W-10

**Booklet Code : A**

# Entrance Examinations – 2020
## M.Sc. Biochemistry

Hall Ticket No. [ ]

**Time : 2 hours** **Max. Marks : 100**

Please read the following instructions carefully before answering:

1. Enter Hall Ticket number in the space provided above and also on OMR sheet.
2. Paper contains three sections: Part A, Part B and Part C together with 85 questions for 100 marks. **Part A contains 25 questions, each question carries one mark. Part B contains 45 questions, each question carries one mark. Part C contains 15 questions, each question carries two marks.**
3. **Part A will be used for tie breaking.**
4. **In Part A there is negative marking. 0.33 marks will be deducted for each wrong answer. In Part B there is no negative marking. In Part C there is negative marking. 0.66 marks will be deducted for each wrong answer.**
5. Answers have to be marked on the OMR sheet as per the instructions provided.
6. Apart from OMR sheet, the question paper contains 14 (fourteen) pages including the instructions.
7. **Please return the OMR answer sheet at the end of examination.**
8. No additional sheet will be provided.
9. Rough work can be carried out in the question paper itself in the space provided at the end of the booklet.
10. Non-programmable calculators are allowed.

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## Part A
**[Each Question has only one right answer. Mark the right answer]**

1. PolydT (deoxythymidilic acid) is
   A. multiple thymine bases
   B. a thymidine nucleotide
   C. a thymidine nucleoside
   D. a nucleic acid

2. Cytosine on deamination produces
   A. Uracil B. Hypoxanthine C. Xanthine D. Thymine

3. During photorespiration, the reactive oxygen species, $H_2O_2$ is produced in
   A. glyoxysome B. peroxisome C. lysosome D. dictyosome

4. The precursor for the biosynthesis of heme is
   A. Glutamic acid B. Pyruvic acid C. Glycine D. Aspartic acid

5. Which of the following statements is correct?
   A. Trehalose is a disaccharide that contains two glucose units
   B. Isomaltose has two glucose residues linked in alpha 1—4 linkage
   C. Lactose consists of two galactose units
   D. Raffinose is an example of a disaccharide

6. In a heterozygous diploid organism carrying two alleles for a trait, both the traits are expressed. This is an example of
   A. multigenic trait B. co-dominance C. incomplete dominance D. polygenic trait

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7. The blood group of a universal blood acceptor is
A. O Rh positive B. O Rh negative C. AB Rh positive D. AB Rh negative

8. All of the following structures are made up of tubulin except
A. cilia B. flagella C. spindle fibre D. lamellopodia

9. Which of the following DNA polymerase is used during Base Excision Repair (BER) in human cells?
A. Pol α B. Pol β C. Pol γ D. Pol δ

10. Which of the following might be the units for specific activity of an enzyme?
A. $\mu mol\ min^{-1}$ B. $\mu mol\ min^{-1}\ mg^{-1}$ C. $sec^{-1}$ D. $\mu g\ ml^{-1}$

11. Which of the following life history strategies is NOT a characteristic of a strictly r-strategist species (species whose life histories are geared to achieve the maximum possible rate of population increase)?
A. Generally, rapid embryonic development, rapid maturation to reproductive age, small body size
B. Long life span, density-dependent mortality, typically a Type 2 survivorship curve
C. Short life span, density-independent mortality, typically a Type 3 survivorship curve
D. Shows semelparity

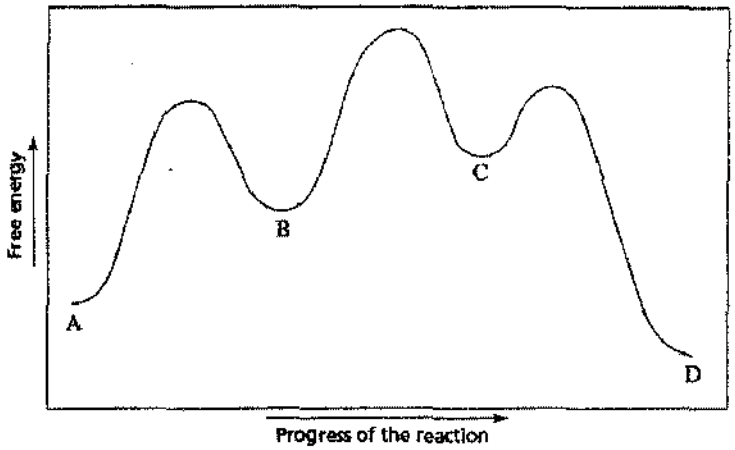
12. A proglottid is a
A. segment before glottis in human which is the part of the larynx consisting of the vocal cords and the opening between them
B. tubular segment of worms of the phylum Annelida
C. pseudo-skeletal structure in protochordate
D. segment of a tapeworm, containing a complete sexually mature reproductive system

