

## CSIR NET LIFE SCIENCE SEPT 2022 (PAPER II)

### SECTION B

1. The B-form double stranded DNA was invaded by complementary RNA sequence to form an R-loop structure. During this process,

- (1) sugar pucker on the DNA strand that pairs with RNA will remain unchanged.,
- (2) sugar pucker on the DNA strand that pairs with RNA will change.,
- (3) sugar pucker on the DNA strand that pairs with RNA will remain unchanged but the number of base pairs per turn in the RNA-DNA hybrid will increase.,
- (4) sugar pucker on the DNA strand that pairs with RNA will change but the number of base pairs per turn in the RNA-DNA hybrid with remain unchanged.,

2. Which one of the following is NOT CORRECT in the context of protein structure and folding?

- (1)  $\beta$ -sheets are more common in the interiors of proteins than surfaces,
- (2)  $\beta$ -sheets are less likely to form than  $\alpha$ -helices in the earliest stages of protein folding,
- (3) Proline residues can occupy the N-terminal turn of an  $\alpha$ -helix,
- (4)  $\alpha$ -helices are less likely to form than  $\beta$ -sheets in the earliest stages of protein folding,

3. Which of the following represents the most oxidized form of carbon?

- (1) HCOOH,
- (2) HCHO,
- (3) CH<sub>3</sub>OH,
- (4) CO<sub>2</sub>,

4. Catabolic end product of purines is

- (1) Xyloric acid
- (2) Allantoin
- (3) Urea
- (4) Uric acid

5. CENP-A containing nucleosomes are found at the centromeric region of the chromosomes. CENP-A is a variant of which one of the following histones?

- (1) H1
- (2) H2A
- (3) H3
- (4) H4

6. Which one of the following is abundant in the plasma membranes of mammalian cells but is absent from most prokaryotic and plant cell

- (1) Phosphoglycerides
- (2) Ergosterol
- (3) Cholin
- (4) Cholesterol

7. In *Saccharomyces cerevisiae*, DNA replication is tightly controlled, and DNA should replicate once per cell cycle. Choose the INCORRECT statement regarding why the cells do not re-replicate their DNA in the S-phase.

- (1) Pre-replicative complex (Pre-RC) remains bound to the DNA in the S-phase and does not allow the re-replication
- (2) Assembly of Pre-RC is inhibited by Cdk activity Cdk
- (3) Assembly of Pre-RC is initiated at the end of mitosis, at the early G1 phase of the cell cycle (when the APC activity is high) Pre-RC
- (4) Cdt1 that helps in the recruitment of MCM proteins in the G1phase is inactivated by geminin in the S-phase of the cell cycle Cdt1

8. To study the cell cycle progression for cultured mammalian cells, one would typically NOT utilize?

- (1) Artificial thymidine analog BrdU
- (2) Kinase inhibitor, LY294002
- (3) Flow cytometry analysis
- (4) Live cell imaging

9. Which one of the following statements about DNA replication is INCORRECT?

- (1) Once DNA replication commences, it always continues uninterrupted until the entire process is complete.
- (2) Eukaryotic genomes replicate from multiple origins of replication.
- (3) A consensus sequence for the origins of DNA replication has been identified in *Saccharomyces cerevisiae*.
- (4) Both, fully methylated as well as non-methylated oriC can initiate DNA replication, while hemi-methylated oriC does not.

10. The long DNA strand depicted below is serving as a template for lagging strand DNA synthesis.



The short lines represent the newly synthesized Okazaki fragments.

At which positions among A, B, C and D would DNA primase act next?

- (1) A (2) B  
(3) C (4) D
11. The post-translational modifications in one or more core histones that are known to be associated with DNA repair pathways are:  
(1) Phosphorylation at specific tyrosine residues  
(2) Ubiquitination at specific lysine residues  
(3) Acetylation at specific serine residues  
(4) Methylation at specific serine residues
12. The amino acid arginine is encoded by six codons: CGU, CGC, CGA, CGG, AGA and AGG. Assuming inosine is not an option in the tRNA anticodon, what is the minimum number of tRNAs (from the options given below) that would be sufficient to read these codons?  
(1) Six (2) Four  
(3) Three (4) Five
13. Which one of the following proteins is NOT related to extracellular matrix?  
(1) Cadherin  
(2) Vitronectin  
(3) Lamin  
(4) Selectin
14. Which one of the following statements about cancers is INCORRECT?  
(1) The c-myc gene is translocated to one of the immunoglobulin loci in a majority of Burkitt's lymphomas.  
(2) Viral integration into the cellular genome may convert a proto-oncogene into an oncogene.  
(3) The functions of p53 and Rb are augmented by E6 and E7 proteins of human papillomavirus.  
(4) Many cases of metastatic breast cancer display increased expression of human epidermal-growth-factor-like receptor 2(HER2).
15. What is the nature of the successful anti-cancer Human Papilloma Virus (HPV) vaccine?  
(1) Chemically inactivated virus  
(2) Live attenuated mutant form of HPV  
(3) L1 major capsid proteins self assembled into virus-like particles (VLP)  
(4) mRNA vaccine expressing viral L1 protein mixed with recombinant viral proteins.
16. An anti-idiotypic antibody with fluorescent tag was used for detection of immune cells in tissue sections from a healthy individual specifically by cell surface labeling. Which of the following will have the highest chances of getting detected?  
(1) Macrophages in lymph nodes  
(2) Mature B cells in spleen  
(3) Terminally differentiated plasma cells in lymph nodes  
(4) Eosinophils in tonsils
17. Which one of the following best describes the ability of the cells to respond to a specific inducing signal?  
(1) Potency (2) Equivalence  
(3) Competence (4) Specification
18. The programmed cell death that separates the digits during a tetrapod limb development is dependent on which one of the following signaling pathways?  
(1) BMP (2) FGF  
(3) Wnt (4) Shh
19. Which one of the following mRNAs is a BMP inhibitor and can rescue the dorsal structures of ventralized Xenopus embryo when injected into it?  
(1) beta-catenin  
(2) Noggin  
(3) Disheveled  
(4) Siamos
20. A type of regeneration in which the differentiated cells divide, maintaining their differentiated function without dedifferentiation and production of undifferentiated mass, is known as  
(1) Epimorphosis  
(2) Morphallaxis  
(3) Compensatory regeneration  
(4) Stem cell mediated regeneration
21. Which one of the following statements is INCORRECT?  
(1) Dehydrins are intrinsically disordered proteins  
(2) Dehydrins have minimal secondary structure  
(3) Dehydrins are often induced by ABA  
(4) Dehydrins are highly hydrophobic proteins
22. Which of the following domains is present in symbiosis receptor-like kinase (SYMRK) proteins?

- (1) Nucleotide binding repeat  
 (2) Leucine-rich repeat region  
 (3) NAC domain  
 (4) W-box
23. Identify the correct site of action of DBMIB (2,5-dibromo-3-methyl-6-isopropyl-p-benzoquinone), an inhibitor of the chloroplast electron transport chain.  
 (1)  $Q_A \rightarrow Q_B$   
 (2)  $Q_B \rightarrow P_Q$   
 (3)  $P_Q \rightarrow CyTb_6f$   
 (4)  $Q_A \rightarrow Q_B$
24. The plant hormone gibberellins (GA) are a group of  
 (1) Monoterpenes ( $C_{10}$ ),  
 (2) Diterpenes ( $C_{20}$ ),  
 (3) Triterpenes ( $C_{30}$ ),  
 (4) Sesquiterpenes ( $C_{15}$ ),
25. Hemoglobin A1c (HbA1c) from diabetic mellitus individuals has a glucose molecule attached to which one of the terminal amino acid residues of globin chain?  
 (1) Lysine of each  $\alpha$  chain  
 (2) Lysine of each  $\beta$  chain  
 (3) Valine of each  $\alpha$  chain,  
 (4) Valine of each  $\beta$  chain,
26. The pericytes are found in  
 (1) myelin sheath  
 (2) surrounding coat of a skeletal muscle fibre,  
 (3) blood capillary wall  
 (4) lymph capillary wall
27. The reabsorption of water and NaCl in kidneys is inhibited by the increased secretion of the following substances EXCEPT one:  
 (1) Urodilatin  
 (2) Uroguanylin  
 (3) Dopamine  
 (4) Norepinephrine
28. Mullerian-inhibiting substance (MIS), a homodimer that causes regression of the Mullerian duct by apoptosis, is secreted by which one of the following cells?  
 (1) Leydig cells  
 (2) Sertoli cells  
 (3) Corpus luteal cells  
 (4) Placental cells
29. In which one of the following human disorders, parents or grandparents are said to carry premutations?  
 (1) Down syndrome  
 (2) Fragile X syndrome  
 (3) Klinefelter syndrome  
 (4) Alkaptonuria
30. The AFLP technique generates polymorphic DNA fragments that are generally scored as dominant markers. However, a pair of DNA fragments (say 'a' and 'b') generated by AFLP can be termed as co dominant, if on analysis of a large progeny of doubled haploids (DH) derived from an F1 (resulting from a cross between two parents one with fragment 'a' and the other with 'b'), it is observed that:  
 (1) 50% of the progeny has both 'a' and 'b' fragments and the rest have none.  
 (2) 50% of the progeny has fragment 'a' and the remaining have fragment 'b'  
 (3) 25% of the progeny has fragment 'a', 50% both 'a' and 'b' and the rest fragment 'b'.  
 (4) 75% of the progeny has both the fragments, while 25% has either 'a' or 'b'.
31. If a gamete produced following non disjunction of a chromosome at second meiotic division was fertilized by a normal gamete, what is the expected frequency of trisomic progeny?  
 (1)  $1/4$   
 (2)  $2/4$   
 (3)  $3/4$   
 (4) 1
32. How many complementation groups do the following mutants m1 to m6 come under?  
 Results of complementation between different mutants
- |    | m1 | m2 | m3 | m4 | m5 | m6 |
|----|----|----|----|----|----|----|
| m1 | -  | -  | +  | +  | -  | +  |
| m2 |    | -  | +  | +  | -  | +  |
| m3 |    |    | -  | -  | +  | +  |
| m4 |    |    |    | -  | +  | +  |
| m5 |    |    |    |    | -  | +  |
| m6 |    |    |    |    |    | -  |
- (1) Two  
 (2) Four  
 (3) Five  
 (4) Three
33. The black buck (Antelope cervicapra) has been traditionally protected by which one of the following communities?  
 (1) Bhils  
 (2) Jats  
 (3) Bishnois  
 (4) Ahirs

