PART – A:

1. A 16.2 m long wooden log has a uniform diameter of 2 m. To what length the log should be cut to obtain a piece of 22 m^3 volume?

(1) 3.5 m (2) 7.0 m

(3) 14.0 m (4) 22.0 m

2. What is the last digit of 7^{73}?

(1) 7 (2) 9

(3) 3 (4) 1

3. A lucky man finds 6 pots of gold coins. He counts the coins in the first four pots to be 60, 30, 20 and 15 respectively. If there is a definite progression, what would be the numbers of coins in the next two pots?

(1) 10 and 5 (2) 4 and 2

(3) 15 and 15 (4) 12 and 10

4. A bee leaves its hive in the morning and after flying for 30 minutes due south reaches a garden and spends 5 minutes colleting honey. Then it flies for 40 minutes due west and collects honey in another garden for 10 minutes. Then it returns to the hive taking the shortest route. How long was the bee away from its hive? (Assume that the bee flies at constant speed)

(1) 85 min (2) 155 min

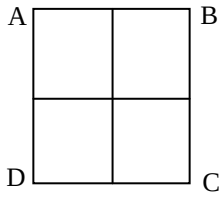
(3) 135 min (4) Less than 1 hour

5. A bird perched at the top of a 12 m high tree sees a centipede moving towards the base of the tree from a distance equal to twice the height of the tree. The bird flies along a straight line to catch the centipede. If both move at the same speed, at what distance from the base of the tree will the centipede be picked up by the bird?

(1) 16 m (2) 9 m

(3) 12 m (4) 14 m

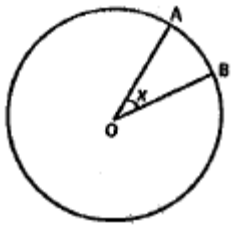
6. An ant goes from A to C in the figure crawling only on the lines and taking the least length of path. The number of ways in which it can do so is



(1) 2 (2) 4

(3) 5 (4) 6

7. A point is chosen at random from a circular disc shown below. What is the probability that the point lies in the sector OAB?

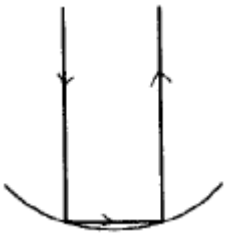


(where $\angle AOB = x$ radians)

(1) $\frac{2x}{\pi}$ (2) $\frac{x}{\pi}$

(3) $\frac{x}{2\pi}$ (4) $\frac{x}{4\pi}$

8. A ray of light, after getting reflected twice from a hemispherical mirror of radius R (See the below figure), emerges parallel to the incident ray. The separation of the original incident ray and the final reflected ray is



(1) R (2) $R\sqrt{2}$

(3) 2R (4) $R\sqrt{3}$

9. A king ordered that a golden crown be made for him from 8 kg of gold and 2 kg of silver. The goldsmith took away some amount of gold and replaced it by an equal amount of silver and the crown when made, weight 10 kg. Archimedes knew that under water gold lost $1/20^{th}$ of its weight, while silver lost $1/10^{th}$. When the crown was weighed under water, it

was 9.25 kg. How much gold was stolen by the goldsmith?

(1) 0.5 kg (2) 1 kg

(3) 2 kg (4) 3 kg

10. What is the angle between the minute and hour hands of a clock at 7:35?

(1) 0° (2) 17.5°

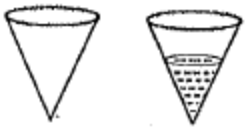
(3) 19.5° (4) 20°

11. A stream of ants go from point A to point B and return to A along the same path. All the ants move at a constant speed and from any given point 2 ants pass per second one way. It takes 1 minute for an ant to go from A to B. How many returning ants will an ant meet in its journey from A to B?

(1) 120 (2) 60

(3) 240 (4) 180

12. The capacity of the conical vessel shown above in V. It is filled with water upto half its height. The volume of water in the vessel is



(1) $\frac{V}{2}$ (2) $\frac{V}{4}$

(3) $\frac{V}{8}$ (4) $\frac{V}{16}$

13. A large tank filled with water is to be emptied by removing half of the water present in it everyday. After how many days will there be closest to 10% water left in the tank?

(1) One (2) Two

(3) Three (4) Four

14. n is a natural number. If n^5 is odd, which the following is true?

(A) n is odd (B) n^3 is odd (C) n^4 is even

(1) A only (2) B only

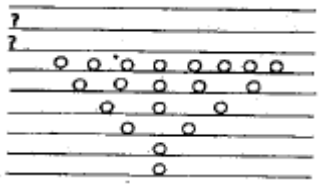
(3) C only (4) A and B only

15. Suppose you expand the product $(x_1 + y_1)(x_2 + y_2) \ldots (x_{20} + y_{20})$. How many terms will have only one x and rest y's?

(1) 1 (2) 5

(3) 10 (4) 20

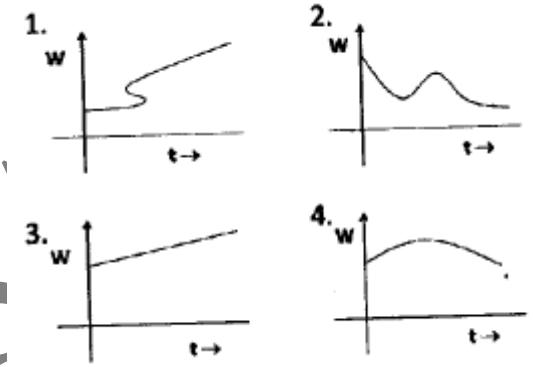
16. In the below figure the numbers of circles in the blank rows must be



(1) 12 and 20 (2) 13 and 20

(3) 13 and 21 (4) 10 and 11

17. If we plot the weight (w) versus age (t) of a child in a graph, the one that will never be obtained from amongst the four graphs given below is



18. Find the missing number:

(1) 1 (2) 0

(3) 2 (4) 3

19. In solving a quadratic equation of the form $x^2 + ax + b = 0$, one student took the wrong value of a and got the roots as 6 and 2; while another student took the wrong value of b and got the roots as 6 and 1. What are the correct values of a and b, respectively?

(1) 7 and 12 (2) 3 and 4

(3) –7 and 12 (4) 8 and 12

20. The distance between two oil rigs is 6 km. What will be the distance between these rigs in maps of 1:50000 and 1:5000 scales, respectively?

(1) 12 cm and 1.2 cm

(2) 2 cm and 12 cm

(3) 120 cm and 12 cm

(4) 12 cm and 120 cm

PART – B:

21. Which one of the following non-covalent interactions between two non-bonded atoms A and B is most sensitive to the distance between them?

(1) A and B are permanent dipoles and are involved in hydrogen bonding.
(2) A and B are fully ionized and are involved in salt bridge formation.
(3) A and B are uncharged and repel each other.
(4) A and B are uncharged and attract each other.

22. Which statement best describes the pKa of amino groups in proteins?

(1) pKa of α-amino group is higher than the pKa of ϵ-amino group.
(2) pKa of α-amino group is lower than the pKa of ϵ-amino group.
(3) pKa of α-amino group is same as the pKa of ϵ-amino group.
(4) pKa of α-amino group is higher than the pKa of guanidine side chain of arginine.

23. What is the effect of 2, 4-dinitrophenol on mitochondria?

(1) Block ATP synthesis without inhibiting electron transport by dissipating the proton gradient.
(2) Blocks electron transport and ATP synthesis by inhibiting ATP-ADP exchange across the inner mitochondrial membrane.
(3) Blocks electron transport and proton pumping at complexes I, II and III.
(4) Interacts directly with ATP synthase and inhibits it activity.

24. A protein has 30% alanine. If all the alanines are replaced by glycines,

(1) helical content will increase.
(2) β-sheet content will increase.
(3) There will be no change in conformation.
(4) The alanine-substituted protein will be less structured than the parent protein.

25. The gel to liquid crystalline transition temperature ™ of phospholipids is dependent on the fatty acid composition. Considering this, Tm of

(1) all the phospholipids will be identical.
(2) DPPC will be lowest and DOPC will be highest.
(3) POPC and DOPC will be identical and lower and DMPC or DPPC.
(4) DOPC will be lowest and DPPC will be highest.

