number of tandem repeats (VNTR) in DNA molecule are highly useful in:
- Fingerprinting
 - Footprinting
 - Gene annotation
 - DNA repair
21. Bovine spongiform encephalopathy is a disease caused by:
- Fungus
 - Bacteria
 - Prions
 - Viroids
22. Which one of the following is used to study the structural details of biological tissues using freeze-fracture technique?
- Scanning electron microscopy
 - Transmission electron microscopy
 - Atomic force microscopy
 - Phase contrast microscopy
23. Which one of the following assures prevention of polyspermy in an egg?
- Activation of PI3 kinase
 - Cortical reaction
 - Acrosome reaction
 - Cross-linking between ZP1 and ZP3
24. Cytotoxic T cells generally recognize antigen in association with:
- class II MHC determinants
 - class I MHC determinants
 - class III MHC determinants
 - HLA-DR determinants
25. With reference to protein precipitation by organic solvents, which one of the following statements is correct?
- It is not influenced by pH.
 - It is dependent on the change in dielectric constant.
 - It is unaffected by ionic strength.
 - It is independent of the molecular size of the protein.

26. An organism exhibits Monod growth with the following growth parameters, $\mu_m = 0.6 \text{ h}^{-1}$ & $K_s = 4 \text{ g/l}$. The specific growth rate, μ , of the organism at a substrate concentration of 2 g/l would be:
- 0.2 h^{-1}
 - 0.3 h^{-1}
 - 0.4 h^{-1}
 - 1.2 h^{-1}
27. What is $10! / 8!$
- $2!$
 - $1.25!$
 - 90
 - 1.25
28. A cricketer has an average of 62 runs after playing 25 innings. How many runs should he score in the next innings so as to increase his average to 65 runs?
- 147
 - 122
 - 140
 - 180
29. The next number in the series 1, 1, 2, 3, 5, 8, 13, 21 is:
- 27
 - 29
 - 32
 - 34
30. A TE buffer contains 200 mM Tris and 50 mM EDTA. Given the stock solutions – 0.5 M Tris and 0.5 M EDTA, volumes of stock solutions required to make 1 liter of buffer solution are respectively:
- 400 ml, 100 ml
 - 200 ml, 50 ml
 - 500 ml, 125 ml
 - 100 ml, 25 ml
31. The pH of a 0.001 molar HCl solution in H_2O is:
- 1
 - 2
 - 3
 - 4
32. To make 2 liters of 0.4 M HCl, how many ml of 28% w/w HCl (specific gravity = 1.15) is required?
- 80.7
 - 90.7
 - 100.7
 - 110.7
33. Two sides of a triangle measure 4 cm and 7 cm. Which one of the following **CANNOT** be a measure of the third side?
- 4 cm
 - 5 cm
 - 8 cm
 - 11 cm
34. A boy appears for a test and scores 35% but fails by 10 marks. If he had scored 46%, he would have passed by 12 marks. What is the pass mark?

- a. 70
- b. 74
- c. 80
- d. 86

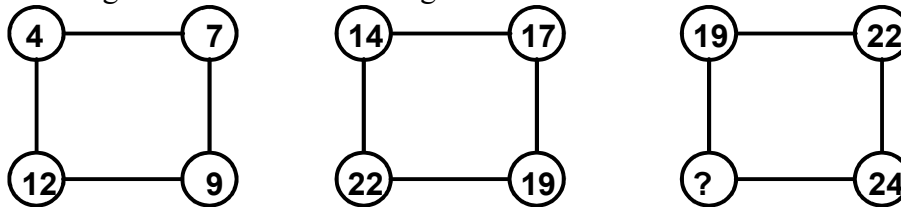
35. If a student runs at 1.5 times his usual speed, he reaches his school 20 minutes early. If he runs at 0.5 times his usual speed, how late will he reach his school?

- a. 60 min
- b. 30 min
- c. 45 min
- d. 15 min

36. A stationary car is accelerated at the rate of 5 m/s^2 . The distance covered by the car till it reaches a speed of 40 m/s is:

- a. 100 m
- b. 120 m
- c. 160 m
- d. 200 m





37. Find the missing number in the following series:



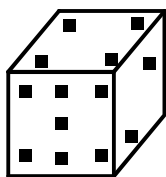
- a. 27
- b. 25
- c. 29
- d. 32

38. Identify the next figure in the series

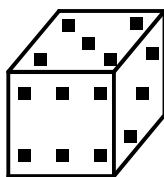


- a) 
- b) 
- c) 
- d) 

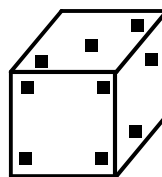
39. If the total number of dots on opposite faces of a cubical block is always 9 and no number is repeated, which of the following figure represents the block:



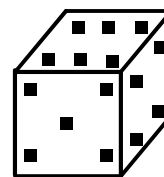
(i)



(ii)



(iii)

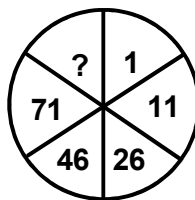


(iv)

- a. (i)
- b. (iii)
- c. (ii)

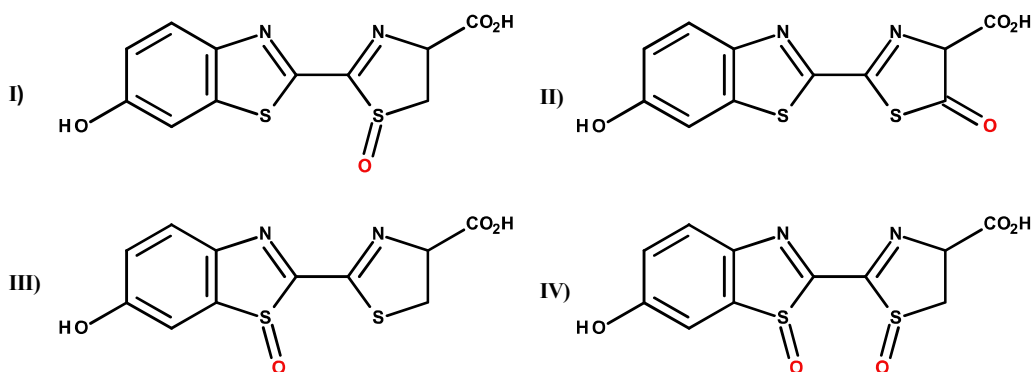
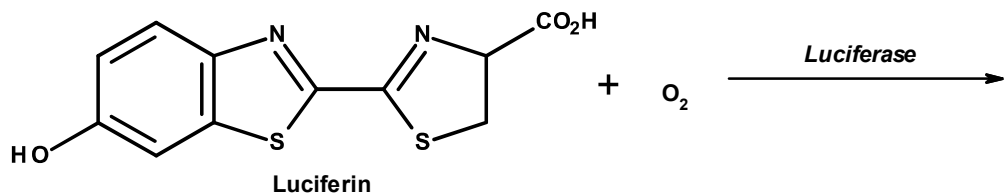
d. (iv)

