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# **DBT-JRF BET**

**Previous Year Paper  
2017**



**BET 2017**  
**Question Paper**

**Part A**

1. For a single substrate reaction, doubling the substrate concentration increases the rate by 10 fold. The order of the reaction is
- a. 2
  - b. 3
  - c. 4
  - d. Between 3 and 4
2. An enzyme reaction follows Michaelis Menten kinetics. What will be the reaction velocity at a substrate concentration =  $K_m/3$ ?
- a.  $V_{max}$
  - b.  $V_{max}/3$
  - c.  $V_{max}/2$
  - d.  $V_{max}/4$
3. What will be the required volumes of 1N HCl and 4N NaOH to prepare one litre solution of pH 7?
- a. 500 ml; 500 ml
  - b. 800 ml; 200 ml
  - c. 600 ml; 400 ml
  - d. 200 ml; 800 ml
4. During a batch culture experiment, the following data was obtained

Time (h)	Substrate (g/l)	Cell (g/l)	Product (g/l)
2	40	1	2
8	20	5	7

What will be the product yield (g) per gram of substrate?

- a. 10
- b. 0.25
- c. 0.5
- d. 2

5. In a bacterial growth experiment, the concentration of cells increased from 10,000 cells/ml to 30,000 cells/ml in 3 h during the exponential growth phase. The doubling time (h) of the bacteria is:
- a. 2.5
  - b. 3.0
  - c. 1.0
  - d. 1.9
6. A 20mer DNA contains A, G and C only. In how many ways can this DNA sequence be constructed?
- a.  $4^{20}$
  - b.  $20^4$
  - c.  $3^{20}$
  - d.  $20^3$

7. Match the Matrices in Group I with appropriate gradient elution condition from Group II

	Group I		Group II
1	DEAE-Sephacel	P	Isocratic gradient
2	Phenyl-Sepharose	Q	Increasing concentrations of sodium chloride
3	Chromatofocusing	R	Decreasing concentrations of ammonium sulphate
4	Sephadex-G100	S	pH gradient

- a. 1-Q; 2-R; 3-S; 4-P
  - b. 1-Q; 2-R; 3-P; 4-S
  - c. 1-R; 2-Q; 3-P; 4-S
  - d. 1-S; 2-P; 3-Q; 4-R
8. The activity of Enzyme X (total volume 5.3 ml) is 2.34 micromoles of product formed per min. The total protein content of this solution is 0.8 mg. What is the specific activity?
- a. 2.93
  - b. 1.87
  - c. 18.2
  - d. 15.5

9. Match the techniques in Group I with applications given in Group II

	Group I		Group II
1	Salting out	P	pI determination
2	Ultracentrifugation	Q	Protein precipitation
3	Dialysis	R	Sedimentation coefficient
4	Isoelectric focusing	S	Removal of low molecular weight impurities

- a. 1-Q; 2-R; 3-S; 4-P
  - b. 1-P; 2-R; 3-Q; 4-S
  - c. 1-S; 2-P; 3R-; 4-Q
  - d. 1-Q; 2-S; 3-R; 4-P
10. What would be the number of protein molecules present in 1.0 mg of protein having a molecular weight of 25 kDa?
- a.  $2.4 \times 10^{15}$
  - b.  $2.4 \times 10^{16}$
  - c.  $2.4 \times 10^{17}$
  - d.  $2.4 \times 10^{18}$
11. Calculate the ionic strength (M) of 50 ml of 0.75 % (w/v) NaCl solution?
- a. 0.128
  - b. 0.256
  - c. 7.8
  - d. 0.064
12. A cell suspension ( $1.5 \times 10^5$  cells per ml) was treated with 1mM HgCl<sub>2</sub> for 30 min. After treatment, the cell suspension was diluted 10 fold and 100 microliter was plated which gave 5 colonies. Calculate the percentage of cells that survived?
- a. 0.00033
  - b. 3.3
  - c. 0.033
  - d. 0.33

13. Purification data for an enzyme is given below:

Steps	Purification step	Volume (ml)	Total protein (mg)	Total activity (micromoles per min)
I	Cell-free extract	20	100	150
II	Ni-NTA chromatography	4	10	120

What is the fold-purification?

- a. 8
  - b. 13.5
  - c. 10.5
  - d. 18
14. Competent cells prepared in your lab have a transformation efficiency of  $10^8$  cfu/ $\mu$ g of plasmid DNA. These competent cells (100  $\mu$ l) were transformed with 10 ng of plasmid DNA using heat shock method followed by addition of 900  $\mu$ l of LB medium. 100  $\mu$ l of transformed cells were plated on antibiotic containing plates. The number of colonies expected to be on the plate would be:
- a.  $10^5$
  - b.  $10^4$
  - c.  $10^3$
  - d.  $10^2$
15. A disease has a prevalence of 1 in 1000 in the general population. A diagnostic kit for the disease has 10% false positives and no false negative. In a general population, if a person tested with the kit gives a positive result, the probability that he **DOES NOT** have the disease is approximately:
- a. 9%
  - b. 90%
  - c. 99%
  - d. 99.9%
16. From the start point on the runaway to final take off, an aircraft takes 50 seconds. During this period it covers a distance of 1 km. What is the acceleration ( $\text{m/s}^2$ ) during take-off?
- a. 0.6
  - b. 0.8
  - c. 1.0
  - d. 1.2

17. A ladder of 5 m length is standing against a wall. The distance between the wall and the base of the ladder is 4 m. If the top of ladder slips down by 0.5 m, the foot of the ladder will shift by:
- 0.25 m
  - 0.33 m
  - 0.5 m
  - 0.6 m
18. A person jogs from his home to the playground at 6 km/h. He walks back from the playground to his home at 4 km/h. What is his average speed (km/h)?
- 4.25
  - 4.8
  - 5
  - 5.25
19. Which one of the following numbers is equal to three times the sum of its digits?
- 15
  - 12
  - 24
  - 27
20. If 5 ml of 20% ethanol is mixed with 25 ml of 80% ethanol, the resulting solution will approximately be:
- 50% ethanol
  - 70% ethanol
  - 100% ethanol
  - 80% ethanol
21. When DNA is extracted from bacterial cells and analyzed for base composition, it is found that 38% of bases are Cytosine (C). What percentage of bases is Adenine (A)?
- 12
  - 24
  - 38
  - 62

22. Equal volumes of cell suspensions of *Escherichia coli*, *Saccharomyces cerevisiae*, *Streptococcus lactis* and *Mycoplasma pneumoniae*, all have the same  $OD_{600nm} = 0.50$ . Which cell suspension would have the minimum and maximum number of cells, respectively?

- Saccharomyces cerevisiae* and *Mycoplasma pneumoniae*
- Saccharomyces cerevisiae* and *Streptococcus lactis*
- Escherichia coli* and *Mycoplasma pneumoniae*
- Mycoplasma pneumoniae* and *Streptococcus lactis*

23. A bag contains 4 red, 5 green and 7 yellow balls. If 2 balls are picked simultaneously in a random manner from the bag, the probability of both being green is:

- 1/16
- 1/8
- 1/12
- 5/16

24. The spectroscopic method for detection of functional groups is:

- CD spectroscopy
- FTIR spectroscopy
- ESR spectroscopy
- UV-VISIBLE spectroscopy

25. Match the native microbial sources in Group I with the products in Group II

Group I

M. *Leuconostoc mesenteroides*

N. *Lactococcus lactis*

O. *Brevibacterium brevis*

P. *Penicillium roqueforti*

Group II

1. Lysine

2. Cheese

3. Dextran

4. Nisin

- M-2. N-1. O-4. P-3.
- M-1. N-2. O-3. P-4.
- M-3. N-4. O-1. P- 2.
- M-4. N-3. O-2. P-1.



26. Match the enzyme in Group I with the application/function in Group II

Group I

M. Pectinase

N. Papain

O. Glucose isomerase

P.  $\beta$ -Galactosidase

Group II

1. Lactose free milk products

2. High Fructose Corn Syrup

3. Juice Clarification

4. Meat tenderisation

- a. M-4. N-3. O-2. P-1.
- b. M-3. N-4. O-2. P-1.
- c. M-1. N-2. O-4. P-3.
- d. M-2. N-1. O-3. P-4.

27. Histone code implies which of the following?

- a. Combination of different histone proteins to form a nucleosome.
- b. Modification of histones.
- c. Different histone proteins present in different eukaryotic organisms.
- d. Different order of histone proteins in a given nucleosome.

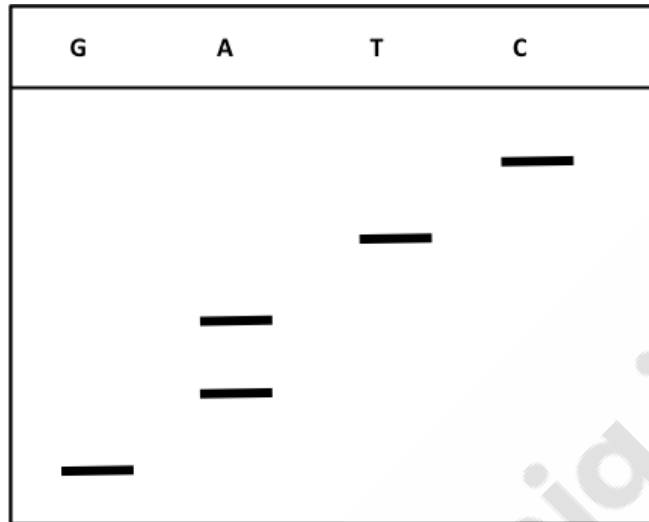
28. The  $A_{260}$  of a plasmid solution after 100-fold dilution is 0.2. Given that  $A_{260}$  of 1.0 represents 50  $\mu\text{g}/\text{ml}$  of DNA and the total volume of isolated plasmid solution is 50  $\mu\text{l}$ , what will be the concentration and amount respectively of the isolated plasmid?

