

Performance at a glance (December - 2015)

CSIR-JRF-NET (Life Sciences)

9 Rank



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16 Rank



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Education for Life...

Pathfinder Academy

Life Sciences

December – 2015

PART – A

1. In each of the following groups of words is a hidden number, based on which you should arrange them in descending order. Pick the correct answer:

E. Papers I Xeroxed

F. Wi-Fi veteran

G. Yourself ourselves

H. Breaks even

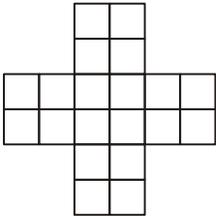
a. H, F, E, G

b. E, G, F, H

c. H, F, G, E

d. H, E, F, G

2.



The number of squares in the above figure is

a. 30

b. 29

c. 25

d. 20

3. A shopkeeper purchases a product for Rs. 100 and sells it making a profit of 10%. The customer resells it to the same shopkeeper incurring a loss of 10%. In these dealings the shopkeeper makes

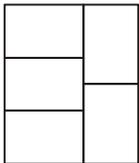
a. no profit, no loss

b. Rs. 11

c. Re. 1

d. Rs. 20

4. Five congruent rectangles are drawn inside a big rectangle of perimeter 165 as shown. What is the perimeter of one of the five rectangles?



a. 37

b. 75

c. 15

d. 165

11. The triangle formed by the lines $y = x$, $y = 1 - x$ and $x = 0$ in a two-dimensional plane is (x and y axes have the same scale)
- isosceles and right-angled.
 - isosceles but not right-angled.
 - right-angled but not isosceles.
 - neither isosceles nor right-angled.
12. There are two buckets A and B. Initially A has 2 litres of water and B is empty. At every hour 1 litre of water is transferred from A to B followed by returning 1/2 litre back to A from B half an hour later. The earliest A will get empty is in
- 5 h
 - 4 h
 - 3 h
 - 2 h
13. Statement A : The following statement is true.
Statement B : The preceding statement is false.
Choose the *correct* inference from the following:
- Statements A and B are always true.
 - Statements A and B can be true if there is at least one statement between A and B.
 - Statements A and B can be true if there are at least two statements between A and B.
 - Statements A and B can never be true, independently.
14. A car is moving at 60 km/h. The instantaneous velocity of the upper most points of its wheels is
- 60 km/h forward
 - 120 km/h forward
 - 60 km/h backward
 - 120 km/h backward
15. If $D + I + M = 1501$
 $C + I + V + I + L = 157$
 $L + I + V + I + D = 557$
 $C + I + V + I + C = 207$
What is $V + I + M = ?$
- cannot be found
 - 1009
 - 1006
 - 509
16. A living cell has a protoplasm which is water based and demarcated by a lipid bilayer membrane. If a cell is pierced up to 1/5th of its diameter with a very sharp needle, after taking the needle out
- no effect will be observed.
 - protoplasm will leak out from the hole made by the needle for a few minutes until the cell heals the wound.
 - protoplasm will keep on leaking out till the cell is dead.
 - the cell will burst like a balloon.
17. Density of a rice grain is 1.5 g/cc and bulk density of rice heap is 0.80 g/cc. If a 1 litre container is completely filled with rice, what will be the approximate volume of pore space in the container?
- 350 cc
 - 465 cc
 - 550 cc
 - 665 cc
18. A turtle starts swimming from a point A located on the circumference of a circular pond. After swimming for 4 meters in a straight line it hits point B on the circumference of the pond. From there it changes direction and swims for 3 meters in a straight line and arrives at point D diametrically opposite to point A. How far is point D from A?
- 3 m
 - 4 m
 - 7 m
 - 5 m

19. Four circles of unit radius each are drawn such that each one touches two others and their centres lie on the vertices of a square. The area of the region enclosed between the circles is
- $\pi - 1$
 - $\pi - 2$
 - $3 - \pi$
 - $4 - \pi$
20. A film projector and microscope give equal magnification. But a film projector is not used to see living cells because
- a living cell cannot be placed in a film projector.
 - the viewer's eye is close to a microscope whereas it is far away from the projector's screen.
 - a microscope produces a virtual image whereas a projector produces a real image.
 - a microscope has greater resolving power than a projector.