40. Find the missing number in the following series:



- a. 96
 - b. 91
 - c. 101
 - d. 121
41. If MONEY is to CARROM, MILITARY is to CHESS, COURT is to CRICKET then, WORLD WIDE WEB is to which of the following?
- a. Kho Kho
 - b. Kabaddi
 - c. Boxing
 - d. Badminton
42. Which one of the following enzymes can hydrolyze both ester and amide bonds?
- a. Methionine racemase
 - b. Thrombin
 - c. Chymotrypsin
 - d. Peroxidase
43. In the citric acid cycle operating under aerobic conditions, which one of the following is not directly involved?
- a) NAD^+
 - b) FAD
 - c) Molecular oxygen
 - d) Succinate

44. Identify the product(s) obtained when luciferin undergoes the following reaction:

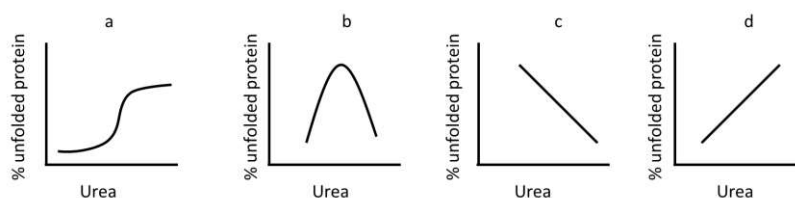


- a) Only I
 - b) I and II
 - c) Only IV
 - d) I, II and III
45. In the DNA methylation reaction mediated by S-adenosylmethionine (SAM) methyltransferase, the nucleophilic species involved is:
- a. an alcohol
 - b. an amine
 - c. a thiol
 - d. a carboxylate
46. Correlation coefficient is a number between:
- a. +1 and +2
 - b. 0 and +1
 - c. -1 and 0
 - d. -1 and +1
47. While making 100 ml of 2M NaCl solution, a student left the solution on a heating platform reducing the volume by 50 ml. This solution was diluted 1:100 for use. What is the final concentration of NaCl in this solution?
- a. 20 mM
 - b. 80 mM
 - c. 40 mM
 - d. 400 mM
48. The pK_a of acetic acid is 4.76. At what pH would the concentration of acetic acid and acetate ion be the same?
- a. pH = 7
 - b. pH = 6.7
 - c. pH = 9.8
 - d. pH = 4.76
49. ¹⁴C has a half-life of 5760 years; 100 mg of a sample of ¹⁴C will completely disintegrate in:
- a. 23,040 years
 - b. 1440 years
 - c. 11,520 years
 - d. infinite time
50. A young scientist was interested in creating a dipeptide using L-alanine and L-glycine. How many different dipeptides can be generated?
- a. One
 - b. Two
 - c. Three
 - d. Four

PART - B

51. A patient is suffering from an auto-immune disorder. Exome analysis has revealed a mutation in the gene 'AIRE'. Which one of the following biological processes is likely to be affected in this patient?
- Positive selection of thymocytes
 - Negative selection of thymocytes
 - Affinity maturation
 - Dendritic cell development
52. Which one of the following genes is mutated in nude mice?
- Foxn1*
 - Foxp3*
 - Foxp1*
 - Prkdc*
53. Which one of the following statements is **TRUE** for long non-coding RNAs?
- They are less than 22 base pair
 - They are processed in the nucleus by RISC complex
 - They have > 300 amino acid open reading frame
 - They may have a poly-A tail
54. Which kind of post-translationally modified protein targets are recognized by Bromodomain containing proteins?
- Acetylated protein
 - Glycosylated protein
 - Ubiquitinated protein
 - Sumoylated protein
55. When dissolved oxygen is lower than the critical concentration in mammalian cell culture systems, cell viability declines because of:
- Complete glutamine oxidation
 - Decrease in specific lactate production from glucose
 - Incomplete glutamine oxidation and increase in lactate production from glucose
 - Accumulation of ammonia
56. Combination of high temperature during processing, low temperature during storage, and increasing the acidity for prevention of food contamination is known as:
- Stumbling technology
 - Mixed preservation approach
 - High pressure food preservation
 - Hurdle technology
57. The production of ethanol rather than biomass by yeast cells at high concentration of glucose is known as:
- Warburg effect
 - Simpson's effect
 - Crabtree effect
 - Olivosky's effect

58. Anhidrotic dysplasia is a condition in which development of sweat glands is prevented. It is caused by mutation present on the X chromosome. A heterozygous female for this allele will:
- Show complete absence of sweat glands.
 - Have normal phenotype
 - Show mosaic pattern of presence and absence of sweat glands
 - Show increased physiological activity of sweat glands
59. The combination of numbered terms that completes all of the following statement is:
- Transport through the phloem is 1 while transport through Xylem is 2
 - Loading of sugar into the phloem is 3 at the source
 - Movement of water out of the phloem at the sink is 4
- 1-bidirectional, 2-unidirectional, 3-by active transport, 4-by osmosis
 - 1-by osmosis, 2-by turgor pressure, 3- by passive transport, 4-bidirectional
 - 1-unidirectional, 2-bidirectional, 3-by diffusion, 4-unidirectional
 - 1-by diffusion, 2-unidirectional, 3-bidirectional, 4-by osmosis
60. A plant with orange flowers was self-pollinated. In the F1 progeny, we obtained 38 plants producing red flowers, 80 plants producing orange flowers and 41 plants producing yellow flowers. The likely explanation for the above observation is that:
- the gene for flower colour shows incomplete dominance.
 - flower colour is a polygenic trait controlled by 3 genes.
 - the gene for flower colour is epistatic to another gene.
 - the trait of flower colour is maternally inherited.
61. Based on equal probability of any base occurrence in a genome, what should be the minimum length of a probe to bind specifically on a single locus on a bacterial genome of 1 Mbp?
- 6 bases
 - 15 bases
 - 10 bases
 - 4 bases
62. Which one of the following techniques can be used to study transient protein – protein interactions in a live cell?
- Pull-down assay
 - Immunoprecipitation
 - Surface Plasmon Resonance
 - Forster Resonance Energy Transfer
63. Which one of the following graphs correctly represents unfolding of a protein in presence of increasing concentration of urea?



64. A tRNA containing an anticodon for leucine was charged with leucine. Subsequently, the attached leucine was chemically modified to arginine. This tRNA will incorporate:
- Arginine against codon of arginine in mRNA.
 - Leucine against codon of arginine in mRNA.
 - Arginine against codon of leucine in mRNA.
 - Leucine against codon of leucine in mRNA.