- a. 1.0  $\mu\text{g}/\mu\text{l}$  and 50  $\mu\text{g}$
- b. 1.0  $\text{mg}/\mu\text{l}$  and 50  $\text{mg}$
- c. 10  $\mu\text{g}/\mu\text{l}$  and 50  $\mu\text{g}$
- d. 10  $\text{mg}/\mu\text{l}$  and 50  $\text{mg}$

29. A gene was cloned into a unique *Hind*III restriction site present in the ampicillin resistance gene of a vector that contains both ampicillin and kanamycin resistance genes. To select for only recombinant clones, the transformation mixture should be plated on which of the following plates?

- a. Ampicillin containing plate
- b. Ampicillin plus Kanamycin containing plate
- c. Ampicillin containing plate followed by replica-plating on kanamycin containing plate
- d. Kanamycin containing plate followed by replica-plating on ampicillin containing plate

30. A student sequenced a DNA using Sanger's method and obtained the following autoradiogram.



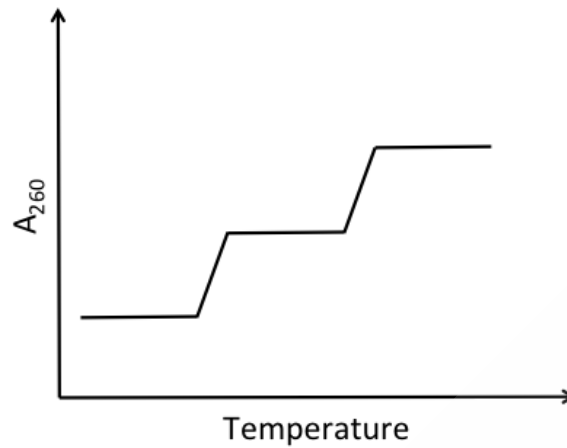
The sequence of DNA is:

- a. 5' CTTAG 3'
- b. 5' GAATC 3'
- c. 5' CTAAG 3'
- d. 5' AATTG 3'

31. From among the options given below, RNA polymerase II transcribes which one of the following?

- a. rRNA
- b. tRNA
- c. MicroRNA
- d. None of the given options

32. The melting curve of a DNA solution is represented below.



It suggests that:

- a. The given DNA has one stretch with a biased base composition
- b. The given DNA has two stretches with a biased base composition
- c. The given DNA has three stretches with a biased base composition
- d. The given DNA has an unbiased base composition

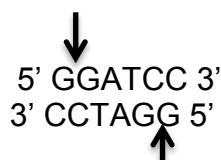
33. The DNA binding domain of a transcription factor that is specifically required for the regulation of gene A is exchanged with the DNA binding domain of another transcription factor that is required specifically for the regulation of gene B. This chimeric transcription factor will regulate:

- a. Gene A only
- b. Gene B only
- c. Both Gene A and B
- d. Neither Gene A nor Gene B

34. Protein synthesis in eukaryotic cells terminates at the stop codon because:

- a. mRNA synthesis stops at the stop codon.
- b. The tRNA corresponding to the stop codon cannot bind to an amino acid.
- c. There is no naturally occurring tRNA with an anticodon corresponding to the stop codon.
- d. The conformation around stop codons prevents binding of aminoacyl tRNA.

35. A DNA fragment was digested with a restriction enzyme X with the recognition sequence



that would cleave at the position of the arrow as shown. You want to clone this fragment in a vector which does not contain the restriction site for X. Which one of the following enzymes will you use to digest the vector?

The sequence of the restriction site and position of cleavage for each enzyme is shown below:

- a. Restriction enzyme A:  $\begin{array}{c} \downarrow \\ 5' \text{ GAATTC } 3' \\ 3' \text{ CTTAAG } 5' \\ \uparrow \end{array}$
- b. Restriction enzyme B:  $\begin{array}{c} \downarrow \\ 5' \text{ CTCGAG } 3' \\ 3' \text{ GAGCTC } 5' \\ \uparrow \end{array}$
- c. Restriction enzyme C:  $\begin{array}{c} \downarrow \\ 5' \text{ AGATCT } 3' \\ 3' \text{ TCTAGA } 5' \\ \uparrow \end{array}$
- d. Restriction enzyme D:  $\begin{array}{c} \downarrow \\ 5' \text{ GTCGAG } 3' \\ 3' \text{ CAGCTC } 5' \\ \uparrow \end{array}$

36. Which one of the following is **NOT** important for regulation of the tryptophan operon by attenuation?

- Presence of two adjacent codons for tryptophan in the leader peptide sequence
- Coupled transcription-translation
- Concentration of tRNA charged with tryptophan
- The operator sequence of tryptophan operon

37. A plasmid DNA when digested with *EcoRI* gave a single band of 16 Kb. When the same plasmid was digested with *BamHI* it gave two bands of 6Kb and 4 Kb. The plasmid has:
- Single site of *EcoRI* and 2 sites of *BamHI*
  - Single site of *EcoRI* and 3 sites of *BamHI*
  - Single site of *EcoRI* and 2 sites of *BamHI*
  - 2 sites of *EcoRI* and 2 sites of *BamHI*
38. Myeloma cells fused with spleen cells in hybridoma technology are:
- Immortal and antibody producing cells
  - Mortal and antibody producing cells
  - Hypoxanthine guanine phosphoribosyl transferase lacking cells
  - Thymidine kinase lacking cells
39. Enzyme inactivation by suicide inhibitors should be:
- allosteric-site directed
  - active-site directed
  - regulatory-site directed
  - both allosteric and regulatory-site directed
40. Resolution in adsorption chromatography is achieved at:
- Elution stage only
  - Binding stage only
  - Equilibration stage only
  - Both binding and elution stage
41. Protein kinases phosphorylate proteins at hydroxyl groups on amino acid side chains. Which one of the following groups of amino acids contain side chain hydroxyl groups?
- Aspartate, glutamate and serine
  - Serine, threonine and tyrosine
  - Lysine, arginine and proline
  - Threonine, phenylalanine and arginine
42. In a segment of a transcribed gene, the non-template strand of DNA has the following sequence 5'..AGCTCACTG..3'. What will be the corresponding 5' to 3' sequence in the RNA produced from this segment of the gene?
- CAGUGAGCU
  - AGCUCACUG
  - CAGTGAGCT
  - UCGAUGAC

43. If the DNA content of a diploid cell in the G1 phase of the cell cycle is X, then the DNA content of the same cell at metaphase of meiosis I would be:

- a. 2X
- b. 4X
- c. 0.5X
- d. X

44. The  $\alpha$ -helix in a protein is primarily due to:

- a. Intramolecular hydrogen bond
- b. Intermolecular hydrogen bond
- c. van der Waals interaction between amino acids
- d. covalent interactions

45. Amino acids with asymmetric  $C_\beta$  atoms are:

- a. Pro, Met
- b. Lys, Ile, Val
- c. Thr, Ile
- d. Cys, Ser, Met

46. The strength of the hydrogen bond represented by D-H...A (where D is the donor atom, H is the hydrogen atom and A is the acceptor atom) depends on

- a. the D-H bond length and the nature of the D and A atoms.
- b. the nature of the D and A atoms and the D...A distance.
- c. the D...A distance and linearity of the angle DHA.
- d. the H...A distance, linearity of the angle DHA and the nature of the atoms D & A.

47. The van der Waals energy of a single water molecule is:

- a. 0
- b. -0.2 Kcal/mol
- c. -0.5 Kcal/mol
- d. 0.2 Kcal/mol

48. What is the minimum number of edges that meet at every branch node in a phylogenetic tree?

- a. 1
- b. 2
- c. 3
- d. 4

49. According to the Induced-fit theory, an agonist is defined as:

- a) A compound which produces an exothermic effect
- b) A compound which occupies the receptor for a longer period
- c) A compound that induces a specific conformational change in the macromolecule
- d) A compound which hits the receptor center more often.