26. You have created a fusion between the trp operon, which encodes the enzymes for tryptophan biosynthesis, under the regulatory control of the lac operator. Under which of the following conditions will tryptophan synthase be induced in the strain that carries the chimeric operator fused operons?

(1) Only when both lactose and glucose are absent.
(2) Only when both lactose and glucose are present.
(3) Only when lactose is absent and glucose is present.
(4) Only when lactose is present and glucose is absent.

27. Which of the following pairs of subcellular compartments is likely to have same pH and electrolyte composition?

(1) Cytosol and lysosomes.
(2) Cytosol and mitochondrial inter membrane space.
(3) Cytosol and endosome.
(4) Mitochondrial matrix and inter membrane space.

28. Regarding microtubule assembly and disassembly during cell division, which will be the most appropriate answer?

(1) Once formed, kinetochore microtubules depolymerize at the plus ends throughout mitosis.
(2) Once formed, kinetochore microtubules polymerize at the plus ends throughout mitosis.
(3) Kinetochore microtubules polymerize at their plus ends up to anaphase, at which point they begin to depolymerize.
(4) Kinetochore microtubules polymerize at their minus ends up to cytokinesis, at which point they depolymerize.

29. Origin of replication usually contains

(1) GC rich sequences.
(2) Both AT and GC rich sequences.
(3) No particular stretch of sequences.
(4) AT rich sequences.

30. σ-subunit of E.coli RNA polymerase **DOES NOT**

(1) Initiate transcription and fall off during elongation.
(2) Increase affinity of the core enzyme to the promoter.
(3) Binds to DNA, independent of core enzyme.
(4) Ensures specificity of transcription by interacting with the core enzyme.

31. The cap binding protein (eIF4E), which is involved in the global regulation of translation, is highly regulated in eukaryotic cells. In an experiment, a researcher transfected mammalian cells with (eIF4E) gene for its overexpression. Due to this, the cells will undergo

(1) apoptosis
(2) neoplastic transformation
(3) no change
(4) differentiation

32. Bacteriophage T4 infects E. coli and injects its DNA inside the cell. The transcription of viral genes occurs in three stages: immediate early, early and late. All the promoters on viral genome are available, but the control takes place at the level of

(1) promoter strength
(2) modification of host RNA polymerase
(3) synthesis of new polymerases
(4) turn over rate of RNA synthesis

33. Gram negative bacterial, *Klebsiella pneumonia,* upon infecting humans, results in severe septic shock after a few hours of infection. Which of the following is not true for this type of infection?

(1) Cell wall endotoxins cause overproduction of cytokines.
(2) Septic shock can be treated by anti-TNFα antibodies.
(3) Recombinant bacterial proteins can be used for the treatment of septic shock.
(4) Recombinant TNFα receptor antagonist can be used for the treatment of septic shock.

34. Which of the following is NOT associated with insulin action?

(1) Increased glucose transport.
(2) Increased glycogen formation.
(3) Enhanced lipolysis is adipose tissue.
(4) Decreased rate of gluconeogenesis.

35. When adenoma is converted to metastatic adenocarcinoma, which of the following combination of proteins is almost certainly to be degraded?

(1) Type IV collagen and laminin.
(2) Fibronectin and β_2 integrin.
(3) Metalloprotease and serine protease.
(4) Elastin and selectin.

36. Which of the following is considered to be a combined B- and T-cell deficiency?

(1) Ataxia-telanglectasia
(2) Swiss type agammaglobulinemia
(3) Wiskott-Aldrich syndrome
(4) Bruton's agammaglobulinemia

37. The part of the embryo from which the ectoderm, mesoderm and endoderm are formed in click is known as

(1) primitive streak (2) hypoblast
(3) epiblast (4) cytotrophoblast

38. Which protein secreted by the amphibian organizer induces neural tissue formation by inhibiting Bone Morphogenetic Protein?

(1) β-catenin (2) Noggin
(3) Dickkopf (4) Dishevelled

39. The homologue of β-catenin in Drosophila is

(1) Fushi tarazu
(2) Engrailed
(3) Armadillo
(4) Cubitus interruptus

40. Which of the floral whorls is affected in *apetala 3/pistillata (ap3/pi*) mutants?

(1) Sepals and petals
(2) Petals and stamens
(3) Stamens and carpels
(4) Sepals and stamens

41. Which one of the following statement is **INCORRECT** about the role of oxidative pentose phosphate pathway in plant metabolism?

(1) Generation of NADPH required to drive biosynthetic reactions.
(2) Production of pentose phosphate for the synthesis of nucleic acids.
(3) Formation of erythrose 4-phospahte for biosynthesis of aromatic amino acids.
(4) Production of NADH to generate ATP.

42. During photosynthetic carbon reduction cycle in green leaves, net production of one molecule of glyceraldehyde 3-phosphate requires one of the following combinations of energy equivalents:

(1) 9 NADPH and 6 ATP
(2) 3 NADPH and 9 ATP
(3) 2 NADPH and 3 ATP
(4) 6 NADPH and 9 ATP

43. Which one of the following essential micronutrients is associated with urease enzyme found in higher plants?

(1) Nickel (2) Molybdenum
(3) Zinc (4) Copper

44. Plants are able to perceive light through various photoreceptors and downstream genes. Which one of the following gens is **NOT** involved in light perception?

(1) PIF3 (2) NPR1
(3) PHY E (4) CRY3

45. In the dark, rods show a large inward "dark" current which is suppressed by a flash of light. Which one of the following statements, explaining the effect of light, is true?

(1) Sodium channels in the outer segment of rods are closed.
(2) Cytoplasmic cGMP concentration increases.
(3) Sodium channels in the inner segment of rods are closed.
(4) Transducin dissociates from beta-arrestin.

46. Four groups of mice were studied for the factor required for mast cell generation: IL-3-deficient, GM-CSF-deficient, G-CSF-deficient and erythropoietin-deficient. In which mice, mast cell generation is most likely to be deficient?

(1) IL-3-deficient
(2) GM-CSF-deficient
(3) G-CSF-deficient
(4) Erythropoietin-deficient

47. What would be the outcome if the theca interna cells were destroyed in a Graafian follicle?

(1) Immediate formation of corpus albicans.
(2) Increased progesterone synthesis in the granulose cells.
(3) Decreased estrogen synthesis in the granulose cells.
(4) Formation of corpus hemorrhagicum.

48. The size of red blood cells (RBC) in venous blood is greater than that of arterial blood. This increased size of red blood cell in the venous blood is due to

(1) the increased permeability of red blood cell (RBC) membrane.
(2) the decreased osmotic pressure in plasma.
(3) the increased osmotic pressure in RBC.
(4) the dissociation of cytoskeletal proteins in RBC.

49. A chromosome aberration leads to change in the order of genes in a genetic map but does not alter its linkage group. This is due to

(1) translocation (2) recombination
(3) transposition (4) inversion

50. The concept of recon was proposed by Seymour Benzer by studying recombination between

(1) lysis mutants of bacteriophage T4.
(2) white eye mutants of *Drosophila melanogaster*.
(3) biochemical mutants of *Neurospora crassa*.
(4) auxotrophic mutants of *Escherichia coli*.

51. Aspartic acid (Asp) is specified by the codon GAU and GAC. After mutation, Asp is changed to Alanine represented by GCX, where X may be A, U, C or G. The reversion of the mutation could only be done with reactive oxygen species. The nature of the mutation is considered to be

(1) transition

(2) transversion

(3) either transition or transversion

(4) depurination

52. A cross is made between two plants with white flowers. All the F1 progeny had red coloured flower. This is because of

(1) complementation (2) recombination

(3) translocation (4) reversion

53. Cladistic classification is based on

(1) sequential order in which branches arise from a phylogenetic trees
(2) the order of sequence divergence.
(3) morphological features and skeleton of individuals.
(4) Cellular organization and cytoskeleton.

54. Tautonym is an informal taxonomic designation used for animals referring to

(1) same name for genus and species.
(2) same name for species and subspecies.
(3) trinomial nomenclature.
(4) the name of the author for the species.

