

51

QUESTION PAPER
SERIES CODE

A

Registration No. :

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Centre of Exam. : _____

Name of Candidate : _____

Signature of Invigilator

ENTRANCE EXAMINATION, 2013

Pre-Ph.D./Ph.D. BIOTECHNOLOGY

[Field of Study Code : SBTP (168)]

Time Allowed : 3 hours

Maximum Marks : 70

INSTRUCTIONS FOR CANDIDATES

Candidates must read carefully the following instructions before attempting the Question Paper :

- (i) Write your Name and Registration Number in the space provided for the purpose on the top of this Question Paper and in the Answer Sheet.
- (ii) **Please darken the appropriate circle of Question Paper Series Code on the Answer Sheet.**
- (iii) The Question Paper is divided into two parts : Part—A and Part—B. Both parts have multiple-choice questions. All answers are to be entered in the Answer Sheet provided with the Question Paper for the purpose by darkening the correct choice, i.e., (a) or (b) or (c) or (d) with **BALLPOINT PEN** only against each question in the corresponding circle.
- (iv) Part—A consists of 30 questions and all are compulsory.
- (v) Part—B contains 70 questions. **Answer any 40 questions.**
In case any candidate answers more than the required 40 questions, the first 40 questions attempted will be evaluated.
- (vi) Each correct answer carries 1 mark. **There will be negative marking and ½ mark will be deducted for each wrong answer.**
- (vii) Answer written by the candidates inside the Question Paper will not be evaluated.
- (viii) Simple Calculators and Log Tables may be used.
- (ix) Pages at the end have been provided for Rough Work.
- (x) Return the Question Paper and Answer Sheet to the Invigilator at the end of the Entrance Examination. **DO NOT FOLD THE ANSWER SHEET.**

INSTRUCTIONS FOR MARKING ANSWERS

1. Use only Blue/Black Ballpoint Pen (Do not use pencil) to darken the appropriate Circle.
2. Please darken the whole Circle.
3. Darken ONLY ONE CIRCLE for each question as shown in example below :

Wrong ● (b) (c) ●	Wrong ⊗ (b) (c) (d)	Wrong ⊗ (b) (c) ⊗	Wrong ⊙ (b) (c) ●	Correct ⊙ (a) (b) (c) ●
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4. Once marked, no change in the answer is allowed.
5. Please do not make any stray marks on the Answer Sheet.
6. Please do not do any rough work on the Answer Sheet.
7. Mark your answer only in the appropriate space against the number corresponding to the question.
8. **Ensure that you have darkened the appropriate circle of Question Paper Series Code on the Answer Sheet.**

PART—A

Answer **all** questions

1. Which of the following represents the most reduced form of carbon?
 - (a) $R-CH_3$
 - (b) $R-COOH$
 - (c) $R-CHO$
 - (d) $R-CH_2OH$

2. The K_m (Michaelis constant) of an enzyme for a substrate is defined operationally as
 - (a) half the substrate concentration at which the reaction rate is maximal
 - (b) the substrate concentration at which the reaction rate is half maximal
 - (c) the dissociation constant of the enzyme substrate complex
 - (d) the dissociation constant of the enzyme product complex

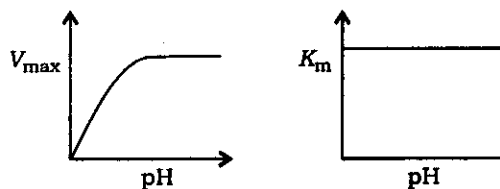
3. Dinitrophenol (DNP) uncouples mitochondrial electron transport from oxidative phosphorylation by
 - (a) dissipating the proton gradient
 - (b) inhibiting cytochrome oxidase
 - (c) dissociating the F_0 and F_1 units of the ATP synthase complex
 - (d) binding irreversibly to ubiquinone

4. Drugs that either stabilize or depolymerize microtubules can be used in cancer chemotherapy. Which of the following is correct concerning such drugs?
 - (a) They stimulate the immune system
 - (b) They prevent the chromatin condensation
 - (c) They prevent the movement of tumour cells into other tissues
 - (d) They interfere with mitosis

5. In humans, the Barr body is an
 - (a) active X chromosome in females
 - (b) active X chromosome in males
 - (c) inactive Y chromosome in females
 - (d) inactive X chromosome in females