50. A recombinant protein is found to be expressed very poorly in *E.coli*. It is hypothesized that the expression is blocked at the translational step. The first experimental technique to test this is:

- a. PCR followed by sequencing
- b. Quantitative RT PCR
- c. Western Blot
- d. EMSA



**Part B**

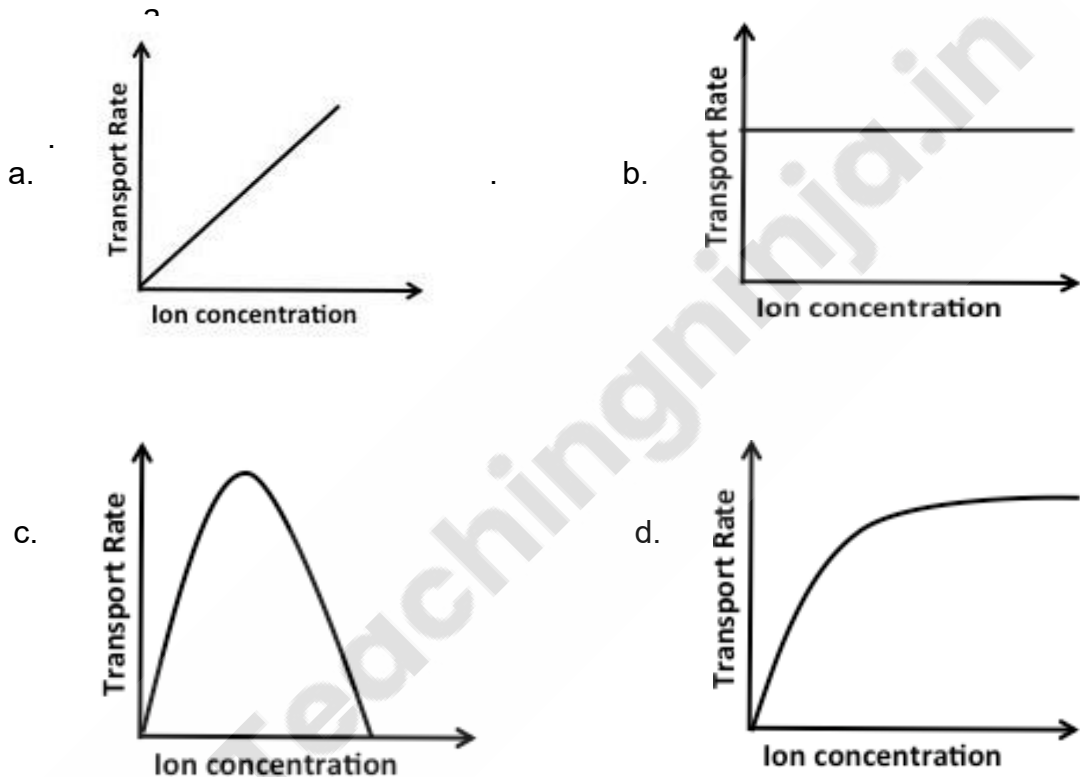
51. There are 3 genes A, B and C that are functionally related. There is a point mutation in gene A due to which gene B is not expressed resulting in a non-functional gene C product. What is the possible relationship between these 3 genes?
- a. A is an enzyme, B and C are substrates of A
  - b. A is transcription factor for B and B is needed for C to be functional.
  - c. B is transcription factor for C and A
  - d. C is enzyme that requires A and B as its substrate
52. Detectable serum antibody against a T-independent pathogen is a good indication that:
- a. A functional B-cell system exists
  - b. A functional T-cell system exists
  - c. The patient has immune suppression
  - d. Both T and B cell systems are not functional
53. If a 1000 kb fragment of DNA has 10 evenly spaced and symmetric replication origins and DNA polymerase moves at 1 kb per minute, how many minutes will it take to produce two daughter molecules ignoring the potential problem at the end of the linear piece of DNA? Assume that the 10 origins are evenly spaced from each other, none starting from the ends of the chromosome.
- a. 20
  - b. 30
  - c. 50
  - d. 100
54. In an experiment, 4 different N-terminal blocked purified proteins were treated with glutaraldehyde, individually. One of the proteins did not get modified. What may be the reason?
- a. The protein lacks histidine
  - b. The protein lacks phenylalanine
  - c. The protein lacks lysine
  - d. The protein lacks arginine



55. Which of the following signatures (the stretch of amino acids) in a protein will target it to the nucleus?
- a. Arg-Glu-Glu-Trp-Glu-Cys
  - b. Arg-Lys-Lys-Lys-Arg-Lys
  - c. Trp-Phe-Phe-Phe-Phe-Gly
  - d. Phe-Pro-Pro-Arg-Tyr-Tyr
56. Which one of the following rearrangements is **NOT** permitted during somatic recombination in the heavy chain and light chain immunoglobulin loci?
- a.  $D_H:J_H$
  - b.  $V_L:J_L$
  - c.  $V_H:J_H$
  - d.  $V_H:D_H$
57. Junctional diversity in CDR3 during gene rearrangement results from the addition of:
- a. Switch region nucleotides
  - b. P and N nucleotides
  - c. V, D and J nucleotides
  - d. Recombination signal sequences
58. The function of negative selection of thymocytes in the thymus is to eliminate:
- a. Single-positive thymocytes
  - b. Double-positive thymocytes
  - c. Alloreactive thymocytes
  - d. Autoreactive thymocytes
59. Antigen recognition by T cells in the absence of co-stimulation results in:
- a. Upregulation of B7.1
  - b. T-cell apoptosis
  - c. T-cell anergy
  - d. Upregulation of B7.2

60. Mutation of homeotic genes often result in which one of the following developmental defects in *Drosophila*?
- Absence of a group of contiguous segments
  - Transformation of one segment to another
  - Tumor formation in imaginal discs
  - Absence of every other segment along the antero-posterior axis

61. Which one of the following graphs represent the kinetics of ion transport through a membrane channel?



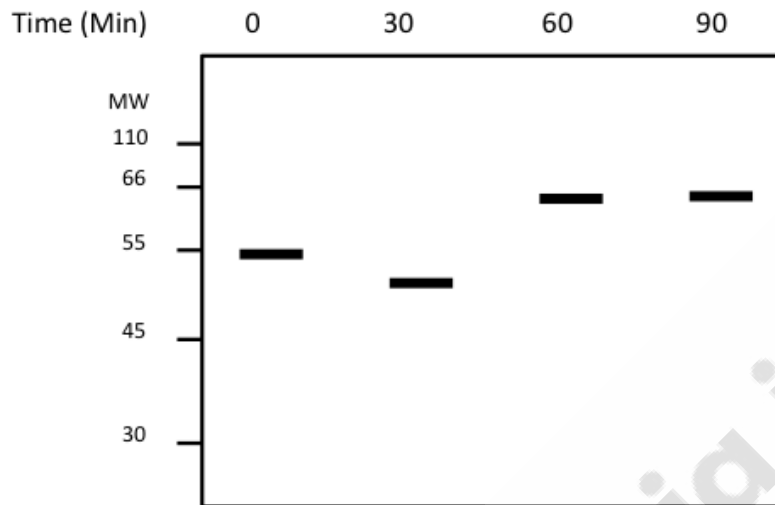
62. Transition type of gene mutation is caused when

- GC is replaced by TA
- CG is replaced by GC
- AT is replaced by CG
- AT is replaced by GC

63. Which one of the following is **NOT** enriched in eukaryotic promoters located in active chromatin?
- a. Acetylated histones
  - b. DNase I hypersensitive sites
  - c. Methylated cytosine
  - d. Bound TFIID
64. One of the reasons why non-substrate inducers (e.g. IPTG) are preferred over substrate inducers (e.g. lactose) for induction of an inducible operon is because:
- a. They directly interact with the promoter sequences
  - b. They directly interact with the repressor
  - c. They directly interact with operator region
  - d. They interact with the activation sequences and induce enhancers
65. In humans, the enzyme having reverse transcriptase activity is:
- a. Ribonuclease P
  - b. Ribonuclease D
  - c. Recombinase
  - d. Telomerase
66. To prepare a DNA probe of high specific activity for detecting a single copy gene in a Zoo-blot experiment, which one of the following procedures would be preferred?
- a. 5' end labelling
  - b. 3' end labelling
  - c. In vitro transcription
  - d. Random primer labelling
67. The function performed in the smooth ER is:
- a. Biosynthesis of secretory proteins
  - b. Folding of membrane proteins
  - c. Addition of N-linked sugars
  - d. Detoxification of drugs
68. In human carcinomas, many proteins including most cytoskeletal proteins undergo modifications, thereby making it difficult for a clinician to identify the origin of the cancer cells. In this context, which one of the following can be relied upon for identification of the origin of cancer cells?
- a. microtubules

- b. F-actin
  - c. G-actin
  - d. Intermediate filament
69. Most organisms can regulate membrane fluidity by changing the lipid composition. If cells are transferred from a warm environment to a cold one, it can be expected that:
- a. There will be a decrease in the proportion of 16-carbon fatty acids compared to 18-carbon fatty acids
  - b. There will be an increase in the proportion of 16-carbon fatty acids compared to 18-carbon fatty acids
  - c. There will be an increase in the proportion of saturated fatty acids
  - d. Phospholipids will not be incorporated into the membrane
70. Glycosylation of membrane proteins and lipids is carried out by enzymes present in the lumen of endoplasmic reticulum and Golgi. The glycosylated part of membrane proteins and lipids in the plasma membrane is likely to be:
- a. Oriented towards the cytosol
  - b. Exposed to the extracellular environment
  - c. The glycosylated parts of the proteins are towards the cytoplasm but glycosylated lipids are exposed to the extracellular environment
  - d. The glycosylated parts of the lipids are towards the cytoplasm but glycosylated proteins are exposed to the extracellular environment
71. Lysosomal storage diseases are a group of inherited diseases that are characterized by the accumulation of specific substances or class of substances within the lysosomes. All of the following mechanisms can cause lysosomal storage disease **EXCEPT**:
- a. Defects in the enzyme N-acetylglucosamine phosphotransferase
  - b. Defective or missing acid hydrolases
  - c. Defects in the transport of lysosomal enzymes to the cell surface
  - d. Defects in the transport proteins that transport proteins from Golgi to lysosomes
72. The gene encoding an enzyme A that functions in a metabolic pathway for conversion of metabolite 'x' to 'y' was knocked out but it still resulted in the formation of metabolite 'y'. From this it can be concluded that:
- a. Enzyme A is necessary but not sufficient for formation of 'y'
  - b. Enzyme A is sufficient but not necessary for formation of 'y'
  - c. Enzyme A is neither necessary nor sufficient for formation of 'y'
  - d. Enzyme A is both necessary and sufficient for formation of 'y'

73. The following figure shows the electrophoretic migration of a secretory protein in SDS-PAGE from the time of its synthesis (0 min) to its secretion (90 min) from the cells.