65. Which one of the following statements regarding base excision DNA repair system is **FALSE**?
- It can be triggered by damaged DNA.
 - The pol β pathway facilitates replacement of a long polynucleotide stretch of DNA.
 - The enzymes that remove bases from DNA are glycosylases and lyases.
 - Damaged DNA that has not been repaired causes stalling of DNA polymerase III.
66. Which one of the following result is expected when a mammalian cell in S phase is fused with another in G₂?
- G₂ phase nucleus will wait for the S phase nucleus to complete the replication and both the nuclei simultaneously enter into M phase.
 - S phase nucleus would immediately enter into G₂ phase without completing the replication phase.
 - Both the nuclei would follow their corresponding cell cycle without influencing each other.
 - Due to influence of S phase promoting factor, G₂ phase nucleus will enter into S phase.
67. Following statements are about chromatin organisation in eukaryotes:
- The length of DNA per nucleosome varies for individual tissue or species.
 - Typical nucleosomal packaging pattern is strictly maintained across the genome of an organism.
 - While wrapping around the histone core particle, uniform structure of DNA is maintained.
 - Histone tail mediated internucleosomal contact is one of the essential factors to achieve the 30 nm fibre structure.
- Select the **correct** combination of statements.
- i and iii
 - ii and iii
 - i and iv
 - iii and iv
68. Which one of the following techniques can be utilized to study both protein–peptide and protein–DNA interactions?
- DNA footprinting
 - 2D-gel electrophoresis
 - Phage display
 - ChIP-on-chip assay
69. In genomic DNA denaturation and renaturation experiments, which one of the following regions would renature the earliest?
- Single-copy gene
 - Satellite DNA**
 - Pseudogenes
 - Multi copy gene families
70. Which one of the following represents an autonomous retrotransposon?
- SINEs
 - LINES

- c. P-element
 - d. Tn10
71. Thallium-208 has a half-life of 3.053 min. How long will a sample containing 120.0 μCi of Thallium-208 take to decay to 7.50 μCi ?
- a. 6.11 min.
 - b. 9.36 min.
 - c. 12.21 min.
 - d. 18.46 min.
72. Injection of *nanos* transcripts at the anterior end of a fertilized *Drosophila* egg is expected to develop in an embryo with:
- a. Two heads at both the ends.
 - b. Two tails at both the ends.
 - c. A tail in middle and two heads at both the ends.
 - d. A head in middle and two tails at both the ends.
73. If nondisjunction of a chromosome occurs in meiosis II, what will be the product at the completion of meiosis?
- a. All the gametes will be diploid
 - b. Two gametes will be $n + 1$, and two will be $n - 1$
 - c. One gamete will be $n + 1$, one will be $n - 1$, and two will be n
 - d. Two of the four gametes will be haploid, and two will be diploid
74. Which one of the following changes occurs in a directionally migrating eukaryotic cell?
- a. The ER is fragmented.
 - b. The mitochondrial membrane potential drops.
 - c. The nucleus moves towards the back and behind the Golgi.
 - d. The Golgi is fragmented.
75. Underwinding or overwinding of circular dsDNA generates supercoils only when it does **NOT** have any of the following:
- a. Nicks
 - b. repeat sequences
 - c. G:C rich regions
 - d. A:T rich regions
76. CRISPR/Cas9 is an example of bacterial adaptive immunity. The transcription of *CRISPR* loci generates small crisp-rNAs (crRNA) to specifically target viral DNA, but not *CRISPR* loci, by forming complex with guide RNA and Cas9 nuclease. This prevention of autoimmunity is due to the:
- a. absence of protospacer adjacent motif sequence in *CRISPR* loci.
 - b. absence of DNA sequence complementary to crRNA in *CRISPR* loci.
 - c. absence of DNA sequence complementary to guide RNA in *CRISPR* loci.
 - d. methylation of *CRISPR* loci.
77. The type of transport that does **NOT** reach V_{max} is:
- a. Simple diffusion across lipid bilayer
 - b. Facilitated diffusion via uniporters
 - c. Movement of ions through ion channels
 - d. Primary active transport via ATP powered pumps
78. What is the **minimum** number of tRNAs required to recognize all six codons of serine (UCU, UCA, UCG, UCC, AGU and AGC)?
- a. 2

- b. 3
- c. 4
- d. 6

79. Which one of the following statements about signal recognition particles (SRPs) is **INCORRECT**?

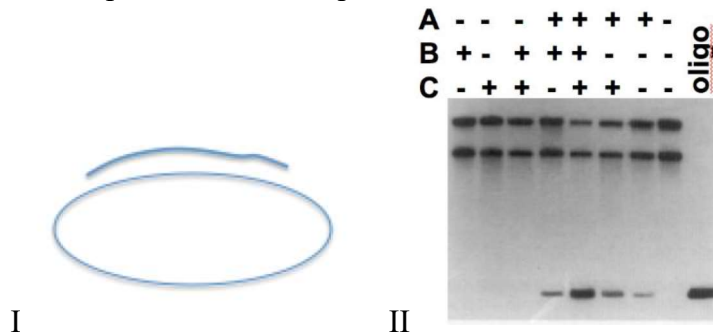
An SRP:

- a. contains RNA and protein.
- b. is an integral membrane protein.
- c. docks with a receptor on the surface of the ER membrane.
- d. binds to localization signal at the N-terminus of the emerging polypeptide chain.

80. Which one of the following materials is a bioplastic?

- a. Polypropylene
- b. Alginate
- c. Polyhydroxybutyrate
- d. Dextran

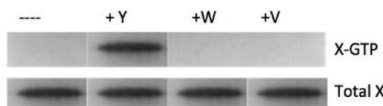
81. Labeled circular single stranded DNA and linear short DNA (oligo) were annealed to form a product shown in figure I. Helicase assay was performed using the annealed product and three proteins A, B, C. Below is the gel profile of the results (figure II).



Based on the results identify the protein with helicase activity?

- a. protein A
- b. protein B
- c. Protein C
- d. Both Protein A and C

82. Protein X exists in both GTP-bound and GDP-bound forms. When this protein was purified, it was always GDP-bound. Proteins Y, W and V were added separately in an experiment along with GTP. The results of the experiment are depicted in the following figure:



Which one of the following could be the right conclusion of the results?