6. An RNA-dependent RNA polymerase is likely to be present in the virion of a
- (a) DNA virus that multiplies in the cytoplasm
 - (b) DNA virus that multiplies in the nucleus
 - (c) minus-strand RNA virus
 - (d) plus-strand RNA virus
7. If sucrose and monosodium glutamate (MSG) are added to a vinegar and oil salad dressing and shaken, the mixture will eventually separate into two phases of different density and polarity. Where will most of the sucrose and the MSG be located following phase separation?
- (a) Both will concentrate in the vinegar
 - (b) Both will concentrate in the oil
 - (c) Both will concentrate at the interface
 - (d) Sucrose will concentrate in the oil and MSG will concentrate in the vinegar
8. The initial product of photosynthetic CO_2 fixation in C_3 plants is
- (a) glyceraldehyde 3-phosphate
 - (b) dihydroxyacetone phosphate
 - (c) 3-phosphoglycerate
 - (d) phosphoenolpyruvate
9. Glycogen phosphorylase exists in two forms in skeletal muscle. The active form phosphorylase *a* is generated from phosphorylase *b* by
- (a) reversible dimerization of phosphorylase *b* triggered by calcium ion
 - (b) proteolytic cleavage of a decapeptide from the N-terminus of phosphorylase *b*
 - (c) protonation of the active-site histidine residue by a decrease in intracellular pH
 - (d) ATP-dependent phosphorylation of a specific serine residue on each subunit
10. Particular RNAs that are important for development are located in distinct regions of the *Drosophila* embryo. This is most directly demonstrated by using
- (a) Western blotting
 - (b) Northern blotting
 - (c) in situ hybridization
 - (d) in vitro translation

11. In a study of arginine biosynthesis in yeast, four mutant haploids requiring arginine (Arg^-) were isolated. The Arg^- haploids were fused in pairwise combinations to form diploids, whose requirement for arginine was tested. The results of the tests were that all diploid combinations yielded arginine prototrophs. How many different Arg genes are represented among the four mutants?
- (a) One
 (b) Two
 (c) Three
 (d) Four
12. A set of genes from *Bacillus subtilis* that encode the proteins required for sporulation have conserved DNA sequences -35 and -10 nucleotides before the site of transcript initiation, although the sequence at -35 is different from that seen in most other genes from that species. Which of the following best explains this difference?
- (a) A novel sigma factor is required for transcription initiation at these genes
 (b) The -35 sequence is the binding site for a repressor of transcription
 (c) The replication of these genes requires a specifically modified DNA polymerase
 (d) Translation of the mRNAs transcribed from these genes requires specific ribosomes that recognize a modified Shine-Delgarno sequence
13. Cyclins are proteins involved in regulation of
- (a) cell cycle protein kinases
 (b) circadian rhythms
 (c) synthesis of cAMP
 (d) membrane circulation via exocytosis and endocytosis
14. The pH dependencies of V_{max} and K_m for an enzyme are shown below. These data are most consistent with the requirement for

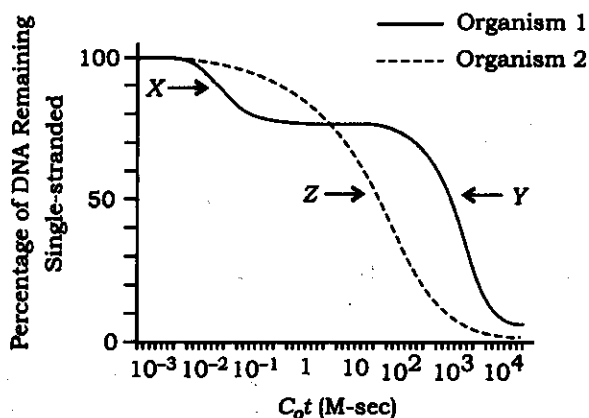


- (a) a general base in catalysis
 (b) a general acid in catalysis
 (c) a dissociable cofactor in catalysis
 (d) a basic residue in substrate binding

15. The glyoxylate cycle is found in plants and bacteria but not in animals. The lack of this cycle in animals results in the inability to
- (a) synthesize oxaloacetate from isocitrate
 - (b) synthesize glutamate from malate
 - (c) perform gluconeogenesis from amino acids
 - (d) perform gluconeogenesis from fatty acids
16. The units of the molar extinction coefficient are
- (a) $\text{L mol}^{-1} \text{cm}^{-1}$
 - (b) L mol cm^{-1}
 - (c) $\text{mol}^{-1} \text{cm}^{-1}$
 - (d) $\text{cm L}^{-1} \text{cm}^{-1}$
17. The equilibrium constant for the reaction catalyzed by malate dehydrogenase (malate to oxaloacetate) is about 5.9×10^{-6} . Which of the following best describes the situation in which malate is converted to oxaloacetate during the citric acid (Krebs) cycle?
- (a) The reaction is exergonic under standard conditions in the direction of the citric acid cycle and this drives the reaction
 - (b) The next reaction of the cycle, citrate synthase, is highly exergonic and it pulls the malate dehydrogenase reaction forward by removing oxaloacetate
 - (c) Malate dehydrogenase catalyzes an irreversible reaction in the citric acid cycle
 - (d) Malate dehydrogenase changes the equilibrium constant for the reaction allowing it to proceed rapidly
18. The increase in the number of nucleoli during oocyte development in the frog *Xenopus laevis* is the result of
- (a) accelerated cell division
 - (b) rapid chromosome replication
 - (c) rapid synthesis of transfer RNA
 - (d) amplification of the ribosomal RNA genes
19. Which one of the following substances specifically cleaves polypeptides on the carboxyl side of methionine residues?
- (a) Chymotrypsin
 - (b) Cyanogen bromide
 - (c) Iodoacetamide
 - (d) Phenylglyoxal

