

62

QUESTION PAPER
SERIES CODE
A

Registration No. :

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Centre of Exam. :

Name of Candidate :

Signature of Invigilator

ENTRANCE EXAMINATION, 2014

M.Phil./Ph.D. LIFE SCIENCES

[Field of Study Code : SLSP (159)

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. Choose the most appropriate answer.
- (iv) Answer all 30 questions of Part—A.
- (v) Answer any 40 questions from Part—B. If you answer more than 40 questions, only first 40 will be checked. **Questions covering both Biological Sciences and Physical Sciences are included. Therefore, it is advised that you read the entire Question Paper.**
- (vi) Each correct answer carries one mark. For every wrong answer, half mark will be deducted.
- (vii) 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.
- (viii) Calculators and Log Tables may be used.
- (ix) Answer written by the candidates inside the Question Paper will not be evaluated.
- (x) Three Pages at the end have been provided for Rough Work.
- (xi) Return the Question Paper and Answer Sheet to the Invigilator at the end of the Entrance Examination.
- (xii) **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	Wrong	Wrong	Wrong	Correct
● (b) (c) ●	(a) (b) (c) (d)	(a) (b) (c) (d)	● (b) (c) ●	(a) (b) (c) ●

- 4. Once marked, no change in the answer is allowed.
- 5. Please do not make any stray marks on the Answer Sheet.
- 6. Please don't 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. A buffer solution contains 0.36 M sodium acetate (CH_3COONa) and 0.45 M acetic acid (CH_3COOH), $\text{p}K_a = 4.8$. What is the pH of this buffer solution?
 - (a) 4.7
 - (b) 5.2
 - (c) 3.8
 - (d) 6.1
2. Repeating units of hyaluronic acid are
 - (a) *N*-acetylglucosamine and D-glucuronic acid
 - (b) *N*-acetylgalactosamine and D-glucuronic acid
 - (c) *N*-acetylglucosamine and galactose
 - (d) *N*-acetylgalactosamine and L-iduronic acid
3. Staphylococcal nuclease has 25 glutamic acid residues. The $\text{p}K_a$ of their side chains are likely to be
 - (a) same for all and identical to that of free glutamic acid
 - (b) same for all but with a value lower than that of free glutamic acid
 - (c) same for all but with a value higher than that of free glutamic acid
 - (d) different for different residues depending upon their adjoining amino acids
4. Optimum pH for lysozyme is ~5.0. The active site of lysozyme contains one glutamic acid ($\text{p}K_a = 5.5$) and one aspartic acid ($\text{p}K_a = 4.0$) residue. What would be the correct statement for its catalytic function?
 - (a) The aspartic acid residue is deprotonated and the glutamic acid residue is protonated
 - (b) The aspartic acid residue is protonated and the glutamic acid residue is deprotonated
 - (c) Both aspartic acid and glutamic acid residues are deprotonated
 - (d) Both aspartic acid and glutamic acid residues are protonated
5. In the presence of high levels of tryptophan (*trp*)
 - (a) attenuator allows the transcription of *trp* structural genes
 - (b) attenuator does not affect the transcription of *trp* structural genes
 - (c) attenuator terminates the transcription of *trp* structural genes
 - (d) leaky transcription of *trp* structural genes takes place

6. A scientist determined the amount of guanine, adenine, thymine and cytosine in four different viruses. Virus A possessed double-stranded DNA genome, virus B possessed single-stranded DNA genome, virus C possessed double-stranded RNA genome and virus D possessed single-stranded RNA genome. Which one of the following statements is true?
- (a) Only virus A will obey Chargaff's rule
 - (b) Virus A and virus B will obey Chargaff's rule
 - (c) Virus C and virus D will not obey Chargaff's rule
 - (d) Virus A and virus C will obey Chargaff's rule
7. The Luria-Delbruck experiment on mutations to phage resistance proved that
- (a) mutations are influenced by selection pressure
 - (b) mutations occur randomly and independent of selection pressure and are propagated clonally
 - (c) mutation frequency increases upon exposure of bacteria to bacteriophage
 - (d) certain fraction of the population is predestined to survive in presence of phage
8. Which one of the following DNA repair mechanisms in *E. coli* is most error-prone?
- (a) Photoreactivation of thymidine dimers
 - (b) Mismatch repair
 - (c) Base excision repair
 - (d) SOS repair
9. Zeolite softening process removes
- (a) only temporary hardness of water
 - (b) only permanent hardness of water
 - (c) both temporary and permanent hardness of water
 - (d) the dissolved gases in permanent hard water
10. Which one of the following binding proteins destabilizes actin filaments?
- (a) Tropomyosin
 - (b) Cofilin
 - (c) Stathmin
 - (d) Thymosin

11. Which of the following is a specific inhibitor for eukaryotic RNA polymerase II?
- (a) Cycloheximide
 - (b) Tetracycline
 - (c) Actinomycin D
 - (d) α -amanitin
12. The function of a Geiger-Müller counter is based on
- (a) liquid scintillation
 - (b) solid scintillation
 - (c) gas ionization
 - (d) autoradiography
13. In the year 2012, Sir John B Gurdon and Shinya Yamanaka won the Nobel Prize in the field of physiology or medicine for
- (a) RNA interference-gene silencing by double-stranded RNA
 - (b) demonstrating that mature cells can be reprogrammed to become pluripotent
 - (c) developing *C. elegans* as a model system for studying developmental biology
 - (d) proposing the concept of 'organizer' in amphibians
14. Cystic fibrosis is an autosomal recessive disorder caused by mutations in CFTR gene. A woman is a heterozygous for the cystic fibrosis mutation but her husband is normal homozygous. Which of the following statements is true?
- (a) The woman will show cystic fibrosis symptoms
 - (b) 25% of the progeny will show cystic fibrosis symptoms
 - (c) 50% of the progeny will be carriers
 - (d) 25% of the progeny will be normal homozygous
15. Guard mother cell is an example of
- (a) secondary meristem
 - (b) primary meristem
 - (c) embryonic meristem
 - (d) ground tissue