- a. Protein Y is GAP for protein X
- b. Protein Y is GEF for protein X
- c. Protein W is GEF for protein X
- d. Protein V is GEF for protein X

83. In a class, students were divided into 3 different groups and each group was given different DNA sample to find the melting temperature (T_m). All the groups observed same T_m for their samples. This is because:

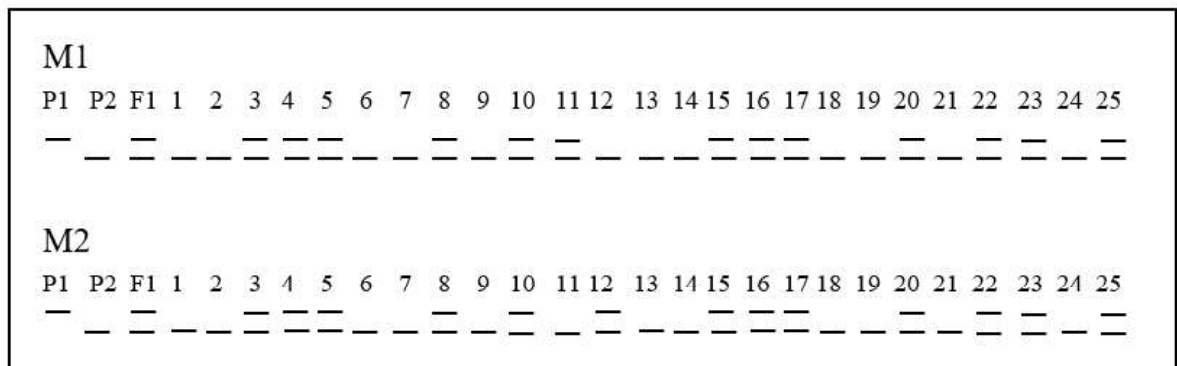
- a. They got different DNA samples from the same organism with different lengths and same GC content.
 - b. They got different DNA samples with same lengths and different GC contents.
 - c. They got different DNA samples with same length and same GC content.
 - d. They got different DNA samples from different organisms with different length and same GC content.
84. For efficient translation of certain eukaryotic mRNAs under many physiological and pathological stress conditions, the small subunit of ribosome binds to the mRNA at the:
- a. 5' Cap.
 - b. Internal ribosome entry sites.
 - c. Secondary structure at 3' UTR.
 - d. Initiation codon.
85. For identifying the distribution of a specific protein in a tissue, which one of the following types of immunofluorescence microscopic methods has attained the highest level of resolution?
- a. Indirect immunofluorescence microscopy
 - b. Confocal microscopy
 - c. Confocal microscopy with deconvolution
 - d. Wide angle microscopy with deconvolution
86. Which one of the following sets of protein factors, named as Yamanaka factors, can be used to convert mammalian somatic cells into induced pluripotent stem cells?
- a. Oct3/4, Sox2, Klf4, c-Myc
 - b. c-fos, nestin, TGF β , c-jun
 - c. Oct3, snail, FGF, nanos
 - d. Hstf, vimentin, ets, ras
87. Hayflick limit of mammalian cells refers to which one of the following?
- a. Cells in primary cell culture undergo senescence after 50-60 passages.
 - b. Primary cells cultured in vitro do not cross the limit of cell transformation.
 - c. Cell lines when cultured in vitro have a limit for their surface to volume ratio.
 - d. Malignant cell lines undergo senescence after 50-60 passages.
88. Midblastula transition is a phenomenon that occurs during early development in certain organisms. It refers to:
- a. Transition from maternal to zygotic gene expression
 - b. Transition of morphology during midblastula stage
 - c. Transition from two germ layer embryo to three germ layer embryo
 - d. Transition of blastula to gastrula
89. Under which of the following circumstances do T cells develop anergy?
- a. With the expression of CD69 on T cells.
 - b. When the CD4/ CD8 molecules present on T cell surfaces do not recognize self MHC II/MHC I molecules.
 - c. When the MHCII molecules present on antigen presenting cells bind to the peptides with less avidity.
 - d. When co-stimulatory molecules present on the antigen presenting cells fail to interact with T cells.
90. A chemist synthesized a new chemical X which is highly mutagenic. He also tested the capacity of mutation induced by X to be reversed by other known mutagens and obtained the following results:

Mutation produced by	Reversed by		
	Nitrous acid	Hydroxylamine	Acridine orange
X	Yes	Some	No

Which one of the following conclusions is appropriate?

- a. X causes transversion
 - b. X causes transition
 - c. X causes single-base insertion
 - d. X causes single-base deletion
91. What would be the best assay to detect and quantify a small and low abundant peptide in a biological sample?
- a. Lowry's assay
 - b. Immuno-diffusion
 - c. Radioimmunoassay
 - d. Immunoblot
92. A mutation in the coding region of a mammalian gene leads to the loss of a single amino acid at the N-terminus of the nascent polypeptide. This is possible when:
- A. The mutation occurs at 3'-end of coding strand.
 - B. The mutation leads to shift of ribosome binding site.
 - C. the first two codons code for methionine.
 - D. the mutation leads to the introduction of premature stop codon.
93. A scientist performs a series of experiments to determine the recombination frequencies between the following genes. He acquires the following data:
- P – Q: 3%; Q – R: 2%; R – S: 13%; P – S: 8%
- Which one of the following represents the correct order of genes?
- a. PQRS
 - b. QPSR
 - c. SPQR
 - d. PRSQ
94. You have two tubes containing bacteriophage labelled with radioactive phosphorous (tube A) and radioactive Sulphur (tube B) that are devoid of bacteria. You use these bacteriophage to infect separate *E. coli* cultures. After infection you separate bacteria from the virus and check them for radioactivity. You will find:
- a. Radioactivity in both bacterial samples.
 - b. Radioactivity in none of them as bacteria have been totally separated from the viruses.
 - c. Radioactivity in bacteria infected with viruses from tube A.
 - d. Radioactivity in bacteria infected with viruses from tube B.
95. Colour blindness (B) in human follows sex-linked recessive mode of inheritance. If a couple with normal colour vision have a colour-blind son. What will be the genotypes of the parents?
- a. X^bX^b and X^bY
 - b. X^BX^b and X^BY
 - c. X^bX^b and X^BY
 - d. X^BX^B and X^bY
96. If the allele *A* is incompletely dominant over allele *a*, what is expected in a progeny of two heterozygous parents?
- a. Same phenotypic and genotypic ratios
 - b. 2:1 phenotypic ratio
 - c. 3:1 phenotypic ratio
 - d. 2:1 ratio of homozygous dominant and intermediate phenotypes

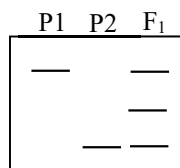
97. An experiment involves formation of RNA-DNA hybrid. Which one of the following enzymes could be utilized to degrade only the RNA strand from the RNA-DNA hybrid?
- Micrococcal nuclease
 - S1 nuclease
 - RNase H
 - RNase P
98. If the intracellular pH of a cell becomes basic, which one of the following will help reduce the pH?
- Export of Cl^- and import of HCO_3^-
 - Import of Cl^- and export of HCO_3^-
 - Import of Na^+ and HCO_3^- and export of Cl^-
 - Export of Na^+ and Cl^-
99. Proteins can act as excellent buffers because of:
- The wide range of pK_a values of side chains found within the proteins.
 - The ability of the terminal regions of the protein to accept or donate H^+ ions.
 - Their hydrogen-bonding capabilities in forming secondary & tertiary structures.
 - The ease with which H^+ & OH^- ions can be absorbed once the protein is hydrolyzed.
100. Which one of the following statements is INCORRECT in relation to reverse phase chromatography?
- The solutes elute with decreasing order of polarity.
 - The stationary phase surface covering the silica particles involves non-polar functional groups.
 - The solutes elute with increasing order of molecular weight.
 - The pH of the mobile phase has a profound influence on retention, selectivity and separation.
101. The DNA gel picture shown below depicts the PCR banding pattern of two markers (M1 and M2).