20. Which one of the following possesses genes that may be integrated into the genome of an infected eukaryotic cell?
- Adenovirus
 - Yeast
 - Bacteriophage T4
 - Bacteriophage lambda
21. Which of the following reactions is anaplerotic (replenishes intermediate pools) for the citric acid cycle?
- Oxaloacetate + GTP \rightarrow Phosphoenolpyruvate + CO₂ + GDP
 - Malate + NAD⁺ \rightarrow Oxaloacetate + NADH + H⁺
 - Citrate + ATP + CoA \rightarrow Oxaloacetate + ADP + acetyl-CoA + Pi
 - Pyruvate + HCO₃⁻ + ATP \rightarrow Oxaloacetate + ADP + Pi + H⁺

22. The figure below is a graph of the reannealing (reforming of double-stranded molecules) of total genomic DNA from two different organisms. DNA was extracted from each organism, sheared to a uniform size and then denatured by heating. An identical amount of each preparation of sheared, single-stranded DNA was allowed to reanneal under identical conditions of pH, buffer, ionic strength and temperature. The reannealing curves shown were obtained by plotting the percentage of DNA remaining single-stranded versus the product of the total DNA concentration (C_0), in moles of nucleotide per litre, times the renaturation time (t), in second.



Proteins are most likely encoded by which of the populations of DNA fragments indicated by X, Y and Z in the figure above?

- X only
- Y and Z
- X and Y
- X and Z

- 23.** Which one of the following amino acids is unlikely to function as a catalytic base within the active sites of enzymes?
- (a) Serine
 - (b) Aspartate
 - (c) Histidine
 - (d) Leucine
- 24.** Brown fat is a heat generating tissue. The brown colour of this fat is due to the presence of
- (a) iron
 - (b) catalase
 - (c) cytochrome
 - (d) ATP
- 25.** Cigarette smoking is strongly correlated with development of lung cancer. Smokers are advised to quit smoking and it has been observed that smokers who have quit smoking have a lower rate of development of lung cancer compared to those who keep smoking. The molecular logic behind this observation is
- (a) continuous smoking is required to generate mutations
 - (b) quitting smoking stops all further mutations
 - (c) quitting smoking slows down the rate of mutations
 - (d) quitting smoking increases the rate of mutations
- 26.** In a culture of 20000 cells, only 2 cells are found to be in mitosis. If the average time the cells spend in mitosis for this cell type is 30 min, the cell cycle duration for these cells is
- (a) 5 hours
 - (b) 50 hours
 - (c) 500 hours
 - (d) 5000 hours

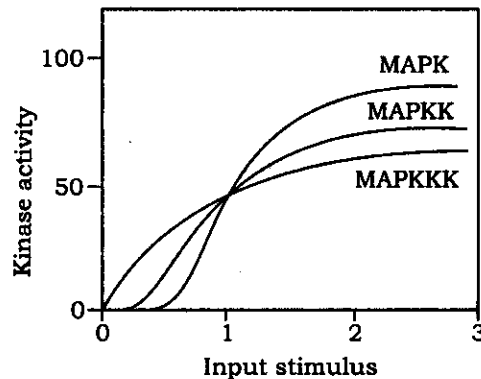
27. Dark plastic handles are often used on kitchen utensils because
- (a) the black material is a good absorber of heat energy
 - (b) the plastic is a good insulator for heat
 - (c) the plastic is a good conductor for heat
 - (d) the black material is a good radiator
28. Which one of the following is true regarding H_3PO_4 at 25°C ?
- (a) It has a very large ionization constant
 - (b) It has a bitter taste
 - (c) It is a weak electrolyte
 - (d) It can be formed by reaction of a metal oxide and water
29. $\text{HNO}_3(\text{aq}) + \text{OH}^-(\text{aq}) = \text{H}_2\text{O}(\text{l}) + \text{NO}_3^-(\text{aq})$
In the above reaction, which species is the conjugate base?
- (a) $\text{HNO}_3(\text{aq})$
 - (b) $\text{OH}^-(\text{aq})$
 - (c) $\text{H}_2\text{O}(\text{l})$
 - (d) $\text{NO}_3^-(\text{aq})$
30. A substance possessing a characteristically low vapour pressure can be expected to have
- (a) extremely weak intermolecular forces
 - (b) a relatively small heat of vaporization
 - (c) a relatively high boiling point
 - (d) a relatively high rate of evaporation

PART—B

Answer *any forty* questions

31. You have raised a specific antibody against a receptor tyrosine kinase and have purified the IgG fraction of the antibody. Then you added the IgG fraction of the antibody to cells expressing the receptor on the cell surface. You expect that the receptor will be
- (a) inhibited
 - (b) activated
 - (c) There will be no effect of the antibody on the receptor
 - (d) internalized by phagocytosis
32. The number of complementarity determining regions (CDRs) in a single-Fab fragment is
- (a) 6
 - (b) 2
 - (c) 1
 - (d) 4
33. The number of epitopes that each Fab fragment can bind is
- (a) 2
 - (b) 6
 - (c) 1
 - (d) 4
34. Bill Gates got a virus infection and developed virus specific T-cells. The chances that the T-cells derived from Bill Gates will be activated by cells infected with the same virus but derived from Steve Jobs are
- (a) close to 100%
 - (b) close to 50%
 - (c) close to 1%–10%
 - (d) close to 25%
35. Inhibition of activity of proteasomes will
- (a) prevent the presentation of peptides by MHCII molecules
 - (b) prevent the presentation of peptides by MHCI molecules
 - (c) have no effect on antigen presentation by MHC molecules because proteasomes are present in the cytosol
 - (d) allow better recognition of MHC-peptide complex by the T-cell receptor