55. A marine biologist dug up a small animal from the ocean floor. The animal was uniformly segmented with short, stiff appendages and soft, flexible skin. It had a complete digestive system and an open circulatory system but no exoskeleton. Based on this description, the animal appears to be a

(1) lancelet (2) roundworm

(3) mollusc (4) crustacean

56. Which of these programs is used to conserve a species facing extinction?

(1) Captive breeding

(2) Natural resources

(3) Sustainable use

(4) Edge effects

57. A grasshopper population is being assessed by capture-mark-release-recapture method. On the first day, 100 grasshoppers were captured from a given area in 1 hour time, marked and released. On the next day during recapture, 10 marked and 90 unmarked grasshoppers could be found in the same time period from same area. What will be the estimated population size in the given area?

(1) 80 (2) 100

(3) 1,000 (4) 10,000

58. Free-living nitrogen fixers can survive in different ecological niches. Identify the **incorrect** combination from the following list:

(1) *Azotobacter* – acidic soil
(2) *Deraxia* – alkaline soil
(3) *Beijernckia* – acid soil
(4) *Frankia* – neutral soil

59. A plot of soil contaminated with diesel oil was inoculated with oyster mushrooms. After 4 weeks, more than 95% of the polycyclic aromatic hydrocarbons had been reduced to non-toxic compounds. This process is called

(1) phytoremediation

(2) chemoremediation

(3) mycoremediation

(4) zooremediation

60. In pre-industrial period in England, peppered moths had light coloration which effectively camouflaged them against light coloured trees and lichens. During industrial revolution, many lichens died out and trees became blackened by soot from factories and interstingly, dark colorued moths were predominantly seen. This happened due to

(1) Natural selection of dark coloured moths which were initially present in fewer numbers.
(2) New mutation which arose due to environmental pollution.
(3) Macroevolution occurring due to environmental change.
(4) Natural selection of the camouflaging mechanism of the moths.

61. The speciation in which a population splits into two geographically isolated populations experience dissimilar selective pressure and genetic drift is known as

(1) sympatric speciation

(2) parapatric speciation

(3) peripatric speciation

(4) allopatric speciation

62. Evolution of multi-gene family occurs by

(1) only gene duplication.
(2) only unequal crossing-over
(3) random mutations.

(4) both duplication and unequal crossing over

63. One aims to find out the role of a gene product in macrophages by using a transgenic mouse expressing the genes under a promoter. Which of the following is the most appropriate promoter?

(1) Actin promoter.

(2) MHC Class II promoter

(3) Mac-I/CD 11b promoter

(4) IL-2 promoter.

64. Which of the following genes was engineered in the "Flavr Savr" transgenic tomato variety?

(1) 1-Amino cyclopropane-1-caboxylic acid synthase
(2) 1-Amino cyclopropane-1-carboxylic acid oxidase.
(3) Expansin
(4) Polygalacturonase.

65. For developing transgenic mice, embryonic stem cells are engineered to express the transgene. These cells are selected by

(1) novobiocin (2) neomycin

(3) tetracycline (4) penicillin

66. Microbial leaching involves the process of dissolution of metals from ore breaking rocks using microorganisms. Which one of the following bacteria helps in leaching copper from its ore?

(1) Acidithiobacillus ferroxidans.
(2) Pseudomonas putida.
(3) Deinococcus radiodurans.
(4) Rhodopseudomonas capsulate

67. Molar absorption coefficient of phenylalanine is 200 M^{-1} cm^{-1} at 257 nm. What concentration (g/L) of this amino acid will give an absorption of 1 in a cell of 0.5-cm path length at 257 nm?

(1) 3.30 (2) 0.33

(3) 1.65 (4) 0.17

68. Which of the following atomic nuclei cannot be probed by nuclear magnetic resonance spectroscopy?

(1) ^{1}H (2) ^{31}P

(3) ^{18}O (4) ^{15}N

69. $t_{1/2}$ of an irreversible first order reaction, S→P is 1 hour. The time (in hours) required to reach 75% completion is

(1) 1.5 (2) 2.0

(3) 2.5 (4) 3.0

70. In the case of monoclonal antibody production by hybridoma technology, myeloma cells used lack the enzyme hypoxanthine-guanine phosphoriboxyl transferase (HGPRT) such that fused cells can only survive when selected on hypoxanthine-aminopterin-thymidine (HAT). What is the role of aminopterin in this medium?

(1) To be used as cell cycle inhibitor of myeloma cells.
(2) To block the pathway for nucleotide synthesis.
(3) To facilitate fusion of myeloid B cells and antibody producing B cells.
(4) To facilitate production of antibody producing B cells.

PART – C:

71. The amino acid alanine has high propensity to occur in helical conformation. The circular dichroism spectrum of an equilmolar mixtue of two 20-residue peptides, one composed of only L-alanine and the other only D-alanine is recorded in the region of 185-250 nm. Which one of the following will be observed?

(1) No signal: as the chiroptical properties of the two peptides will cancel out.
(2) Bands with only negative ellipticity: as helix formed by the D-Ala peptide will be unstable.
(3) Bands with only positive ellipticity: as both the peptides will form right-handed helices.
(4) Bands with identical negative and positive ellipticity.

72. The following small peptide substrates are used for determining elastase activity and the following data have been recorded.

Substrate	**K_M(mM)**	**K_{cat}(s^{-1})**
P A P A↓G	4.02	26
P A P A↓A	1.51	37
P A P A↓F	0.64	18

The arrow indicates the cleavage site. From the above observations, it appears that:

(A) PAPAF is digested most rapidly.
(B) PAPAG is digested most rapidly.
(C) A hydrophobic residue at the C-terminus seems to be favored.
(D) A smaller residue at the C-terminus seems to be favored.
(E) Elastase always requires a smaller residue at the N-terminus of the cleavage site.

Which of the following is true?

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

73. The apparent pH of a fluid is 7.45, where bicarbonate buffer is involved for maintaining its pH. Values of pKa of carbonic acid are 6.15 and 10.45. The molar ratio of [conjugate base] : [acid] is

(1) 1 : 20 (2) 20 : 1
(3) 1 : 1000 (4) 1000 : 1

(Hint: antilog 1.3 = 20.0, and antilog 10^{-3} = 1000)

74. A segment of B-DNA encodes an enzyme of molecular mass 50 kD. The estimated length of this segment in μm would be

(1) 0.1547 (2) 0.1547×10^{-3}
(3) 0.4641 (4) 0.4641×10^{-3}

75. In order to determine the primary structure of an octapeptide, amino acid composition was determined by acid hydrolysis (A). The intact oligopeptide was treated with carboxypeptidase (B), chymotrypsin (C), trypsin (D) and CNBr (E). The peptides were separated in each case and acid hydrolysis was carried out for B – E. Following results were obtained (the brackets represent mixtures of amino acids in each fragment):

(A) (2Ala, Arg, Lys, Met, Phe, 2Ser)
(B) (Ala, Arg, Lys, Met, Phe, 2Ser) and Ala
(C) (Ala, Arg, Phe, Ser), (Ala, Lys, Met, Ser)
(D) (Ala, Arg), (Lys, Phe, Ser), (Ala, Met, Ser)
(E) (Ala, Arg, Lys, Met, Phe, Ser), (Ala, Ser)

Which one is the correct sequence of the oligopeptide?

(1) Arg-Ala-Ser-Lys-Met-Phe-Ser-Ala
(2) Arg-Ala-Ser-Lys-Phe-Met-Ser-Ala
(3) Ala-Arg-Ser-Phe-Lys-Met-Ser-Ala
(4) Ala-Arg-Phe-Ser-Lys-Met-Ser-Ala

76. You are following the intracellular sorting of an integral plasma membrane protein in a living cell, in culture. You have decided to probe this protein by metabolic labeling technique with ^{35}S-methionine (pulse-chase technique). After one cycle of division, the cells were treated with a potent inhibitor of protein biosynthesis and processed for subcellular fractionation. In which of the following fractions will you have expect the presence of this protein upon immunoprecipitation with a specific antibody?

(1) Only cytoplasm
(2) Only plasma membrane
(3) Both endoplasmic reticulum and plasma membrane
(4) Only secretory vesicles and endoplasmic reticulum

77. The principla pathway for transport of lysosomal hydrolases from the trans Golgi network (pH 6.6) to the late endosomes (pH 6.0) and the recycling of M6P (mannose 6 phosphate) receptors back to the Golgi depends on the pH difference between those two compartments. From what you know about M6P receptor binding and recycling and the pathways for delivery of material to lysosomes, predict what would happen if the pH in late endosomes was raised to 6.6?