**34. Savannas are biomes where tree and grass vegetation coexist over large areas. Which one of the following statements does NOT explain the occurrence of savannas in the India subcontinent?**

- (1) Selective logging of forests opens up the canopy and grasses take over
- (2) Low rainfall maintains low tree cover that helps grasses establish
- (3) Fires do not allow trees to establish closed canopies
- (4) Browsing by herbivores limits tree establishment

**35. Diclofenac toxicity has been suggested to be the cause for population decline in which one of the following animals?**

- (1) Gyps vultures
- (2) Olive Ridley turtles
- (3) Honey bees
- (4) Oceanic sharks

**36. An Indian bird species known to defend flowers is the**

- (1) Purple-throated hummingbird
- (2) Jungle babbler
- (3) Purple-rumped sunbird
- (4) Crescent honeyeater

**37. Which one of the following survivorship curves is typical of invasive insect pest species?**

- (1) Invasive insect pest species do not follow specific survivorship curves
- (2) Type II
- (3) Type III
- (4) Type I

**38. Which one of the following statements is NOT correct?**

- (1) Both alpha and gamma diversities measure the presence and abundance of species in a community
- (2) Gamma diversity can be expressed as the product of alpha and beta diversities across sites
- (3) Gamma diversity is the sum of alpha diversities for a set of sites
- (4) Gamma diversity can be expressed as the sum of alpha and beta diversities across sites

**39. Which one of these statements is NOT CORRECT with respect to ecotones?**

- (1) Intertidal zones and estuaries are two examples of ecotones
- (2) They are transitional areas of vegetation between two different plant communities
- (3) Populations in ecotones are potentially pre-adapted to changing environment.
- (4) They harbour only K-selected species that can survive in changing habitats

**40. Which one of the following countries has contributed the maximum towards CO<sub>2</sub>**

- (1) India,
- (2) USA
- (3) China,
- (4) Russia,

**41. An ecologist studying molluscs concluded that there is a correlation between the thickness of the shell and weight of the mollusc. Based on this information, one can conclude that**

- (1) heavier molluscs are better defended from attacks by predators.,
- (2) heavier molluscs are poorly defended from attacks by predators., ,
- (3) most likely there is a cause-effect relationship between the two traits.,
- (4) weight and thickness are variable traits in mollusc population,

**42. Which of the following life history traits is most likely in a rodent species when snakes prefer to prey upon large, older individuals of the rodent species that grow continuously over their lifespan?**

- (1) Early reproduction and slow growth rate
- (2) Delayed reproduction and fast growth rate,
- (3) Delayed reproduction and slow growth rate,
- (4) Early reproduction and fast growth rate,

**43. Pick the statement that includes both a proximate and an ultimate explanation for the evolution of a given behaviour.**

- (1) Elevated heart beat and higher levels of stress hormone
- (2) Scent marking along boundaries of territories and high aggression,
- (3) Social communication through odours and increased group survival,
- (4) Higher maternal fitness and increased offspring survival,

**44. Bioaugmentation refers to:**

- (1) Developing microbial strains through genetic engineering which can degrade pollutants and toxic compounds efficiently.
- (2) Ex- situ bioremediation of toxins from soil or any other contaminant site by addition of selected microbes to enhance biodegradation.
- (3) Addition of nutrients at contaminated sites to enhance growth of indigenous microflora which will in turn degrade pollutants,
- (4) Addition of selected microbes both archaea and bacteria to the polluted site so that biodegradation is enhanced.

**45. Which of the following methods can be used to selectively lyse newly dividing cells?**

- (1) MTT (3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) treatment of dividing cells followed by UVB irradiation
- (2) Treatment of dividing cells with caspase inducers
- (3) Bromodeoxyuridine (BrdU) labelling of dividing cells followed by exposure to light
- (4) Treatment of dividing cells with  $^{51}\text{Cr}$  and measuring its release over a period of time.

**46. The information obtained by comparing a new diagnostic test with the gold standard is summarized in a two-by-two table given below**

	Gold standard disease present	Gold standard disease absent
New test Positives	68 (true positives)	22 (false positives)
New Test Negatives	32 (false negatives)	78 (true negatives)

**What is the sensitivity and specificity of the new test?**

- (1) Sensitivity = 76%; Specificity = 71%
- (2) Sensitivity = 32%; Specificity = 22%
- (3) Sensitivity = 68%; Specificity = 78%
- (4) Sensitivity = 34%; Specificity = 39%

**47. What can you infer if the correlation coefficient, [Pearson correlation (r)], is close to -1 (minus 1) for two set of variables?**

- (1) There is no relationship between the two variables,
- (2) There is an exponential relationship between the two variables
- (3) There is a linear relationship in which when there is a decrease in one variable, there is also a decrease in the second variable
- (4) There is a linear relationship in which, when there is an increase in one variable, there is a decrease in the second variable

**48. The distribution of heights of college students aged between 18 to 20 was found approximately normally distributed with an average (mean) of 54 inches and a standard deviation of 2.5 inches. What will be the z-score for a student who is five feet tall?**

- (1) 2.4
- (2) 3.1
- (3) 1.5
- (4) 2.9

**49. Emission maximum of a fluorophore is shifted to longer wavelength when compared to the wavelength of excitation. What is the reason?**

- (1) Non-radiative loss of excitation energy
- (2) Partial absorbance of incident light
- (3) Scattering of light by molecules
- (4) Radiative loss of excitation energy

**50. What will be the percentage transmission when absorbance is 1, 2 and 3, respectively?**

- (1) 10, 1, 0.1
- (2) 1, 10, 100,
- (3) 0.2, 0.1, 0
- (4) 20, 10, 0

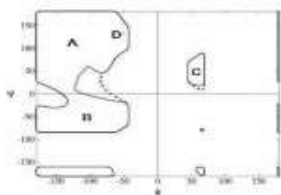
**SECTION C**

**51. An enzyme has a  $K_m$  of  $5 \times 10^{-5} M$  and a  $V_{max}$  of  $100 \mu\text{moles.lit}^{-1} \text{min}^{-1}$  ( $K_m$  is the Michaelis constant and  $V_{max}$  is the maximal velocity).**

**What is the velocity in the presence of  $1 \times 10^{-4} M$  substrate and  $2 \times 10^{-4} M$  competitive inhibitor, given that the  $K_i$  for the inhibitor is  $2 \times 10^{-4} M$ ?**

- (1)  $0.005 \mu\text{moles.lit}^{-1} \text{min}^{-1}$ ,
- (2)  $50 \mu\text{moles.lit}^{-1} \text{min}^{-1}$ ,
- (3)  $5 \mu\text{moles.lit}^{-1} \text{min}^{-1}$ ,
- (4)  $500 \mu\text{moles.lit}^{-1} \text{min}^{-1}$ ,





52.

The regions of phi, psi space occupied by well characterized protein secondary structures are marked on a Ramachandran plot as shown above.