13. Long filamentous threads protruding at the end of the young cob of maize are
A. hairs B. anthers C. styles D. ovaries

14. Deficiency of which of the cofactors adversely affects the synthesis of purines and pyrimidines?
A. Folate B. Glutathione C. Cytidine diphosphate D. Glutamate

15. The sedimentation velocity of a protein in a centrifuge **DOES NOT** depend on
A. density of the protein. B. charge on the protein.
C. mass of the protein D. shape of the protein.

16. For the reaction where substrate A is converted into product D, the reaction coordinate diagram is given below.



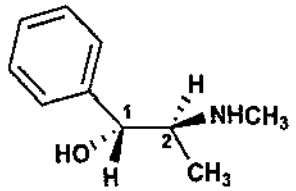

The number of intermediates, transitions states and the reactant of the rate-determining step are ___, ____, and ____ respectively. Choose the correct combination from the options given below.

A. 2, 3, B B. 3, 2, B C. 2, 3, C D. 3, 2, A

17. The number of signals expected in the $^1$H NMR spectra of the two compounds (i) Br-$CH_2$-$CH_2$-Br, and (ii) $CH_3$-$CH_2$-CH(Cl)-$CH_2$-$CH_3$ are ___ and ___ respectively.

A. 1 and 2 B. 1 and 3 C. 2 and 2 D. 2 and 3

18. The pharmacologically active stereoisomer of ephedrine that is used to treat asthma is given below.




What is the absolute configuration of the two chiral centers present in it?

A. 1*R*, 2*R* B. 1*R*, 2*S* C. 1*S*, 2*R* D. 1*S*, 2*S*

19. Which of the following is a unit of catalytic efficiency of an enzyme?

A. $min^{-1}$ B. $M^{-1}$ C. $min^{-1}$ $M^{-1}$ D. $s^{-1}$ mM

20. Aerobic oxidation of glucose or fructose releases 32 ATP molecules. How many ATPs are generated upon complete breakdown of sucrose when metabolized by sucrose synthase?

A. 64 B. 32 C. 65 D. 72

21. A sodium and potassium pump is a type of

A. symport B. uniport C. antiport D. passive transport

22. Which one of the following liver enzymes, absent from other tissues, gives the liver an advantage over other cells in taking up glucose after a meal?

A. Aldolase B. Hexokinase C. Glucose-6-phosphatase D. Glucokinase

23. If $Fe^{3+}$ is to be reduced to metallic iron under conditions of constant current electrolysis, what will be the total charge (in coulombs) required to reduce 2 moles of $Fe^{3+}$?
Faraday constant is 96,500 coulombs/mol

A. 3 B. 96,500 C. 579,000 D. 289,500

24. Given below are names of infectious disease-causing pathogen and vectors that are linked to their spread. Select the option that represents the correct combination of infectious disease-causing organisms and their vectors.

| Pathogen | | Vector | |
|---|---|---|---|
| 1 | *Yersinia pestis* | a | *Anopheles gambiae* |
| 2 | *Leishmania donovani* | b | *Phlebotomus argentipes* |
| 3 | *Borrelia burgdorferi* | c | *Aedes aegypti* |
| 4 | Dengue virus (DENV) | d | Blacklegged ticks |
| | | e | Flea |

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

25. Which of the following statements are TRUE for sponges?
A. Sponges are diploblastic animals.
B. Sponges have specialized organs for digestion.
C. Gemmules are internal buds found in sponges and are involved in asexual reproduction.
D. Internal skeleton of sponges is made up of calcium phosphate.