(1) M6P will bind to hydrolases but will not release the hydrolases in the late endosomes.
(2) M6P will bind to hydrolases and will release the hydrolases in the late endosomes.
(3) At higher endosomal pH, the receptor would not release the hydrolase and could not be recycled back to the trans Golgi network.
(4) M6P will be degraded at higher pH.

78. The diploid genome of s species comprises 6.4×10^9 bp and fits into a nucleus that is 6 μm in diameter. If base pairs occur at intervals of 0.34 nm along the DNA helix, what is the total length of DNA in a resting cell?

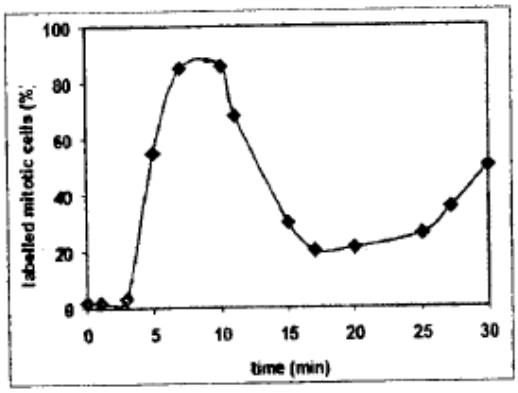
(1) 3.0 m (2) 3.5 m
(3) 2.2 m (4) 4.0 m

79. Phosphorylation of serines as well as methylation and acetylation of lysines in histone tails effect the stability of chromatin structure above the nucleosome level and have important consequences for gene expression.

The resulting changes in charge are expected to affect the ability of the tails to interact with DNA because

(1) DNA is negatively charged.
(2) DNA-histone interaction is independent of net charge.
(3) Phosphorylation of serine increases DNA-histone interaction.
(4) Methylation and acetylation of lysine increases DNA-histone interaction.

80. Cells that grow and divide in a medium containing radioactive thymidine covalently incorporate the thymidine into their DNA during S phase. Consider a simple experiment in which cells are labeled by a brief (30 minutes) exposure to radioactive thymidine. The medium is then replaced with one containing unlabeled thymidine, and the cells grow and divide for some additional time. At different time points after replacement of the medium, cells are examined under a microscope. Cells in mitosis are easy to recognize by their condensed chromosomes and the fraction of mitotic cells that have radioactive DNA can be estimated by autoradiography and plotted as a function of time after the thymidine labeling as in the figure below:



The rise and fall of the curve is because:

(1) Initial rise of the curve corresponds to cells that were just finishing DNA replication when radioactive thymidine was added (S phase).
(2) The peak of the curve corresponds to cells in M phase.
(3) The rise in curve after 20 min corresponds to cells in apoptotic phase.
(4) The fall in curve after 10 min indicates the cells exiting M phase.

81. A rapidly growing bacterial species such as E. coli exhibits a typical phase of growth cycle in liquid nutrient broth (lag phase $\rightarrow$ log phase $\rightarrow$ stationary phase $\rightarrow$ death phase). If a bacterial culture has a starting density of 10^3 cells/ml has a lag time of 10 minutes and a generation time of 10 minutes, what will the cell density be at (cells/ml) 30 minutes?

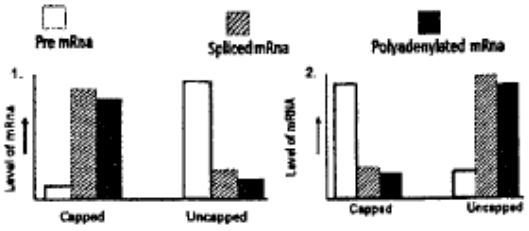
(1) 6.0×10^3 (2) 2.0×10^3
(3) 3.0×10^3 (4) 4.0×10^3

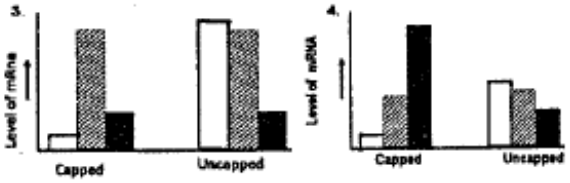
82. In order to study the role of telomeres in DNA replication, genetically engineered mice were prepared, where the gene for telomerase RNA was knocked out. When cells from these knock out mice were taken and cultured in vitro, they proliferated even after 100 cell divisions which is quite unlikely in the case of human cells.

Which of the following is the correct reason?

(1) Human and mice are fundamentally different with respect to their requirements for telomerase enzyme in the context of DNA replication.
(2) In vitro, mice DNA becomes circular due to end to end chromosome fusion and does not require telomerase for DNA end replication.
(3) Mice have very long stretch of telomere DNA sequence compared to that of human.
(4) In vitro, mice DNA replication does not required the removal of RNA primers.

83. You are working with an in vitro eukaryotic transcription system, which produced both capped and uncapped mRNAs. You incubated these mRNAs with mammalian cell nuclear extract and then quantified the different products as shown below. Which of the following graphs correctly represents the expected result?





84. A non-enzymatic viral protein X was found to be inducing a cellular gene promote activity. Although no in vitro DNA binding activity could be identified with X protein, it was found to be co-recruited on the cellular promoter along with a cellular transcription factor in vivo.

Which one of the following statements seems to be the best interpretation of the above findings?

(1) X is a DNA-binding protein.
(2) X physically interacts with the transcription factor.
(3) X modifies the chromatin for transcription activation.
(4) X is a chaperone.

85. During elongation step of protein synthesis, translocation moves the mRNA and the peptidyl t-RNA by one codon through the ribosome. Translocation in E. coli involves GTP and EF-G. However, in vitro translocation can take place independent of GTP and EF-G. Based on these observations, the following hypothesis can be made:

A. The molecular mechanism of translocation in vitro is completely different from that in vivo.
B. Translocation activity is independent of GTP hydrolysis.
C. Translocation activity is completely dependent on GTP and EF-G.
D. Translocation activity is inherent in ribosomes, however, the rate of translocation in who is enhanced significantly in presence of GTP and EF-G.

Which one of the following combinations is correct?

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

86. DNA methylation plays an important role in transcription regulation in vertebrates. There is an inverse correlation between the level of DNA methylation in the vicinity of a gene and its transcription rate, whereas there is a direct correlation between histone acetylation and increased transcription. β-thalassemia is a common genetic impairment of hemoglobin β-chain synthesis in humans. If these patients can synthesize hemoglobin-F instead of hemoglobin β-chain in its place, they would be notably benefited. Administration of 5-azacytidine to β-thalassemia patients increases hemoglobin-F level in erythrocytes and thus benefit the patients.

Which one of the following statements about 5-azacytidine is **NOT** correct?

(1) Cells exposed to 5-azacytidein incorporate it into DNA in place of cytidine.
(2) 5-azacytidine decrease DNA methylation.
(3) 5-azacytidine promotes histone acetylation.
(4) 5-azacytidien does not promote gene expression.

87. In cells having G protein coupled receptor, inhibition of protein kinase A by siRNA technology led to diminished transcription of androgen binding protein (ABP) and CREB protein. Addition of cAMP, which is a second messenger, will lead to

(1) Increased transcription of ABP.
(2) Increased phosphorylation of CREB protein.
(3) No change in transcription level.
(4) Increased GTPase activity of Gα subunit.

88. Binding of a ligand to a cell-surface receptor activates and intracellular signal transduction pathway through the sequential activation of four protein kinases. In the human cell line A, these kinases are held in a signaling complex by a scaffolding protein whereas in another cell line B, these kinases are freely diffusible. Which one of the following possibilities do you think is **NOT** correct?

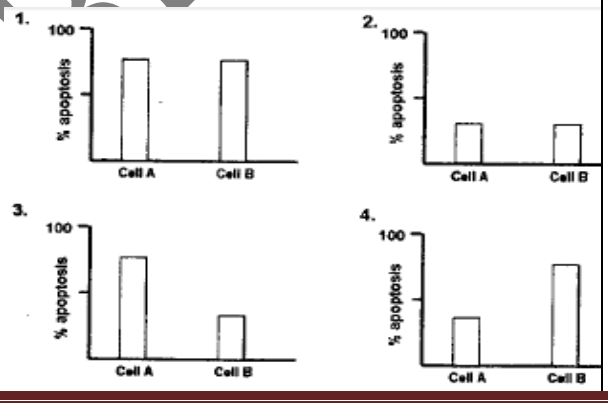
(1) Speed of signal transduction will be higher in cell A.
(2) Possibility of cross-linkage with other signal transduction pathways will be lesser in cell A.
(3) Possibility of signal amplification will be higher in cell A.
(4) Potency of spreading signal through other signaling pathways will be higher in cell B.