16. A mutated/genetically modified dicotyledonous flower showing only stamens, as opposed to the wild type plant which has sepal, petal, stamen and carpel. Which of the following kinds of modification has possibly occurred in the mutated plant?
- (a) 'A' class gene mutated and 'B' class gene overexpressed
 - (b) 'B' class gene mutated and 'A' class gene overexpressed
 - (c) Both class 'A' and class 'B' genes are mutated
 - (d) Both class 'A' and class 'B' genes are overexpressed
17. Which of the following is very specific to plants?
- (a) Cell movement during embryogenesis
 - (b) Presence of totipotent cells during embryonic stage
 - (c) Recurrence of germ-line cells throughout development
 - (d) Imprinting of maternal genes
18. Lateral branching of roots of dicotyledonous plants often originates from
- (a) axial root meristem
 - (b) lateral cap and epithelial initials
 - (c) vascular initial
 - (d) differentiated cells of pericycle or cortex
19. A 25-year-old medical student spent a summer volunteering in the sub-Sahara region of Africa. There he observed a high incidence of people reporting difficulty with night vision due to lack of vitamin A in their diet. Vitamin A is precursor for the synthesis of
- (a) rod and cones
 - (b) retinal
 - (c) rod transducin
 - (d) opsin
20. The mammalian blood cells are prevented from sticking to one another or to the walls of blood vessels due to which of the following in their plasma membranes?
- (a) Glycolipid
 - (b) Glycocalyx
 - (c) Cholesterol
 - (d) Phospholipid

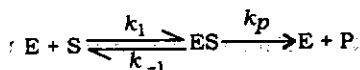
21. A neuroscientist is studying communication between hypothalamus and pituitary gland in the rat. He interrupts blood flow through the median eminence and then measures circulating levels of pituitary hormones. Secretion of which one of the following hormones will be unaffected by the experimental manipulation?
- (a) Growth hormone
 - (b) Thyroid-stimulating hormone
 - (c) Arginine vasopressin
 - (d) Adrenocorticotropin hormone
22. Which one of the following characteristics of an axon is dependent on its diameter?
- (a) The magnitude of its resting potential
 - (b) The duration of its refractory period
 - (c) The conduction velocity of its action potential
 - (d) The activity of its sodium-potassium pump
23. For high resolution of biological specimen in electron microscope, a high-velocity electron beam is used for illumination, rather than using visible light, because of its
- (a) shorter wavelength
 - (b) ionizing property
 - (c) electrical property
 - (d) migration through gaseous phase
24. Which of the following is a characteristic of a *T* cell epitope but not of a *B* cell epitope?
- (a) They generally are located on the surface of a protein
 - (b) Multiple different epitopes may occur in the same antigen
 - (c) Their immunogenicity may depend on the 3D structure of the antigen
 - (d) They generally are located in the interior of a protein
25. A parallel-plate capacitor with air between its plates is charged until a potential difference of V appears across it. Another capacitor, having hard rubber (dielectric constant = 3) between its plates but otherwise identical is also charged to the same potential difference. If the energy of the first capacitor is W , that of the second is
- (a) $1/3 W$
 - (b) W
 - (c) $3W$
 - (d) $9W$

26. What is the minimum number of lines in a plane transmission grating of width 2.5 cm so that in the first-order spectrum the yellow lines of sodium (5890 Å and 5896 Å) can just be resolved?
- (a) 393
 - (b) 2455
 - (c) 982
 - (d) 491
27. At a railway station a 24-hour watch loses 3 minutes in 4 hours. If it is set correctly on Sunday noon, when will the watch show correct time again?
- (a) 6 pm after 40 days
 - (b) 12 noon after 75 days
 - (c) 12 pm after 100 days
 - (d) 12 noon after 80 days
28. Sodium salts of carboxylic acids when heated with soda lime would yield
- (a) alkanes
 - (b) alkenes
 - (c) alkynes
 - (d) alkyl hydroxides
29. Isomers that have the same molecular formula but differ in their physical and chemical properties are called
- (a) structural isomers
 - (b) enantiomers
 - (c) conformers
 - (d) rotamers
30. Moving 2.5×10^{-6} coulomb of charge from point *A* to point *B* in an electric field requires 6.3×10^{-4} Joule of work. The potential difference between points *A* and *B* is approximately
- (a) 1.6×10^{-9} V
 - (b) 4.0×10^{-3} V
 - (c) 2.5×10^{-2} V
 - (d) 1.0×10^{-14} V