The linkage distance between the two markers from a test cross population is:

- 4 cM
- 6 cM
- 8 cM
- 10 cM

102. For metabolic engineering in plants having improved tolerance to osmotic stress, mannitol is overproduced because it:
- lowers the water potential in the plant cell
 - increases the water potential in the plant cell
 - lowers membrane potential in the plant cell
 - increases membrane potential in the plant cell
103. For engineering virus resistance in plants, which one of the following viral components is commonly targeted?
- coat protein
 - replication protein
 - satellite RNA
 - movement protein
104. The Bt protein employed for raising insect-resistant plants is not toxic to humans because:
- it is inactive under acidic pH
 - it is inactive under basic pH
 - it is inactive at 37°C
 - it is rendered inactive by inhibitors
105. In rice, while pyramiding three genes for a trait, two donors were used. One donor carries two desirable genes, which are present on chromosome #2 and #4, while other donor has one desirable gene present on chromosome #3. Both the donors were crossed to produce a biparental F₂ population. The theoretical expectations of an individual carrying all the desirable allele in homozygous condition is one out of:
- 4
 - 16
 - 64
 - 256
106. An isoenzyme may be a monomer, dimer or multimer with identical or distinct subunits. Following picture depicts a native PAGE profile of the isoenzyme from a diploid plant (P1 – Parent 1, P2 – Parent 2, F₁ – Progeny).



This isoenzyme is a:

- monomer
 - homodimer
 - homotrimer
 - homopentamer
107. Which one of the following sets is an example of specific sequence-based PCR analysis in marker assisted selection?
- RAPD, DAF, AP-PCR

- b. SCAR, SSR, COS
 - c. SCAR, SSR, DAF
 - d. RAPD, SSR, COS
108. *Opaque2* gene in maize and *Wx* gene in rice affects the and content, respectively.
- a. protein quality, amylose
 - b. oil, wax
 - c. protein quality, wax
 - d. oil, starch
109. Which one of the following is associated with RNA-induced gene silencing in plants?
- a. DNA methylation
 - b. DNA acetylation
 - c. DNA degradation
 - d. DNA restriction
110. The oxidative photosynthetic carbon cycle salvages:
- a. C3 carbon
 - b. C4 carbon
 - c. CO₂
 - d. C2 carbon
111. The term 'co-suppression' was coined by Richard Jorgensen to explain:
- a. Patchy flower colour in petunia.
 - b. Resistance to viral infection in tobacco.
 - c. Production of white flowers in Ipomea.
 - d. Silencing of actin gene in *C. elegans*.
112. Which one of the following plants exhibits both C3 and C4 pathways?
- a. *Zea mays*
 - b. *Oryza sativa*
 - c. *Mesembryanthemum crystallinum*
 - d. *Arabidopsis thaliana*
113. 'Dichogamy' refers to a phenomenon in which anther dehiscence and stigma receptivity are:
- a. temporally separated

- b. spatially separated
 - c. temporally coinciding
 - d. spatially coinciding
114. Light compensation point is the irradiance at which:
- a. net photosynthetic photon flux is zero.
 - b. there is no photosynthesis.
 - c. net CO₂ exchange is zero.
 - d. quantum yield of photosynthesis is 1.
115. Fusicoccin promotes cotyledon growth by promoting:
- a. cell division
 - b. cell wall biosynthesis
 - c. tonoplast acidification
 - d. cell wall acidification
116. Plants take up water from the soil predominantly by the apoplastic and symplastic modes of transport. Which one of the following statements is true?
- a. Apoplastic transport is ATP-dependent, symplastic is ATP-independent.
 - b. Symplastic transport is ATP- dependent, apoplastic is ATP-independent.
 - c. Both apoplastic and symplastic transport are ATP-dependent.
 - d. Both apoplastic and symplastic transport are ATP-independent.
117. Which one of the following is a Mo-Fe containing protein?
- a. Nitrate reductase
 - b. Nitrogenase
 - c. Nitrite reductase
 - d. Leghemoglobin
118. TIR1, an auxin receptor, is a:
- a. F-box protein
 - b. MAP kinase
 - c. His kinase
 - d. Ser/Thr kinase
119. Phytochromes A and B maximally absorb light at wavelength range:
- a. 150-300 nm
 - b. 300-450 nm
 - c. 450-550 nm
 - d. 600-750 nm
120. A researcher wants to ectopically express protein X exclusively in the seeds of Arabidopsis. Which one of the following promoters is most suitable for this purpose?
- a. CaMV 35S
 - b. Maize ubiquitin
 - c. Napin

d. rd22

121. Given below are the names of different phytohormones in the left column. Match them with their corresponding precursor molecules in the right column.

Phytohormone	Precursor molecule
(A) Auxin	I. Methionine
(B) Jasmonic acid	II. L-Tryptophan
(C) Ethylene	III. alpha-linolenic acid
(D) Brassinolide	IV. Campesterol

Select the correct combination:

- A-I, B-II, C-III, D-IV
 - A-II, B-III, C-I, D-IV
 - A-IV, B-III, C-II, D-I
 - A-II, B-III, C-IV, D-I
122. Which one of the following is a sulphur containing secondary metabolite in mustard plant derived from glucose and an amino acid?
- Glucosinolates
 - Phytoalexins
 - Ecdysones
 - Cyanogenic glycosides
123. Disarmed Ti plasmid of *Agrobacterium tumefaciens* does not result in crown gall phenotype since it does not possess:
- ipt* and *iaaH* genes
 - Vir D* gene
 - Vir A* gene
 - Vir G* gene
124. A plant that survives a local pathogen infection, often develops increased resistance to a subsequent attack by a mechanism called:
- Systemic Acquired Resistance
 - DAMP-triggered immunity
 - Hypersensitive response
 - Heat Shock Response
125. In genetically modified Dhara Mustard Hybrid – 11, male sterility is conferred by, while restores fertility.
- barnase, barstar
 - barstar, barnase
 - bar, barnase
 - barnase, bar

126. Glycosylation of a monoclonal antibody **DOES NOT** affect:

- in vivo* stability of antibody
- mediation of phagocytosis and cytotoxicity of antibody
- efficacy of monoclonal antibody
- fluorescence spectrum of antibody**

127. Match the common antibody origin with appropriate generic name/brand name of the antibody

a	Mouse	(i)	Binatumomab
b	Chimeric	(ii)	Herceptin
c	Humanized	(iii)	Pantimumab
d	Human	(iv)	Retuxan

- a-ii, b-i, c-iv, d-iii
- a-i, b-iv, c-iii, d-ii
- a-i, b-iv, c-ii, d-iii**
- a-iv, b-i, c-ii, d-iii

128. A recombinant therapeutic protein is intracellularly produced in soluble form using *E. coli*. Which one of the following sequences of chromatographic separation methods is preferable for obtaining clinical grade protein?