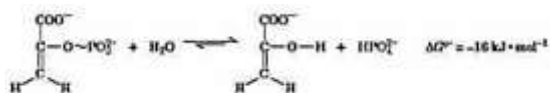
Which of the following statements is CORRECT?

- (1) A- right handed  $\alpha$  helix, B-  $\beta$  strand, C- left handed  $\alpha$  helix, D- collagen,
- (2) A-  $\beta$  strand, B- right handed  $\alpha$  helix, C- left handed  $\alpha$  helix, D- collagen,
- (3) A- collagen, B- right handed  $\alpha$  helix, C- left handed  $\alpha$  helix, D-  $\beta$  strand,
- (4) A- left handed  $\alpha$  helix, B-  $\beta$  strand, C-collagen, D- right handed  $\alpha$  helix,,

51. The  $F_1$  subunit of  $F_0F_1$  ATP synthase synthesizes ATP from ADP in the mitochondrial inner membrane. Purified  $F_1$  subunit hydrolyses ATP to ADP. Which one of the following reasons explains the difference between the activities of the  $F_1$  subunit in soluble and membrane bound form?

- (1) A conformational change in the  $F_1$  subunit between the two environments,
- (2) The lipid bilayer environment facilitates the synthesis of ATP by enhancing the rate of the dehydration reaction,
- (3) The ATP synthesis reaction is driven by coupling to an electrochemical potential across the inner mitochondrial membrane
- (4) In the soluble form, the electrochemical potential drives the  $F_1$  subunit to hydrolyze ATP,

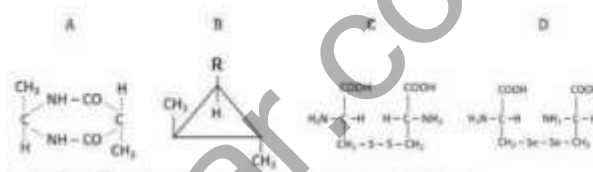
54. Pyruvate kinase, the enzyme that catalyzes the conversion of PEP to pyruvate transfers the Pi from PEP to ADP to generate ATP. The standard free energies of the half-reactions are given below.



$$\text{ADP} + \text{P}_i = \text{ATP} \quad \Delta G^\circ = +30.5 \text{ kJ} \cdot \text{mol}^{-1}$$

How is the free energy for generation of ATP from ADP derived in the reaction catalyzed by pyruvate kinase?

- (1) through coupling with keto-enol tautomerism where the enol form of pyruvate is converted to the keto form,
- (2) through condensation of  $\text{P}_i$  with ADP,
- (3) through linking to proton motive force,
- (4) through coupling with hydrolysis of  $\text{P}_i$



55.

Which of the four molecules shown above are optically active?

- (1) A, B, C and D
- (2) B and D only,
- (3) A and C only,
- (4) B only,

56. The actin-binding proteins regulate microfilament turnover in a eukaryotic system. Match the actin-binding protein (in column I) with their functions (in column II).

Column A		Column B	
A	Cofilin	i	binds ADP-G-actin and catalyzes the exchange of ADP for ATP
B	Profilin	ii	binds preferentially to filament containing ADP-actin
C	Thymosin	iii	assembles unbranched filament
D	Formin	iv	binds to ATP-G-actin and inhibits addition of actin subunit to filament

- (1) A-iii, B-iv, C-ii, D-i
- (2) A-ii, B-iii, C-i, D-iv
- (3) A-ii, B-i, C-iv, D-iii
- (4) A-iii, B-ii, C-iv, D-i

57. Given below are a few steps in clathrin-coated vesicle formation in the secretory pathway.

- (A) Receptor-ligand recognition and binding
- (B) Recruitment of adapter protein and clathrin
- (C) Vesicle formation
- (D) Uncoating of clathrin coats

Choose the option that correctly identifies the sequence of events in making a clathrin coated vesicle.

- (1) A, B, C, D
- (2) B, A, C, D
- (3) A, B, D, C
- (4) B, A, D, C

58. To ensure proper segregation of chromosomes during mitosis, the sister chromatid pairs must be stably bi-oriented on the mitotic spindle. In animal cells, after nuclear envelope breakdown (NEBD), chromosomes glide along the microtubules' length with the help of the motor proteins. When the chromosomes reach the plus-end of microtubules, the kinetochores attach to the microtubules.

Which one of the following is the correct option for the kinetochore-microtubules attachment configuration that ensures proper chromosome segregation?

- (1) Monotelic (2) Merotelic  
(3) Amphitelic (4) Syntelic

59. Following statements were made about mitochondria:

- A. The D loop of the mitochondrial genome is required for replication, but not for the regulation of transcription.  
B. The L strand of mitochondrial genome possesses more cytosine.  
C. In plants, most mitochondrial tRNAs are encoded by the nuclear genome and then imported into the mitochondrion.  
D. Cycloheximide inhibits protein synthesis by mitochondrial ribosomes, but does not affect eukaryotic cytosolic ribosomes.  
E. Some organisms have been found to carry linear mitochondrial DNA.

Which one of the following options represents a combination of the correct statements?

- (1) A, B, C (2) B, D, E  
(3) A, C, D (4) B, C, E

61. Some of the steps in the process of eukaryotic DNA replication mentioned below require hydrolysis of ATP.

- A. Phosphodiester bond formation  
B. DNA strand separation by helicase  
C. Clamp-loader association with clamp and DNA  
D. Joining of Okazaki fragments

Choose the following option that correctly identifies all the steps utilizing ATP hydrolysis

- (1) A, B and D only (2) B, C and D only  
(3) B and C only (4) B and D only.

62. The following statements refer to the E.coli replicative DNA polymerase:

- A. DNA Pol I displays very limited processivity and possesses 3'→ 5' exonuclease activity, allowing fidelity of DNA replication.  
B. DNA Pol III is suitable for leading strand DNA synthesis due to its high processivity and 5'→ 3' exonuclease activity that removes incorrect nucleotides incorporated during DNA synthesis.  
C. DNA Pol I possesses 5→ 3' exonuclease activity which allows removal of the RNA primer while its 5→ 3' polymerase activity allows it to fill the gap created by removal of the RNA primer  
D. DNA Pol III is suitable for lagging strand DNA synthesis due to its low processivity and 5'→ 3' exonuclease activity.

Which one of the options below represents the combination of all correct statements?

- (1) D only  
(2) B and C  
(3) A and B  
(4) A and C

63. The 5' UTR of ferritin mRNA forms a stem-loop structure called the iron regulatory element [IRE]. The Iron Regulatory Binding Protein [IRBP] binds this IRE.

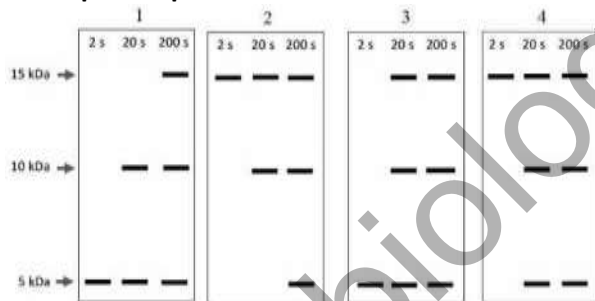
The following statements were made with reference to IRBP- IRE interaction:

- A. IRBP-IRE interaction prevents eIF4A from resolving the stem-loop structure, thus preventing initiation of translation of ferritin genes.  
B. IRBP-IRE interaction recruits eIF4A to the 5' UTR, thus promoting translation initiation.  
C. In presence of ferrous ions IRBP is unable to bind the IRE.  
D. eIF4A binds directly at the 5' UTR and disrupts the stem-loop structure, thus promoting translation initiation.

Which one of the options below represents the combination of all correct statements?

- (1) B only  
(2) A and D  
(3) A and C  
(4) B and C

64. An *in vitro* translation system capable of incorporating ~8 amino acids s-1 was programmed to translate a single mRNA that codes for an alanine-rich (~35% alanine with uniform distribution of alanine) protein of 275 amino acids (~30kDa) including a hexa-histidine tag at the C-terminal end of the protein. The protein possesses three methionine residues at amino acid positions 1, 135 and 230 and generates polypeptides of ~15 kDa, ~10 kDa and ~5 kDa upon degradation with cyanogen bromide. The translation reaction was initiated and the ongoing reaction was supplemented with 14C Ala after 5 min. Soon after addition of 14C Ala, aliquots were drawn at 2, 20, and 200 s, and reactions in the aliquots were instantaneously stopped. The translated proteins were purified on Ni NTA columns, processed for degradation by CNBr, resolved on SDS-PAGE, and visualized by nonquantitative autoradiography. Which of the following autoradiograms represents the expected pattern of the bands?