PART—B

Answer **forty** questions

31. A five-year-old boy shows abnormally low ketone and glucose levels and is diagnosed with primary carnitine deficiency. Carnitine is directly involved in
- (a) activation of fatty acids
 - (b) transport of fatty acyl CoA
 - (c) β -oxidation
 - (d) ω -oxidation
32. You are asked to monitor the rate of O_2 consumption in a well-buffered suspension of mitochondria containing an excess of ADP and P_i in presence of oligomycin at $t = 1$. After sometime, at $t = 2$, 2,4-dinitrophenol is added to the above suspension. How will the rate of O_2 consumption be affected?
- (a) O_2 consumption will continue at $t = 1$ but will be blocked at $t = 2$
 - (b) O_2 consumption will continue at the same rate at both the time points
 - (c) O_2 consumption will be blocked at $t = 1$ but will resume at $t = 2$
 - (d) O_2 consumption will be slower at $t = 1$ but will be faster at $t = 2$
33. Between rotenone and antimycin A, the latter is considered a more potent poison because of which of the following reasons?
- (a) Antimycin A blocks all electron flow to oxygen, while rotenone blocks electron flow from NADH
 - (b) Antimycin A blocks all electron flow from NADH, while rotenone blocks all electron flow to oxygen
 - (c) Antimycin A blocks electron flow from cytochrome b to ubiquinone, while rotenone blocks electron flow from $FADH_2$
 - (d) Antimycin A blocks electron flow from $FADH_2$, while rotenone blocks all electron flow to oxygen
34. Given the reaction



where $k_1 = 1 \times 10^7 \text{ M}^{-1} \text{ sec}^{-1}$, $k_{-1} = 1 \times 10^2 \text{ sec}^{-1}$ and $k_p = 3 \times 10^2 \text{ sec}^{-1}$. The value of K_s and K_M are respectively

- (a) $1 \times 10^{-5} \text{ M}$ and $4 \times 10^{-5} \text{ M}$
- (b) $1 \times 10^{-6} \text{ M}$ and $4 \times 10^{-6} \text{ M}$
- (c) $4 \times 10^{-5} \text{ M}$ and $1 \times 10^{-5} \text{ M}$
- (d) $4 \times 10^{-6} \text{ M}$ and $1 \times 10^{-6} \text{ M}$

35. One microgram of pure enzyme (MW = 92000 Da) catalyzed a reaction at a rate of 0.50μ moles/min under optimum conditions. Specific activity of the enzyme in terms of units/mole is

(a) 4.6×10^{10}

(b) 4.6×10^9

(c) 2.3×10^{10}

(d) 2.3×10^9

36. A suspension of bacteria containing 400 mg dry weight per liter has an optical density of 1.00 in a 1 cm cuvette at 600 nm. What is the cell density in a suspension that has a transmission of 30% in a 3 cm cuvette? [$\log 3.333 = 0.523$]

(a) 6.97 mg/L

(b) 06.93 mg/L

(c) 69.7 mg/L

(d) 690 mg/L

37. The reduction potential of the following compounds are given below :

$$\text{Acetoacetate} = -0.346$$

$$\text{Cytochrome b (Fe}^{3+}\text{)} = 0.077$$

$$\text{NAD}^+ = -0.315$$

$$\text{Pyruvate} = -0.185$$

The above according to their increasing oxidizing power will be

(a) cytochrome b (Fe³⁺), acetoacetate, NAD⁺, pyruvate

(b) acetoacetate, NAD⁺, pyruvate, cytochrome b (Fe³⁺)

(c) cytochrome b (Fe³⁺), pyruvate, NAD⁺, acetoacetate

(d) acetoacetate, cytochrome b (Fe³⁺), NAD⁺, pyruvate

38. A researcher isolated 6 mutants of *Neurospora crassa* and performed the following complementation assay :

Mutant	Precursor added to the minimal media					
	A	J	G	B	M	R
1	+	-	+	+	+	+
2	+	-	+	-	+	+
3	-	-	+	-	+	+
4	-	-	-	-	+	+
5	-	-	-	-	+	-
6	+	+	+	+	+	+

+ = growth is observed
 - = no growth is observed

Which of the following is most likely the biochemical pathway?

- (a) $\rightarrow A \rightarrow G \rightarrow B \rightarrow R \rightarrow J \rightarrow M$
 (b) $\rightarrow J \rightarrow B \rightarrow A \rightarrow G \rightarrow R \rightarrow M$
 (c) $\rightarrow A \rightarrow B \rightarrow J \rightarrow R \rightarrow G \rightarrow M$
 (d) $\rightarrow J \rightarrow A \rightarrow B \rightarrow G \rightarrow R \rightarrow M$
39. Protein X contains a kinase domain and a transcription activator domain. The kinase domain is required for autophosphorylation as well as phosphorylating serine residues on many other target proteins. The transcription activator domain is required for interacting with p53, a transcription factor. A researcher does the following co-immunoprecipitation experiments to study the interaction between protein X and p53 :
- A. Immunoprecipitate protein X and blot with p53 antibody
 B. Immunoprecipitate protein X and blot with antibody recognizing phosphorylated p53
 C. Immunoprecipitate protein X lacking the kinase domain and blot with p53 antibody
 D. Immunoprecipitate protein X lacking the transcription activator domain and blot with p53 antibody.

Which of the above experiments prove that protein X phosphorylates p53?