**Part B**

**[These questions may have more than one right answer. Mark all the correct answers. For eg. If there are three right answers for a particular question, all three options must be marked otherwise it will be considered incorrect]**

26. Higher amount of polyribosome fraction in the total ribosome of a given cell might suggest that
A. rate of protein synthesis is high.
B. there is a block in protein synthesis.
C. the initiation of protein synthesis is high.
D. the rate of elongation in protein synthesis is decreased.

27. A bacterial operonic mRNA
A. codes for a single polypeptide.
B. has multiple stop codons.
C. has a poly-A tail at the 3' end.
D. has 5' phosphate.

28. Based on function, a gene can code for
A. repressor
B. transfer RNA
C. ribosomal RNA
D. operator

29. Which of the following conditions promote maximal expression of lac operon?
A. High cAMP, no glucose and no lactose
B. With glucose and high cAMP and without lactose
C. In the presence of glucose, low cAMP and lactose
D. High cAMP and lactose without glucose

30. Which of the following exist as isoenzymes in humans?
A. Hydratase
B. Lactate dehydrogenase
C. Pyruvate Kinase
D. Threonine deaminase

31. Which of the following have more than one chiral center?

A. Isoleucine B. Isocitric acid C. Valine D. Leucine

32. Which of the following biochemical reactions catalyzed by the enzymes are reversible?
A. Threonine deaminase B. Lactate Dehydrogenase
C. Transaminase D. Pyruvate dehydrogenase complex

33. Glutamine serves as an amide group donor in the formation of
A. Glucosamine 6-phosphate B. Histidine
C. Isoleucine D. Uronic acid

34. Urea cycle enzymes
A. are found in the mitochondria and cytosol.
B. facilitate removal of toxic excess ammonia from the blood.
C. occurs in invertebrates.
D. are also found in some plants.

35.Which of the following statements about digestion and absorption of dietary lipids in humans are correct?
A. Digestion by lingual lipase, gastric lipase and pancreatic lipase
B. Channelled through lacteal system as chylomicrons
C. Absorbed by active transport
D. Absorbed by complexing with a tripeptide

36. Which of the following traits show polygenic inheritance?
A. Human skin colour B. Sickle -cell anemia
C. Phenylketonuria D. Human height

37. Which of the following enzymes can catalyse the formation of phosphodiester bonds?
A. DNA Pol I B. RNA Pol II C. DNA Topoisomerase II D. DNA Ligase I

38. Which of the following genes code for enzymes that have RNA dependent DNA polymerase activity?
A. *POL* gene of HIV B. *POL* gene of copia retroelement
C.*POL G* gene of human D. *hTERT* gene of human

39. During lagging strand synthesis, to join together two precursor fragments, several enzymatic activities happen in a sequential manner. From the following, pick the relevant activities that are required once the two Okazaki fragments are already synthesized.
A. 5'-3' polymerase activity of DNA Pol III
B. 5'-3' polymerase activity of DNA Pol I
C. Ligase activity
D. 5'-3' exonuclease activity of DNA pol I

40. The B-form of DNA
A. is the most common form.
B. is a left-handed helix.
C. is stabilized by hydrogen bonds between successive residues.
D. has grooves that allow molecules interacting with DNA to recognize base sequences.

41. Catabolic repression, a mechanism of gene control in prokaryotes,
A. is mediated through cAMP.
B. Is mediated through CAP.

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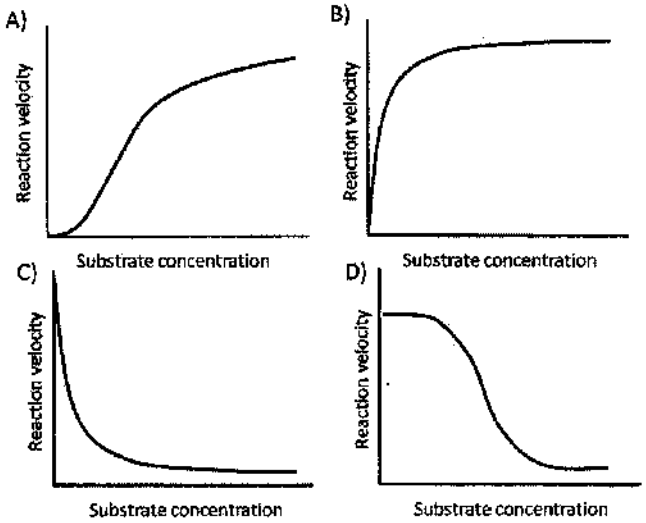
C. Results in *de novo* synthesis of positive activator protein.
D. Affects enzymes involved in catabolic reactions.

