IIT JAM 2018 Biological Sciences (BL) Question Paper

Time Allowed :3 Hours	**Maximum Marks :**100	**Total questions :**60

General Instructions

General Instructions:

i) All questions are compulsory. Marks allotted to each question are indicated in the margin.

ii) Answers must be precise and to the point.

iii) In numerical questions, all steps of calculation should be shown clearly.

iv) Use of non-programmable scientific calculators is permitted.

v) Wherever necessary, write balanced chemical equations with proper symbols and units.

vi) Rough work should be done only in the space provided in the question paper.

Q1. One of Koch's postulates states that the suspected causative organism should

(A)not grow in artificial media

(B)get cleared by the host immune system

(C)always be associated with other organisms and hence cannot be grown as pure culture

(D)be grown in pure culture

Q2. Archaebacteria differ from bacteria in

(A)lacking peptidoglycan in the cell wall

(B)lacking membrane bound organelles

(C)containing circular chromosome

(D)containing formyl-methionine as an initiator amino acid

Q3. Which one of the following, involving transfer of a phosphate group, is an example of substrate-level phosphorylation?

(A)ATP to phosphoenolpyruvate

(B)GTP to ADP

(C)ATP to lipids

(D)phosphoenolpyruvate to ADP

Q4. Lysosomal targeting of proteins involves recognition of

(A)N-terminal signal peptide alone

(B)mannose phosphorylated at 6^{th} carbon in N-linked oligosaccharide

(C)KDEL sequence at the C-terminus

(D)dilysine motifs in the internal sequence of the protein

Q5. In vitro, group I introns have the ability to

(A)undergo autosplicing in the presence of an external nucleophile

(B)undergo autosplicing without the need of a nucleophile

(C)make secondary structures that are similar to that of group II introns

(D)undergo complete self-degradation

Q6. In polypeptide chains, the proline residue is unique in

(A)having an aromatic ring

(B)being abundantly present in most proteins

(C)being the site for phosphorylation on proteins

(D)having its side chain connected to the peptide backbone twice

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Q7. Which one of the following microscopes has working principle most similar to the way a blind person reads?

(A)Confocal microscope

(B)Epifluorescence microscope

(C)Atomic force microscope

(D)Total internal reflection fluorescence microscope

Q8. Many plasma glycoproteins are protected from uptake and degradation by the hepatocytes in liver due to the presence of a terminal saccharide moiety known as

(A)N-Acetylneuraminic acid

(B)N-Acetylgalactosamine

(C)D-Galactose

(D)D-Mannose

Q9. In mammals, which one of the following vitamins is required in amino group transfer reaction?

(A)Riboflavin

(B)Pantothenic acid

(C)Folic acid

(D)Pyridoxine

Q10. 'Philadelphia chromosome' is NOT linked to

(A)cancer

(B)hyperactive tyrosine kinase

(C)chromosomal aberration

(D)Down's syndrome

Q11. Decreasing the concentration of sodium ions from double stranded DNA solution results in decrease in Tm. This happens because of increased

(A)repulsion of bases between two strands

(B)repulsion of phosphate groups between two strands

(C)stacking of bases in two strands

(D)repulsion of deoxyribose sugars between two strands

Q12. During pre-mRNA splicing reaction, a lariat RNA is formed when the intron cleaved at the 5' splice site gets linked by a

(A)5' 2' bond to a base within the intron

(B)5' 3' bond to a base within the intron

(C)5' 2' bond to a base at the 5' end of the immediate downstream exon

(D)5' 3' bond to a base at the 5' end of the immediate downstream exon

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Q13. Match the endocrine gland in Group A with the hormone secreted by them in Group B:

Group A	Group B
(P) Anterior Pituitary	(i) Melatonin
(Q) Thyroid	(ii) Glucocorticoids
(R) Adrenal	(iii) Prolactin
(S) Pineal	(iv) Calcitonin

(A) P: ii, Q: i, R: iv, S: iii

(B) P: iii, Q: iv, R: ii, S: i

(C) P: iii, Q: i, R: ii, S: iv

(D) P: ii, Q: iv, R: iii, S: i

Q14. A plant producing white flower with white seed coat (dominant) was crossed with a plant producing violet flower with gray seed coat (recessive). Upon selfing of 144 F2 progeny plants, the number of plants continuing to produce violet flower with gray seed coat will be:

(A) 72

(B) 36

(C) 18

(D) 9

Q15. A dihybrid phenotypic ratio of 15:1 was obtained while making a cross of AaBb × AaBb. This is an example of:

(A) Cytoplasmic inheritance

(B) Incomplete dominance

(C) Complete dominance and epistasis

(D) Co-dominance

Q16. On infection by a specific virus, a host generates cytotoxic T cells that kill:

(A) infected cells expressing self MHC

(B) infected cells expressing MHC of different genotype

(C) uninfected cells expressing self MHC

(D) cells infected by an unrelated virus, expressing self MHC

Q17. Which one of the following combinations showing the chromosome numbers for human cells is CORRECT?

(A) Oogonium = 23, Fibroblast at G2/M = 92, Egg before fertilization = 23, Sperm = 23

(B) Oogonium = 46, Fibroblast at G2/M = 92, Egg before fertilization = 46, Sperm = 23

(C) Oogonium = 46, Fibroblast at G2/M = 46, Egg before fertilization = 46, Sperm = 23

(D) Oogonium = 46, Fibroblast at G2/M = 92, Egg before fertilization = 23, Sperm = 23

Q18. The function $y = 1$ is an equation of a:

(A) point

(B) line with a slope of 0

(C) line with a slope of infinity

(D) line with a slope of 1 passing through (1,1)

Q19. Bottle X contains 1 L of water, while bottle Y, which has the same capacity as X, is empty. Water is poured from bottle X to Y. The plot of the quantity of water in Y as a function of the quantity of water in X is:

(A) an exponential function

(B) straight line with a slope of 0

(C) straight line with a slope of 1

(D) straight line with a slope of -1

Q20. The derivative of 2^x with respect to x is:

(A) $\ln(x) \cdot 2^x$

(B) $x \cdot 2^{x-1}$

(C) $\ln(2) \cdot 2^x$

(D) $2 \cdot 2^{x-1}$

Q21. An example of transcytosis is:

(A) transmission of a nerve impulse from cell to cell

(B) a pancreatic cell secreting pancreatic juice

(C) an infant getting antibodies from mother's milk

(D) a macrophage engulfing bacteria

Q22. Which of the following techniques can be used to detect protein-protein interactions in-vivo?

(P) Two hybrid assay

(Q) Fluorescence resonance energy transfer

(R) Fluorescence recovery after photobleaching

(S) Gel-shift assay

(A) P and Q

(B) P and S

(C) Q and R

(D) P, Q and S

Q23. The predominant mechanism of microRNA mediated regulation of gene expression is inhibition of:

(A) capping of the target mRNA

(B) translation of the target mRNA

(C) polyadenylation of the target mRNA

(D) transport of the target mRNA from nucleus to cytosol

Q24. In human reproduction,

(P) spermatogenesis starts at puberty

(Q) oogenesis starts at fetal stage

(R) following meiosis, one oogonium produces 4 eggs

(S) following meiosis, one spermatogonium produces 4 sperms

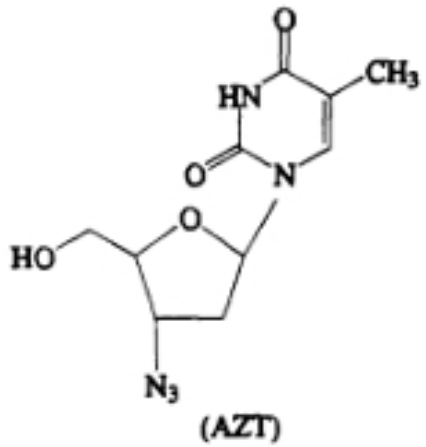
(A) P, Q, R and S

(B) P, Q and S

(C) P, R and S

(D) P and S

Q25. 3'-Azido-2',3'-dideoxy thymidine (AZT) with the structure shown above has potential to work as a drug against HIV because:



(AZT)

(A) of its ability to competitively bind reverse transcriptase and inhibit its activity

(B) its addition at the 3' end of the growing DNA strand will terminate viral DNA synthesis

(C) it stacks between successive nucleotide bases thereby inhibiting viral DNA synthesis

(D) it binds to the minor groove of the viral DNA thereby inhibiting the binding of reverse transcriptase

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Q26. A bacterium that arose 3.5 billion years ago divides once every 12 hours. Under ideal conditions, the number of generations the bacterium has undergone will be approximately:

(A) 2.6×10^{12}

(B) 73×10^{9}

(C) 1.06×10^{12}

(D) 1.3×10^{12}

Q27. Which one of the following matches is CORRECT between the inhibitors given in Group A with their modes of action in Group B?