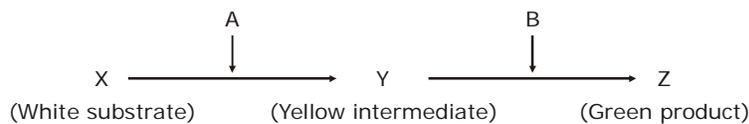
PART – B

21. The ionic strength of a 0.2 M Na_2HPO_4 solution will be
- 0.2 M
 - 0.4 M
 - 0.6 M
 - 0.8 M
22. A cell line deficient in salvage pathway for nucleotide biosynthesis was fed with medium containing ^{15}N labelled amino acids. Purines were then extracted. Treatment with which one of the following amino acids is likely to produce ^{15}N labelled purines?
- Aspartic acid
 - Glycine
 - Glutamine
 - Aspartamine
23. Enzymes accelerate a reaction by which one of the following strategies?
- Decreasing energy required to form the transition state.
 - Increasing kinetic energy of the substrate.
 - Increasing the free energy difference between substrate and the product.
 - Increasing the turn over number of enzymes.
24. Coupling of the reaction centers of oxidative phosphorylation is achieved by which one of the following?
- Making a complex of all four reaction centers.
 - Locating all four complexes in the inner membrane.
 - Ubiquinones and cytochrome C.
 - Pumping of protons.
25. The genome of a bacterium is composed of a single DNA molecule which is 10^9 bp long. How many moles of genomic DNA is present in the bacterium? [Consider Avogadro No. = 6×10^{23}]
- $\frac{1}{6} \times 10^{-23}$
 - $\frac{1}{6} \times 10^{-14}$
 - 6×10^{14}
 - 6×10^{23}
26. It takes 40 minutes for a typical *E. coli* cell to completely replicate its chromosome. Simultaneous to the ongoing replication, 20 minutes of a fresh round of replication is completed before the cell divides. What would be the generation time of *E. coli* growing at 37°C in complex medium?
- 20 minutes
 - 40 minutes
 - 60 minutes
 - 30 minutes

27. Glycophorin having one highly hydrophobic domain is able to span a phospholipid bilayer membrane only
- once
 - twice
 - thrice
 - four times
28. Given below are events in the cell cycle:
- P. Phosphorylation of lamin A, B, C.
Q. Phosphorylation of Rb (Retinoblastoma protein).
R. Polyubiquitination of securin.
S. Association of inner nuclear membrane proteins and nuclear pore complex proteins with chromosomes.
- Which one of the following reflects the *correct* sequence of events in the mammalian cell cycle?
- $P \rightarrow Q \rightarrow R \rightarrow S$
 - $Q \rightarrow R \rightarrow S \rightarrow P$
 - $R \rightarrow P \rightarrow Q \rightarrow S$
 - $Q \rightarrow P \rightarrow R \rightarrow S$
29. Which one of the following chemicals is a DNA intercalator?
- 5-Bromouracil
 - Ethyl methanesulfonate
 - Acridine orange
 - UV
30. An antibiotic that resembles the 3' end of a charged tRNA molecule is
- Streptomycin
 - sparsomycin
 - Puromycin
 - Tetracycline
31. α -amanitin is a fungal toxin which inhibits eukaryotic RNA polymerases. The three eukaryotic RNA polymerases show differential sensitivity to this toxin. Which one of the following order (higher to lower) is *correct* in respect of sensitivity towards α -amanitin?
- RNA Pol III > RNA Pol II > RNA Pol I
 - RNA Pol II > RNA Pol III > RNA Pol I
 - RNA Pol I > RNA Pol III > RNA Pol II
 - RNA Pol II > RNA Pol I > RNA Pol III
32. In eukaryotic replication, helicase loading occurs at all replicators during
- G_0 phase
 - G_1 phase
 - S phase
 - G_2 phase
33. Cytotoxic T-cells express
- CD8 marker and are class II MHC restricted.
 - CD4 marker and are class I MHC restricted.
 - CD4 marker and are class II MHC restricted.
 - CD8 marker and are class I MHC restricted.
34. The mutation in an oncogene falls under which of the following classes?
- Loss of function mutation.
 - Frameshift mutation.
 - Gain of function mutation.
 - Dominant negative mutation.
35. Which of the following is *not* a cell adhesion protein?
- Cadherin
 - Selectin
 - Immunoglobulin (Ig) superfamily
 - Laminin
36. Which of the following is *not* a second messenger?
- Cyclic GMP
 - Diacylglycerol
 - Inositol triphosphate
 - Phosphatidylinositol