42. Lysogenic state of Lambda Phage is favoured when
A. nutrients are limited
B. low levels of cIII
C. expression of an antiterminator Q protein
D. high cAMP levels are found in host cells

43. Assuming that the IgG and IgE isotypes of antibodies were raised against the same antigenic epitope, which of the following may differ between the two isotypes of antibodies?
A. The constant regions of heavy chains
B. The constant regions of light chains
C. Only the variable regions of both light and heavy chains
D. The J-chain that connect two monomers of these immunoglobulins

44. Which of the following kinetics plots suggest cooperativity and possible allosterically regulated enzyme?




45. Cell elongation in internodal regions of the green plants takes place due to
A. cytokinins B. ethylene C. gibberellins D. diterpenoid acids

46. Which elements helps in the transport of electrons from water in photosynthesis?
A. Mn B. Cl C. Na D. K

47. The substrate(s) for the enzyme primase is/ are:
A. DNA B. RNA primer C. dNTPs D. NTPs

48. Assimilatory powers produced during photosynthesis are
A. water and oxygen B. ATP C. $NADPH_2$ D. RuDP

49. In UV absorption spectroscopy, which of the following statements are true?
A. $\sigma \rightarrow \sigma^*$ transitions are lower in energy than $\pi \rightarrow \pi^*$ transitions
B. A conjugated systems of double bonds in a molecule shifts the absorption maxima to higher wavelengths
C. $\sigma \rightarrow \sigma^*$ transitions are higher in energy than $\pi \rightarrow \pi^*$ transitions

D. The longer the wavelength the lower is the energy.

50 When a thermodynamic equilibrium state at a given temperature and pressure is reached,

A. the Gibbs free energy of the state at equilibrium is always higher than that of any other state at the same T and P.
B. the enthalpy of the state at equilibrium is always lower than that of any other state at the same T and P.
C. the Gibbs free energy of the state at equilibrium is always lower than that of any other state at the same T and P.
D. the enthalpy of the state at equilibrium may be higher than that of any other state at the same T and P.

51. Which one of the following is equal to the pKa of a weak acid?
A. The pH of at which weak acid is half dissociated
B. The pKb of its conjugate base
C. The pH of a solution containing equal amounts of the acid and its conjugate base
D. The equilibrium concentration of its conjugate base

52. What is the pressure exerted by 0.1 mol of an ideal gas in a 2 litre chamber at 25°C?
A. 246 MPa B. 123.8 MPa C. 61.9 MPa D. 1.23 $X10^5$ MPa

53. What characteristic is shared by D-gulose and D-glucose?
A. They both are non-reducing sugars
B. Both are pyranose
C. The pyranose forms are mirror images to each other
D. They both have two anomeric forms

54. Which of the following forms of anions are possible with boron?
A. $BH_4^-$ B. $B(OH)_4^-$ C. $BO_2^-$ D. $BF_6^{3-}$

55. Which of the following gas(es) is/are used for artificial fruit ripening?
A. Ethyne B. Ethylene C. Ethane D. Ethylene diamine

56. Which of the following statements are true regarding microtubules?
A. Globular proteins are involved in microtubule lattice formation.
B. Microtubules display polarity. The plus-end of the microtubule is terminated by a row of beta-tubulin subunits and the opposite, minus-end of the microtubule is terminated by a row of alpha-tubulin subunits.
C. Microtubule polymerization involves ATP hydrolysis.
D. Nocodazole inhibits cell division as it inhibits microtubule growth.