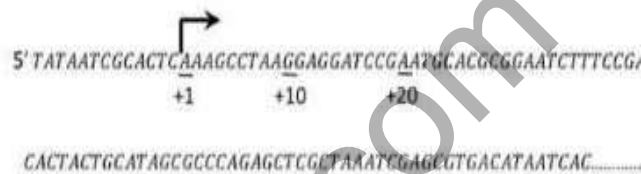
65. The following statements are made with respect to merodiploids of the lac operon, where "I" is the lac repressor, "O" is the lac operator, "Z" is the lacZ gene encoding beta-galactosidase and "Y" is the lacy gene encoding permease

- A. In  $I^s O^+ Z^+ Y^+ / I^+ O^c Z^- Y^+$  the lacZ is inducible and lacy is constitutively expressed
- B. In  $I^+ O^+ Z^+ Y^- / I^- O^+ Z^- Y^+$  the lacZ and lacy are both inducible.
- C. In  $I^+ O^c Z^+ Y^- / I^s O^+ Z^- Y^+$  the lacZ is constitutively expressed and lacy is inducible
- D. In  $I^s O^+ Z^+ Y^+ / I^+ O^c Z^- Y^+$  the lacZ is inducible and lacy is constitutively expressed

Which of the following options represents the combination of all correct statements?

- (1) B and D only. (2) A and B only.  
(3) A, B and C (4) B, C and D

66. The sequence below represents part of the coding strand of the bacterial gene Z. The arrow indicates the transcription start site.



The following statements were made with reference to transcription & translation of the strand:

- A. Insertion of an 'A' nucleotide after position +8 increases the length of the transcript by 1 nucleotide and changes the amino acid sequence of the protein being translated.
- B. Substitution of the T at position 22 changes the primary structure of the protein without altering transcript length
- C. Insertion of an 'A' after position 26 changes the primary structure of the protein and results in synthesis of a truncated protein.
- D. Deletion of 'A' at position 9 creates the 'STOP' codon that prevents translation of the protein.

Which one of the options below represents the combination of all correct statements?

- (1) C only  
(2) A and D  
(3) B and C  
(4) A and B

67. Which one of the following statements relating to the mechanism of color development in response to LacZ expression in Escherichia coli is INCORRECT?

- (1) E. coli growth on LB agar with X-gal results in blue colored colonies because LacZ produced in the cell hydrolyses X-gal present in the medium into a blue colored product.
- (2) When the membranes of the cells harboring LacZ are permeabilized and cells incubated in a buffer with ONPG, the solution turns yellow because LacZ encoded protein hydrolyzes
- (3) E. coli growth on MacConkey agar results in pink colored colonies because LacZ encoded protein produced in the cell hydrolyzes the neutral red dye present in the medium into a pink colored product.
- (4) E. coli growth on MacConkey agar results in pink colored colonies due to shift in pH of the medium MacConkey



68. For an experiment, the hapten DNP was conjugated with the carrier protein BSA or with the carrier protein OVA. A set of mice were primed with either DNP-BSA conjugate or with OVA which was not conjugated to DNP. The following experiments were then performed.

A. X-ray irradiated syngeneic mice were injected with spleen cells from both DNP-BSA- primed mice and OVA-primed mice and then challenged with DNP-OVA conjugate.

B. X-ray irradiated syngeneic mice were injected with T-cell depleted spleen cells from DNP-BSA-primed mice and spleen cells from OVA-primed mice and then challenged with DNP-OVA conjugate.

C. X-ray irradiated syngeneic mice were injected with spleen cells from DNP-BSA-primed mice and T-cell depleted spleen cells from OVA-primed-mice and then challenged with DNP-OVA conjugate.

Which one of the following options of mice will generate secondary anti-hapten response to DNP?

- (1) The mice in experiment A only
- (2) The mice in experiment B only
- (3) The mice in experiment C only
- (4) The mice in experiments A and B

69. Consider the defects in human macrophage cell lines (antigen presenting cells, Column A) and their possible consequence on T cell activation (Column B).

Column A		Column B	
A	$\beta$ 2-microglobulin knockout macrophages	i	Cannot activate CD4+ or CD8+ T cells
B	TLR4 knockout macrophages	ii	Cannot activate CD4+ T cells
C	Macrophages with HLA region for DP, DQ and DR deleted	iii	Cannot activate CD8+ T cells
D	B7 knockout macrophages	iv	Can activate CD4+ or CD8+ T cells

Select the option that represents all the correct matches

- (1) A-i, B-iii, C-ii, D-iv
- (2) A-iv, B-ii, C-iii, D-i
- (3) A-iii, B-iv, C-ii, D-i
- (4) A-ii, B-i, C-iv, D-iii

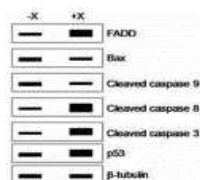
70. Consider the cancer types in Column P and the cancer related descriptions (Column Q)

Column P		Column Q	
A	Leukemia	(i)	A tumor that has arisen from endodermal tissue
B	Sarcoma	(ii)	Hematopoietic cell cancer that does not grow as a solid tumor
C	Carcinoma	(iii)	A tumor that develops from mesodermal connective tissue
D	Melanoma	(iv)	Cancer that develops from the pigment-producing cells of skin

Select the option that represent all the correct matches

- (1) A-ii; B-iii; C-i; D-iv
- (2) A-iv; B-i; C-iii; D-ii
- (3) A-i; B-iii; C-ii; D-iv
- (4) A-ii; B-i; C-iii; D-iv

71. Cervical cancer cells were untreated (-), or treated (+) with compound 'X'. a putative anti-cancer drug. The cell extracts were analyzed by immunoblotting for the levels of specific markers as indicated by the band thickness. The following results were obtained



Which one of the following options best describes the action of compound 'X'?

- (1) Compound 'X' induced cell death via the intrinsic pathway by activating caspase 8 and apoptosis was p53 independent
- (2) Compound 'X' induced cell death via the extrinsic pathway by inducing the Fas ligand associated death domain (FADD) and apoptosis was p53 dependent
- (3) Compound 'X' induced cell death by reducing the expression of Bax in a p53-dependent manner and consequently increasing the expression of caspase 9
- (4) Compound 'X' induced cell death by activating the death domain together with increasing the expression of the pro-apoptotic protein in a p53 independent manner

72. Physical attachment between cells and extracellular matrix is critical in both animals and plants because it imparts rigidity and strength to tissues and organs. However, junctions between cell-cell or between cell-matrix are diverse in structure and play roles beyond providing physical support. Column "X" lists some of the cell junctions and column "Y" lists their characteristic functions

Column X	Column Y
A. Tight junctions	(i) connect intermediate filaments in one cell to those in the next cell
B. Gap junctions	(ii) seal gaps between epithelial cells.
C. Plasmodesmata	(iii) allow passage of small water-soluble molecules from cell to cell in animal tissues
D. Desmosomes	(iv) allows passage of small molecules but not macromolecules (with some exceptions) in plants.

- (1) A-i; B-ii; C-iv; D-iii                      (2) A-ii; B-iii; C-iv; D-i  
 (3) A-iii; B-iv; C-i; D-ii                      (4) A-iv; B-i; C-ii; D-iii

73. Inbred mouse strains with different MHC haplotypes (homozygous H-2<sup>m</sup> MHC haplotype and homozygous for the H-2<sup>n</sup> haplotype) were mated resulting in F1 progeny (H-2<sup>m/n</sup>). Skin transplantation experiments were performed between these mouse strains (parents with H-2<sup>m</sup> and H-2<sup>n</sup> MHC haplotypes and progeny with H-2<sup>m/n</sup> MHC haplotype). Which one of the following statements with respect to acceptance and rejection of the skin graft is correct?

- (1) Skin graft from the progeny will be accepted by any of the parents (recipient).
- (2) Skin graft from one parent (donor) will be accepted by the other parent (recipient).
- (3) Skin graft from progeny will be accepted by the parent homozygous for the H-2<sup>m</sup> haplotype, but not by the parent homozygous for the H-2<sup>n</sup> haplotype.
- (4) Skin graft from any of the parents will be accepted by the progeny recipient.

74. Tbx4 and Tbx5 are critical in the specification of hindlimbs and forelimbs, respectively.

The following statements were made regarding experiments involving expression of Tbx4 or Tbx5 genes and their probable outcomes:

- A. When chick embryo was made to express Tbx4 throughout the flank tissue, limbs induced in the anterior region often become legs instead of wings.
- B. Loss of Tbx4 function in the hindlimb field completely inhibits leg initiation and growth.
- C. Loss of Tbx5 gene in chick results in complete failure of forelimb formation which includes even the most proximal shoulder/girdle structure.

Which one of the following options represents all correct statements as made above?