Assuming that there was no problem in sample preparation and SDS-PAGE, the reason for a lower band at 30 min and a higher band at 60 and 90 min compared to that at 0 min could be due to:

- Changes in the rate of protein synthesis at various time points
- The protein was associated with other proteins at different time points resulting in change in its migration
- The protein underwent processing and posttranslational modifications as a function of time
- Small changes observed in the migration of the protein do not give enough information to derive a meaningful conclusion

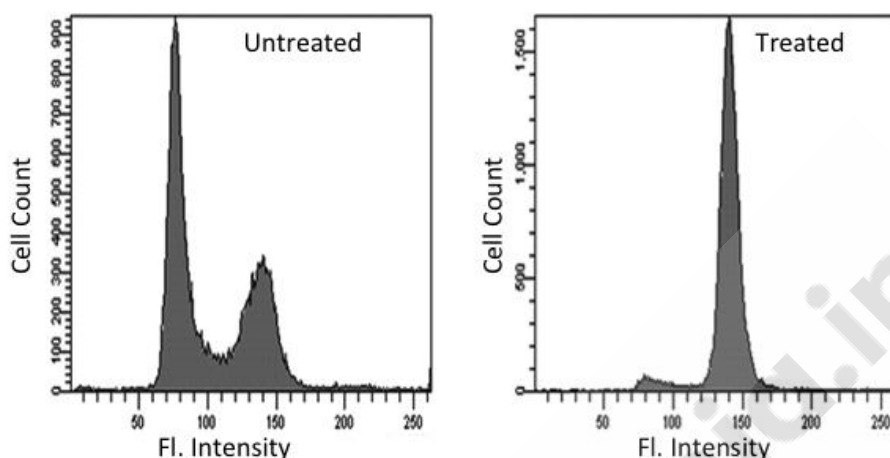
74. Four yeast mutants block membrane and secretory proteins in following compartments:

Mutant A: Golgi  
 Mutant B: Endoplasmic reticulum  
 Mutant C: Cytosol  
 Mutant D: Secretory vesicles

If two new mutants are made that have combined defects of A+C and B+D, proteins of the new mutants will accumulate in:

- Golgi and ER, respectively
- Golgi and secretory vesicle, respectively
- Cytosol and ER, respectively
- Cytosol in both cases

75. Asynchronous animal cells were stained with a fluorescent DNA binding dye and analyzed by flow cytometry. The histogram of cell count versus fluorescence intensity is shown below with or without treatment.



It can be concluded from the histogram that:

- a. The treatment inhibits the cells from entering the S-phase
  - b. The treatment increases the proportion of G1 phase
  - c. The treatment increases the proportion of G2/M phase
  - d. The treatment increases the proportion of S phase
76. Which one of the following eIF2 $\alpha$  kinases get activated during unfolded protein response (UPR) in mammalian cells?
- a. PKR
  - b. GCN<sub>2</sub>
  - c. PERK
  - d. HRI
77. *E. coli* RNA polymerase has six subunits two  $\alpha$ , one  $\beta$ , one  $\beta'$ , one  $\omega$  and one  $\sigma$ . Which among these subunits imparts specificity of transcription of a gene and how?
- a.  $\omega$ , by binding to -10 sequence
  - b.  $\sigma$ , by binding to both -10 and -35 sequences
  - c.  $\beta$ , by binding to -10 sequence
  - d. Both  $\sigma$  and  $\omega$ , by binding to -10 and -35 sequences

78. The use of guide RNA to bind to DNA and target the double strand break at a specific site is a feature of:
- Gene knockout by homologous recombination
  - Gene knock down by RNAi
  - Genome editing by CRISPR/Cas system
  - Gene silencing by siRNA
79. Epidermolysis bullosa simplex (EBS) disease is caused by a mutation in which one of the following genes?
- $\beta$ -tubulin
  - Keratin
  - Collagen
  - Tau
80. The genes that have been used for reprogramming somatic cells of an adult mammal to stem cells called induced pluripotent stem cells (iPSC) are KLF4, SOX2, OCT4 and c-MYC. These code for:
- Transcription factors
  - Both transcription factors and RNA binding proteins
  - Chaperone proteins
  - Growth factors
81. Following fertilization, zygote divides rapidly to form a large number of cells within a short time through a process called cleavage. In some organisms like sea urchin the cells of the early embryos skip some stages of cell cycle in order to achieve this. Which of the following steps may be skipped?
- $G_1$
  - $G_1$  and  $G_2$
  - S
  - $G_0$
82. Cell cycle regulatory genes (cdc) were originally discovered by Paul Nurse in yeasts using genetic approach involving temperature sensitive mutant screening. Which of the following was used to identify cdc?
- Genome sequencing
  - cDNA complementation assay
  - RNAi method
  - Homologous recombination
83. Bindin is a protein that is expressed in the tip of sperm head (acrosome) and is important for sperm-egg interaction. Its distribution pattern changes during sperm maturation. Which one of the following methods may be used to monitor the expression pattern of bindin in a simple light microscope?

- a. Phase contrast microscopy
  - b. Normarski-contrast microscopy
  - c. Immuno cytochemistry
  - d. Immunofluorescence
84. Which of the following mechanisms converts c-erbB (EGFR) to an oncogene?
- a. Point mutation
  - b. Truncation
  - c. Recombination
  - d. Gene amplification
85. Midblastula transition (MBT) is a characteristic process that occurs in early embryogenesis of organisms (like Amphibians) whose eggs are large. MBT refers to:
- a. Transition of structures from early embryonic to late embryonic
  - b. Transition of gene expression from maternal to zygotic
  - c. Regulation of transition of primordial germ cells to Gonadal structure
  - d. Epigenetic modification of gene regulation
86. Introns which are self-splicing and do not require any cofactor for their splicing, are present in the primary transcripts of:
- a. miRNA
  - b. Nuclear mRNA
  - c. tRNA
  - d. Mitochondrial mRNA
87. The phenomenon of transfer of traits from a man to his grandson through his daughter is known as:
- a. Sex influenced inheritance
  - b. Criss-cross inheritance
  - c. Y-linked inheritance
  - d. Sex-limited inheritance
88. If the doubling time of a prokaryotic cell becomes progressively shorter, then it can be predicted that the ribosome concentration will:
- a. remain constant
  - b. decrease
  - c. increase
  - d. remain constant but their composition will be different



89. How many DNA molecules of 6 base pairs length are possible where the first base is a purine and the last base is a pyrimidine?
- 32
  - 256
  - 4096
  - 1024
90. A recombinant protein is expressed in *E. coli* under T7 promoter at 37°C. However no biological activity is obtained in the cell lysate. If the same experiment is carried out at 25°C, the cell lysate shows a reasonable biological activity. The most probable explanation for this is:
- lower temperature increases recombinant protein stability
  - lower temperature increases rate of production of recombinant protein
  - IPTG used for induction does not get degraded
  - recombinant protein is properly folded at low temperature
91. IPTG is used as an inducer in the T7 expression system for recombinant protein expression in *E.coli*. This is because of:
- availability of special *E.coli* cells which have the T7 RNA polymerase gene integrated into their genome under a regulatable promoter
  - T7 promoter is recognized by *E.coli* RNA polymerase
  - High copy number of plasmid allows sequestration of *E.coli* RNA polymerase by T7 promoter
  - IPTG facilitates binding of *E.coli* RNA polymerase to the T7 promoter.
92. Pyrosequencing derives its name from the fact that:
- the bases are detected by pyrolysis
  - it detects pyrophosphate released during base incorporation
  - it uses apyrase to detect the bases
  - it generates a pyrogram as an output
93. Which of the following is a reason that geneticists use mtDNA to study the relatedness of animal populations?
- mtDNA mutates at a slower rate than nuclear DNA
  - mtDNA transmitted from mother to child, is free from recombination
  - All mitochondrial proteins are coded by mitochondrial genes
  - There are only a few single nucleotide polymorphisms in the mtDNA
94. Lyophilization is a method used for preservation of microbes because:
- moisture is removed by sublimation
  - moisture is removed by very slow evaporation
  - ice crystals formed at low temperature improves cell viability
  - removal of air during lyophilization prevents formation of free radicals

95. Stoichiometric matrices in metabolic pathways are used in:

- a. Gene regulatory network analysis
- b. Measuring robustness of a system
- c. Flux Balance Analysis
- d. Analysis of phenotypic characters from genome.