57. Which of the following statements are true for enzymes and catalysts?
A. Both affect the rate of reaction
B. Both decrease the activation energy
C. Both increase the rate of reaction at similar scale
D. They both are specific in nature

58. Which of the following evidences suggest that mammalian mitochondria originated from an endosymbiotic proteobacteria?
A. Circular DNA B. Presence of a double membrane
C. 60S ribosomes D. Similar genome size

59. Which of the following cell junctions are involved in anchoring the extracellular matrix to the cell?
(i) Gap junctions
(ii) Focal Adhesions
(iii) Desmosomes
(iv) Hemidesmosomes
A. i, ii & iii B. ii & iv C. iii & iv D. iv only

60. Identify the correct statements about glycogen synthase and glycogen phosphorylase.
(i) Both the enzymes are active upon phosphorylation.
(ii) Active form of glycogen synthase is dephosphorylated.
(iii) Phosphorylated form of glycogen phosphorylase is active.
(iv) Both the enzymes are inactive upon phosphorylation
A. i & iii B. ii & iv C. ii & iii D. iv only

61. Identify the cellular localization of these two enzymes: Ornithine transcarbamoylase (OTC) and argininosuccinate lyase (ASL):
(i) OTC-Cytosol
(ii) OTC and ASL-Cytosol
(iii) OTC-Mitochondria & ASL-Cytosol
(iv) ASL-Mitochondria
A. i & ii B. iii C. ii D. i & iv

62. Identify the correct sequence of reactions found in the citric acid cycle?
(i) pyruvate → citrate → oxaloacetate
(ii) citrate → alpha-ketoglutarate → isocitrate
(iii citrate → aconitate → isocitrate
(iv) succinate → fumarate → malate
A. ii, iii & iv B. ii & iii C. iii & iv D. i & iv

63. A salt was dissolved in water and the pH of the resultant solution was found to be ~10. Based on this, which of the following statement(s) is/ are correct?
A. It was a salt of a strong acid and a strong base
B. It was salt of a strong acid and a weak base
C. It was a salt of the weak acid and a strong base
D. It was salt of a weak acid and a weak base

64. When toluene is treated with a mixture of concentrated nitric acid and sulphuric acid, which of the following products can result from the reaction?
A. 3-nitro toluene B. 4-nitro toluene
C .2-nitro methylbenzene D. 2,4 dinitro methylbenzene

65. In the Haber process, nitrogen (from air) and hydrogen combine to form Ammonia. Which of the following would give more ammonia (a useful product) and why?
A. Increasing the pressure because increasing pressure shifts the equilibria towards product for all reactions involving gases
B. Suddenly decreasing the pressure to shift the equilibria towards more product.
C. Increasing pressure to shift the equilibria towards more product
D. Periodically cooling the reaction mixture to liquefy part of the mix and recycling residual gases

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66. Which of the following are correct?
A. Two molecules that are enantiomers of each other may not always be chiral
B. Two molecules that are diastereomers of each other would always be chiral
C. Enantiomers would have minimum of two chiral centers each
D. Diastereomers would have minimum of two chiral centers each

67. Anthracene is fluorescent. The emission maxima for anthracene would be
A. same as the emission maxima for naphthalene
B. of shorter wavelength compared to its absorption maxima
C. of longer wavelength compared to its absorption maxima
D. of shorter wavenumber compared to its absorption maxima

68. Which of the following is/are the measures of dispersion?
A. Range B. Mean C. Mean deviation D. Quartile deviation

69. Which of the following denotes the active form of the enzyme?
A. Dephosphorylated Adenylate Kinase B. Dephosphorylated Glycogen Synthase
C. Phosphorylated Glycogen Synthase D. Phosphorylated Adenylate Kinase

70. Which of the following provide atoms to form histidine
A. Phosphoribosylpyrophosphate B. Glutamine
C. Phosphoenolpyruvate D. ATP