36. *Paramecium caudatum* deals with changes in osmolarity of the environment by collecting fluid from a system of canals in the cytoplasm into a vacuole called 'contractile vacuole' that expels water out by contraction. If this organism swims from a hypotonic environment to an isotonic environment, it will be expected that
- the contractile vacuole becomes more active
 - the contractile vacuole becomes less active
 - the activity of the contractile vacuole does not change
 - the contractile vacuole will swell due to accumulation of larger volume of fluid
37. Arf-1 is a monomeric G-protein that helps in the formation of COPI-coated vesicles at the Golgi membrane by inserting a hydrophobic tail in Golgi membrane that then recruits other necessary adapter proteins to start bud formation. The hydrophobic tail of Arf-1 is exposed when Arf-1 is bound to GTP and is retracted when Arf-1 hydrolyzes the bound GTP to GDP. If there is a mutation in Arf-1 so that it cannot hydrolyze GTP, then all of the following can be expected to happen, *except*
- COPI-coated vesicles will readily form but may form at places other than Golgi
 - COPI-coated vesicles will disassemble quickly
 - transport mediated by COPI-coated vesicles will be inhibited
 - it would be lethal for the cell
38. The stimulus response curve for the components of the MAP-kinase pathway is shown below :



It can be concluded from this curve that

- components of the cascade are arranged on a scaffold
- MAPK is upstream of MAPKKK
- MAPK is upstream of MAPKK
- MAPK is acting like a switch

39. Ion channels have a central region that is constricted such that only ions of a certain diameter can pass through. If a threonine in the central region is replaced with a leucine, it can be expected that
- (a) the current flowing through the channel will be unaltered
 - (b) the current flowing through the channel will be increased
 - (c) the current flowing through the channel will be reduced
 - (d) the channel will allow freer flow of ions
40. Sexual reproduction is said to be advantageous as it generates genetic diversity. It is almost universal among animals except for the microscopic animal 'bdelloid rotifer' that originated about 40 million years ago, has about 400 species living in very different environmental niches and reproduces exclusively asexually. It can be expected that
- (a) bdelloid rotifer probably does not have any genetic diversity
 - (b) bdelloid rotifer undergoes asexual reproduction because the energy cost of such reproduction is more
 - (c) bdelloid rotifer undergoes asexual reproduction because its environment is stable
 - (d) bdelloid rotifer may be generating diversity through other means like horizontal gene transfer
41. You are studying the cell cycle parameters of an organism that can exist as haploid, diploid and tetraploid forms. You estimate the length of the S-phase of the cell cycle that represents the time the cells spend in duplicating its genome for all the three forms of the organism. You find that
- (a) the duration of the S-phase for the haploid form is the shortest and longest for the tetraploid form that has four times as much DNA to be duplicated
 - (b) the duration of the S-phase for the haploid form is the longest and shortest for the tetraploid form that has four times less DNA to be duplicated
 - (c) the S-phase duration is constant for all the three forms
 - (d) the S-phase duration has no correlation with the ploidy of the genome as chromosomes and genomes have a defined order and timing of replication which depends on epigenetic modifications and overall organization of the genome that may be different for all the three forms of the organism

42. You and your friend are interested in establishing whether a particular protein is a nuclear protein or a shuttling protein between the nucleus and cytoplasm. To find it out, both of you make a fusion of this protein with GFP and transfect cells. Then you make a heterokaryon of transfected cells with untransfected cells so that the fused cells have two nuclei each coming from untransfected and transfected cells. At this point you and your friend carry out separate experiments and in the end compare your results. To your surprise, you find that both of you have different results. While you find that after two days incubation, your samples show one nucleus with GFP fluorescence and the other nucleus blank for GFP fluorescence; your friend finds GFP fluorescence in both the nuclei. It appears that your friend forgot to add the following in his experiment.
- (a) Colchicine in the sample to inhibit mitosis
 - (b) Aphidicolin in the sample to inhibit DNA duplication
 - (c) Cycloheximide to the sample to inhibit protein synthesis
 - (d) ATP to provide energy for transport
43. Which pair of forces can produce a resultant of 15 N?
- (a) 20 N, 20 N
 - (b) 25 N, 5 N
 - (c) 5 N, 5 N
 - (d) 7 N, 7 N
44. As the angle between two forces increases, the magnitude of their resultant
- (a) increases only
 - (b) decreases only
 - (c) first increases and then decreases
 - (d) first decreases and then increases
45. A person travels 10 km North, 10 km East followed by 10 km South and finds that he has returned to his initial position. Other than the South Pole, where else is his initial position most likely to be?
- (a) At the North Pole
 - (b) Close to the North Pole
 - (c) Close to the South Pole
 - (d) On the Equator