- (a) A and B
 (b) A and C
 (c) B and C
 (d) B and D

40. When one provides labelled ATP to the β -position of a given eukaryotic cell undergoing transcription and RNA processing; where would the radioactive isotope appear in mature RNA?
- Phosphate groups of the phosphodiester backbone will be labelled
 - Label will appear at the 5'-end of mRNA molecule that has A as the first residue
 - Label will not appear in the RNA chain as the β -phosphate is released as PP_i
 - The label will appear at the 5'-end of all the newly synthesized mRNA molecules

41. In density gradient centrifugation, the Okazaki fragments can be separated from the leading strand. A researcher has isolated the following mutants :

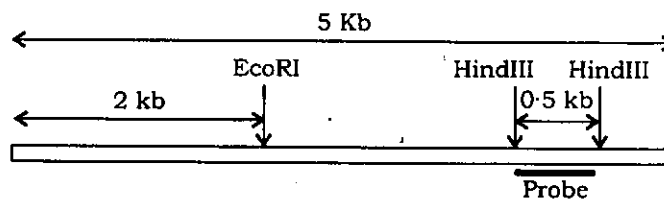
Mutant 1 : polymerase deficient DNA pol I

Mutant 2 : 5' \rightarrow 3' exonuclease deficient DNA pol I

Mutant 3 : 3' \rightarrow 5' exonuclease deficient DNA pol I

In which of the above mutants will the researcher see large number of Okazaki fragments?

- Mutant 1 only
 - Both mutants 1 and 2
 - Both mutants 1 and 3
 - Both mutants 2 and 3
42. A transgenic organism was developed with a DNA fragment as shown below :



Southern hybridization was carried out using EcoRI digested genomic DNA and hybridized with a 0.5 kb HindIII fragment (probe) as shown above. Considering that two unlinked copies of the DNA fragment was incorporated in the genome, which of the following is expected?

- A single band greater than or equal to 3 kb
- Two bands greater than 3 kb
- One band of 3 kb and one band of 2 kb
- Two bands of 0.5 kb

43. Protein Y from mammalian cell contains three domains—a transactivator domain, a DNA-binding domain, and a kinase domain. A researcher does the following experiments :

- A. EMSA using protein Y lacking transactivator domain and radiolabelled DNA
- B. EMSA using protein Y lacking kinase domain and radiolabelled DNA
- C. EMSA using protein Y lacking DNA-binding domain and radiolabelled DNA
- D. EMSA using just the DNA-binding domain and radiolabelled DNA

Which of the above experiments prove that the DNA-binding domain is necessary and sufficient for interaction with DNA?

- (a) A and C
- (b) B and C
- (c) B and D
- (d) C and D

44. The following statements were made regarding the tryptophan operon :

- A. It is an inducible operon
- B. It is a repressible operon
- C. It is controlled by a positive regulator
- D. It is controlled by a negative regulator
- E. The rate of translation of the *trpL* region controls transcription of the structural gene
- F. Attenuation inhibits the translation of the polycistronic mRNA

Which of the above statements are true?

- (a) A, C and E
- (b) B, D and E
- (c) A, C and F
- (d) B, D and F

45. Cell fusion experiments with cultured mammalian cells showed that diffusible factors regulated cell cycle. Following possible observations regarding this were made :
- A. When cells in G_1 were fused with cells in S phase and the fused cells were exposed to radiolabelled thymidine, the label was incorporated into the G_1 and S phase nucleus
 - B. When cells in G_2 phase were fused to S phase cells, no incorporation of labelled thymidine occurred in G_2 nuclei
 - C. When cells in G_1 were fused with cells in S phase and the fused cells were exposed to radiolabelled thymidine, the label did not get incorporated into the G_1 and S phase nucleus
 - D. When cells in G_2 phase were fused to S phase cells, incorporation of labelled thymidine occurred in G_2 nuclei

Which one of the following combinations of the above statements is true?

- (a) A and B
 - (b) A and D
 - (c) B and C
 - (d) C and D
46. Toxins like cytochalasin D and lantrunculin perturb the pool of actin monomers and are useful in studying actin dynamics. Following few statements regarding their mode of action were made :
- A. Both promote depolymerization of filaments by the same mechanism
 - B. Cytochalasin D depolymerizes actin filaments by binding to the (+) end of F-actin, where it blocks further addition of subunits
 - C. Lantrunculin binds and sequesters G-actin, inhibiting it from adding to a filament end
 - D. Cytochalasin D depolymerizes actin filaments by binding to the (-) end of F-actin, where it blocks further addition of subunits
 - E. Exposure to either toxin decreases the monomer pool
 - F. When either of them is added to live cells, the actin cytoskeleton disassembles and cell movements such as locomotion and cytokinesis are inhibited

Which of the above statements are correct?

- (a) A, B and C
- (b) B, C and D
- (c) C, D and E
- (d) B, C and F

47. Na-K ATPase is a tetramer, transmembrane protein. It exchanges Na^+ and K^+ at the cost of hydrolysis of ATP and ouabain is its specific inhibitor. Which of the following statements about the binding of these molecules/ions on the Na-K ATPase is correct?

- (a) Na^+ and K^+ bind on the extracellular side, while ATP and ouabain bind on the intracellular side
- (b) Na^+ and K^+ bind on the intracellular side, while ATP and ouabain bind on the extracellular side
- (c) K^+ and ATP bind on the intracellular side, while Na^+ and ouabain bind on the extracellular side
- (d) Na^+ and ATP bind on the intracellular side, while K^+ and ouabain bind on the extracellular side

48. Nitroglycerine has been used as a treatment for intense chest pain of angina. Few of the events possibly taking place during this are listed below :

- A. Signal-induced relaxation of vascular smooth muscle is mediated by cGMP activated protein kinase G and involves nitric oxide (NO)
- B. NO is synthesized by the smooth muscle cells in response to acetylcholine and subsequent elevation in cytosolic calcium
- C. NO is synthesized by the endothelial cells in response to acetylcholine and subsequent elevation in cytosolic calcium
- D. Protein kinase G activates a signalling cascade that results in inhibition of actin-myosin complex, relaxation of the cell and thus dilation of the blood vessel
- E. Protein kinase G activates a signalling cascade that results in activation of actin-myosin complex, contraction of the cell and thus dilation of the blood vessel

Which of the following combinations of the above statements is correct?