89. Mouse erythroleukemia (MEL) cells are used as an in vitro cell culture model for understanding erythropoiesis. These cells are arrested at the stage of pro-erythroblast due to transformation. These cells could be induced by heme to differentiate further so as to synthesize hemoglobin. The most probable molecular mechanism for this could be that heme may suppress and/or down regulate an endogenous heme-regulated inhibitor (HRI) kinase, an inhibitor of globin synthesis. This downregulation in turn promotes differentiation.

To validate this hypothesis which of the following approaches is **NOT** appropriate?

(1) Transfect MEL cells with HRI kinase gene.
(2) Knock down HRI kinase gene in MEL cells.
(3) Determine the rate of protein synthesis *in situ* as a function of differentiation.
(4) Measure HRI kinase activity as a function of differentiation.

90. Cells undergo apoptosis by two distinct and inter-connected pathways: extrinsic and intrinsic. Extrinsic pathway is activated by extracellular ligand binding to cell surface death receptors. Whenever an apoptotic stimulus activates intrinsic pathway, the proapoptotic Bax and Bak proteins become activated and induce the release of cytochrome C from mitochondria leading to caspase cascade activation resulting in paoptosis. In cell A, cytochrome C is introduced by microinjection whereas in cell B, cytochrome C is introduced by microinjection but Bax and Bak are inactivated. What will be the most appropriate apoptotic response type in both cells?



91. Dendritic cells (DC) from BALB/c mice were treated with 1L-10 or with IFN-γ. Similarly, dendritic cells from β2-microglobulindeficint mice were also treated with 1L-10 or with IFN-γ. These cells were co-cultured with CD8* T cells from hen egg lysozyme (HEL)-specific T cell receptor transgenic mice in presence of the HEL peptide. Five day later, CD8* T cells were assayed for target cell lysis. Which one of the following combinations will have the highest target cytotoxicity?

(1) CD (BALB/c)$^{1L\text{-}10}$ × $CD8^{+}T$
(2) DC (BALB/c)$^{1FN\text{-}\gamma}$ × $CD8^{+}T$
(3) DC (β2-microglobulin-deficient)$^{1L\text{-}10}$ × $CD8^{+}T$
(4) DC (β2-microglobulin-deficient)$^{1FN\text{-}\gamma}$ × $CD8^{+}T$

92. Polyspermy results when two or more sperms fertilize an egg. It is usually lethal since it results in blastomeres with different numbers and types of chromosomes. Many species therefore, have two blocks to polyspermy: the fast block and the slow block.

In the case of sea urchins:

A. The fast block is immediate and causes the egg membrane resting potential to rise which does not allow the sperm to fuse with the egg and is mediated by an influx of sodium ions.
B. The fast block is immediate and causes the egg membrane resting potential to rise which does not allow the sperm to fuse with the egg and is mediated by an efflux of sodium ions.
C. The slow block or cortical granule reaction is mediated by calcium ions.
D. The slow block or cortical granule reaction is mediated by potassium ions.

Which of the above statements are true?

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

93. In an experiment, the cells that would normally become the middle segment of a *Drosophila* leg were removed from the leg forming area of the larva and were placed in the top of the fly's antenna. Based on the "French flag" analogy for the operation of a gradient of positional information, which of the following statements is true?

(1) The transplanted cell retain their committed status as leg cells, but respond to the positional information of their environment by becoming leg tip cells-ie., claws.
(2) The transplanted cells are determined as leg cells and therefore would from a complete limb instead of an antenna.
(3) The transplanted cells would intermingle with the cells present in the new environment and develop accordingly to give rise to an antenna.
(4) The transplanted cells retain their committed status as leg cells and would develop to form a chimeric structure having proximal region made of antenna and the distal region ending in a complete leg.

94. Which of the inferences (A-D) given below would you draw from the following tissue transplantation experiments performed with the early and late gastrula stages of the newt?

	Host regions	**Donor regions**	**Differentiation of donor tissue**	
	Earl Gastrula			
(i)	Prospective neurons	Prospective epidermis	Epidermis	
(ii)	Prospective epidermis	Prospective neurons	Neurons	
	Late Gastrula			
(i)	Prospective neurons	Prospective epidermis	Neurons	
(ii)	Prospective epidermis	Prospective neurons	Epidermis	

A. Cells of early newt gastrula exhibit conditional development.
B. Cells of early newt gastrula exhibit autonomous development.
C. Cells of late newt gastrula exhibit conditional development.
D. Cells of the late gastrula exhibit autonomous development.

The correct inferences are:

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

95. Segmentation genes in Drosophila are divided into three groups (gap, pair rule and segment polarity) based on their mutant phenotype, Below are some of the major genes expressed in a sequential manner (with respect to the groups) affecting segmentation pattern.

A. hairy → paired → tailless → patched.
B. hunchback → even-skipped → fushi tarazu → wingless
C. odd-skipped → giant → paired → wingless
D. tailless → hairy → fushi tarazu → gooseberry

Which of the above sequence(s) of genes expressed from early to late embryo is/are correct?

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

96. Human chorionic gonadotropin (hCG) is known to facilitate attachment of blastocyst to uterus. In women with mutation in hCG gene, biologically inactive hCG was formed but implantation occurred. When hCG was immune-neutralized in the uterus of normal woman, implantation failed. This suggests that for implantation in humans:

(1) Biologically active circulating hCG is not required.
(2) Blastocyst can produce the required hCG, which helps locally in uterine attachment.
(3) Trophoblastic cells do not require hCG for the invasion of uterus.
(4) Extra-embryonic tissue is not responsible for the attachment of embryo to uterus.

97. During reproductive development in plants:

A. Male and female gametes are produced as a result of two mitotic divisions after meiosis.
B. Vegetative cells in pollen contribute to pollen development.
C. Antipodals provide nourishment to developoing embryos.
D. Pollen tube ruptures and releases both the male gametes in one of the degenerated synergids.

Which of the above statements are true?

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

98. During fertilization in mammals, sper-egg interaction is mediated by zona pellucida (ZP) membrane proteins and their receptors present in sperm membrane. ZP3 has been identified to be the principle ZP protein whose post-translational modification is important for sperm – egg interaction. In a competitive inhibition assay the sperm is saturated with either active ZP3 or its modified forms, before studying sperm-egg-interaction. Which of the following experiments will **NOT** inhibit sperm-egg-interaction

(1) Saturate sperm with ZP3 protein prior to use.
(2) Deglycosylate the ZP3 protein and use it for saturation of sperm.
(3) Phosphorylate the ZP3 protein and use it for saturation of sperm.
(4) Dephosphorylate the ZP3 protein and use it for saturation of sperm.

99. If an Arabidopsis plant, mutated in lycopene biosynthetic pathway is grown in sunny tropical climate in the presence of oxygen:

(1) It would accumulate higher biomass due to higher rate of photosynthesis.
(2) There will not be any influence of this mutation on the rate of photosynthesis and plant growth.
(3) It would show reduced biomass due to photo oxidative damage.
(4) The leaves would be bluish purple in color because of higher accumulation of xanthophylls.

100. According to the current model of alternative oxidase regulation, the following factors cause induction of alternative oxidase:

A. Significant increase in the ubiquitin pool in the cytosol.
B. Presence of α-keto acids (like pyruvate and glyoxylate).
C. Cold stress.
D. Increase in cytosolic ATP concentration.

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

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

101. The oxidative pentose phosphate pathway provides the reducing equivalents for nitrite reduction in plastids (leucoplasts) of non-green tissues. Which one of the following statements would be correct for the above mentioned pathway?

(1) Glutamate synthesized from NH_4^+ is translocated from cytosol to leucoplast.
(2) α-ketoglutarate is translocated from cytosol to leucoplast.
(3) Glucose-6-phosphate is translocated and moves from leucoplast to cytosol.
(4) Triose phosphate is translocated from cytosol to leucoplast.