Group A	Group B
(P) Antimycin A	(i) Inhibits cytochrome c oxidase
(Q) Amytal	(ii) Blocks electron transfer from cyt b to cyt c1
(R) Carbon monoxide	(iii) Inhibits adenine nucleotide translocase
(S) Atractyloside	(iv) Prevents electron transfer from Fe-S centers of complex 1 to ubiquinone

(A) P: ii, Q: iv, R: i, S: iii

(B) P: iii, Q: iv, R: ii, S: i

(C) P: iv, Q: iii, R: ii, S: i

(D) P: ii, Q: iv, R: iii, S: iv

Q28. During synthesis of N-linked glycosylated proteins in mammalian cells, which one of the following compositions of sugars is originally added as a core through dolichol-phosphate precursor?

(A) 2 moieties of N-acetylglucosamine, 9 moieties of mannose and 3 moieties of glucose

(B) 2 moieties of N-acetylglucosamine, 5 moieties of mannose and 3 moieties of glucose

(C) 1 moiety of N-acetylglucosamine, 5 moieties of mannose and 3 moieties of glucose

(D) 2 moieties of N-acetylglucosamine, 9 moieties of mannose and 1 moiety of glucose

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Q29. For accurate determination of evolutionary relationship within elephants, an approach of choice would be to compare

(A) the size of their nuclei

(B) the size of their Golgi bodies

(C) their mitochondrial DNA sequences

(D) the number of mitochondria in their cells

Q30. Which of the following combinations of the statements about photorespiration is CORRECT?

(P) Photorespiration generates no ATP

(Q) Photorespiration produces no glucose

(R) Photorespiration releases O_2

(S) Photorespiration does not occur in C_4 plants

(A) P and S

(B) P and Q

(C) Q, R and S

(D) P, Q and S

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31. Which of the following statements are TRUE for hexokinase and glucokinase?

(A) They are both ubiquitously present in all cells

(B) They are isozymes

(C) They differ in their K_m for glucose

(D) They are identical in their primary structure

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32. Which of the following statements about mature tRNA and/or mRNA are FALSE?

(A) tRNAs end with CCA sequence at the 3' end

(B) Both form clover-leaf structures

(C) Both are polyadenylated at their 3' ends

(D) All tRNAs are devoid of introns

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33. Which of the following statements are CORRECT about meiosis?

(A) Bivalents are formed in meiosis I

(B) Homologous chromosomes separate from each other in meiosis I

(C) Sister chromatids are separated from each other in meiosis I

(D) Each round of chromosome segregation is followed by one round of DNA replication

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34. Phospho-mimic mutants of proteins can be generated by replacing

(A) serine with aspartic acid

(B) alanine with glutamic acid

(C) serine with alanine

(D) threonine with glutamic acid

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35. Which of the following statements are TRUE for phosphoinositide signaling cascade?

(A) Phospholipase A catalyzes cleavage of PIP2

(B) Generation of IP_3 transiently increases cytosolic Ca^{2+} concentration

(C) Ca^{2+} facilitates the activation of protein kinase C

(D) DAG always activates protein kinase A

36. A bacterial culture growing at 20°C was shifted to 45°C. Incorporation of which of the following fatty acids in the membrane will be beneficial for its survival?

(A) long chain fatty acids

(B) short chain fatty acids

(C) unsaturated fatty acids

(D) saturated fatty acids

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37. The copy number of a plasmid in bacterial cells can be determined by

(A) western blotting

(B) southern blotting

(C) northern blotting

(D) quantitative polymerase chain reaction

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38. Choose the CORRECT statements about a nucleosome core particle

(A) It is a packaging unit of eukaryotic DNA

(B) It contains eight histones of four types

(C) It contains eight histones of five types

(D) Histones can be dissociated from nucleosome using high salt concentration

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39. Bacterial superantigens

(A) bind to VβCDR2 loop in T cells without being processed into peptides

(B) bind to VβCDR2 loop in T cells after being processed into peptides

(C) are recognized by B cells after being processed into peptides

(D) bind to VβCDR1 and HV4 loops in T cells without being processed into peptides

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40. When grown in the presence of glucose and lactose together, *E. coli* does not utilize lactose first because

(A) lactose permease is not present on the bacterial membrane

(B) glucose inhibits the synthesis of cyclic AMP

(C) glucose activates the synthesis of cyclic AMP

(D) glucose stimulates the efflux of cyclic AMP out of the cell

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Q41. A plasmid is digested with a restriction enzyme to produce three fragments of sizes 7 kb, 3 kb and 2 kb. To obtain 500 ng of a 3 kb fragment, the amount of plasmid required to be digested in µg is .....