46. Which of the following approaches would be most suitable for extracting caffeine from coffee beans in order to make decaffeinated coffee?
- (a) Extraction using benzene as solvent
 - (b) Extraction using ethyl acetate as solvent
 - (c) Extraction using methylene chloride as solvent
 - (d) Extraction using supercritical carbon dioxide as solvent
47. A change in configuration of a molecule must be accompanied by which of the following processes?
- (a) Breakage or formation of a covalent bond
 - (b) Breakage or formation of a hydrogen bond
 - (c) Breakage or formation of a salt bridge
 - (d) None of the above
48. Which of the following phenomena *does not* involve any change in configuration?
- (a) Denaturation of a protein without reduction of disulfide bonds
 - (b) Denaturation of a protein with reduction of disulfide bonds
 - (c) Changes in the linking number of a supercoiled plasmid
 - (d) Interaction between an enzyme and its substrate
49. Which of the following will happen if all the L-amino acids in an α -helix are replaced with the corresponding D-amino acids in the same order?
- (a) The α -helix may change into a β -sheet or turn into a random coil
 - (b) There will be no change. The α -helix will remain as it was before
 - (c) The right-handed α -helix will turn into a left-handed helix without any change in helical parameters, or hydrogen bonding pattern
 - (d) The right-handed α -helix will turn into a left-handed α -helix accompanied by changes in helical parameters and hydrogen bonding pattern

- 50.** Epimeration of UDP- β -D-glucose to UDP- β -D-galactose due to the action of the enzyme UDP-glucose-4-epimerase is an example of
- (a) a reaction where there is inversion of configuration although the absolute configuration of the reactant and the product does not change
 - (b) a reaction where there is complete retention of configuration although the absolute configuration of the reactant and the product are different
 - (c) a reaction where there is an inversion of configuration leading to a difference in absolute configurations between the reactant and the product
 - (d) a reaction that involves a double-inversion of configuration in two different centres leading to overall retention of absolute configuration between the reactant and the product
- 51.** Which one of the following statements is true?
- (a) In biological systems, conformational changes may happen spontaneously but configurational changes almost always require the mediation of an enzyme
 - (b) Enzymes are so specific for the configuration of substances and products that they are unable to form chiral products from non-chiral substrates and vice versa
 - (c) Only D to L type changes in a monosaccharide can be termed as configuration change. A change into a different epimer, e.g., from glucose to mannose is only a conformational change
 - (d) All of the above statements are false
- 52.** The 'elongation' stage of translation, after the arrival of each new tRNA, involves
- (a) passing of the amino acid from the tRNA in the A-site to the tRNA in the P-site
 - (b) binding of the newly arriving tRNA to the E-site
 - (c) passing of the peptide from the tRNA in the P-site to the tRNA in the A-site
 - (d) binding of the new tRNA to the P-site of the ribosome
- 53.** The complementary nature of the two strands of the DNA molecule for any given gene allows
- (a) binding of the RNA polymerase to either strand
 - (b) transcription of that gene in the 5' to 3' direction on one strand and transcription from 3' to 5' direction on the other strand
 - (c) transcription from only one strand that carries the genetic code for a particular gene
 - (d) transcription to take place from other strand in case a mutation occurs in the strand carrying the genetic code

- 54.** Conservative replication of DNA if occurred in cells would result in
- (a) each newly replicated strand of DNA to be paired with the parent strand of DNA
 - (b) both the newly replicated strands of DNA will be paired together in a duplex
 - (c) presence of newly made DNA segments between the segments of the original DNA on the same strand
 - (d) presence of newly made DNA segments between the segments of the original DNA on the other strand
- 55.** Ligation to close nicks in the DNA by DNA ligase by using the energy of ATP involves a mechanism which includes
- (a) an AMP in a phospho-ester linkage to the 5'-hydroxyl at one side of the nick
 - (b) an AMP in a phospho-anhydride linkage to the 5'-phosphate at one side of the nick
 - (c) an AMP in a phospho-anhydride linkage to the side chain of a tyrosine in DNA ligase
 - (d) a linkage of the side chain of a tyrosine in DNA ligase to the 5'-phosphate at one side of the nick
- 56.** Any DNA polymerase that is involved in cellular DNA replication, when used to replicate a DNA in vitro in a test tube, is unable to synthesize DNA that is as long as the DNA that it makes in cells, because in the test tube, it
- (a) lacks a sliding clamp
 - (b) has proofreading activity
 - (c) lacks RNaseH activity
 - (d) cannot synthesize DNA without a primer
- 57.** Which of the following enzymes is *not* required for *E. coli* DNA replication?
- (a) Gyrase
 - (b) DNA polymerase I
 - (c) Telomerase
 - (d) DNA ligase
- 58.** Transposons are
- (a) short DNAs that bind to RISC and direct the specificity of degradation of mRNA by RISC
 - (b) important for DNA repair because they facilitate sister-chromatid exchanges of DNA
 - (c) uncommon forms of DNA recombination that cause rearrangement of the immunoglobulin locus to contribute to the high amount of antibody diversity in the immune system
 - (d) short DNAs that can move around in the genome via transpositional recombination or simply inserting them