96. The main difference between domain and motif in protein structure is:

- a. Domain can remain stable, independent of the rest of the protein while motif cannot.
- b. Domain cannot remain stable, independent of the rest of the protein while motif can.
- c. Domain can be predicted but motif cannot be predicted.
- d. Both are synonyms and there is no difference

97. Select the best algorithm to do pairwise alignment when two proteins are very different in length.

- a. Smith-Waterman
- b. Needleman-Wunsch
- c. dot-matrix
- d. ClustalW

98. From literature it is known that the length of an *E. coli* bacterium is 1  $\mu\text{m}$  with a standard deviation of 0.1  $\mu\text{m}$ . After treatment with chemical "X" the mean length of 100 cells is 1.1  $\mu\text{m}$  with a standard deviation of 0.1  $\mu\text{m}$ . What will you conclude from this experiment?

- a. Treatment with chemical "X" has increased the length with a statistical confidence of more than 99%
- b. The length has increased with statistical confidence of 67%
- c. Length has not increased and the observed difference is due to statistical error
- d. Length increased can be claimed with 95% statistical confidence.

99. Which one of the following techniques **CANNOT** be used to remove salt from a protein solution

- a. Ultrafiltration
- b. Ion exchange chromatography
- c. Gel filtration chromatography
- d. Dialysis

100. The jelly roll in protein structure is:

- a. made of eight alpha helices
- b. made of four alpha/beta motifs
- c. made of seven hydrophobic strands and an amphipathic helix
- d. formed from eight beta strands

101. Which one of the following is **NOT** a structure or structurally derived database?

- a. PDB
- b. PROSITE
- c. SCOP
- d. CATH

102. Which of the following is **TRUE**?

In the threading approaches for prediction of protein structure, the optimization is used for:

- a. Sequence to sequence alignment
- b. Generation of profile by converting three-dimensional structure to one-dimensional string
- c. Alignment of sequence to structure which minimizes energy of the target sequence in the template fold
- d. Alignment of target sequence to one-dimensional profile of a template fold

103. The statistical significance of the BLAST hit is obtained using:

- a. extreme value distribution
- b. normal distribution
- c. Poisson distribution
- d. random distribution

104. What is referred by the term  $k$  in the following energy expression  $E = \frac{1}{2} k (b - b_0)^2$  where  $b$  and  $b_0$  refer to the bond length and reference bond length respectively?

- a. van der Waals radius
- b. stretching constant for bond length variation
- c. torsional potential
- d. kinetic energy of an atom

105. The estimates of number of false positives from a BLAST search can be made using:

- a. Percent positives
- b. Percent identity
- c. E value
- d. Bit score

106. The length of Beta Hairpin motif is usually:

- a. 2 to 7 residues
- b. 12 to 15 residues
- c. 22 to 25 residues
- d. 6 to 10 residues

107. A scoring function is used in which one of the following drug design technologies?

- a. QSAR
- b. Molecular docking
- c. Molecular dynamics
- d. Pharmacophore mapping

108. BLOSUM matrices are based on:

- a. mutations observed throughout a global alignment
- b. highly conserved regions in a series of alignments forbidden to contain gaps
- c. explicit evolutionary model
- d. alignment of same sequences containing highly mutable regions

109. ProDom is a comprehensive set of protein domain families automatically generated from:

- a. Pfam
- b. UniProt Knowledge Database
- c. Swiss-prot
- d. InterPro

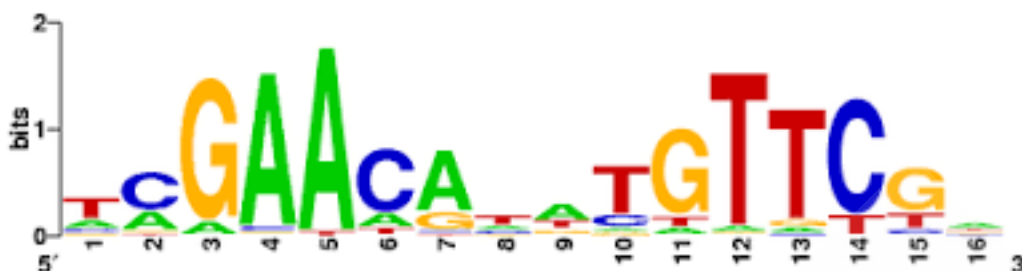
110. Which one of the following methods used to find evolutionary trees is also referred as “the minimum evolution method”?

- a. Distance Method
- b. Maximum Parsimony Method
- c. Fitch and Margoliash Method
- d. UPGMA Method

111. Z-score =

- a.  $(\text{score of alignment} - \text{mean}) / \sqrt{(\text{standard deviation})}$
- b.  $(\text{variance} - \text{score of alignment}) / \text{standard deviation}$
- c.  $(\text{mean} - \text{score of alignment}) / \text{standard deviation}$
- d.  $(\text{score of alignment} - \text{mean}) / \text{standard deviation}$

112. In a *sequence logo* of the type given below, the sizes of the letters are proportional to the:



- a. number of residues in the sequences
  - b. information content of the respective residues
  - c. frequencies of the respective residues in the sequences
  - d. resolution of the output device (terminal/printer)
113. For a homology search program such as BLAST, which one of the following best describes the scoring pattern?
- a. identical residue = 10 pts, conservative substitution = 5 pts, gap = 0 pts
  - b. identical residue = 10 pts, conservative substitution = 1 to 9 pts, gap = -3 pts
  - c. identical residue = 10 pts, conservative substitution = 1 to 9 pts, gap = 0 pts
  - d. identical residue = 10 pts, conservative substitution = 10 pts, gap = -3 pts
114. Given the results of a 'sequence versus fingerprint' search, which of the following would be considered the best hit?
- a. Motifs: 7 of 7 p-value:  $2.2 \times 10^{-8}$  & e-value:  $4.5 \times 10^{-5}$
  - b. Motifs: 8 of 8 p-value:  $2.2 \times 10^{-8}$  & e-value:  $4.5 \times 10^{-5}$
  - c. Motifs: 8 of 8 p-value:  $2.2 \times 10^{-18}$  & e-value:  $4.5 \times 10^{-15}$
  - d. Motifs: 7 of 8 p-value:  $2.2 \times 10^{-18}$  & e-value:  $4.5 \times 10^{-15}$
115. In a Multi-Locus Variable number tandem repeat Analysis (MLVA) for *Salmonella enterica* subspecies, three tandem repeats loci have been identified inside *yohM* gene of *S. typhimurium* LT2, *S. typhi* CT18 and *S. typhi* Ty2 strains. Motif lengths for the loci are 2, 3 and 5 respectively. Motif AT and ATG are found to be repeated by 13 and 5 times respectively in all the strains. Motif ATGTC is repeated 13 times in *S. typhimurium* LT2, 15 times *S. typhi* CT18 and 12 times *S. typhi* Ty2 strains. Which locus is Variable Number Tandem Repeat (VNTR)?
- a. AT
  - b. ATG
  - c. ATGTC
  - d. GTCA

116. Of a population of cells undergoing meiosis, 1% of the cells undergo recombination between genes *A* and *B*. What is the distance between the two genes?
- 0.25 cM
  - 0.75 cM
  - 0.50 cM
  - 1.00 cM
117. Which one of the following combinations of marker genes and promoters **CANNOT** be used for selection of transgenic plants under *in vitro* conditions?
- positive selection marker genes under the *Agrobacterium*-derived NOS promoter
  - conditional negative selection marker genes under an inducible promoter
  - positive selection marker genes under CaMV 35S promoter
  - non-conditional negative selection marker genes under CaMV 35S promoter
118. Several experiments have shown leaky/deregulated expression of reporter genes viz., *GUS* from plant promoters in *Agrobacterium* cells. Which one of the following approaches would be most useful in restricting transgene expression in transformed plant cells and prevent their expression in *Agrobacterium*?
- Use of weak promoters to express the transgene
  - Use of 5' and 3' UTRs flanking the transgene
  - Avoiding use of the polyA signal
  - Use of intron(s) within the transgene sequence
119. A  $T_0$  transgenic plant showing two copies of T-DNA on Southern analysis, segregated in a 3:1 ratio for the transgenic:non-transgenic phenotype among  $T_1$  progeny obtained by self-pollination. Which one of the following statements best explains this observation?
- The  $T_0$  plant contains a single copy of the transgene.
  - The  $T_0$  plant contains two linked copies of the transgene.
  - The  $T_0$  plant contains two unlinked copies of the transgene.
  - The  $T_0$  plant contains at least three copies of the transgene.
120. Which one of the following statements is correct?
- All the virulence genes of *Agrobacterium tumefaciens* are expressed in a constitutive manner.
  - Opines are a source of iron for *Agrobacterium* cells.
  - One *Agrobacterium* cell can generate only one T-DNA molecule for transfer into the host cell.
  - Integration of T-DNA in the genome can mutate or modulate endogenous plant genes.