Q42. A pentapeptide consisting of amino acids with molecular weights of 165, 131, 75, 204 and 146 Da has an approximate molecular weight (in Da) of .....

Q43. At 2 mg/mL pure tubulin concentration, a microtubule consisting of 13 protofilaments grows unidirectionally at a rate of about 2 µm/min. At this growth rate, the number of tubulin dimers (each 8 nm in length) added to the ends of the microtubule each second is ..... (decimal digits up to 2 places)

Q44. Three sides of a triangle are 1, 1 and 0.5 meters in length. The area of the triangle in m^2 is ..... (decimal digits up to 2 places)

Q45. The sum of the internal angles of a regular pentagon is ..... degrees

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Q46. A protein solution gives absorbance of 0.34 at λ280 using 0.5 cm path length cuvette. Given the extinction coefficient of the protein is 3.4×10^3 M^{-1} cm^{-1}, the concentration of protein in the solution in mM is ..... (decimal digits up to 2 places)

Q47. The pitch of an α-helix is 5.4 Å. The approximate length of the α-helix consisting of 15 amino acids in Å is ..... (decimal digits up to 1 place)

Q48. The maximum resolution in nm achieved through an oil immersion lens of numerical aperture 1.4 using an incident light of wavelength 380 nm is ..... (decimal digits up to 2 places)

Q49. The number of NADPH molecules required for the synthesis of palmitate (C16:0) from acetyl CoA is .....

Q50. The number of peptide fragments generated from the sequence: Ala-Trp-Val-Ala-Phe-Thr-Gly-Lys-Glu-Tyr-Asp-Ser-Lys on treatment with chymotrypsin is .....

Q51. The prevalence of a severe form of sickle-cell anemia (ss) in an African population is 16%. The percentage of the population resistant to malaria because of heterozygous (Ss) genotype for the sickle-cell gene is .....

Q52. The maximum velocity of an enzymatic reaction is 0.4 mole/sec. At 5 mM concentration of the substrate, the reaction velocity was found to be 0.2 mole/sec. If the enzyme shows standard Michaelis-Menten kinetics, the rate of the reaction at 10 mM substrate concentration in mole/sec is ..... (decimal digits up to 3 places)

Q53. A chromatin fiber of 40 nm length contains 25 nucleosomes (200 bp per nucleosome). The degree of compaction of DNA associated with this chromatin fiber is ..... fold (decimal digits up to 1 place)

Q54. A ball is dropped from a height of 1 meter. Every time the ball bounces up, it reaches 50% of the height of the previous bounce (i.e., it rises up to 0.5 meters on the first bounce, 0.25 meters on the second bounce and so on). After an infinitely long time, the total distance covered by the ball in m is .....

Q55. Let y = $\sum_{n=1}^{3} nx^n. The value of \int_0^1 ydx is .....(decimal digits upto 2 places)$

Q56. Ram's mother is thrice his age now. Ten years from now, she will be twice his age. Ram's present age is ..... years

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Q57. An unbiased coin is tossed 4 times. The probability of getting exactly 2 heads and 2 tails in any order is ..... (decimal digits up to 2 places)

Q58. Rod shaped E. coli is 2 µm long and has diameter of 0.8 µm. The average density of E. coli is 1.1 x 10^3 g/L. The mass of single E. coli cell in pg is ..... (decimal digits up to 1 place)

Q59. The length of each side of a regular octagon is 1 meter. The area of the octagon in m^2 is ..... (decimal digits up to 2 places)

Q60. Molecular weight of the genomic DNA of an organism is 3.96 x 10^9 g/mol. The average molecular weight of nucleotide pair is 660 g/mol. If an average protein in this organism consists of a chain of 400 amino acids, the maximum number of proteins coded by DNA molecule will be .....