- (a) A, C and D
- (b) A, B and C
- (c) B, D and E
- (d) A, B and E

49. In developing brain, notch signalling

- (a) promotes neuron formation
- (b) promotes astrocyte formation and inhibits neuron formation
- (c) inhibits stem cell to neural progenitor cell formations
- (d) inhibits astrocyte formation

50. In mitogenic signalling in cancer, epidermal growth factor receptor (EGFR) plays an important role in cell proliferation. What is the classical sequence for activation of this signalling?
- (a) EGFR-Ras-Raf-MAPK-AP1
 - (b) EGFR-MAPK-Ras-Raf-AP1
 - (c) EGFR-Raf-Ras-AP1-MAPK
 - (d) EGFR-Raf-MAPK-AP1-Ras
51. Which of the following objectives would give you the best resolution of small objects?
- (a) 10 × air, N.A. 0.25
 - (b) 40 × air, N.A. 0.65
 - (c) 64 × oil, N.A. 1.4
 - (d) 100 × oil, N.A. 1.25
52. *Helicobacter pylori* uses the enzyme urease to counteract a chemical defense in the human organ in which it lives. This chemical defense is
- (a) lysozyme
 - (b) hydrochloric acid
 - (c) superoxide radicals
 - (d) sebum
53. Archeal cells usually do not contain peptidoglycan, rather contain pseudo-peptidoglycan which is largely composed of
- (a) N-acetylmuramic acid and L-amino acids
 - (b) N-acetylmuramic acid and D-amino acids
 - (c) N-acetyltalosaminuronic acid and D-amino acids
 - (d) N-acetyltalosaminuronic acid and L-amino acids
54. The ability of *Vibrio fischeri* to produce bioluminescence chemicals only when a certain population density has been reached is an example of
- (a) Liebig's law of the minimum
 - (b) Shelford's law of tolerance
 - (c) Quorum sensing
 - (d) Heisenberg's principle of uncertainty

55. When composite transposons are formed
- (a) a small deletion occurs in the transposase gene of an IS element
 - (b) a small deletion occurs in the transposase gene of an IS element and plasmid is integrated
 - (c) an IS element integrates with another IS element with the help of a plasmid
 - (d) two IS elements integrate into a chromosome with only a small distance separating them
56. You could identify an unknown bacterium by all of the following, **except**
- (a) hybridizing a DNA probe from a known bacterium with the unknown's DNA
 - (b) percentage of guanine and cytosine
 - (c) making a fatty acid profile of the unknown
 - (d) ribosomal RNA sequencing
57. You are given two 24-hour-grown cultures that have entered the stationary phase. These cultures were inoculated with 100 cells into 100 ml of nutrient broth and 100 cells in 200 ml of nutrient broth. What should be the number of cells after 24 hours?
- (a) More cells per ml in the 100 ml
 - (b) More cells per ml in the 200 ml
 - (c) The same number of cells per ml in each
 - (d) Less cells per ml in the 100 ml
58. Organisms with complex life cycle that include a mammalian host and an insect host, and involve schizogony as part of the cycle belong to which one of the following groups of Protozoa?
- (a) Sarcocystophora
 - (b) Apicomplexa
 - (c) Microspora
 - (d) Myxozoa
59. Retinoic acid is synthesized in the wound epidermis of the regenerating limb and forms a gradient along the proximal-distal and anterior-posterior axes of the blastema. What would be the effect of retinoic acid on the positional information of the blastema cells when applied on the amputated newt limb?
- (a) The cells will become respecified to a more proximal position
 - (b) Exogenous retinoic acid will have no effect on the regeneration
 - (c) The cells will become respecified to a more distal position
 - (d) The cells will lose their positional identity and remain dedifferentiated in the blastema

60. Following results of tissue transplantation during early and late gastrula stages of newt were obtained :

Experiment Number	Donor region	Host region	Differentiation of donor region	Conclusion
1.	Prospective neuron from early gastrula	Epidermis	Epidermis	Conditional development
2.	Prospective epidermis from early gastrula	Neuron	Epidermis	Conditional development
3.	Prospective neuron from late gastrula	Epidermis	Neuron	Autonomous development
4.	Prospective epidermis from late gastrula	Neuron	Neuron	Autonomous development

Which of the conclusions drawn from the abovesaid experiments are true?

21 TA

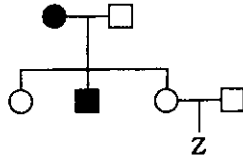
- (a) Conclusions drawn from experiments 1 and 4
- (b) Conclusions drawn from experiments 2 and 3
- (c) Conclusions drawn from experiments 2 and 4
- (d) Conclusions drawn from experiments 1 and 3
61. Mutations in the terminal genes in case of *Drosophila* result in loss of acron and most anterior head segments as well as telson and most posterior abdominal segments. Following statements regarding the terminal ends of *Drosophila* were made :
- A. Embryos of mothers with mutation of *torso* have neither acron nor telson
- B. Torso protein is spatially restricted to the ends of the egg
- C. Torso-like gene is usually expressed in the anterior and posterior follicle cells
- D. The end products of the RTK cascade activated by torso diffuse into the cytoplasm and activate the Grouch protein, a transcriptional inhibitor of *tailless* and *huckebein* gap genes

Which of the above statements is/are true?