- (1) A only.
- (2) A and B only.
- (3) B and C only.
- (4) A, B and C

75. The following statements were made regarding the patterning of anterior-posterior body plan of *Drosophila*:

- A. Microinjection of bicoid mRNA in the middle of a bicoid-deficient embryo leads to formation of 'head' in the middle and telson at the two ends.
- B. Nanos protein inhibits the translation of caudal mRNA at the posterior half of the embryo.
- C. The Bicoid protein activates the zygotic expression of the hunchback gene.
- D. The segment polarity genes are expressed in segments of the embryo.

Which one of the following options represents all correct statements as made above?

- (1) A and B only
- (2) A and C only
- (3) A, C and D
- (4) B, C and D B

76. The mammalian genital ridge is bipotential. Which one of the following statements regarding determination of the fate of genital ridge is INCORRECT?

- (1) The activation of Sox9 gene promotes testis determining pathway.
- (2) The accumulation of  $\beta$ -catenin is critical for activating ovarian development.
- (3) R-spondin 1 (Rspo1) stimulates the Disheveled protein, thus promoting testis determining pathway.
- (4) Though Wnt4 is expressed in the bipotential gonads, it is an important factor in ovary determination.

77. The group of 6 cells (P3.p to P8.P) called vulval precursor cells (VPCs) of *C. elegans* form an equivalence group. The following statements were made as evidence that VPCs form an equivalence group:

A. If the anchor cell is destroyed the VPCs contribute to the formation of hypodermal tissues.

B. If the 3 central cells (P5.p to P7.p) are destroyed the remaining cells can generate vulval cells.

C. If expression of *lin-3* is increased VPCs contributing to the secondary lineage can form cells of primary lineage.

D. Ectopic expression of *let-23* in P5.p and P7.p VPCs converts them to primary cell lineage.

Which one of the following options is a combination of all correct statements?

- (1) A and B only.
- (2) B and C only
- (3) A, B and C
- (4) B, C and D

78. The table below summarizes the key signaling pathways that orchestrate development, their receptors, transcription effectors and output.

	SIGNALING PATHWAY	RECEPTOR	TRANSCRIPTIONAL EFFECTOR	OUTPUT
A	Wnt	Thick veins	$\beta$ -catenin	Patterning
B	Hedgehog	Frizzled	Ci/Gli	Growth
C	RTK	EGFR	Pointed/Yes	Morphogenesis
D	TGF $\beta$	Notch	NICD	Cell Fate
E	JNK	TNF	Jun/Fos	Specification

Which of the above pathways is correctly depicted in one of the options given below?

- (1) A, C and D
- (2) Only B and E
- (3) Only A and D
- (4) Only C and E

79. In mammals, autophagy is involved in specific cytosolic rearrangements needed for proliferation and differentiation during embryogenesis and postnatal development. Embryos have the ability to activate general protective strategy against many stress-inducing conditions. Which one of the following statements DOES NOT conform to the role of autophagy during early development?

- (1) Autophagy is a process of cytosolic renovation, crucial for cell fate decisions.
- (2) Autophagy plays a dual role both in adaptation to stress and starvation during morphogenesis and in cell elimination along with apoptosis.
- (3) Functional characterization of the autophagy regulatory genes indicates that autophagy is definitely not an evolutionarily conserved process.
- (4) Defects in autophagy during early embryogenesis can be lethal for the organism.

80. Plant nodulation genes encode proteins with receptor-like-features. Following are the list of some nodulation proteins (Column X) and their possible domain characteristics (Column Y):

Column X	Column Y
A. Entry receptor	(i) Extracellular leucine-rich repeat domains in a large N-terminal segment and the cytoplasmic portion having kinase domains.
B. Signalling receptor	(ii) Extracellular LysM domains and the cytoplasmic kinase domain/s
C. Symbiosis receptor kinase	(iv) Extracellular LysM domains but lacks the kinase features in the cytoplasmic portion.

Which of the following is the correct match?

- (1) A – i, B – ii, C – iii
- (2) A – ii, B – iii, C – i
- (3) A – iii, B – ii, C – i
- (4) A – i, B – iii, C – ii

81. Phytochrome photoreceptors exist in two isoforms, P<sub>R</sub> and P<sub>FR</sub>. Following are certain statements regarding the function of P<sub>FR</sub>:

- A. P<sub>FR</sub>: form induces phosphorylation and ubiquitin linked degradation of PIFs transcription factor.
- B. P<sub>FR</sub>: mediated degradation of PIFs inhibits photomorphogenesis.
- C. P<sub>FR</sub>: inhibits the activity of COPI.
- D. P<sub>FR</sub>: increases the stability of transcription factors HFR 1, HY5 and LAF1.

Which one of the following combinations is correct?

- (1) A, B and C only
- (2) A, C and D only
- (3) B, C and D only
- (4) A, B and D only

82. A student listed following combinations of enzymes and their involvement in different phases of Calvin-Benson cycle:

- A. Phosphoglycerate kinase – Reduction phase
- B. Glyceraldehyde-3-phosphate dehydrogenase – Regeneration phase
- C. Triose-phosphate isomerase – Reduction phase
- D. Phosphoribulokinase – Regeneration phase

Which one of the following combinations is correct?

- (1) A, B and C
- (2) B and C only
- (3) B, C and D
- (4) A and D only

83. The following statements were made regarding submergence tolerance in plants.

- A. Wetland plants have structural barrier to prevent O<sub>2</sub> diffusion into soil.
- B. Dryland plants have structural barrier to prevent O<sub>2</sub> diffusion into soil.
- C. Lowering of cytosolic Ca<sup>2+</sup> prevents aerenchyma formation.
- D. Activation of ethylene signal transduction pathway prevents aerenchyma formation.

Which one of the following options has all correct statements?

- (1) A and C
- (2) B and C
- (3) A and D
- (4) B and D

84. The first common enzyme in the biosynthesis of the branched-chain amino acids (Leu, Ile and Val) is aceto-hydroxy acid synthase (AHAS). Following statements are made about the enzyme:

- A. AHAS requires thiamine diphosphate as cofactor.
- B. The plant AHAS comprises a large catalytic subunit and a smaller regulatory subunit.
- C. The large subunit alone is sensitive to inhibition by Leu, Ile and Val in plants.
- D. Most of the bacterial and fungal AHAS enzymes are sensitive to inhibition by Val only.

Select the option with all correct statements.

- (1) A, B and C
- (2) A, C and D
- (3) B, C and D
- (4) A, B and D

85. Members of the WUSCHEL RELATED HOMEBOX (WOX) transcription factor family play an important role during zygote elongation and division in Arabidopsis. Following are certain statements regarding the expression of different members of WOX gene family during zygote elongation.

- A. WOX2 and WOX8 are present in both the egg cell and the zygote.
- B. WOX2 is present in the apical and basal cell.
- C. WOX8 along with WOX9 regulates the development of basal lineage.
- D. WOX8 and WOX9 are directly activated in the zygote by the transcription factor WRKY2.

Which one of the following options represents combination of all correct statements?

- (1) A, B and C
- (2) A, B and D
- (3) A, C and D
- (4) B, C and D

86. Following statements were made regarding gibberellins (GA) biosynthesis in plants and fungi.

- A. Two separate enzymes are involved in synthesis of ent-kaurene from GGDP in plants
- B. Only a single bifunctional enzyme catalyses the synthesis of ent- kaurene from GGDP in fungi
- C. GA-biosynthesis genes are mostly clustered on a single chromosome in fungi.
- D. GA-biosynthesis genes are randomly located on chromosomes in fungi.

Which one of the following combination of statements is correct?

- (1) A, B and C only
- (2) A, B and D only
- (3) B and C only
- (4) A and D only



87. Insulin is a polypeptide hormone that reduces blood glucose levels in human. Following statements are made for insulin synthesis and structure:

- A. It is synthesized in rough endoplasmic reticulum of the B cells of islets of Langerhans.
- B. It is synthesized in cytosol on free ribosomes of the B cells of islets of Langerhans.
- C. Insulin has an AB heterodimer structure with one intra-chain (A8-A13) and two inter-chain disulfide bridges (A6-B10 and A21-B18)
- D. Insulin has an AB heterodimer structure with one intra-chain (A6-A11) and two inter-chain disulfide bridges (A7-B7 and A20-B19).
- E. The gene for insulin is located on the long arm of chromosome 11 and has two introns and three exons.
- F. The gene for insulin is located on the short arm of chromosome 11 that has two introns and three exons.

Which one of the following combination of statements is correct?

- (1) B, D and E
- (2) A, C and F
- (3) B, C and E
- (4) A, D and F

88. Plasma proteins have vital roles in the body ranging from maintaining osmolarity to transport of hormones. Certain statements are given below for the functions of selected plasma proteins:

- A. Von Willebrand factor is normally synthesized in the liver.
- B. Ceruloplasmin is a copper carrier protein.
- C. Genetic deficiency of  $\alpha_1$ - antiproteinase causes emphysema.
- D. Most plasma proteins including albumin are covalently glycosylated.
- E.  $\alpha_1$ - acid glycoprotein (AGP) level increases during body's response to inflammation.