102. Perception of blue light in plants causes

(1) Inhibition of cell elongation and stimulation of stomatal opening.
(2) Stimulation of cell elongation and inhibition of stomatal opening.
(3) Inhibition of stomatal opening.
(4) Inhibition of cell elongation.

103. Following are few statements regarding water potential of soil

A. The osmotic potential (Ψ_s) of soil water is generally negligible, except in saline soils.
B. The osmotic potential (Ψ_s) of saline soil is always more than zero.
C. In dry soils and hydrostatic pressure (Ψ_p) of soil water potential is always positive.
D. Gravitational potential (Ψ_g) of soil water is always proportional to height of the tree.

Which of the following combinations of above statements is true?

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

104. Which one of the following pairs of precursor amino acid and alkaloid is correct?

(1) 'Ornithine aspartate-nicotine' and tryptophan –quinine'
(2) 'Ornithine-nicotine' and 'tyrosine-orphine'
(3) 'Tyrosine-quinine' and 'tryptophan-orphine'
(4) 'Ornithine-quinine' and 'ornithine aspartate – nicotine'

105. Typical morphological defects are routinely used in genetic screens to identify novel genes in signal transduction pathways. Which one of the following morphology has been used to decipher the ethylene signaling pathways?

(1) Light grown morphology of seedling.
(2) Triple response morphology of seedling.
(3) Dark grown morphology of seedling.
(4) Morphology of true leaves.

106. In bone marrow, stem cells are committed to different lineages. Factors that stimulate the colonies of these different lineages are interleukin-3 (multi-CSF), granulocyte-macrophage colony stimulating factor (GM-CSF) and granulocyte or macrophage colony stimulating factor (G-CSF or M-CSF). In a mouse deficient in GM-CSF, the number of hematopoietic cells will be altered. Which one of the following is correct?

(1) Mast cells will be normal in number while granulocytes and macrophages will be deficient in number.
(2) Granulocytes count will be normal but not of macrophages.
(3) Macrophage number will remain unaltered.
(4) Mice will be deficient in all the three cell types.

107. An individual was suffering from digestive complications. It was observed that the individual has dehydrated gastrointestinal tract. When an advanced investigation was done, the person was found to have defects in the following:

A. Cystic fibrosis transmembrane conductance regulator protein.
B. Glucose transporter protein.
C. Na^+/K^+ ATPase.
D. Ca^{2+} ATPase.

Which of the above could be the cause for such a digestive disorder?

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

108. The action potential was recorded intracellularly from a squid giant axon bathed in two types of fluid such as sea water and artificial sea water having lower concentration of sodium ions while maintaining the same osmotic pressure with choline chloride. The nature of action potential was different in the two bathing fluids. Which of the following results is most likely?

(1) The resting transmembrane potential was not changed but the amplitude of action potential was increased with lower sodium concentration in the bathing fluid.
(2) The amplitude of action potential as gradually decreased with reduction of sodium concentration in bathing fluid but the duration of action potential was prolonged.
(3) The resting transmembrane potential was decreased and the amplitude of action potential was also decreased with lower sodium concentration in the bathing fluid.
(4) The amplitude of action potential was not changed with reduction of sodium concentration in the bathing fluid but the duration of action potential was prolonged.

109. Three forms of dextrans namely neutral, polyanionic and polycationic having different molecular radii were injected separately in three groups of rats. The concentrations of dextrans in glomerular filtrate were measured to determine the filterability of the dextrans. The possible outcomes could be as follows:

A. The dextrans having smaller diameter have greater filterability than larger dextrans.
B. Neutral dextrans were filtered more than polycationic and polyanionic dextrans.
C. Polycationic dextrans were filtered more than neutral and polyanionic dextrans.
D. Polyanionic dextrans were filtered more than neutral and polycationic dextrans.

Which one of the following combinations is correct?

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

110. A novel enzyme was identified in humans. The following approaches are available to identify the chromosome on which the gene encoding the enzyme is present:

A. Suppress the activity of enzyme by RNAi.
B. Identify polymorphism in the population and carry out pedigree analysis to study its inheritance.
C. Purify the enzyme, decipher its amino acid sequence, predict its DNA sequence and search for its presence in the available human genome sequence.
D. Create chromosome addition lines by making somatic hybrids between human and mouse cells, identify, lines showing

the enzyme activity and the human chromosome present in it.

Which of the above approaches can be used?

(1) A or B (2) B or C

(3) C or D (4) A or C

111. In an experiment on transposition in an eukaryotic system, an intron was cloned within a transposable element and allowed to transpose from a plasmid to genomic DNA. The intron was found to be absent in the transposable element in its new location. It is

(1) Not a case of transposition.
(2) A case of replicative mode of transposition.
(3) A case of conservative mode of transposition.
(4) A retroposon.

112. In a plant species, a segregating line (one that contains both homozygotes and heterozygotes at a locus) can be made homozygous be repeated selfing for several generations. What is the level of remaining heterozygosity after three generations of selfing, if the level of heterozygosity in generation '0' is denoted as 1?

(1) 0.5 (2) 0.25

(3) 0.125 (4) 0.0625

113. Given below is the result of a complementation test for six independent mutants (1 to 6)

1	2	3	4	5	6	
0	+	0	+	+	0	1
	0	+	+	+	+	2
		0	+	+	0	3
			0	0	+	4
				0	+	5
					0	6

'+' represents complementation; '0' represents non-complementation

Based on the above, which one of the following conclusions is correct?

(1) The mutations can be ordered in a single cistron as 1-3-5-2-4-6.
(2) All mutations belong to a single cistron, but their order cannot be determined.
(3) There are three cistrons, mutations, 1, 3 and 6 represent one cistron, 4 and 5 represent the second cistron and 2 represents the third cistron.
(4) There are three linkage groups, mutations 1, 3 and 6 represent linkage group A, 4 and 5 represent linkage group B, and 6 represents linkage group C.

114. In a hospital three babies were mixed up. The blood group of the babies were A, B and AB. In order to identify the parents of the babies, the blood groups of the parents were determined. The results obtained were:

Parent set 1 – A and AB

Parent set 2 – AB and O

Parent set 3 – B and AB

Which of the following conclusions can be definitively made?

(1) The baby with blood group A is the child of the parent set 2.
(2) The baby with blood group AB is the child of the parent set 1.
(3) The baby with blood group B is the child of the parent set 3.
(4) The parentage of none of the babies can be determined from the given information.

115. There are two mutant plants. One shows taller phenotype than wild type, whereas the other has the same height as the wild type. When these two mutations were brought in together by genetic crosses, the double mutant displaced even taller phenotype than the tall mutant plants. This genetic interaction is called

(1) Antagonistic interaction.
(2) Additive interaction.
(3) Synergistic interaction.
(4) Suppressive interaction.

116. The following table gives vascular tissue characteristics of four divisions of Tracheophyta.

	Divisions	**Vascular tissue characteristics**
(A)	Psilophyta	i. Well-developed tracheid and pits in lateral wall

(B)	Lycopodiophyta	ii. Tracheids
(C)	Sphenophyta	iii. Tracheids, vessels and well-developed phloem
(D)	Pteridophyta	iv. Primitive tracheids and pits in lateral wall

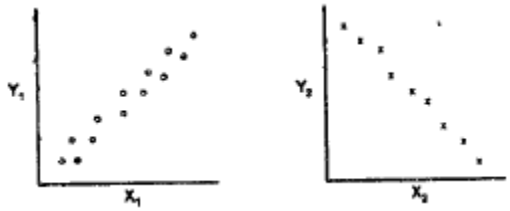
Identify the correct combinations:

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

117. Which of the following is NOT an advantage to seed-based reproduction?

(1) Reserve food material is provided for the developing embryo.
(2) Seed coat protects the embryo and allows it to remain dormant until favorable environmental conditions are available.
(3) The amount of energy spent per female gametophyte is less than that spent on making a spore.
(4) The female gametophyte remains on the sporophyte which provides protection and nourishment.

118. In a study of sexual isolation in a species of salamander, scientists brought together males and females from different populations and from the same population. They observe the frequency of mating and calculated a sexual isolation index. One graph shows the relationship between mating frequency and genetic distance, and the other shows the relationship between sexual isolation index and geographic isolation.