121. Which one of the following statements related to transgene silencing in plants is **INCORRECT**?
- a. Transgene silencing is usually accompanied by methylation of cytosine residues in 'CG' and/or 'CNG' sites.
  - b. Events with multi-copy integrations of the T-DNA are more susceptible to transgene silencing.
  - c. Transgene silencing always occurs in T<sub>0</sub> individuals and never in subsequent generations.
  - d. Transgene silencing may lead to silencing of endogenous plant gene homologs.
122. Two independent transgenic plants, one with single copy of gene A and another with single copy of gene B were expressed under the same seed-specific promoter. In transgenic plants, seed formation on self-pollination was similar to that of untransformed plants. When homozygous plants with gene A (male parent) were crossed with homozygous plants with gene B (female parent), viable seed formation did not occur although, pollen production was normal. What could be the possible reason for this observation?
- a. Product of gene A is lethal to the male gametophyte.
  - b. Interaction between products of genes A and B is lethal to the zygote.
  - c. Interaction between products of genes A and B is lethal to the male gametophyte.
  - d. Product of gene B is lethal to the zygote.
123. The range of transformation frequencies obtained in independent transformation experiments using four different constructs with different combinations of promoters (Pr) and selection marker genes, is given below:

Construct	Transformation frequency
CaMV35S Pr – <i>bar</i> – nos polyA	20% – 35%
Nos Pr – <i>bar</i> – nos polyA	2% – 4%
CaMV35S Pr – <i>NPTII</i> – nos polyA	46% – 49%
Nos Pr – <i>NPTII</i> – nos polyA	24% – 28%

In the absence of any other factors, which one of the following statements is **NOT** acceptable as a logical conclusion based on the above data?

- a. Use of stronger promoters for expression of selection marker genes can increase transformation frequencies.
- b. Variations in expression levels between the *NPTII* and *bar* genes is not influenced by the nos poly A signal.
- c. Production of herbicide resistant plants at high frequency can be achieved with lower expression levels of the transgene.
- d. Use of kanamycin as a selection marker appears to be more favorable for production of larger number of transgenic plants.



124. Callus-mediated regeneration is **NOT** preferred for micropropagation because:
- it takes longer time for regeneration.
  - plant regeneration is problematic due to poor organogenesis
  - it leads to generation of variants
  - hardening of plants is difficult to achieve.
125. In a transgenic plant, the phenomenon of Co-suppression is due to:
- transgene integration within the endogenous gene
  - transgene integration at a locus very close to the endogenous gene
  - similarity between the transgene and endogenous gene sequences
  - lack of similarity between the transgene and endogenous gene sequences
126. In inbred lines, gene and genotypic frequencies are maintained by growing them in isolation followed by:
- self-pollination
  - self-pollination and selection
  - pair-wise crossing
  - random mating without selection
127. Homozygous plants from bi-parental mating for development of mapping populations can be obtained in a short time by:
- development of RILs
  - development of doubled haploids
  - random mating in F<sub>2</sub> followed by selfing in subsequent generations
  - chromosome elimination technique
128. Which one of the following is **NOT** required for QTL analysis in association mapping?
- Phenotypic data from multi-location trials
  - Polymorphic markers
  - Genetic linkage map
  - Diverse germplasm lines
129. Which one of the following hormones promote production of seedless grapes?
- IAA
  - IBA
  - BAP
  - GA<sub>3</sub>



130. Which one of the following molecular markers is associated with bacterial blight resistance in rice?

- a. PiB
- b. Rar
- c. Xa21
- d. Pi9

131. Match the proteins in Group I with members in Group II

	Group I		Group II
1	Alkaline phosphatase	P	Extracellular
2	F <sub>o</sub> component of ATP synthase	Q	Cytoplasm
3	Alcohol dehydrogenase	R	Inner membrane
4	Pectinase	S	Periplasm

- a. 1-S; 2-R; 3-Q; 4-P
- b. 1-P; 2-R; 3-Q; 4-S
- c. 1-R; 2-S; 3-P; 4-Q
- d. 1-Q; 2-P; 3-S; 4-R

132. Application of the herbicide, phosphinothricin, results in death of plants due to accumulation of:

- a. CO<sub>2</sub>
- b. NH<sub>3</sub>
- c. CN
- d. Cl<sub>2</sub>

133. Which one of the following is **NOT** a feature of *Agrobacterium* VirE protein?

- a. Its synthesis is induced by VirG protein
- b. It contains a nuclear localization signal
- c. It protects T-DNA from being destroyed by plant defense mechanism
- d. It is a component of T-pilus

134. Transgenic potato plants with high amylose starch were developed by:

- a. suppression of starch branching enzymes
- b. over-expression of starch branching enzymes
- c. over-expression of ADP-glucose pyrophosphorylase
- d. suppression of granule-bound starch synthase

135. Developing cisgenic disease resistant apple is advantageous over conventional breeding because:
- genes cannot be transferred from sexually compatible species through pollination due to hybridization barriers.
  - there is no linkage drag.
  - apple is vegetatively propagated and produces sterile seeds.
  - cisgenes will not disrupt endogenous genes when introduced by *Agrobacterium* mediated transformation.
136. For development of selection marker-free transgenic plants by co-transformation using *Agrobacterium*, the marker genes are:
- segregated out in  $T_0$  generation
  - excised out in  $T_0$  generation
  - segregated out in  $T_1$  generation
  - excised out in  $T_1$  generation
137. Breakdown of Bt- mediated insect resistance in crops can be delayed by:
- Refugia strategy
  - Cultivation of different Bt cotton varieties with same Bt gene
  - Application of Bt Bio-pesticides
  - application of systemic insecticides
138. Which one of the following is matched **INCORRECTLY**?
- |                         |   |                       |
|-------------------------|---|-----------------------|
| a. Nanopore             | — | DNA sequencing        |
| b. beta-carotene        | — | golden rice           |
| c. <i>bar</i> gene      | — | resistance to viruses |
| d. Figwort Mosaic Virus | — | constitutive promoter |
139. Which one of the following would produce androgenic haploids in anther culture?
- Anther wall
  - Tapetal layer
  - Connective tissue
  - Young microspores
140. Male sterility in plants is induced by expression of the TA29-*barnase*-pA cassette in:
- Pollen mother cell
  - Stamen
  - Tapetum
  - Pollen grain

141. Anchorage dependent CHO cells are grown by aeration using micro carrier beads. The maximum detrimental effect of shear occurs due to agitation if the size (Kolmogorov scale) of eddies is:
- lesser than the size of the beads
  - equal to the size of beads
  - larger than the size of beads
  - independent of the size of beads
142. With progress in the growth of *E. coli* in a minimal medium (constant aeration and agitation), the dissolved oxygen (DO) initially declined and then started to increase. If the DO again starts to decrease on addition of glucose, then the most probable explanation is:
- growth is limited by glucose
  - growth is limited by oxygen
  - decrease in solubility of oxygen occurred due to glucose addition
  - decrease in the number of cells takes place due to cell lysis
143. An organism obeys Andrews model for growth inhibition with  $K_s$  and  $K_i$  values of 0.01 g/l and 1.0 g/l respectively. If the substrate is present at an initial concentration of 1.0g/l, the specific growth rate of the culture upon entering log phase would be approximately:
- $1/5^{\text{th}}$  of  $\mu_{\text{max}}$
  - $1/4^{\text{th}}$  of  $\mu_{\text{max}}$
  - $1/3^{\text{rd}}$  of  $\mu_{\text{max}}$
  - $1/2$  of  $\mu_{\text{max}}$
144. In a stirred tank reactor when the agitation rate is increased, the  $k_L$  and  $k_L a$  values will:
- increase and decrease respectively
  - decrease and increase respectively
  - both increase
  - both decrease
145. Which one of the following is correct regarding cell damage in an agitated and sparged mammalian cell bioreactor?
- High shear stress arising during mixing of the cell culture is the major cause of cell damage.
  - Shear stress arising from the breakup of bubbles at the liquid surface is a major cause of cell damage.
  - Shear stress between bubbles in the foam at the liquid surface is a major cause of cell damage
  - Using agitator blades of a radial flow type with mirror finish reduces shear and hence cell damage

146. Which one of the statements given below is **NOT** true? Equilibrium constant ( $K$ ) of a chemical reaction at a specific temperature can be determined if the:
- $\Delta G^0$  of the reaction is known
  - Equilibrium concentrations of reactants and products are known
  - $\Delta H$  and  $\Delta S$  of the reaction are known
  - $\Delta H$  and initial concentrations of the reactants and products are known
147. If a big centrifuge with the bowl diameter of 1m rotates at 60 rpm, at what speed (rpm) does a smaller centrifuge with a diameter of 0.5 m need to be operated for achieving the same separation factor?
- 85
  - 120
  - 30
  - 42
148. What is the linear flow rate (superficial velocity in cm/h) in a chromatographic column of 1.0 cm inner diameter with a bed porosity of 0.8 when the volumetric flow rate is 1 ml/min?
- 61.1
  - 76.4
  - 38.2
  - 15.2
149. For a cell growth process, the units for yield, productivity and titre are:
- $\text{gl}^{-1}$ ,  $\text{gl}^{-1}\text{h}^{-1}$  and  $\text{gl}^{-1}$
  - $\text{gg}^{-1}$ ,  $\text{gl}^{-1}\text{h}^{-1}$  and  $\text{g g}^{-1}\text{l}^{-1} \text{h}^{-1}$
  - $\text{gl}^{-1}$ ,  $\text{gl}^{-1}\text{h}^{-1}$  and  $\text{gg}^{-1}$
  - $\text{gg}^{-1}$ ,  $\text{gl}^{-1}\text{h}^{-1}$  and  $\text{gl}^{-1}$
150. In a fermentor the impeller diameter is increased from 0.5 m to 1 m and the rpm is increased from 100 rpm to 400 rpm. Reynolds number will increase by?
- 16 fold
  - 8 fold
  - 2 fold
  - 4 fold
151. *Zymomonas mobilis* is cultivated in a 60 l chemostat. The  $\mu_{\max}$  and  $K_s$  values are  $0.2 \text{ h}^{-1}$  and  $0.5 \text{ g l}^{-1}$  respectively. The flow rate ( $\text{l h}^{-1}$ ) required for a steady state substrate concentration of  $0.5 \text{ g l}^{-1}$  in the reactor is:
- 6
  - 9