Which one of the following represents all correct combination of statements?

- (1) A, B and C only
- (2) B, C and D only
- (3) B, C and E only
- (4) A, D and E only

89. A potential difference of about -70 mV between inside and outside of a single axonal membrane in resting condition may be recorded by suitable electrodes and amplifier. The physico-chemical and biological basis of the origin of this resting membrane potential (RMP) are suggested below:

- (A) The RMP is close to the equilibrium of  $Na^+$  ion.
  - (B) There must be an unequal distribution of diffusible ions across the axonal membrane for the RMP.
  - (C) The axonal membrane must be permeable to one or more species of ions for the RMP.
  - (D) The concentration gradient of  $Na^+$  and  $K^+$  ions across the axonal membrane required for the RMP, is dependent on the activity of  $Na^+$ ,  $K^+$ -ATPase.
  - (E) Impermeable proteins in the axoplasm do not affect the distribution of diffusible ions across the axonal membrane which is required for the RMP.
  - (F)  $Na^+$ ,  $K^+$ -ATPase pump in the axonal membrane which is essential for the RMP, is not electrogenic.
- Choose all correct statements from the following options:

- (1) A, B and C only
- (2) B, C and D only
- (3) C, D and E only
- (4) D, E and F only

90. Iron deficiency is a common problem in humans worldwide. The homeostasis of iron in the body is maintained using various proteins (column- X) and their function (column- Y):

Column-X		Column-Y	
A	Ferritin	i.	Hypoxia is known to reduce its synthesis
B	Ferroportin	ii.	Plasma iron binding protein
C	Transferrin	iii.	Intramucosal cell iron binding protein
D	Hepcidin	iv.	Iron leaves mucosal cells through it

Choose the correct option from below that most appropriately matches in column X with that of column Y.

- (1) A-i, B-iii, C-ii, D-iv
- (2) A-iii, B-iv, C-ii, D-i
- (3) A-ii, B-i, C-iv, D-iii
- (4) A-iv, B-ii, C-iii, D-i





95. During development, many gene products are provided by the females to the eggs which are needed for normal development of the zygote. Such genes are called as maternal-effect genes. The following are a set of crosses between parents carrying a recessive mutant allele (m) and the offspring obtained:

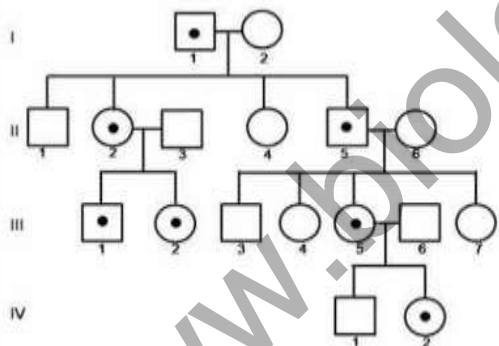
Phenotype of offspring

Cross No	Genotype of Parents	Phenotype of offspring
I	$m/+♂ \times m/+♀$	All normal
II	$m/m♂ \times m/+♀$	All normal
III	$m/+♂ \times m/m♀$	All mutants
IV	$m/m♂ \times m/m♀$	All mutants
V	$m/+♂ \times m/+♀$	Both normal and mutant

Which of the above cross(es) is/are indicative that the mutation is in a maternal-effect gene?

- (1) Cross III only (2) Cross V only  
 (3) Cross I, II and III (4) Cross II and V

96. The pedigree below is in reference to Angelman Syndrome (AS), which is caused by a mutation in the UBE3A gene on chromosome 15. The gene is also paternally imprinted. Individuals showing AS, have not been indicated in the given pedigree. Individual 1-1 does not have AS. Individuals marked with dots are carriers for UBE3A mutation



Which of the following progeny shows Angelman Syndrome (AS)?

- (1) II-1, III-1 and IV-1 (2) III-1, III-2 and IV-2  
 (3) II-2, III-2, III-5 and IV-2 (4) II-1 and II-V

97. The Western Ghats (WG) is a 1600 km mountain chain along the west coast of peninsular India, which intercepts the south-west monsoon winds. Monsoon starts in the southern WG and moves progressively north and retreats in the reverse direction. The southern WG also receives some rainfall from the north-east monsoon. Based on this information, which one of the following statements is most likely to be INCORRECT?

- (1) Vegetation in the southern WG experiences a more seasonal climate.  
 (2) Vegetation in the northern WG experiences a more seasonal climate.  
 (3) Generally, less seasonal areas tend to have higher plant diversity, so tree diversity will decrease from south to north in the WG.  
 (4) Tree species in the northern WG will have to handle longer dry seasons than species found in the southern WG.

98. The table lists information about different classes of retroelements:

Column X		Column Y	
A	LTR retrotransposons	(i)	7-21 bp target sequence
B	Non-LTR retrotransposons	(ii)	copied elements
C	SINES	(iii)	Alu elements

Which one of the following options has all correct matches between column X and Y?

- (1) A- (ii), B- (i), C- (iii)  
 (2) A- (i), B- (iii), C- (ii)  
 (3) A- (iii), B- (ii), C- (iv)  
 (4) A- (iv), B- (iii), C- (i)

99. Four different Hfr strains of E. coli were mated with  $F^-$  recipients, and the time of entry of various donor markers were found to be as below:  
 Hfr 1: met [15 min] thr [30 min] phe [42 min] mal [57 min]  
 Hfr 2: bio [50 min] thy [51 min] his [60 min] mal [77 min]  
 Hfr 3: cys [10 min] phe [26 min] his [58 min]  
 Hfr4: his [12 min] bio [22 min] azi [27 min] thi [44min]

Based upon the above observations, the following statements were made assuming met to be at 0 min and thr at 15 min:

- A. his is located at 59 min  
 B. azi is located at 74 min  
 C. cys is located at 11 min  
 D. mal is located at 76 min

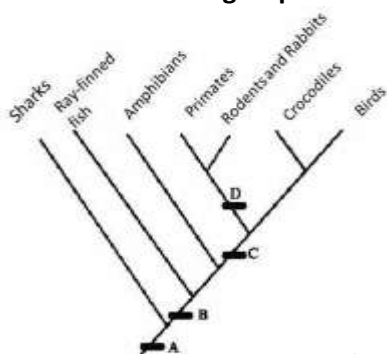
Which one of the following options represents all correct statements?

- (1) A and D only  
 (2) B, C and D B  
 (3) A, B and C  
 (4) C and D only

100. Which one of the following statements about corals is NOT CORRECT?

- (1) Corals possess special stinging cells called nematocytes in their tentacles for capturing prey.
- (2) Several corals have mutualistic interactions with microorganisms called zooxanthellae that photosynthesize and pass some of the food to their hosts.
- (3) Reefs form when corals grow in shallow water close to the shores.
- (4) All corals grow only in the photic zones as they need sunlight for their growth.

101. The cladogram given below shows the distribution of derived characters (A to D) that define each of the groups shown at the tip



Select the correct arrangement of characters that are being described by A to D.

- (1) A = Bony skeleton, B = Four limbs, C = Hair, D = Amniotic egg
- (2) A = Vertebrate, B = Bony skeleton, C = Amniotic egg, D = Hair
- (3) A = Vertebrate, B = Bony skeleton, C = Hair, D = Four limbs
- (4) A = Amniotic egg, B = Four limbs, C = Vertebrate, D = Hair

102. Select the option that correctly identifies all organisms that are included in the International Code of Nomenclature (Shenzhen Code, 2017) along with plants:

- (1) Prokaryotes together with all algae and fungi, except their fossils.
- (2) All algae and fungi along with their fossils, except Microsporidia.
- (3) Prokaryotes and algae, except Microsporidia.
- (4) Photosynthetic algae and fungi.

103. Match the Indian Biosphere reserves (Column P) with the key fauna (Column Q) they are intended to protect.

Column P (Biosphere Reserve)		Column Q (Key fauna)	
A	Gulf of Mannar	(i)	Musk deer
B	Dihang-Dibang	(ii)	Saltwater crocodile
C	Great Nicobar	(iii)	Dugong
D	Seshachalam Hills	(iv)	Lion-tailed macaque
E	Nilgiri Biosphere Reserve	(v)	Slender loris

Which one of the following options has all correct matches between column P and Q?