**Part C**
**[Each Question has only one right answer. Mark the right answer]**

71. You want to clone a gene in a plasmid. The gene is flanked by Bam HI on one side and Kpn I on the other side. The plasmid has a unique Eco RV site. You have noticed that digestion with Bam HI and Kpn I produce a 5' overhang and a 3' overhang, respectively. Eco RV is a blunt end cutter. Your advisor suggested you to convert the overhangs to blunt ends either by fill-in or by resection and then clone the insert with newly generated blunt ends into the plasmid that has been digested with Eco RV. Which one of the following would be the most appropriate order of this multi-step cloning process?
A. i) Digest the insert with Kpn I and Bam HI; ii) fill-in the overhangs with Klenow DNA Pol and dNTPs; iii) ligate it with the Eco RV digested plasmid.
B. i) Digest the insert with Bam HI; ii) resect the overhang with Klenow DNA Pol; iii) digest with Kpn I; iv) fill-in the overhang with Klenow DNA Pol and dNTPs; v) ligate it with the Eco RV digested plasmid.
C. i) Digest the insert with Kpn I; ii) resect the overhang with Klenow DNA Pol; iii) digest with Bma HI; iv) fill-in the overhang with Klenow DNA Pol and dNTPs; v) ligate it with the Eco RV digested plasmid.
D. i) Digest the insert with Bam HI; ii) fill-in the overhang with Klenow DNA Pol and dNTPs; iii) digest with Kpn I; iv) resect the overhang with Klenow DNA Pol; v) ligate it with the Eco RV digested plasmid.

72. What would be the expression level of beta-galactosidase in the presence and absence of lactose in a *E. coli* bacterial strain harbouring partial diploid of lac operon as shown here: $O^cI^+Z^+$ and $O^+I^-$ and $Z^+$?
A. Without Inducer: minimum; with inducer: maximum
B. Without inducer: maximum, with inducer: maximum
C. Without inducer: half maximum; with inducer: maximum

D. Without inducer: maximum: with inducer: half maximum

73. In a test cross, the phenotypic ratio of the two traits was found to be 1:1:1:1. Which of the following statements about this cross is INCORRECT?
A. The self-cross of the F1 from homozygous parents is likely to produce 9:3:3:1
B. The genotype ratio is 1:1:1:1
C. The two traits are segregating independently
D. The two traits are linked

74. Given below are the kinetic parameters of an enzyme, without and with two inhibitors X and Y.

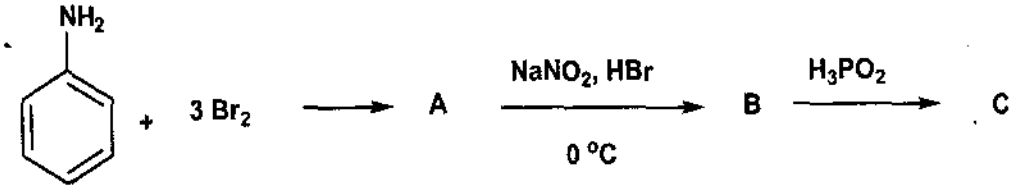
| Without Inhibitor | With inhibitor X | With inhibitor Y |
|---|---|---|
| Km = 3 mM | Km = 2.75 mM | Km = 3 mM |
| Vmax = 30 μmol $ml^{-1}s^{-1}$ | Vmax = 22.5μmol $ml^{-1}s^{-1}$ | Vmax = 24.6 μmol $ml^{-1}s^{-1}$ |

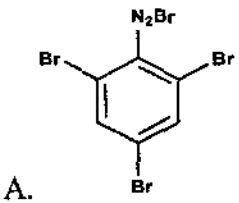
Which of the following statements is correct with respect to inhibitors A and B used for this enzyme?
A. X is competitive inhibitor while Y is non-competitive inhibitor
B. X is uncompetitive inhibitor while Y is non-competitive inhibitor
C. X is non-competitive inhibitor while Y is uncompetitive inhibitor
D. X is non-competitive inhibitor while Y is competitive inhibitor

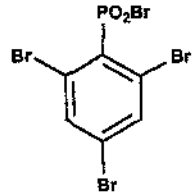
75. One mole of an ideal gas in a piston changes its volume from 2 to 4 litre at 25°C. What will be change in the internal energy?
A. 50 J B. 0 J C. 25 J D. 75 J

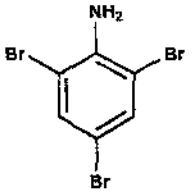
76. The $pK_1$ (-COOH), and $pK_2$ ($-NH_3^+$) of aspartic acid are 1.88, and 9.6 respectively. Its side chain pKa is 3.65. Calculate the pH where Asp will not move in an electric field?
A. 2.77 B. 5.74 C. 6.0 D. 6.6

77. Write the structure of C in the following reaction..




A.