- c. 4  
d. 12
152. Which one of the following statements is **WRONG** for conventional batch filtration of a mycelial fermentation broth?
- a. Blockage of the membrane pores by cell debris
  - b. The specific cake resistance remains constant
  - c. compressible cake deposition on the membrane
  - d. medium resistance remain constant
153. The reason for the choice of *E. coli* for the production of ethanol from lignocellulose is because it:
- a. grows efficiently in various hexoses and pentoses
  - b. can be grown to high cell density
  - c. can tolerate very high concentration of ethanol
  - d. is a GRAS organism
154. Two organisms A and B with the same  $\mu_{\max}$  and  $Y_{x/s}$  are cultivated independently in batch culture. They have  $K_s$  values of  $1 \text{ g.l}^{-1}$  and  $3 \text{ g.l}^{-1}$  respectively. Given that the initial substrate concentration was  $5 \text{ g/l}$ , which of the following is **TRUE** after complete exhaustion of the substrate?
- a. Organism A will have lower average specific growth rate than B.
  - b. Organism A will have higher average specific growth rate than B.
  - c. Both the organisms would have same average specific growth rate.
  - d. The final biomass achieved in B would be higher than in A.
155. *Pseudomonas* with the elemental composition of  $\text{CH}_3\text{O}_{0.5}\text{N}_{0.5}$  (MW = 30) is grown in a bioreactor to a final cell mass of  $30 \text{ g/l}$ . The minimum concentration (g/l) of ammonia ( $\text{NH}_3$ ) (MW = 17) (as the sole nitrogen source) required is:
- a. 17
  - b. 8.5
  - c. 14
  - d. 15
156. To reduce the level of deactivation of media components for culturing *Lactobacillus* spp., a high temperature and short time (HTST) regime is used for sterilization, PRIMARILY because:
- a. Deactivation energy of contaminants > Deactivation energy of medium components
  - b. Deactivation energy of contaminants < Deactivation energy of medium components
  - c. Deactivation energy of contaminants = Deactivation energy of medium components
  - d. the time required for sterilization is reduced

157. *Acetobacter aceti* converts alcohol to acetic acid according to the stoichiometric relation



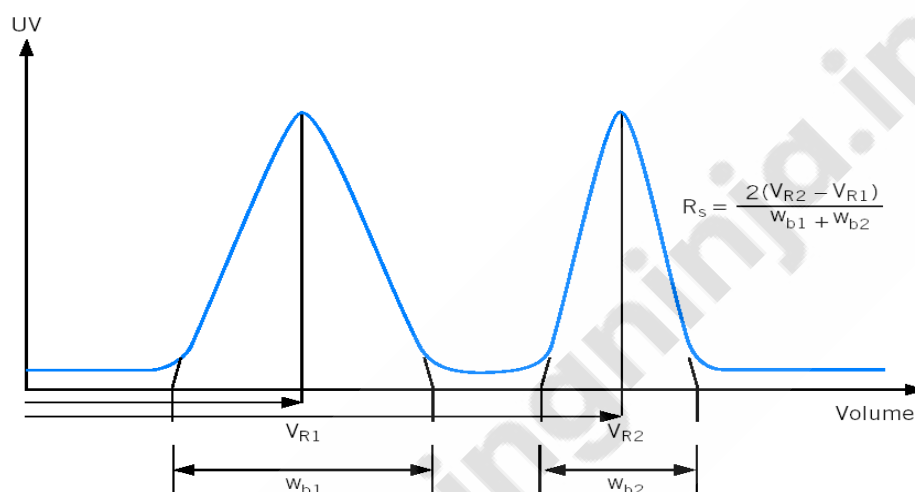
In a vigorously agitated and aerated reactor containing 20 g/l ethanol, the organism produces 16 g/l acetic acid and 2 g/l was the residual ethanol concentration. What are the theoretical and observed yields of acetic acid expressed in g/g ethanol?

- a. 60/46 and 16/18
  - b. 50/46 and 18/16
  - c. 46/60 and 18/16
  - d. 26/60 and 16/18
158. A continuous stirred tank bioreactor produces 48 kg lysine.day<sup>-1</sup>. If the volumetric productivity is 2 g.l<sup>-1</sup>.h<sup>-1</sup>, the volume of the reactor is:
- a. 1 m<sup>3</sup>
  - b. 1.5 m<sup>3</sup>
  - c. 0.1 m<sup>3</sup>
  - d. 2 m<sup>3</sup>
159. Aqueous Two Phase System (ATPS) is used to isolate a protease from a fermentation broth. The partition coefficient (K) is 2.5. For 80 % recovery of protease in a single step, the volume ratios of upper and the lower phases should be:
- i. 1.6:1
  - ii. 3.2:1
  - iii. 2.4:1
  - iv. 1.2:1
160. To have an overall yield of greater than 50% in a three step purification process for a food additive, the minimum average step yield(%) necessary would be around:
- a. 95
  - b. 80
  - c. 50
  - d. 20
161. In a fed batch process for the production of an antibiotic, the dissolved oxygen (DO) level was found to be falling below 30%. If the DO level of 30% is to be maintained in the reactor (without altering the composition of oxygen-air mixture, aeration rate and agitation) then we need to:
- a. increase the feed rate
  - b. decrease the feed rate
  - c. increase the concentration of feed
  - d. decrease the volume of the broth by partial withdrawal

162. In a batch sterilization process if  $\nabla_{\text{overall}}$ ,  $\nabla_{\text{heating}}$  &  $\nabla_{\text{cooling}}$  are 32.2, 9.8 & 10.1 respectively, THEN the holding time at 121°C of the process is (given that the specific death rate ( $k$ ) of microorganisms at 121°C is  $2.54 \text{ min}^{-1}$ ):

- a. 4.84 min
- b. 6.75 min
- c. 2.96 min
- d. 9.25 min

163. To achieve complete separation of two pharmaceutical compounds (shown as two peaks in the chromatogram), the relative separation ( $R_s$ ) should be:



- a.  $< 1$
- b.  $\geq 1.5$
- c.  $< 0.5$
- d.  $= 0.8$

164. The anticancer drug, Halichondrin – D is isolated from:

- a. Corals
- b. Gorgonians
- c. Sponges
- d. Sea anemone

165. Heparin is a:

- a. Glycosylated lipid
- b. Glycoprotein
- c. Lipopolysaccharide
- d. Sulphated polysaccharide

166. The only naturally transformable marine cyanobacteria is:

- a. *Agmenellum* sp.
- b. *Spirulina* sp.
- c. *Oscillatoria* sp.
- d. *Nostoc* sp.

167. Marine chemosynthesis is mainly based on:

- a. Oxygen
- b. Carbon dioxide
- c. Sulphate
- d. Manganese nodules

168. Which one is a DNA replication blocking agent produced by sponges?

- a. Clathesine
- b. Spongoides
- c. Spongin
- d. Sclerol

169. Eutrophication in aquatic ecosystems is due to reduction of:

- a. Carbon
- b. Oxygen
- c. Sulphur
- d. Hydrogen

170. Halotolerant and halophilic microbes can be isolated from ----- and -----, respectively.

P. Sea      Q. River      R. Lake      S. Estuary

- a. S and P
- b. P and S
- c. Q and P
- d. R and S

171. Heavy metal pollutants like Cd and Hg inactivate enzymes by interacting with:

- a. cysteine
- b. glutamic acid
- c. lysine
- d. histidine



172. Which of the following class of enzymes initiates aerobic degradation of aromatic pollutants (like naphthalene) in bacteria?
- a. Oxido-reductases
  - b. Hydrolases
  - c. Ligases
  - d. Lyases
173. Which one of the following organisms is **NOT** able to perform light harvesting reaction?
- a. *Azospirillum*
  - b. *Chlamydomonas*
  - c. *Rhodopseudomonas*
  - d. *Halobacterium*

174. In the soil environment, which one of the following factors is responsible for the biotic stress on the microbial community?
- a. Nutrients
  - b. Oxidation-reduction potential
  - c. Moisture
  - d. Microflora
175. Match the enzymes in Group I with their appropriate role in the environment from Group II

	Group I		Group II
1	Laccase	P	Xenobiotic detoxification
2	Catalase	Q	Nitrogen fixation
3	Nitrogenase	R	Lignin degradation
4	Cytochrome p450	S	Neutralization of toxic O <sub>2</sub> species