Choose the appropriate terms for of X_1, Y_1, X_2 and Y_2 in the figures, above

(1) X_1 = Geographic distance, Y_1 = Sexual isolation index; X_2 = Genetic distance, Y_2 = mating frequency.
(2) X_1 = Geographic distance; Y_1 = mating frequency; X_2 = Genetic distance, Y_2 = Sexual isolation index
(3) X_1 = Genetic distance; Y_1 = mating frequency; X_2 = Sexual isolation index; Y_2 = Geographic distance
(4) X_1 = Genetic distance; Y_1 = Geographic distance; X_2 = Sexual isolation index; Y_2 = mating frequency

119. As per the of International Code of Botanical Nomenclature, 2006 (Vienna Code), which of the following is a Nothospecies?

(1) Polypodium vulgare subsp. Prionodes (Asch.) Rothm.
(2) Polypogon monspeliensis (L.) Desf.
(3) Agrostis stolonifera L.
(4) Agrostis stolonifera L. × Polypogon monspeliensis (L.) Desf.

120. Which of the following groups have only two wings?

(1) Honey bee, beetle, ant
(2) Butterfluy, housefly, fruitfly
(3) Dragonfly, butterfly, fruitfly
(4) Housefly, fruitfly, mosquito

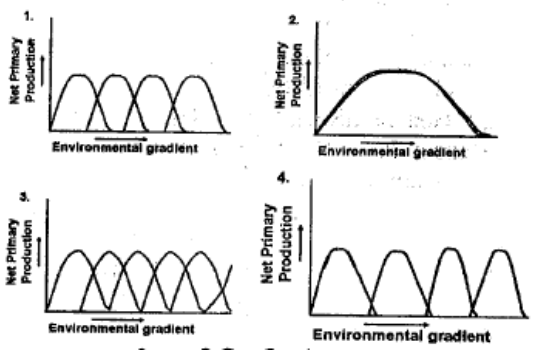
121. India has currently 17 biosphere reserves representing different ecosystems. These conservation areas significantly differ from the conventional protected areas of the country. Identify the correct combination of attributes (A to G) that best explains the concept of biosphere reserve.

(A) Conservation
(B) Education,
(C) Human habitation allowed,
(D) Human habitation not allowed,
(E) Strong legal back-up,
(F) No supporting act,
(G) Research.

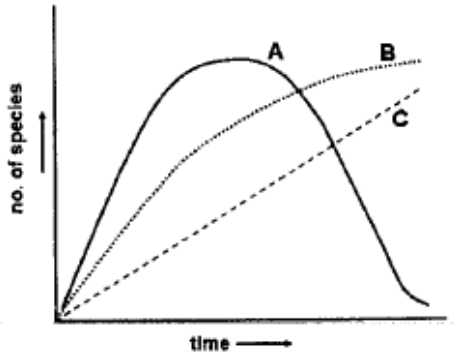
(1) (A), (B), (C), (F), (G)
(2) (A), (B), (D), (F), (G)
(3) (A), (B), (C), (E), (G)
(4) (A), (D), (E), (G)

122. Followings are the niche characteristics of the constituent species and resources

partitioning pattern in different ecosystems. Which of these would lead to competitive exclusion of species?



123. Environmental conditions can influence accumulation of species in successional communities. Curves representing changes in forest species over time are given in the figure below. Which of the following keys is correct for the curves?



(1) A = xeric, B = mesic, C = intermediate
(2) A = intermediate, B = xeric, C = mesic
(3) A = intermediate, B = mesic, C = xeric
(4) A = mesic, B = intermediate, C = xeric

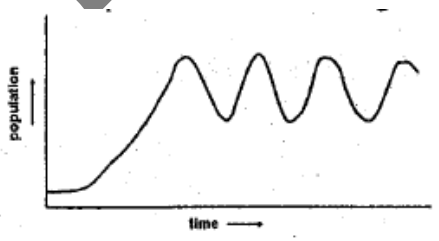
124. A plant with blue-coloured flowers was observed to attract a large number of pollinators. However, these flowers were not producing any nectar. Which of the following can be a logical explanation to the observation?

(1) There could be another species in the vicinity that has blue flowers and is rich in nectar.
(2) There is no other species with blue flowers in the vicinity so pollinators are compelled to visit this species.
(3) Pollinators may not have blue-colour vision.
(4) Pollinators may be able to see only blue colour.

125. Three islands have identical habitat characteristics. On first island rodent species A is present at a density 325/km^2. Second island has only species B at a density of 179/km^2. On the third island, both A and B co-exist with densities 297/km^2 and 150/km^2, respectively. Which of the following can be inferred from this?

(1) The two species do not compete with each other.
(2) The intra-species competition is more intense than inter-species competition.
(3) The inter-species competition is more intense than intra-species competition.
(4) The inter and intra species competition are of the same intensity.

126. A few males and females of a species were introduced to a new island. Their population was monitored over several generations and followed a pattern shown in the figure:



Which of the characteristics of the species does **NOT** explain the pattern?

(1) Skewed sex ratio (more females than males).
(2) Large litter size.
(3) Delayed sexual maturity
(4) Effects of intra-uterine development on fecundity

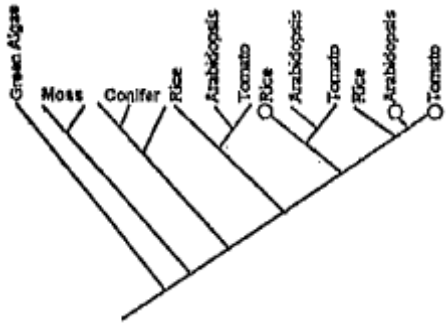
127. Plasmids are self replicating small circular DNA elements in bacterial cells that can be said to have a stable symbiotic existence with the host cell. They often carry genes useful to the host. Which of the following is a potential threat to the evolution and stability of the symbiotic coexistence?

(1) 'Copy-up' mutations that increase the rate of plasmid replication per host cell cycle.
(2) Reversible integration of plasmid DNA into the host DNA
(3) Transfer of plasmids to new cells by conjugation
(4) Spontaneous curing of plasmids in a small proportion of host cells.

128. Complex eukaryotic cells may have evolved from simpler prokaryotic cells because complexity of organization increases the

(1) Growth rate.
(2) Efficiency of energy utilization.
(3) Tolerance to starvation.
(4) Ability to attain larger size.

129. *Knox* genes code transcriptional factors important for the regulation of indeterminate growth in plant shoots. These gens also regulate patterns of development of plant organs such as leaves and flowers. The figure represents a phylogenetic tree of the multigene family in some land plants. The circles represent genes that act to maintain shoot apical meristem (equivalent to stem cells). Orthologues are genes that duplicate due to speciation and paralogues are genes that duplicate within a species.



From the figure; the following inferences were made,

A. Multiple gene duplication occurred in vascular plants.
B. Gene duplications may have enabled shoot diversification in vascular plants.
C. Shoot apical meristems are regulated by orthologous gens in vascular plants.
D. Shoot apical meristems are regulated by paralogous gens in vascular plants.

Which of the following represents a combination of correct inferences?

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

130. In an experiment that has continued for more than 50 years, corn has been propagated by breeding only from plants with the highest amount of oil in the seeds. The average oil content is now much greater than any of the plants in the original population.

The following hypotheses were proposed as explanations for this observation.

A. Mutations occurred that increased the oil content in seeds.
B. Plants with high oil content were stimulated to produce offspring with more oil in their seeds.
C. The breeding led to increased frequency of alleles at multiple loci, so that new combinations of genes for even higher oil content were formed.

Which of the following represents a combination of correct statements?

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

131. The Galapagos finches were an important clue to Darwin's thinking about the origin of species. These finches are believed to have descended from a single ancestral species that colonized the Galapagos archipelago, America, over a short period of time. The Galapagos finches differ in their beak shape and size. Different species feed on seeds that vary in size and hardness.

Which of the following is the most likely explanation for these patterns?

(1) The finches represent an example of directional trend in beak size from small to big.
(2) Beak shapes changed in response to different seed types and these changes were inherited by subsequent generations.
(3) The ancestral finch already had all the beak variations and different lineages formed that were specialized to eat different seed types.
(4) The finches represent an example of adaptive generated by mutation followed by selection by different seed types.