- Hydrophobic interaction followed by ion-exchange
- Dye-ligand followed by ion-exchange
- Ion-exchange followed by gel-filtration
- Gel-filtration followed by metal-affinity

129. What property is involved in the separation of a mixture of analytes using gas chromatography?

- Partitioning
- Conductivity
- Mass
- Polarity

130. Which organization in India approves and gives regulatory clearance of biologicals?

- Central Drugs Standard Control Organization (CDSCO)
- National Institute of Biologicals (NIB)
- Indian Pharmacopoeia Commission (IPC)
- Department of Biotechnology (DBT)

131. In a crossflow filtration process, if the volumetric flow rate of the feed is 10 times that of the retentate, the concentration factor is:

- 9
- 9/10
- 1/10
- 10

132. In a bioprocess, assume that only cell mass is formed. Due to a variation in process conditions, if the microbial cell yield has halved, what would be the rate of substrate consumption to maintain the same rate of cell mass production?
- It would be doubled
 - It would be halved
 - It would be unchanged
 - It would increase four folds
133. In a chemostat, which one of the following would increase the exit cell concentration?
- Increase in inlet substrate concentration
 - Increase in dilution rate
 - Increase in inoculum size
 - Increase in impeller size
134. The ratio of gassed to ungassed powder (P_g/P) in a bioreactor will be in the range of:
- 0.4 – 0.9
 - 1.0 – 2.0
 - 1.2 – 2.4
 - 4.0 – 8.0
135. Scale up of a fermenter is done based on constant impeller tip speed. If the diameter of the impeller is increased by 10 fold, the agitator speed will:
- decrease by 10 fold
 - decrease by 100 fold
 - increase by 10 fold
 - increase by 100 fold
136. For an enzyme catalyzed reaction in a batch bioreactor, which one of the following is true under quasi-steady state conditions:
- Enzyme-substrate complex concentration remains nearly constant
 - Substrate concentration remains nearly constant
 - Product concentration remains nearly constant
 - Both substrate and product concentration remain nearly constant
137. In a batch reactor, which one of the following is true regarding specific growth rate?
- It remains constant with time.
 - It continuously increases with time.
 - It continuously decreases with time.
 - It reaches a maximum in the exponential phase.
138. For a Rushton turbine impeller (Reynold's number greater than 10,000) when RPM is doubled, the power absorption increases by:
- 2 fold
 - 4 fold
 - 8 fold
 - 32 fold

139. Reynold's number is ratio of:
- viscous force to inertial force.
 - inertial force to viscous force.
 - gravitation force to inertial force.
 - inertial force to gravitational force.
140. In developing a structured model for microbial cell growth, we:
- separate the population by age.
 - compartmentalize the cell into different components.
 - separate the cells by age and also compartmentalize it.
 - treat cells to be composed of a single component only.
141. Glycerol is a:
- Newtonian fluid
 - Pseudoplastic fluid
 - Thixotropic fluid
 - Dilatant fluid
142. A catalyst:
- Reduces the free energy change of the reaction
 - Increases the free energy change of the reaction
 - Reduces the activation energy of the reaction
 - Reduces the heat of reaction
143. If the pulse input response curve for a CSTR shows a long tail, it means:
- Strong internal circulation in the reactor
 - Dead space in the reactor
 - Short circuiting in the reactor
 - Parallel flow in the reactor
144. During mixed acid fermentation by *E. coli*, which one of the following is **NOT** produced?
- Lactic acid
 - Ethanol
 - Succinic acid
 - Citric acid
145. The maximum yield for microbial conversion of Glucose ($C_6H_{12}O_6$) to ethanol (C_2H_5OH) on a mol/mol basis is approximately:
- 1
 - 2
 - 3
 - 0.5
146. A substrate is consumed in a zero order reaction such that the concentration falls from 40 g/l to 20 g/l in 4 h. How long will it take the substrate to fall from 20 g/l to 2 g/l:
- 2.5 h
 - 1.8 h
 - 3.6 h
 - 4.8 h

147. The least used heat transfer-design in bioreactor is:
- Jacket
 - Limpet coil
 - Internal cooling coil
 - External heat exchanger
148. The major drawback in using wild type *S. cerevisiae* for producing ethanol from biomass hydrolysate is:
- Low biomass yield of hexose sugars
 - Presence of solid residues
 - Low concentration of sugars
 - Non utilization of Pentose sugars

149. Match the physical/chemical property with the corresponding unit operations used for separation:

a) Density difference	(i) Distillation
b) Partition coefficient	(ii) Filtration
c) Relative volatility	(iii) Liquid-liquid extraction
d) Particle size	(iv) Centrifugation

- a-iii b-iv c-i d-ii
 - a-i b-iii c-ii d-iv
 - a-iv b-ii c-iii d-i
 - a-iv b-iii c-i d-ii
150. One microgram of a pure enzyme (MW: 92,000) catalyzed a reaction at a rate of 0.50 $\mu\text{moles}/\text{min}$ under optimum conditions. The specific activity of the enzyme [$\mu\text{moles}/\text{min}/\text{mg}$ protein] is:
- 0.5
 - 5.0
 - 500
 - 5000
151. The ion transport that will be the most affected following mutation in Cystic fibrosis transmembrane conductance regulator (CFTR) gene is:
- Sodium
 - Potassium
 - Chloride
 - Calcium
152. The organism in which the luciferase gene is termed as “*lux*” gene is:
- Algae
 - Insects
 - Bacteria
 - Jelly fishes
153. The first humanized monoclonal antibody approved by the US-FDA for targeted treatment of breast cancer was:
- Trastuzumab

- b. Palivizumab
- c. Gemtuzumab
- d. Natalizumab

154. Which one of the following statements is **INCORRECT** with regard to DNA vaccines?

- a. No risk of infection
- b. Proteins produced are likely to be correctly post translationally modified
- c. It can persist for an extended time period in the cell
- d. Introduced DNA stimulates a protective immune response

155. Antibiotic bleomycin is secreted by:

- a. *Bacillus sp.*
- b. *Aspergillus sp.*
- c. *Streptomyces sp.*
- d. *Acremonium sp.*

156. Zinc deficiency among children primarily results in the atrophy of:

- a. Thymus
- b. Spleen
- c. Lymph nodes
- d. Peyer's patches

157. Antigen activated B cells differentiate into antibody producing plasma cells in:

- a. Lymphoid follicles
- b. Hassall's corpuscles
- c. Lamina propria
- d. Phagosome