B.



C.


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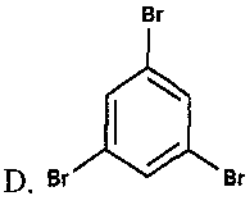


D.

78. Match the items in two columns and choose the correct answer from the following options:

| | |
|---|---|
| I) Endoplasmic Reticulum | i) Lipid oxidation |
| II) Mitochondria | ii) Glycosylation |
| III) Vacuole | iii) Na/K pump |
| IV) Plasma membrane | iv) Hydrolytic enzymes |
| V) Peroxisomes | |

A. I, ii; II, iv; III, i; IV, iii; V, ii
B. I, iii; II, i; III, iv; IV, iii; V, ii
C. I, ii; II, i; III, iv; IV, ii, V, i
D. I, ii; II, i: III, iv; IV, iii; V, i

79. Find mean deviation from the mean for the following given data:
6, 7, 10, 12, 13, 4, 8, 20

A. 3.75 B. 2.35 C. 4.75 D. 5.35

80. Which of the following statements are TRUE for endoplasmic reticulum?
(a) Smooth endoplasmic reticulum is involved in lipid synthesis.
(b) It controls secretory protein synthesis.
(c) It regulates protein glycosylation.
(d) It is a control center of protein phosphorylation.

A. b and d B. a, b and c
C. b, c and d D. a and d only

81. Ten microliters of a protein solution is diluted into 990μL of a buffer solution, then 50 μL of this diluted sample is added to 450μL of buffer. The absorbance of this solution is determined to be 0.1 in a 1 cm cuvette. If the extinction coefficient of the protein is 1.0 $(mg/ml)^{-1}cm^{-1}$, what was the starting concentration of the protein solution?

A. 100 mg/ml B. 10 mg/ml C. 1mg/ml D. 0.1 mg/ml

82. When the mixture of Protein M (mol. wt. 20 kDa) and another protein X (15 kDa) is run on a native gel, there is a retardation of mobility of protein M during gel electrophoresis, as compared to pure protein M. Based on this result, which of the following are likely to be correct?

A. Protein M has no interaction with protein X
B. Protein X degrades protein M
C. Dye labeled protein M will definitely show a fluorescence resonance energy transfer (FRET) signal with dye labeled protein X
D. Dye labeled protein X may show increased fluorescence anisotropy when incubated with protein M

83. In an interrupted mating experiment, between a donor who is His+, $Str^R$, $Ton^R$ and $lac^+$, the recipient was found to be $lac^+$ in 5 min, $His^+$ in 10min, $Str^r$ in15 min. However, the strain almost never was $Ton^R$ in the course of the experiment. Based on this data, which one of the following statements about the position of origin is correct?

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A. between $His^+$ and $Str^R$ B. between $Ton^R$ and $Str^R$
C. between $His^+$ and $Ton^R$ D. between $Ton^R$ and $lac^+$

84. In aerobic organisms Glycolysis is followed by citric acid cycle. Match the enzymes listed in column A to those in Column B

| | Column A | | Column B |
|---|---|---|---|
| a | Pyruvate to Acetyl CoA | i | Cytosol |
| b | Phosphoenolpyruvate to Pyruvate | ii | Mitochondrial matrix |
| c | Succinate dehydrogenase | iii | Outer mitochondrial membrane |
| d | Fumarate to malate | iv | Inner mitochondrial membrane |

A. a.iii; b.i; c.iv; d.ii B. a.ii; b.i; c.iv; d.ii
C. a.iv; b.iii; c.ii; d.i D. a.iii; b.ii; c.i; d.iv

85. For each of the item listed below which of them are indicative of a catabolic pathway?

a. consumption of ATP
b. reduction of compounds using NADPH
c. yielding energy
d. involvement of the cofactor $NAD^+$
e. production of glucose by photoautotroph
f. decrease in molecular complexity

A. a, b, d B. b, c, e C. b, c, f D. c, d, f