59. Which of the following is the odd one?
- (a) P elements
 - (b) FB elements
 - (c) Copia elements
 - (d) Ds elements
60. Which of the following repair mechanisms would most likely repair damage caused by ultraviolet (UV) radiation?
- (a) Photoreactivation of pyrimidine dimers
 - (b) Nucleotide excision repair
 - (c) Mismatch repair
 - (d) Recombination repair
61. Indicate the part of the mechanism involved in recognition of the start codon.
- (a) Binding of the 16S rRNA to a consensus sequence in the mRNA near the start codon
 - (b) Base pairing of the tRNA carrying N-formylmethionine with the start codon
 - (c) Formation of a pre-initiation complex by the 60S ribosomal subunit and initiation factors
 - (d) Scanning of the mRNA by the 40S ribosomal subunit for the first initiation codon from the 5' end
62. The checkpoint controls in cell cycle mostly work in which of the following ways?
- (a) They use positive signaling to allow incremental increase in the signal till a threshold to allow the progression of subsequent phase of the cycle
 - (b) They use negative signaling to ensure that the last inhibitory signal is removed before the next step can proceed
 - (c) Checkpoint controls exclusively work at the level of transcriptional regulation
 - (d) Checkpoint controls exclusively work at the level of translational regulation

63. Microtubules display the property of dynamic instability that causes them to either grow or shrink. If free tubulin concentration is increased, then it can be expected that
- (a) the frequency of switching to growing mode will be higher for a growing microtubule
 - (b) the frequency of switching to growing mode will be lower for a shrinking microtubule
 - (c) the frequency between growing and shrinking modes will be unaffected
 - (d) the frequency of switching to growing mode will be higher till the concentration of free tubulin falls so that the rate of GTP-tubulin addition is slowed down and the microtubule will then switch to shrinking mode
64. Disulfide bonds do not form in the cytosol but keratin intermediate filaments in the skin are cross-linked by disulfide bonds. This can be explained by the following
- (a) Intermediate filaments are transported to the cell exterior via the secretory pathway that allows the formation of disulfide bonds
 - (b) Keratinocytes do not have a strongly reducing cytosol thereby allowing the formation of disulfide bonds in the cytosol
 - (c) Keratinocytes lack glucose-6-phosphate dehydrogenase so that their cytosol is less reducing
 - (d) Disulfide bonds in keratin are formed after cells have died and therefore cannot maintain the reducing environment in the absence of metabolic activity and cellular contents are oxidized
65. You have a bet with your friend that you can dissolve the hard-boiled egg—a process that appears irreversible. In order to win the bet you will need the following
- (a) Iodoacetamide and strong detergent
 - (b) Strong detergent and heat
 - (c) 2-mercaptoethanol and strong detergent
 - (d) 2-mercaptoethanol and heat
66. Export of HCO_3^- out of cells via a $\text{Cl}^- - \text{HCO}_3^-$ exchanger will result in
- (a) increase in intracellular pH
 - (b) decrease in intracellular pH
 - (c) no change in intracellular pH
 - (d) switch in the directionality of the exchanger

67. A 1 mM solution of a protein, whose concentration was determined using a UV spectrometer and knowledge of its extinction coefficient, was diluted 100 fold. Given that molecular weight of the protein is 50 kDa, its concentration in mg/ml units after dilution would be
- (a) 0.1
 - (b) 0.5
 - (c) 1.0
 - (d) 10.0
68. Isoelectric point of the enzyme ribonuclease is 9.3. It was observed that at this point there are 10 positively charged and 10 negatively charged side chains of amino acids. When the enzyme solution was titrated with HCl to give a pH of 3, it was observed that 2 ionized glutamic acid and 1 ionized aspartic acid side chain got protonated. The net charge on the enzyme at pH 3 would, therefore, be
- (a) +2
 - (b) +3
 - (c) +7
 - (d) +9
69. Tubulin is a GTP binding protein. When GTP was incrementally added to tubulin at 25 °C, a binding curve was generated, the fitting of which to a single-site binding model resulted in the free energy of binding of -10 kcal/mol. The dissociation constant for the binding of GTP to tubulin would, therefore, result in a value nearly equal to
- (a) 4 nM
 - (b) 20 nM
 - (c) 45 nM
 - (d) 100 nM
70. Water has a high-dielectric constant of 80 in contrast with many non-polar solvents having a very low dielectric constant. Due to this property, the electrostatic interactions between various charged side chains of amino acids in proteins after their transfer from a non-polar solvent to water
- (a) would decrease
 - (b) would increase
 - (c) remain unaffected
 - (d) attain a value of zero