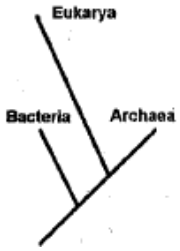
132. In order of demonstrate that the long tails of males attracted females in a bird species, experimenters captured and cut the tails of 'n' number of males and monitored the number of females mated by each male. They had two types of controls in the experiment.

(i) 'n' males that were not captured.
(ii) 'n' males that were captured, had their tails cut and then stitched back to attain the original size.

The males with cut tails mated with a significantly smaller number of females than both the controls. Which of the following alternative explanations is NOT ruled out by the experiment?

(1) The stress of cutting tails affected the performance of males.
(2) The time wasted in the capture reduced mating opportunities of males.
(3) Females avoided any deviation from normal.
(4) Females chose males randomly.

133.



In the phylogenetic trees above, branch-lengths are drawn proportional to the number of changes along a lineage. The following inferences were made from this tree.

A. Bacterial are more closely related to Eukarya than to Archaea.
B. Bacteria and Archaea are more similar to each other than either is to Eukarya.
C. Archaea and Eukarya diverged from each other after their common ancestor diverged from bacteria.

Which of the following represents a combination of correct inferences?

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

134. While attempting to create a disease model of poliomyelitis in mice, it was found that mice can not be infected with the said virus. Since human beings are susceptible to this viral infection, which kind of transgenic mice should be generated to have a transgenic mouse model that can be infected with polio virus? Select the right approach from below:

(1) A mouse expressing surface protein of polio virus.
(2) A mouse expressing human receptor gene which makes cell surface protein for docking and internalization of polio virus.
(3) A mouse expressing human MHC class II invariant chain.
(4) A mouse expressing human receptor gene which makes cell surface protein for docking and internalization of polio virus along with a gene designed to express surface protein of this virus at puberty.

135. Protoplast fusion is used in plant tissue culture for various applications.

In protoplast fusion:

A. Naked plant cells are sued.
B. Transfer of organelles is not possible.
C. Partial genome transfer is involved.
D. Cells from two different plants can be mixed together and forced to fuse.

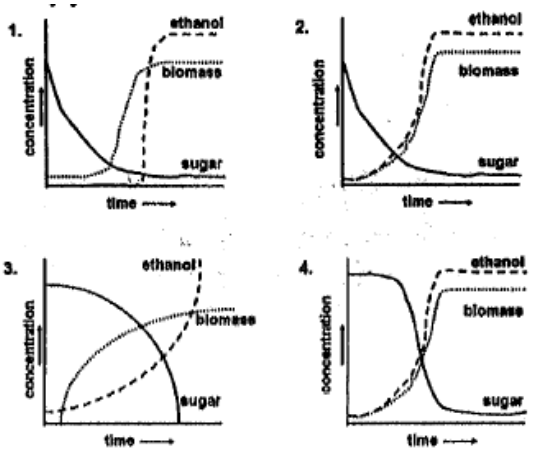
Which one of the following combinations of the above statements is correct?

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

136. Which of the following is a mismatch between the plant drug and its source?

(1) Codeine – *Papaver somniferum*
(2) Vinblastine – *Catharanthus roseus*
(3) Quinine – *Cinchona ledgeriana*
(4) Digitalin – *Artemisia annua*

137. Which of the following curves correctly represents the process of ethanol production by yeast?



138. Inbreeding for 5 generations led to production of homozygous transgenic mice. However, these homozygous transgenic mice. However, these homozygous males or females were infertile. Which of the following approach is most preferable and

economical to obtain heterozygous transgenic animals continuously?

(1) More transgenic founder (1st animal) should be generated.
(2) Crossing (breeding) of transgenic mice with wild type mice in earlier generations should be done for continued production of transgenic heterozygous offspring.
(3) Inbreeding should be avoided after 5th generation.
(4) Homozygous transgenic mice should be mated with wild type mice foe continued production of transgenic heterozygous offspring.

139. Following are few statements for regeneration of plants from explants/tissues.

A. Cytokinin is required for shoot development.
B. Auxin is required for shoot development.
C. Auxin to cytokinin ratio is very important.
D. Jasmonic acid is required for both root and shoot development.

Which of the following combinations of above statements is true?

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

140. A set of neonatal mice are divided into four groups. Group 1 neonates were not primed with any antigen. Group 2 neonates were primed with KLH. Group 3 neonates were primed with KLH but thymectomized. Group 4 neonates were KLH-primed, thymectomized, but reconstituted with KLH-specific CD4*T cells. All these mice, when grown adult, where challenged with KLH and the anti-KLH IgG antibody was measured in sera. Which of the following is the correct order of magnitude of antibody response?

[> = greater than, ≥ = greater than or equal to]

(1) Group 1 > Group 2 > Group 3 > Group 4
(2) Group 2 > Group 1 > Group 3 ≥ Group 4
(3) Group 2 > Group 3 > Group 1 > Group 4
(4) Group 4 > Group 1 > Group 2 ≥ Group 3

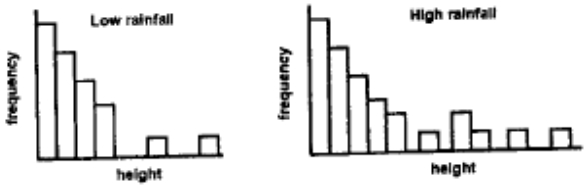
141. Choose the correct sequence of events in a next generation sequencing technology-based whole genome sequencing project.

(1) DNA extraction → shearing → library preparation → sequencing → assembly → finishing → annotation → submission to Genbank.
(2) DNA extraction → library preparation → sequencing → assembly → annotation → finishing → submission of Genbank.
(3) DNA extraction → shearing → adapter ligation → library amplification → sequencing → assembly → finishing → annotation → submission to Genbank.
(4) DNA extraction → adapter ligation → library amplification → shearing → sequencing → finishing → assembly → annotation → submission to Genbank.

142. An investigator discovers a new receptor for a known ligand and wanted to identify the binding partner of the receptor i.e. its co-receptor. The antireceptor antibody is not available but anti GFP-antibody is available. Which one of the following strategies is most likely to identify the co-receptor?

(1) The GFP-receptor fusion is expressed in a cell line and analyzed by LC-MS/MS.
(2) The GFP-receptor fusion protein is expressed in a cell line and the cells positive for GFP were sorted out, lysed and run on a polyacrylamide gel.
(3) The GFP-receptor protein is coated on ELISA plate, followed by ELISA with anti-GFP antibody.
(4) The receptor is cloned as a fusion protein of GFP and expressed in stimulated cells. The immune-precipitated complex obtained by anti-GFP antibody was analyzed by LC-MS/MS.

143. The frequency distribution of tree heights in two forest areas with different annual rainfall are given.



Which of the following statistical analysis will you choose to test whether rainfall has an effect on tree heights?

(1) t test for comparison of means.

(2) A non-parametric comparison of the two groups
(3) Correlation analysis of rainfall and mean tree heights.
(4) Regression of tree heights on rainfall.

144. Two species of plants were sampled in 32 quadrants in a forest. The mean and variance for the occurrence of species 1 were 16.2 and 48 and species 2 were 3.6 and 3.2 respectively. Which of the following statements about the distribution of the two species in these quadrats is supported by these findings?

(1) Both species are distributed randomly.
(2) Species 1 is distributed randomly and species 2 is clustered.
(3) Species 1 is clustered and species 2 is distributed randomly.
(4) Both species are clustered.

145. Poly-L-lysine exists in pure α-helix, β-sheet and random coiled conformations depending upon the solvent conditions. The values of mean residue ellipticity at 220 nm ($[\theta]_{2220}$) are –35,700, –13,800 and +3,900 deg cm^2dmol^{-1} for α-helix, β-sheet and random coil conformations of this polypeptide, respectively. The polypeptide exists in α-helix conformation at pH 10.8 and 25°C. Addition of urea leads to a two state transition between α-helix and random coil conformation. It has been observed that $[\theta]_{2222}$ of the polypeptide is –14800 deg cm^2dmol^{-1} in the presence of 6M urea. The percentage of the polypeptide in α-helix conformation is :

(1) 37 (2) 41
(3) 47 (4) 50