- a. 1-R; 2-S; 3-Q; 4-P
  - b. 1-P; 2-R; 3-Q; 4-S
  - c. 1-S; 2-P; 3-R; 4-Q
  - d. 1-R; 2-Q; 3-S; 4-P
176. Which one of the following types of mutation would usually **NOT** be detected in a molecular diagnostic test that is based on sequencing each exon of a gene individually from a male suspected of having an X-linked disorder?
- a. Missense mutation
  - b. Nonsense mutation
  - c. Deletion of an exon
  - d. Inversion of a part of the gene

177. A couple came for counselling following three first-trimester miscarriages and underwent chromosomal analysis. The man was found to have pericentric inversion with the karyotype 46,XY,inv8(p12q22). Which one of the following would be a correct conclusion?
- This is a normal variant, likely of no significance
  - This is an abnormal chromosome that would cause congenital anomalies if transmitted to a child.
  - This rearrangement might lead to chromosomal imbalance in an offspring and could explain multiple miscarriages.
  - This rearrangement might cause dicentric or acentric chromosomes in an offspring, which would probably not be compatible with survival.
178. Unequal crossing over between two *Alu* repeats can lead to an LDL receptor gene with an internal deletion or duplication. Based on this information, which of the following must be true?
- The LDL receptor gene contains one and only one *Alu* repeat sequence.
  - The LDL receptor gene does not contain *Alu* repeat sequences.
  - The genome contains only one copy of the *Alu* repeat sequence.
  - The LDL receptor gene contains at least two *Alu* repeat sequences
179. Linkage analysis is performed in a large family with an autosomal dominant hemolytic anemia, using a polymorphic marker within the  $\beta$ -globin locus. The LOD score at  $q=0$  is negative infinity. The LOD score at  $q=0.01$  is  $-4.5$ . You conclude that the disorder in this family is:
- not due to a  $\beta$ -globin gene mutation
  - due to a  $\beta$ -globin gene mutation
  - an acquired disorder, due to a somatic gene mutation
  - due to a mutation in a gene on chromosome 11, 10 cM centromeric of  $\beta$ -globin
180. In Li-Fraumeni syndrome most frequent mutation occurs in:
- p53
  - RB
  - BRCA1
  - PTEN
181. Which one of the following promoters is most efficient for transgene expression in mammary gland of livestock?
- Beta-casein
  - Prolactin
  - Uromodulin
  - Immunoglobulin

182. Epinephrine is used along with local anaesthetic because of its:

- a.  $\alpha$ -adrenergic receptor agonist properties
- b.  $\beta_2$  adrenergic receptor agonist properties
- c.  $\beta_1$  adrenergic receptor agonist properties
- d. nicotinic receptor agonist properties

183. Founder effects and bottlenecks are:

- a. expected only in large populations
- b. mechanisms that increase genetic variation in a population
- c. two different modes of natural selection
- d. forms of genetic drift

184. In commercial farms, embryos are routinely recovered by non-surgical methods. On which day are the embryos recovered from the donor cow after the onset of estrus?

- a. 21
- b. 7
- c. 14
- d. 5

185. Human mesenchymal stem cells:

- a. Can differentiate into only one type of cell
- b. Can differentiate into few types of cells
- c. Can differentiate into all types of cells
- d. Do not differentiate at all

186. Vectors are important in transmission of diseases. Match group 1 with group 2.

	Group 1		Group 2
1	Louse	A	West Nile Fever
2	Tick	B	Scrub Typhus
3	Mite	C	Lyme disease
4	Mosquito	D	Epidemic Typhus

- a. 1-D; 2-C; 3-B; 4-A
- b. 1-A, 2-B; 3-C; 4-D
- c. 1-B; 2-C; 3-D; 4-A
- d. 1-C, 2-D; 3-A; 4-B

187. Which one of the following is an inhibitory neurotransmitter?

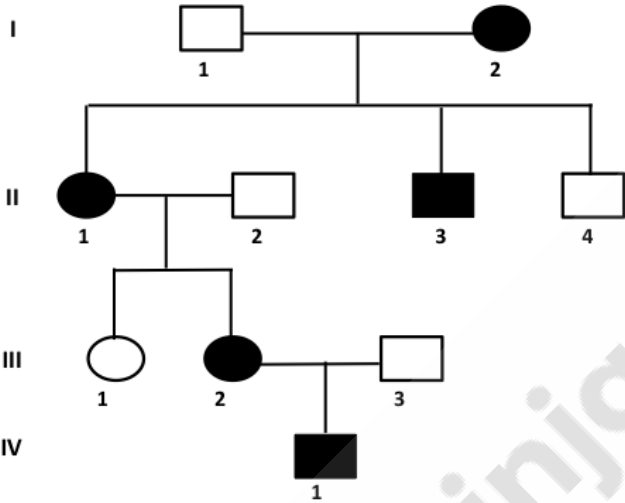
- a. GABA
- b. Glutamate
- c. Acetylcholine
- d. Dopamine

188. Huntington's disease is clinically characterized by chorea (abnormal involuntary movements). Which part of the brain is responsible for this phenotype?
- Basal Ganglia
  - Cerebellum
  - Hippocampus
  - Brain stem
189.  $\alpha$ -Amanitin is a fungal toxin which inhibits eukaryotic RNA polymerases. The three eukaryotic RNA polymerases show differential sensitivity to this toxin. Which one of the following order (higher to lower) is correct with respect to sensitivity towards  $\alpha$ -amanitin?
- RNA POL III > RNA POL II > RNA POL I
  - RNA POL II > RNA POL III > RNA POL I
  - RNA POL I > RNA POL III > RNA POL II
  - RNA POL II > RNA POL I > RNA POL III
190. A primary cell culture can be transformed into a cell line by all EXCEPT:
- Simian Virus 40
  - Hepatitis B virus
  - Human Papillomavirus
  - Epstein-Barr Virus
191. In a randomly breeding population, an autosomal recessive condition affects 1 newborn in 10,000. The expected frequency of carriers will be nearly:
- 1 in 25
  - 1 in 50
  - 1 in 100
  - 1 in 1,000
192. Assessment of the extent of DNA double strand breaks in cultured human cells, following exposure to ionizing radiation, can be done by quantitation of :
- acetylated histones H3 and H4
  - methylated histones H3 and H4
  - ubiquitinated histone H2A.X
  - phosphorylated histone H2A.X
193. There are reports of more than 100 mutations at different sites of Factor IX that manifests Haemophilia B. This is an example of:
- clinical heterogeneity
  - allelic heterogeneity
  - protein heterogeneity
  - locus heterogeneity

194. Specificity factor which activates ubiquitin ligase activity of APC/C during separation of sister chromatids is:
- a. CDC10
  - b. CDC20
  - c. CDH1
  - d. CDC45A
195. In a diploid organism, loss of function mutations produce dominant phenotypes when there is:
- a. pleiotropy
  - b. epistasis
  - c. multiple allelism
  - d. haploinsufficiency
196. In Mendel's dihybrid cross experiment, if the two selected traits were on the same chromosome (linked) and assuming that there is no recombination, what would be the expected genotypic ratio in the  $F_2$  generation?
- a. 1:2:1
  - b. 9:3:3:1
  - c. 1:3
  - d. 1:1
197. Huntington disease is caused by:
- a. Expanded dinucleotide repeats sequence in coding region
  - b. Expanded trinucleotide repeats in non-coding region
  - c. Expanded trinucleotide sequence in coding sequence
  - d. Expanded dinucleotide sequence in non-coding sequence



198. The following pedigree shows the inheritance of a very rare human disease. What is the most likely mode of inheritance for the disease trait and what is the probability that the second child of III-2 and III-3 will be a son and will also have the disease?

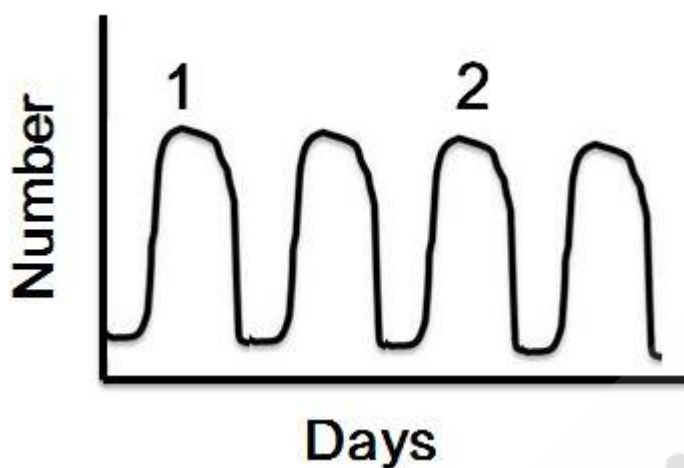


- a. Sex-linked recessive; 0.5
- b. Autosomal recessive; 0.25
- c. Autosomal dominant; 0.75
- d. Autosomal dominant; 0.25

199. Microscopic evaluation of a post-mortem brain exhibits hyperchromatic areas when stained with glial fibrillary acidic protein (GFAP). This suggests activation of:

- a. astrocytes
- b. oligodendrocytes
- c. Microglia
- d. neurons

200. Parasite numbers in the blood of a patient with *Trypanosoma brucei* (Sleeping sickness) shows the following pattern:



Parasites isolated from population 1 and 2 were found to be antigenecially non-cross reactive. The parasite distribution seen may be due to:

- a. Change in gene expression
- b. Loss of antigenic epitopes
- c. Post-translational modification of antigen
- d. Antigenic switching