- (a) A only
- (b) A and C
- (c) A and B
- (d) B and D

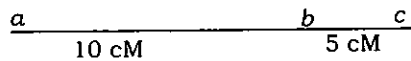
62. A state of immunity can be induced by active or passive immunization. Which of the following confers active immunity?
- (a) Administration of antiserum to provide protection from poisonous snakebite
 - (b) Newborn infants benefitting from the presence of maternal antibodies in their circulation
 - (c) Administration of antisera to diphtheria toxoid to provide immediate protection to travellers who will soon be exposed to the infectious organism
 - (d) Administration of tetanus toxoid to prevent fatal tetanus infection from a deep puncture wound by stepping on a rusty nail
63. Immunity is the state of protection against foreign organisms or substances (antigens). Vertebrates have two types of immunity—innate and adaptive, that operates cooperatively. The following are the features of innate or adaptive immunity or both :
- A. Antigenic specificity
 - B. Diversity in recognition
 - C. Immunologic memory
 - D. Pathogen-associated molecular pattern recognition
 - E. First line of defense against infection
- Which of the above are hallmarks of an adaptive immune response?
- (a) B, C and D
 - (b) A, B and C
 - (c) A, C and D
 - (d) C, D and E
64. You are an energetic immunology student who wants to raise antibodies directed against dinitrophenol. Which of the following injection schedules in an animal will allow dinitrophenol to become accessible to the immune system and function as an immunogen?
- (a) Injection with dinitrophenol alone
 - (b) Injection with a large protein molecule like BSA followed by injection with dinitrophenol
 - (c) Injection with a complex containing multiple copies of dinitrophenol conjugated to BSA
 - (d) Injection with dinitrophenol followed by injection with BSA

65. The following pedigree shows the inheritance pattern of an autosomal recessive trait :



Considering that the probability of a carrier in the population is $1/3$, what is the probability of the child (Z) to show the trait?

- (a) $1/4$
 (b) $1/18$
 (c) $1/24$
 (d) $1/48$
66. The linkage map of three genes is shown below :



A stock of the genotype $\frac{a}{+} \frac{+}{b} \frac{+}{c}$ was testcrossed.

Considering that there were no double crossovers, what percentage of the progeny will be of the genotype $aabbcc$?

- (a) 20
 (b) 10
 (c) 5
 (d) 2.5
67. A couple comes to a hospital for genetic counselling. They do not want a second child to have the X-linked recessive disease observed in their son. The parents do not display this X-linked recessive trait. What advice would the doctor likely give?
- (a) They are not at risk of having another affected child
 (b) They have $\frac{1}{8}$ chance of having another affected child
 (c) They have $\frac{1}{4}$ chance of having another affected child since it is a recessive trait
 (d) They have $\frac{1}{4}$ chance of having another affected child if the child is a boy
68. By using a laser beam a few cells of a root endodermis layer of a seedling was killed, and the plant was allowed to grow normally. After a few days it was observed that the positions of the dead cells were refilled by the division of neighboring cells. The newly made cells would show cell fate similar to
- (a) cortical cell
 (b) endodermal cell
 (c) vascular cell
 (d) epithelial cell

69. When the plane of division is perpendicular to the nearest surface, it is referred to as anticlinal cell division, while a cell division with perpendicular plane is referred to as periclinal cell division. Following statements indicate the role of these two types of cell division :

- A. Anticlinal cell division increases thickness of the plant
- B. Anticlinal cell division increases height of the plant
- C. Periclinal cell division promotes peripheral organ formation
- D. Anticlinal and periclinal cell divisions together promote peripheral organ formation

Which of the above statements are true with respect to shoot apical meristem?

- (a) A and C
- (b) B and C
- (c) B and D
- (d) A and D

70. RuBisCO has the capacity to catalyze both carboxylation and oxygenation of ribulose 1,5-biphosphate. Carboxylation yields two molecules of 3-phosphoglycerate while oxygenation produces one molecule each of 3-phosphoglycerate and 2-phosphoglycerate. The oxygenation of ribulose 1,5-biphosphate catalyzed by RuBisCO initiates a coordinated network on enzymatic reactions that are compartmentalized in various organelles. Mentioned below are some of the reactions which take place during the C_2 oxidative photosynthetic cycle :

- A. $2 \text{ glycolate} + 2\text{O}_2 \rightarrow 2 \text{ glyoxylate} + 2\text{H}_2\text{O}_2$
- B. $\text{Serine} + 2\text{-oxoglutarate} \rightarrow \text{hydroxypyruvate} + \text{glutamate}$
- C. $\text{Glutamate} + \text{NH}_4^+ + \text{ATP} \rightarrow \text{glutamine} + \text{ADP} + \text{P}_i$
- D. $\text{Hydroxypyruvate} + \text{NADH} + \text{H}^+ \rightarrow \text{glycerate} + \text{NAD}^+$

Which of the above reactions take(s) place in chloroplast?

- (a) A only
- (b) C only
- (c) Both A and C
- (d) B, C and D

71. The chloroplast is the site of photosynthesis. Almost all the chemical processes that make up photosynthesis are carried out by four major protein complexes—photosystem I, photosystem II, the cytochrome b6f complex and the ATP synthase. These four integral membrane complexes are oriented in the thylakoid membrane to function as follows :
- A. Photosystem II oxidizes water to O_2 in the lumen
 - B. Cytochrome b6f oxidizes plastoquinone molecules
 - C. Photosystem I reduces $NADP^+$ to NADPH in the stroma
 - D. ATP synthase produces ATP as protons diffuse back from the stroma into the lumen

Which of the following options is **correct** with respect to Z scheme?