71. Each strand of the triple-helical form of collagen consists of
- (a) polyglycine-I type of secondary structure
 - (b) polyproline-I type of secondary structure
 - (c) polyglycine-II type of secondary structure
 - (d) polyproline-II type of secondary structure
72. When ribonuclease at pH 7 is titrated with alkali and the process monitored spectrophotometrically, an abrupt change in absorption occurs at pH 10.5. This is due to the titration of
- (a) aspartic acid
 - (b) exposed tyrosine
 - (c) buried tyrosine
 - (d) glutamic acid
73. Two proteins in a mixture have the same molecular weight and the same isoelectric point but different amino acid compositions. The best way to resolve them would be by using which one of the following techniques?
- (a) Reverse-phase chromatography
 - (b) Ion-exchange chromatography
 - (c) Gel filtration chromatography
 - (d) Chromatofocussing
74. At a temperature slightly above the midpoint of denaturation of a DNA molecule, it is observed that the fraction of the native form of DNA was 0.4 and that of the denatured form was 0.6. The free energy change, ΔG° at this temperature, which turns out to be 75 °C, would therefore be nearly
- (a) 0 cal/mol
 - (b) -60 cal/mol
 - (c) -150 cal/mol
 - (d) -300 cal/mol
75. A protein molecule containing 5 disulfide bonds is reduced to open up the structure. This structure could be folded back to the native state by using
- (a) a mixture of oxidized and reduced glutathiones
 - (b) dithioerythritol
 - (c) beta-mercaptoethanol
 - (d) reduced glutathione

76. A coiled-coil structure found in keratins consists of
- two β -strands forming a sheet structure
 - two polyproline-I helices wound around each other
 - two right-handed α -helices wound around each other
 - cross-beta structure similar to that of amyloid fibrils
77. What is the oxidation number of oxygen in hydrogen peroxide?
- 1
 - 0
 - +1
 - +2
78. What will be the outcome if an iron nail is dipped into a solution containing either copper sulfate solution or aluminium sulfate solution?
- Iron will displace copper from its salt producing free copper, there will be no reaction with aluminum sulfate
 - Iron will displace aluminum from its salt producing free aluminium, there will be no reaction with copper sulfate
 - Iron will displace both copper and aluminium from their salts
 - There will be no reaction in either case
79. In an exponentially growing cell population with a doubling time of 1 h, the death rate (which is happening simultaneously) is proportional to the cell biomass with the proportionality constant (k) being 1 h^{-1} . If the initial live cell count is 10^6 cells/ml, then after one hour the count of live cells would approximately be
- 10^6 cells/ml
 - 0.5×10^6 cells/ml
 - 0.693×10^6 cells/ml
 - 0.735×10^6 cells/ml
80. Two different microbes A and B having the same maximum specific growth rate are grown in two CSTRs at steady state at the same dilution rate D . At time $t = 0$, the substrate concentration in the feed of both reactors is halved and it is observed that while A gets washed out B reaches a new steady state. From this, we can conclude that
- the K_s of A is greater than K_s of B
 - the K_s of A is smaller than K_s of B
 - the $Y_{x/s}$ of A is greater than $Y_{x/s}$ of B
 - the $Y_{x/s}$ of A is smaller than $Y_{x/s}$ of B

81. A recombinant enzyme is cloned and expressed in *E. coli* at 37 °C where very little enzymatic activity is obtained even though a thick protein band of the correct size is observed in SDS-PAGE. Lowering the temperature of growth increases enzymatic activity while reducing the thickness of band seen in SDS-PAGE. If you want to get better activity even while growing the cells at 37 °C, you should as a first step

- (a) use a codon optimized strain
- (b) coexpress chaperones
- (c) increase the inducer concentration while expressing the protein
- (d) reduce glucose to prevent acetate accumulation

82. In a fed batch reactor with a constant feed rate of concentrated substrate, the cells are found to be growing at a μ of 0.3 h⁻¹ when the biomass concentration is 5 g/l. If the increase in biomass tapers off to reach an asymptotic value of 20 g/l (and the $Y_{x/s}^{true}$ is 0.5 g/g of substrate), the maintenance coefficient is approximately

- (a) 0.1
- (b) 0.2
- (c) 0.3
- (d) 0.4

83. If product formation kinetics is given by

$$\frac{1}{x} \left(\frac{dp}{dt} \right) = \beta$$

where $\beta = 0.1 \text{ h}^{-1}$ and the cells are in stationary phase with the biomass concentration being constant at 7 g/l, then in 5 hours the increase in product concentration will be

- (a) zero
- (b) 2.5 g/l
- (c) 3.0 g/l
- (d) 3.5 g/l

84. 1 ml working solution of 50 mM Tris-HCl, 20 mM EDTA, 10% sucrose and 10 mM MgSO₄ has to be made from stock of 100 mM Tris-HCl, 100 mM EDTA, 40% sucrose and 0.5 M MgSO₄. The amount of distilled water required will be