- (1) A-(iii); B- (i); C- (ii); D- (v); E- (iv)
- (2) A- (ii); B- (iv); C- (v); D- (i); E- (iii)
- (3) A- (iii); B- (iv); C- (i); D- (ii); E- (v)
- (4) A- (v); B- (iii); C- (ii); D- (iv); E- (i)

104. Table below shows the protected areas, their description and the protected area types.

Protected areas	Description	Protected Area Type
Kaziranga National Park	D1- World's largest population of one-horned rhinoceroses	T1- RAMSAR Wetland Site
Beas Conservation Reserve	D2- Major wintering areas for large numbers of aquatic birds	T2- UNESCO Natural World Heritage Site
Keoladeo National Park	D3- Site for threatened species such as mahseer, hog deer, smooth-coated otter	
Manas Wildlife Sanctuary	D4- Home to many endangered species including tiger, pygmy hog, Indian rhinoceros and Asian elephant	

Select the option that is NOT CORRECT based on the information provided in the Table.

- (1) Beas Conservation Reserve, D3, T1,
- (2) Kaziranga National Park, D1, T2,
- (3) Keoladeo National Park, D2, T2,
- (4) Manas Wildlife Sanctuary, D4, T1,

105. Fragmentation breaks up contiguous tracts of natural habitats into smaller patches. In a fragmented landscape where a previously large forest has become a mosaic of patches of different sizes, the following statements can be made about the fragment size and its species diversity.

- A. Smaller fragments will always have lower species richness than larger fragments.
- B. Species richness will depend on fragment size.
- C. Species richness will depend on physical connectivity between fragments.
- D. Species richness cannot be compared between large and small fragments.

Select the option where both the statements are correct

- (1) A and B
- (2) B and C
- (3) A and C
- (4) B and D

106. The Montreal Protocol and its subsequent amendments have resulted in reduced ozone depletion. It is also observed that ozone depletion over the South Pole is much more severe than over the North Pole. In this regard, consider the following statements.

- A. A polar vortex is formed around the North Pole.
- B. Stratospheric temperatures over the South Pole are much lower compared to the North Pole.
- C. Emissions of ozone depleting substances are higher in the southern hemisphere compared to northern hemisphere.
- D. More extensive formation of polar stratospheric clouds over the South Pole compared to the North Pole.

Select the option which includes the correct combination of statements that explain the difference in the ozone depletion between the poles.

- (1) A and D
- (2) B and D
- (3) B and C
- (4) A and C

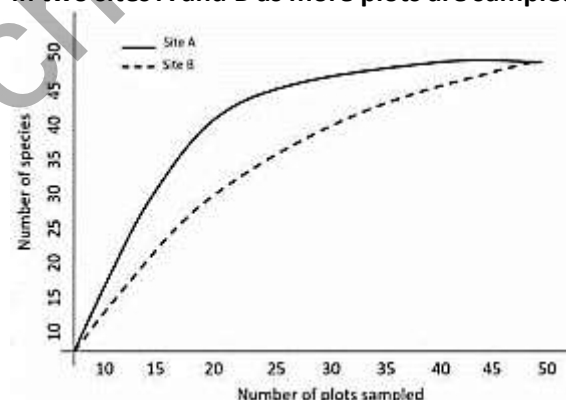
107. The intensity of competition can be inferred from knowing the carrying capacity (K) and the population size (N) in the equation below:

$$\frac{dn}{dt} = rN \frac{(K-N)}{K}$$

Assume that populations have the same intrinsic growth rates (r) and carrying capacities (K). Then, at which one of the following values of the second term (K-N)/K in the equation, is the intraspecific competition likely to be the highest?

- (1) 0.001
- (2) 0.009
- (3) 0.15
- (4) 0.015

108. The graph below shows the accumulation of species in two sites A and B as more plots are sampled



Based on this graph, following statements were made.

- A. In both sites, sampling more plots will not add any more species.
- B. Sampling more plots will add more species in Site B but not Site A.
- C. Sites A and B are likely to have similar species richness.
- D. Site B is likely to have higher species richness than Site A

Which one of the following options contains both statements that are INCORRECT?

- (1) A and C
- (2) A and B
- (3) B and C
- (4) C and D

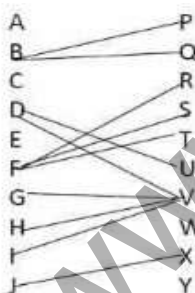
109. Study the global ecosystem data provided in the following table.

Ecosystem	Global Area ( $10^6 \text{ Km}^2$ )	Mean Net Primary Productivity (NPP) per unit area ( $\frac{\text{gm}^2}{\text{m}^2\text{yr}}$ )	Mean biomass per unit area ( $\frac{\text{kg}}{\text{m}^2}$ )
Tropical Rainforest	17	2000	44
Swamp and marsh	2	2500	15
Cultivated land	14	644	1.1
Open ocean	332	127	0.003

Based on the data provided in the table, choose the correct option that represents ecosystems with the highest global primary production and the highest relative NPP, respectively.

- (1) Tropical rainforest and tropical rainforest
- (2) Swamp and marsh, and tropical rainforest
- (3) Cultivated land and open ocean
- (4) Open ocean and open ocean.

110. Interacting plant (A-J) and insect herbivore (P-Y) species in a community are depicted in the network below.



Consider the following statements about the network drawn above.

- A. Insects are more specialised than plants.
- B. There are no obligate interactions in this network
- C. The community is modular
- D. Missing links always represent the absence of an interaction

Given this network, which one of the options below is correct?

- (1) A only
- (2) A and C only
- (3) B, C and D only
- (4) B and D only

111. A researcher observed ants in contact with plant hoppers that were feeding on tree sap. Which of the following conclusions made by her would be correct?

- (1) This is an example of ants being predatory.
- (2) This is an example of ants upsetting the ecological balance of nature.
- (3) This is an example of a multitrophic interaction.
- (4) This is an example of the tree attracting ants to get rid of plant hoppers.

112. The following statements explain various evolutionary outcomes:

- A. Within a lineage, organisms show a constant rate of extinction.
  - B. Even in the absence of changing interactions, organisms are constantly evolving.
  - C. Organisms with novel genotypes are at a selective disadvantage.
  - D. Coevolution between two interacting species act to maintain genetic variation through time.
- Which of the following combinations of the above statements are supported by the 'Red Queen hypothesis'?

- (1) A and D
- (2) A and B
- (3) B and C
- (4) C and D

113. In a particular population A, individuals are under stress and they produce smaller offspring. Based on this, one may conclude that

- (1) stress in a population affects offspring size but not the number of offspring.
- (2) stressed adults prefer to produce smaller offspring that require less food.
- (3) stress may be linked to offspring size.
- (4) stress in a population directly affects offspring size.

114. Sexually reproducing organisms employ signals to attract mates. If such signals honestly reflect an individual's quality, then which of the following is expected?



- (1) Organisms in poor metabolic condition signal more.
- (2) Organisms in poor metabolic condition signal less.
- (3) Organisms will not modulate signalling behaviour with metabolic condition.
- (4) Organisms in good metabolic condition will signal less.

115. A plant species with unisexual flowers has the following traits: floral longevity = 12 hours, pollen: ovule = 10:1, male and female flowers with synchronized anthesis. Given these, which of the following mutations would be most detrimental to seed set in this plant species?

- (1) The pollen:ovule ratio drops to 3:1
- (2) Longevity of male and female flowers increases to 16 hours.
- (3) Anthesis in male flowers occur 2 hours after female flowers.
- (4) The pollen:ovule ratio increases to 15:1

116. PBMCs from the blood collected from a tuberculosis (TB) patient were given to four lab technicians to perform ELISPOT assay for interferon  $\gamma$  (IFN $\gamma$ ) While all steps recommended for ELISPOT were followed, the first step was performed differently by the four lab technicians, as detailed below.

A Lab technician 1 coated each well with 250,000 formaldehyde- treated cells and stimulated the cells with TB-specific antigen.

B. Lab Technician 2 coated each well with 250,000 cells and did not stimulate the cells with TB-specific antigen.

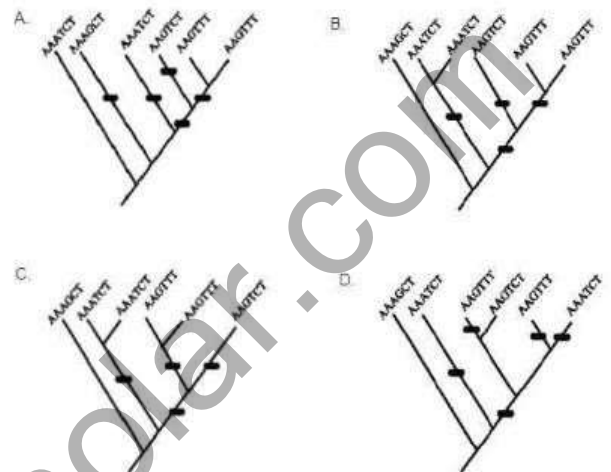
C. Lab technician 3 depleted T cells from PBMCs completely, coated the wells with monocyte-enriched PBMCs, and stimulated them with TB-specific antigen.