- (a) A and B
 - (b) B and C
 - (c) A and C
 - (d) B and D
72. After infection of a cell by HIV, which one of the following is responsible for synthesis of progeny genomes?
- (a) Viral-encoded DNA-dependent RNA polymerase
 - (b) Viral-encoded RNA-dependent RNA polymerase
 - (c) Host-encoded DNA polymerase
 - (d) Host-encoded RNA polymerase
73. After many trials, a research scholar could not transform tobacco for expressing gene *X* by *Agrobacterium*-mediated transformation method. He suspected that gene *X* could be toxic; so he attempted the transformation by particle bombardment method. To his surprise, he observed that the tobacco plants expressing gene *X* were very normal. Then he started investigating the reasons for his failure by *Agrobacterium* transformation method. Following were his observations :
- A. The T_1 helper plasmid had gentamycin resistance gene, but he did not use gentamycin during selection step
 - B. The T-DNA contained kanamycin resistance gene, but during selection, but he did not use kanamycin
 - C. The T_1 vector plasmid had ampicillin gene for bacterial resistance, but he did not use ampicillin during selection step
 - D. In the experiments, he used both kanamycin and gentamycin during selection step

Based on the statements mentioned above, which of the following are logical conclusion for failure to get transformation?

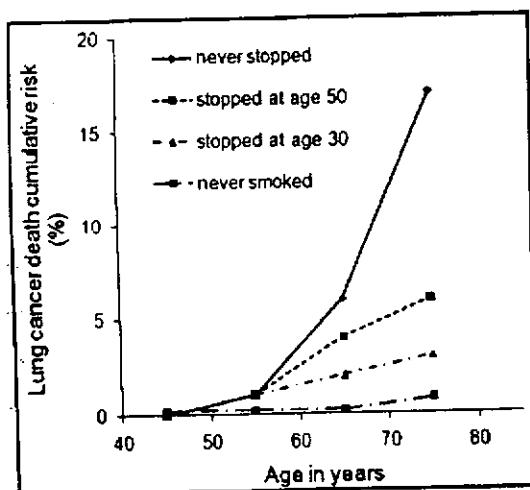
- (a) A and B
- (b) B and C
- (c) C and D
- (d) B and D

74. Some viruses, surrounded by membranous envelope, originate from the
- (a) plasma membrane of the host cell
 - (b) synthesis of proteins and lipids inside the virus
 - (c) synthesis of proteins in the virus and lipids in the host cell
 - (d) synthesis of lipids in the virus and proteins in the host cell
75. A 30-year-old patient comes to his doctor complaining of headaches and vertigo. A blood test reveals a hematocrit of 55% and a diagnosis of polycythemia is made. Which of the following would also increase?
- (a) Blood pressure
 - (b) Radius of vessels
 - (c) Capillary blood flow
 - (d) Central venous pressure
76. The composition of dry air is 21% O₂, 0.04% CO₂, 78% N₂ and 0.96% other inert constituents. The barometric pressure at sea level is 760 mm Hg, where the partial pressure of oxygen is 160 mm Hg. The barometric pressure, however, at the top of the Mount Everest is 250 mm Hg and air is dry. What would be the approximate partial pressure of oxygen at the Mount Everest?
- (a) 0.5 mm Hg
 - (b) 5 mm Hg
 - (c) 50 mm Hg
 - (d) 100 mm Hg
77. A newborn becomes lethargic after feeding and increases his respiratory rate. He becomes virtually comatose, responding only to painful stimuli, and exhibits mild respiratory alkalosis. Suspicion of a urea cycle disorder is aroused and evaluation of serum amino acid levels is initiated. In the presence of hyperammonemia, production of which of the following amino acids is always increased?
- (a) Arginine
 - (b) Proline
 - (c) Histidine
 - (d) Glutamine
78. The brain of a gazelle remains at a lower temperature in comparison to the body core temperature, because the
- (a) temperature of the arterial blood supplying to the brain is colder than venous blood
 - (b) cerebrospinal fluid circulation in the brain is faster
 - (c) cranium is porous
 - (d) air entering through nostril passes through the cranium

79. Loss of appetite and depression inhibit the stimulatory impulses to
- (a) sympathetic centre on the stomach
 - (b) parasympathetic centre on the intestine
 - (c) parasympathetic centre on the stomach
 - (d) sympathetic centre on the duodenum
80. Regulation of wound healing from a connective tissue perspective is due to
- (a) hypertrophy
 - (b) metaplasia
 - (c) atrophy
 - (d) hyperplasia
81. Molecules having same number of carbon atoms but different structural configuration have
- (a) different odour
 - (b) similar odour
 - (c) no odour
 - (d) Both (b) and (c)
82. Which of the following statements concerning X-ray crystallography is **not** true?
- (a) Only crystallized proteins can be analyzed
 - (b) The electron density maps are obtained by applying the Fourier transform to the scattered electron intensities
 - (c) A protein in its soluble form can be analyzed
 - (d) A structure with a resolution of 2 Å gives atomic details about the protein
83. A D-amino acid would interrupt α helix made of L-amino acids. Another naturally occurring constraint on the formation of a helix is the presence of a
- (a) negatively charged arginine residue
 - (b) positively charged lysine residue
 - (c) nonpolar residue near the carboxyl terminus
 - (d) proline residue
84. Phosphorescence measurements are usually made at a lower temperature to
- (a) prevent thermal degradation of the phosphorescent species
 - (b) promote phosphorescence by slowing the rate of radiationless transfer processes
 - (c) increase the efficiency of the detector
 - (d) decrease the efficiency of the detector