- (a) 10 μ l
- (b) 20 μ l
- (c) 30 μ l
- (d) 40 μ l

85. Plasmids are inherited by daughter cells by random partitioning and thus there is a finite probability of plasmid-free cell emergence when a daughter cell does not receive a plasmid. If the plasmid copy number is 20 and the plasmid exists as dimers instead of as monomers, then the probability of plasmid-free cell emergence increases
- (a) 2 fold
 - (b) 10 fold
 - (c) 100 fold
 - (d) 1000 fold
86. In a size exclusion gel chromatography run under gravity, two proteins of slightly different sizes get partially separated. Using longer columns *does not* improve separation because of
- (a) increased axial dispersion
 - (b) increase in number of theoretical plates
 - (c) increase in loading capacity
 - (d) increase in flow rate
87. Methylotrophic yeasts are grown anaerobically using glucose as sole carbon source. The theoretical maximum product yield per unit substrate consumed ($Y_{p/s}$) is
- (a) 0.49 g/g
 - (b) 0.67 g/g
 - (c) 0.71 g/g
 - (d) 1.07 g/g
88. A fermenter is cooled by cooling coils made of thin copper where the internal and external film heat transfer coefficients are both $500 \text{ W/m}^2\text{K}$. If due to increased agitation the external film heat transfer coefficient doubles to $1000 \text{ W/m}^2\text{K}$, then the overall heat transfer coefficient (U) will increase by approximately
- (a) 25%
 - (b) 33%
 - (c) 50%
 - (d) 100%

89. Consider a large protein moving by diffusion in a solvent. After an elapsed time t , the protein has performed a random walk of N diffusion moves of its centre of mass in the solvent. What is the standard deviation $\langle x_{tot}^2 \rangle^{1/2}$ of the N moves?

(Note : D = diffusion coefficient in m^2/s of the protein in the solvent.)

- (a) $\sqrt{2D}$
- (b) $2D\sqrt{t}$
- (c) $\sqrt{2Dt}$
- (d) $t\sqrt{2D}$

90. Consider a chemical binding reaction of ligands with protein receptors. In this system, there are only two states— A when the ligand is bounded to the protein and B when the ligand is not bounded (free) to the protein. The states A and B respectively present numbers of molecules N_A and N_B as well as chemical potentials μ_A and μ_B . When binding equilibrium is reached, which of the following relations is wrong?

[Note : $G(T, P, N_A, N_B)$ is the Gibbs free energy of the system taken at constant T and P .]

- (a) $\mu_A = \mu_B$
- (b) $(\partial G / \partial N_A) \times (\partial G / \partial N_B) < 0$
- (c) $\frac{dG}{dN_A} = 0$
- (d) $\frac{dG}{dN_B} = 0$

91. A pendulum is hanging from a hook attached to a horizontal board. If the board is allowed to fall from a height, then the pendulum is deflected from the equilibrium. As the board is falling, the pendulum will

- (a) swing faster
- (b) not swing
- (c) swing slower
- (d) swing irregularly

92. The total energy spend by a satellite, orbiting the earth having mass m and orbital radius r , in completing a circular orbit once round the earth (of mass M) is

- (a) zero
- (b) $-GMm/r$
- (c) GMm/r
- (d) $-GMm/2r$

93. The Gibbs free energy is defined as

(a) $G = TU + TS + PV$

(b) $G = U - TS + PV$

(c) $G = U + TdS + PV$

(d) $G = U + TS + PdV$

94. A culture containing two species of microbes in equal numbers is plated on an agar plate so as to form single colonies. The probability that 10 colonies picked at random would all belong to the same species is given by

(a) $\frac{1}{64}$

(b) $\frac{1}{256}$

(c) $\frac{1}{512}$

(d) $\frac{1}{1024}$

95. At absolute zero

(a) an isothermal and an adiabatic process are identical

(b) isothermal curves are steeper than adiabatic curves

(c) adiabatic curves are steeper than isothermal curves

(d) the molecular energy is zero

96. A force of 500 N is required to push a car of mass 1000 kg slowly at constant speed on a level road. If a force of 1000 N is applied, the acceleration of the car will be

(a) 1 m/s^2

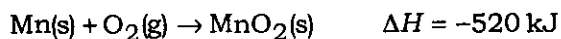
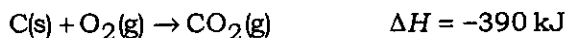
(b) 0.5 m/s^2

(c) 0 m/s^2

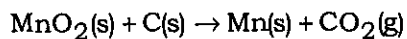
(d) 1.5 m/s^2

97. Find the correct combination.
- (a) Microwave – rotation, IR – vibration, UV visible – electronic
 - (b) Microwave – vibration, IR – rotation, UV visible – electronic
 - (c) Microwave – electronic, IR – rotation, UV visible – vibration
 - (d) Microwave – electronic, IR – vibration, UV visible – rotation
98. Clathrate compounds formed by noble gases are essentially maintained by
- (a) multiple bonding
 - (b) coordinate bonding
 - (c) covalent bonding
 - (d) hydrogen bonding
99. Benzene undergoes substitution reactions more easily than addition reactions because
- (a) it has a cyclic structure
 - (b) it has three double bonds
 - (c) it has six hydrogen atoms
 - (d) there is a delocalization of electrons

100. Using the following equations



determine the ΔH (in kJ) for the reaction



- (a) 910
- (b) 130
- (c) -130
- (d) -910

SPACE FOR ROUGH WORK

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