158. Allergenicity of a protein refers to its capacity to activate:

- a. Mast cells
- b. B cells
- c. Dendritic cells
- d. M cells

159. Secondary immune response to a hapten depends on the:

- a. Hapten immunization alone
- b. Carrier immunization alone
- c. Both hapten and carrier used in the primary immunization
- d. Hapten and is independent of the carrier used during immunization

160. Ig class specific antigenic determinants are known as:

- a. Allotypic determinants
- b. Isotypic determinants
- c. Idiotypic determinants
- d. Gm determinants

161. Isotypic determinants of the Ig molecule are located in the:

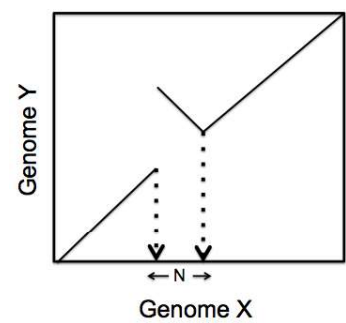
- a. HC
- b. LC
- c. Constant region of HC and LC

- d. Variable region of HC and LC
162. A chimeric organism is generated when:
- a. Cells of different genetic constitution appear in the same organism
 - b. Union of two different genomes occur within a cell
 - c. A genome of another individual is injected into an adult organism
 - d. A part of the genome is inactivated by chromosomal rearrangement
163. Metaplasia represents:
- a. Uncontrolled proliferation of cells initiated at the metaphase of cell cycle
 - b. Transformation of one differentiated cell type to another
 - c. Cell proliferation during metamorphosis
 - d. A measure of metabolic activity in hyperplastic cells
164. The taxonomic method of identifying an organism to its species is:
- a. Genetic speciation
 - b. DNA barcoding
 - c. RFLP
 - d. AFLP
165. In *Drosophila*, the growth of legs on the head instead of antennae during development is an example of:
- a. Homeotic transformation
 - b. Epigenetic modification
 - c. Chromosomal aberrations
 - d. Dysgenesis
166. Ameloblasts are differentiated cells:
- a. that secrete amylase
 - b. of amygdala
 - c. of adrenal gland
 - d. that secrete enamel
167. Which one of the following contributes to the development of the reproductive tract in a male foetus?
- a. Anti-diuretic hormone
 - b. Inhibin
 - c. Anti-Mullerian hormone
 - d. Activin
168. Neurotransmitter at the neuromuscular junction is:
- a. Epinephrine
 - b. Serotonin
 - c. Acetylcholine
 - d. Dopamine
169. Viral vector that is ideal for expressing therapeutic gene in non-dividing cells is:
- a. Lentiviral vector
 - b. Retroviral vector

- c. Adeno-associated viral vector
 - d. Adenoviral vector
170. Which one of the following amino acids can be used as a diuretic because of its importance in metabolism of ammonia?
- a. Asparagine
 - b. Leucine
 - c. Tryptophan
 - d. Isoleucine
171. Paralytic shellfish poisoning is a foodborne illness that typically develops after consumption of shellfish contaminated chiefly with the heat stable and acid stable toxin:
- a. Okadaic acid.
 - b. Mitotoxin.
 - c. Saxitoxin.
 - d. Aflatoxin.
172. The antifreeze molecules that prevent intracellular ice formation in marine organisms are generally:
- a. calcium salts.
 - b. glycoproteins.
 - c. membrane phospholipids.
 - d. long chain alcohols.
173. Which one of the following transgenes expressed in transgenic fish by an appropriate inducible promoter, may be used for detecting environmental toxicants?
- a. Super oxide dismutase
 - b. Green Fluorescent Protein
 - c. Antimicrobial peptide
 - d. Aromatic hydrocarbon decarboxylase
174. Ballast water may be carried onboard by ships to maintain stability and improve maneuverability during transit. Introduction of which one of the following is regarded as the major threat in release of untreated ballast water?
- a. pathogenic microbes.
 - b. terrestrial inputs of pollutants.
 - c. invasive marine species.
 - d. algal blooms.
175. Remote sensing of ocean-atmospheric parameters carried out in the microwave channels is based on the phenomenon of:
- a. emission.
 - b. reflection.
 - c. scattering.
 - d. diffraction.

176. A starch containing wastewater sample with high BOD, CaCl_2 and NH_4NO_3 was subjected to aerobic oxidation using a designed bacterial consortium. The oxidised product(s) will have:
- Cl_2 , N_2 , O_2 , and CO_2
 - Cl_2 , N_2 , and O_2
 - O_2 and CO_2
 - CO_2
177. A wastewater has BOD of 1500 mg/L and COD of 2400 mg/L. Assuming 80% treatment efficiency in an activated sludge bioreactor, the BOD/COD ratio of treated effluent will be:
- 0.25
 - 0.50
 - 0.625
 - 0.78
178. A slaughter house waste was subjected to anaerobic digestion. If the operation conditions are mesophilic then the biogas will have only:
- H_2S , H_2 , CH_4 , and CO_2 .
 - H_2S , CH_4 , and CO_2 .
 - CH_4 , and CO_2 .
 - CH_4 .
179. A pilot plant treating organic waste in aerobic and continuous mode was running with a constant organic load. It was observed that after three days, the Dissolved Oxygen level had increased from 3mg/L to 4.5mg/L under the same operating conditions. This suggests that:
- treatment system running efficiently
 - treatment system not running efficiently
 - treatment system not getting affected
 - activated biomass generating oxygen
180. An anaerobic flask containing 50 ml of media with glucose as the sole carbon source was inoculated with a consortium consisting of *Methanosarcina* and *Bacillus*. After two weeks of incubation, there will be:
- no growth
 - growth with methane production
 - growth with acetate and methane production
 - growth with CO_2 production
181. A representative sequence profile of a given nucleotide binding domain is to be used to mine related sequences from TrEMBL. The database to be used to extract the query corresponding to this fold is:
- Interpro
 - Pfam
 - TrEMBL
 - Gene Ontology

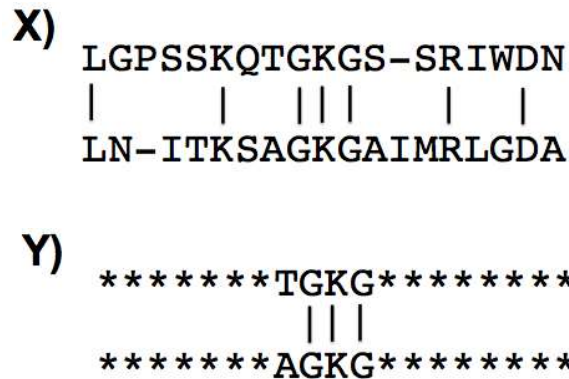
182. The figure represents a dot plot comparing two genomes X and Y. The portion marked N is a/an:



- a. Translocation
 - b. Inversion
 - c. Repeat Sequence
 - d. Insertion or deletion (Indel)
183. Which one of the following methods is most **accurate** in rescoring docked ligand-protein complexes?
- a. Molecular mechanics non-bonded energy functions
 - b. Binding free energy calculations incorporating solvation models
 - c. X-score – which is an independent score based on an energy function
 - d. Ensemble scoring of multiple docking algorithms
184. A reference set of molecules is experimentally assayed for xenobiotic toxicity using the MTS assay which is a colorimetric measurement of cell viability. As part of the lead optimization step in drug discovery, which one of the following steps can be used to predict the toxicity of a new set of compounds?
- a. Estimation of $\log P$ values
 - b. Building a regression model of the reference compounds using molecular descriptors and toxicity measures
 - c. Docking of molecules against an essential enzyme like DHFR
 - d. Building a classifier without molecular descriptors of the reference compounds
185. In a *de novo* RNASeq analysis, the typical steps are (1) transcript assembly, (2) cluster sequence contigs and construct complete *de Bruijn* graphs for each cluster, and (3) separate the *de Bruijn* graph to full length alternatively spliced isoforms or transcripts from paralogous genes. Which one of the following statements is **INCORRECT** in this context?
- a. The first two steps are memory intensive
 - b. The speed of the process is improved by a pre-processing step involving removal of redundant transcripts with no loss of accuracy
 - c. It is not possible to distinguish between alternatively spliced and paralogous transcripts
 - d. The last step can be parallelized to run on multiple processors

186. For Gene Set Enrichment Analysis (GSEA), differentially expressed genes are grouped into broader functions. A typical tool/resource used for this purpose is:
- Gene Ontology
 - BLAST against the nr database
 - Pfam database
 - PRODOM database

187. Two types of pair-wise sequence alignment of the same hypothetical protein sequence fragments are illustrated in the figure below. Vertical bars between the sequences indicate the presence of identical amino acids. * symbols in Figure Y indicate residues not included in the alignment.



Which one of the following is correct?

- Figures X and Y are examples of *global* and *local* sequence alignment, respectively.
- Figures X and Y are examples of *local* and *global* sequence alignment, respectively.
- Figures X and Y are examples of *local* sequence alignment.
- Figures X and Y are examples of *global* sequence alignment.

188. Match the items in **Group I** with **Group II** with reference to a database search for identifying homologs of human hemoglobin.

Group I

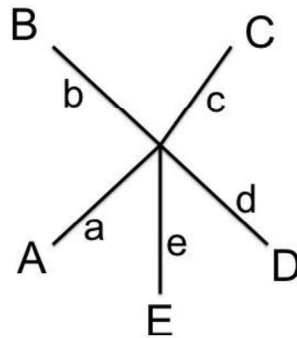
- (P) Sensitivity
 (Q) 100% Sensitivity
 (R) Specificity
 (S) 100% Specificity

Group II

- (1) Measure of how many correct hits are found
 (2) Measure of how many hits found are correct
 (3) Measure indicating that all correct hits are found
 (4) Measure indicating that all hits found are correct

- P-1, Q-3, R-2, S-4
- P-2, Q-4, R-1, S-3
- P-3, Q-1, R-2, S-4
- P-4, Q-2, R-3, S-1

189. The following phylogenetic tree of five sequences (A-E) indicates:



- Pairing of A and B
- Pairing of C and D
- Pairing of A, E and D
- No pairing of sequences

190. Genes or proteins that display the same activity, but have different origins and are the product of convergent evolution, are called:

- Analogs
- Paralogs
- Orthologs
- Xenologs

191. Match the type of BLAST programs given in **Group I** to the particular type of sequence search task described in **Group II**

Group I		Group II	
1	tblastn	P	A nucleotide sequence is to be used as a query to search for similar proteins against a nucleotide database
2	tblastx		
3	blastx	Q	A nucleotide sequence is to be used as a query to search against a protein database
4	blastn		

- 2-P, 3-Q
- 1-P, 3-Q
- 4-P, 3-Q
- 2-P, 1-Q

192. In a multiple sequence alignment of homologous protein sequences, a region of multiple insertions and deletions indicates the presence of:

- a secondary structure element
- a buried region in the protein
- a surface random coil region
- a motif

193. Two charged molecules are at a distance 'r' from each other. Which one of the following is correct regarding the electrostatic interactions between them?

- The interaction energy is proportional to r^{-1} and the force is proportional to r^{-2}
- The interaction energy is proportional to r and the force is proportional to r^2
- The interaction energy is proportional to r^2 and the force is proportional to r^{-3}
- The interaction energy is proportional to r^{-3} and the force is proportional to r^{-2}

194. The structure of two molecules P and Q with three atoms (u, v, w) each, are defined by coordinates given below.

	u	v	w
P	1,4,1	4,1,1	4,4,1
Q	0,0,1	2,0,1	3,2,1

The root mean square deviation between the two structures is:

- $\sqrt{3}$
 - 3
 - 9
 - 27
195. A novel protein from a deep sea archaeobacterium was identified and sequenced. The sequence is expected to be widely divergent from known sequences. Which scoring matrix will produce the most appropriate alignment in a search for homologs in the NCBI database?
- PAM1
 - PAM250
 - BLOSUM90
 - BLOSUM82
196. The measured values of main chain torsion angles of a residue in a polypeptide has values ($\Phi=+50$, $\Psi=+60$). What type of secondary structure is it most likely to be present in?
- Left-handed α -helix
 - Right-handed α -helix
 - Type II β -turn
 - Parallel β -sheet
197. Which one of the following experimental methods is **NOT** used to determine three-dimensional structures of biological macromolecules?
- Nuclear Magnetic Resonance Spectroscopy
 - Fluorescence spectroscopy
 - X-ray crystallography
 - Cryo-Electron microscopy
198. Which one of the following is **NOT** an assumption of an evolutionary model of the PAM matrix?
- Probability of a mutation at one position of a sequence is dependent on the identity of the amino acid
 - Probability of a mutation is dependent on the position of the mutation
 - Probability of a mutation is independent of the previous mutation at the position
 - Probability of a mutation is independent of the neighboring residues
199. Which one of the following is a valid assumption regarding the molecular clock hypothesis in evolution?
- For a given protein sequence, mutations accumulate at a constant rate in all lineages
 - For a given protein sequence, mutation rates are different in different lineages

- c. All proteins evolve at the same constant rate
 - d. For a given lineage, mutation rates are the same for all proteins
200. Which of the following is **NOT** true of protein folds?
- a. Proteins assume a limited number of folds
 - b. Proteins with the same fold may perform different functions
 - c. Proteins with different folds can carry out the same function
 - d. A stable fold is a prerequisite for the function of all proteins