85. Blood coagulation involves a cascade of events. Which one of the following conversion pathways associated with the formation of blood clot is correct?
- (a) Fibrin-fibrinogen-fibrin clot
 - (b) Prothrombin-thrombin-fibrinogen-fibrin-fibrin clot
 - (c) Fibrinogen-fibrin-fibrin clot
 - (d) Fibrinogen-prothrombin-thrombin-fibrin-fibrin clot
86. Which of the following statements is incorrect in relation to the brain of higher animals?
- (a) Glia are more in number than the neurons and they help in providing protection, growth and development of neurons
 - (b) Glia are significantly fewer in number than the neurons, the latter help in the survival of the former
 - (c) Neurons are significantly fewer in number than the glia and the latter help maintaining ionic homeostasis of neurons
 - (d) Glia are significantly more in number than neurons, they help in making blood-brain barrier but apparently does not appear to directly regulate the rate of propagation of action potential in neurons
87. In a neuronal culture experiment, the effect of a chemical was prevented by pretreating the cells with prazosin, an alpha-1-adrenoceptor antagonist but not by propranolol, a β -adrenoceptor antagonist. The chemical under study is likely to be
- (a) acetylcholine or carbachol
 - (b) orexin or serotonin
 - (c) GABA or glutamate
 - (d) noradrenaline or methoxamine

88. Mortality due to lung cancer was followed in a group of male population for 50 years. Figure below shows the cumulative risk of death from lung cancer as a function of age and smoking habits for four groups :



The data show that cumulative risk of dying from lung cancer is substantially reduced by stopping smoking. What could be the basis for this observation?

- (a) Incidence of cancer increases dramatically with age
 - (b) A linear relationship between carcinogen concentration and cancer formation
 - (c) Mutations in a reformed smoker are generated at a slower rate than in a continuing smoker
 - (d) Cancer is a multistep process in which cancer-causing changes accumulate over time
89. One major goal of cancer therapy is to identify small-molecule anti-cancer drugs that can be used to inhibit the products of specific cancer-critical genes. If you are searching for such molecules, you would choose to design inhibitors for products of
- (a) oncogenes
 - (b) tumor suppressor genes
 - (c) DNA maintenance genes
 - (d) RNA maintenance genes

90. What is the most likely mechanism of ultraviolet radiation-induced skin carcinogenesis?
- (a) Formation of thymine dimers in skin epidermal cells
 - (b) Damaging effect of ultraviolet radiation on cellular proteins
 - (c) Formation of thymine dimers in epidermal cells which are left unrepaired
 - (d) Formation of DNA-protein cross-link
91. If an organism is exposed to equal doses of radiation given from radiation sources with different linear energy transfer values, the effect produced will be
- (a) equal
 - (b) rarely the same
 - (c) equal if they are given at the same dose rate
 - (d) equal if they are given in equal fractions
92. There is an interest in developing gene therapy vectors containing suicide genes with radiation-inducible gene promoters in order to increase the toxicity of radiation locally at the tumor site. Which one of the following genes contains a promoter that could be used for this purpose?
- (a) Early growth response protein 1 (EGR1)
 - (b) Actin
 - (c) Caspase 8
 - (d) Ku-80
93. The chromosome aberrations which would best indicate that cells are irradiated in the G_2 stage of their cell cycle are
- (a) ring aberrations
 - (b) anaphase bridge aberrations
 - (c) dicentric aberrations
 - (d) acentric fragments
94. In gas chromatography, the basis for separation of the components of the volatile material is the difference in
- (a) partition coefficients
 - (b) conductivity
 - (c) molecular weight
 - (d) molarity

95. You are given two tubes (*A* and *B*) containing actively growing cell cultures. The cell culture in tube *A* is treated with a drug that inhibits cell division, while the culture in tube *B* remains untreated. Which one of the following techniques you would use to analyze the inhibition of cell cycle?
- (a) Fluorescence spectroscopy
 - (b) Fluorescence-activated cell sorting
 - (c) UV-VIS spectroscopy
 - (d) NMR spectroscopy
96. Of the following types of interaction, which one is least likely to limit population size?
- (a) Predation
 - (b) Commensalism
 - (c) Competition
 - (d) Brood parasitism
97. Character displacement is associated with
- (a) sympatric species
 - (b) allopatric species
 - (c) primary succession
 - (d) secondary succession
98. Which of the following is essentially Gause's principle of competitive exclusion?
- (a) The more abundant species will exclude the less abundant species through competition
 - (b) Competition for the same resources excludes species having different life styles
 - (c) No two species can occupy the same niche indefinitely when resources are limited
 - (d) Larger organisms exclude smaller ones through competition as in the case of large Trees controlling underbrush
99. PRINTS software is used for
- (a) detection of genes from genome sequence
 - (b) detection of tRNA genes
 - (c) prediction of function of a new gene
 - (d) identification of functional domains/motifs of proteins
100. Which of the following is a key difference between DNA alignment and protein alignment?
- (a) Amino acid pairs can be scored based on similarity as well as identity
 - (b) There can be no internal gaps in a protein alignment
 - (c) The protein alignment demonstrates the locations of the introns and exons
 - (d) Matches and mismatches get the same score in a protein alignment