D. Lab technician 4 coated each well with 250,000 cells and stimulated the cells with TB-specific antigens.

Which of the lab technicians' assays will yield a correct ELISPOT result for interferon  $\gamma$ ?

- (1) Lab technician 1
- (2) Lab technician 2
- (3) Lab technician 3
- (4) Lab technician 4

117. In the cladograms given below each nucleotide change is indicated by a black bar



Which one of the following options represents two equally most parsimonious trees?

- (1) A and B
- (2) B and C
- (3) C and D
- (4) A and D

118. In a modified version of ELISA, a student first incubated antibody against the *Pseudomonas aeruginosa* exotoxin A (Pa-exotoxin A) with culture samples in a 0.5mL tube to check for *Pseudomonas* contamination. Each antibody-culture mixture was then added to a microtiter plate whose wells were coated with Pa-exotoxin A. This was followed by removing the antibody-culture mix from the wells, washing the wells, adding enzyme-conjugated secondary antibody specific for the isotype of the primary antibody, and then detection with enzyme-specific substrate reaction absorbance at 450 nm. The values of absorbance at 450 nm for each of four samples A-D is given below:

Samples	A150
A	0.323
B	0.582
C	0.098
D	0.220

Select the option that arranges the samples from having highest to least contamination.

- (1) C, D, A, B
- (2) B, A, D, C
- (3) C, D, B, A
- (4) B, A, C, D

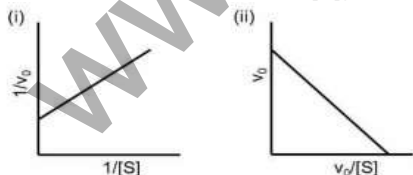
119. The table below lists terms used in bioremediation (column X) and explanations for the terms (column Y).

Column X		Column Y	
(A)	Bioventing	(i)	Indigenous level of containment egradation without any treatment
(B)	Natural attenuation	(ii)	It is a technique of adding oxygen to the saturated zone below water table to stimulate degradation
(C)	Air spraying	(iii)	It is a technique to add oxygen directly to a site of contamination in an unsaturated zone which stimulates in situ aerobic degradation
(D)	Biostimulation	(iv)	Modification of environmental conditions by adding nutrients to enhance biodegradation process

Which one of the following options is a correct match between terms in column X and explanations in column Y?

- (1) A (iii), B (i), C (iv), D (ii) (2) A (iv), B (iii), C (i), D (ii)  
 (3) A (iii), B (iv), C (ii), D (i) (4) A (iii), B (i), C (ii), D (iv)

122. Given below are plots of the linear derivation of Michaelis-Menten kinetic equation and statements related to the variables (initial velocity- $V_0$  and substrate concentration -  $[S]$ ) used.



- A. In plot (i), both x and y axes have dependent variables  
 B. In plot (ii) neither x nor y axis has independent variables  
 C. In plot (i) only y-axis has a dependent variable  
 D. In both the plots, x axis has an independent variable

Select the option that has all the correct statements.

121. Given below are terms related to Genome-editing tools in Column A and their feature in Column B.

Column A		Column B	
A	ZFN	i	Homing endonuclease (I-SceI)
B	Meganuclease	ii	Repeat of -35 amino acid length, each amino acid binding a specific DNA base in the target sequence
C	CRISPR/Cas 9	iii	Fusion of Zinc finger DNA binding domain with endonuclease domain of FokI restriction enzyme
D	TALEN	iv	Target specificity using guide RNA

Which one of the following options is the most appropriate match between terms of Column A and Column B?

- (1) A - iv, B - iii, C - ii, D - i (2) A - iii, B - i, C - iv, D - ii  
 (3) A - ii, B - iv, C - i, D - iii (4) A - iii, B - iv, C - ii, D - i

122. The functions of some components used for magnetic resonance imaging (MRI) technique are proposed in the following statements:

- (A) The static magnetic field used by MRI causes all the magnetically sensitive particles to align themselves in same direction.  
 (B) The pulse sequence used by MRI is an oscillating magnetic field which causes perturbation of static magnetic field.  
 (C) The receiver coil placed near a portion of subject's body is a radiofrequency coil that records the relaxation time of protons.  
 (D) Various parameters of pulse sequence cannot be adjusted to maximize the ability to image certain substances.  
 (E) The signal intensity received by the receiver coil can provide the location of brain from which it is coming

Choose the option with all INCORRECT statements.

- (1) A and B  
 (2) B and C  
 (3) C and D  
 (4) D and E

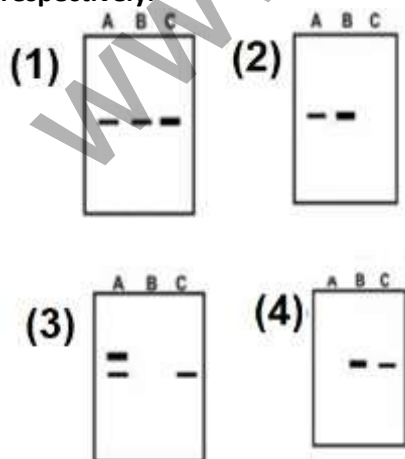
123. Given below are a list of statistical terms in Column A and associated properties/features/descriptors in Column B.

Column A		Column B	
A	ANOVA	i	Quantify errors in count data.
B	Poisson distribution	ii	Pointedness of a frequency distribution.
C	Standard error	lii	Comparison of means of two or more samples.
D	Kurtosis	iv	Dispersion of repeated sample means around the true value.

Which one of the options given below is the most appropriate match between entries of Column A with those of Column B?

- (1) A - ii, B - i, C - iv, D - iii (2) A - ii, B - iii, C - iv, D - i  
 (3) A - iii, B - i, C - iv, D - ii (4) A - iv, B - iii, C - ii, D - i

124. Three reactions were performed to detect a 150 bp DNA fragment rich in GC content, using PCR amplification method and the following radiolabeled material (i) 5'-<sup>32</sup>P-labelled primers (ii) α-<sup>32</sup>P-labelled dCTP and, (iii) γ-<sup>32</sup>P-labelled dATP. All the reactions had the remaining components for a successful PCR amplification. After PCR amplification the samples were run on a 2% Agarose gel. The gel was then exposed to radiographic film. From the radiographs given below, which is the correct representation of the reactions (i),(ii) and (iii) in lanes A, B and C respectively.



125. Given below are radio-imaging technologies with the type of radiation/ radioisotope is used for the same.

- A. Computed tomography scanner uses UV-rays  
 B. Magnetic resonance imaging [MRI] uses non-ionization radiation  
 C. Thyroid scintigraphy uses Iodine-123 ( $I^{123}$ )  
 D. Phase-contrast radiography uses X-rays  
 E. Fluoroscopy uses X-rays

Which of the options represents all correct statements?

- (1) B and E only (2) A, C and D only  
 (3) A, B, D and E only (4) B, C, D and E only

Answers									
Section - B									
1	2	3	4	5	6	7	8	9	10
(2)	(4)	(4)	(4)	(3)	(4)	(1)	(2)	(1)	(4)
11	12	13	14	15	16	17	18	19	20
(2)	(3)	(3)	(3)	(3)	(2)	(3)	(1)	(2)	(3)
21	22	23	24	25	26	27	28	29	30
(4)	(2)	(3)	(2)	(4)	(3)	(4)	(2)	(2)	(2)
31	32	33	34	35	36	37	38	39	40
(1)	(4)	(3)	(1)	(1)	(3)	(3)	(3)	(4)	(3)
41	42	43	44	45	46	47	48	49	50
(3)	(1)	(3)	(4)	(3)	(3)	(4)	(1)	(1)	(1)
SECTION - C									
51	52	53	54	55	56	57	58	59	60
(2)	(2)	(3)	(1)	(2)	(3)	(1)	(3)	(4)	(4)
61	62	63	64	65	66	67	68	69	70
(4)	(3)	(*)	(*)	(*)	(1)	(3)	(*)	(*)	(*)
71	72	73	74	75	76	77	78	79	80
(*)	(*)	(*)	(*)	(2)	(3)	(2)	(4)	(3)	(2)
81	82	83	84	85	86	87	88	89	90
(2)	(4)	(1)	(4)	(3)	(1)	(4)	(3)	(2)	(2)
91	92	93	94	95	96	97	98	99	100
(2)	(2)	(3)	(2)	(2)	(2)	(4)	(1)	(3)	(4)
101	102	103	104	105	106	107	108	109	110
(2)	(2)	(1)	(3, 4)	(2)	(2)	(1)	(1)	(4)	(2)
111	112	113	114	115	116	117	118	119	120
(3)	(1)	(3)	(2)	(1)	(4)	(2)	(1)	(4)	(2)
121	122	123	124	125					
(2)	(4)	(3)	(*)	(4)					