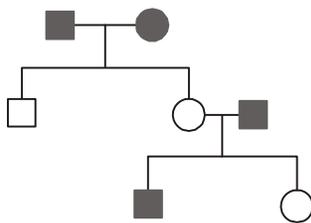
37. In chick, development of wing feather, thigh feather and claws depends on epithelial specificity conferred by induction from mesenchymal components from different sources of the dermis. This may be attributed to
- autocrine interaction
 - regional specificity of induction
 - receptor activation by hormones
 - inactivation of genetic interactions
38. Alveolar cells of the lung arise from which one of the following layer(s)?
- Mesoderm
 - Endoderm
 - Ectoderm
 - Both ectoderm and endoderm
39. Migration of individual cells from the surface into the embryo's interior is termed as
- ingression
 - involution
 - invagination
 - delamination
40. Floral organ development is controlled by overlapping expression of 'A' class, 'B' class and 'C' class genes in different whorls. In an *Arabidopsis* mutant, the flowers had sepals, sepals, carpels and carpels in the four whorls. Mutation in which one of the following is the cause for the mutant phenotype?
- 'A' class gene alone
 - 'B' class gene alone
 - 'A' and 'B' class genes
 - 'C' class gene alone
41. Phenylalanine, a precursor of most of the phenolics in higher plants is a product of which one of the following pathways?
- Shikimic acid pathway
 - Malonic acid pathway
 - Mevalonic acid pathway
 - Methylerythritol pathway
42. For which one of the following physiological studies $^{12}\text{CO}_2$ and $^{13}\text{CO}_2$ are used?
- Estimate the rate of photosynthesis.
 - Determine rate of photorespiration.
 - The ratio of C_4 and CAM pathways of CO_2 fixation.
 - The ratio of C_3 and C_4 pathways of CO_2 fixation.
43. Gibberellic acid (GA) controls seed germination by directing breakdown of the stored starch. In which one of the following tissues of the barley seed, α -amylase gene is induced in response to GA?
- Endosperm
 - Coleoptile
 - Aleurone layer
 - Embryo
44. The photosynthetic assimilation of atmospheric CO_2 by leaves yield sucrose and starch as end products of two gluconeogenic pathways that are physically separated. Which one of the following combination of cell organelles are involved in such physical separation of the process?
- Sucrose in cytosol and starch in mitochondria.
 - Sucrose in chloroplasts and starch in cytosol.
 - Sucrose in mitochondria and starch in cytosol.
 - Sucrose in cytosol and starch in chloroplasts.
45. A diabetic patient developed metabolic acidosis resulting in deep and rapid breathing which is called
- Kussmaul breathing
 - Cheyne-Stokes respiratory pattern
 - Apneustic breathing
 - Periodic breathing

46. Which one of the following is *not* involved with the pacemaker potential of heart?
- "h"-channel
 - Transient calcium channel
 - Long-lasting calcium channel
 - "f"-channel
47. You are asked to identify the stage of estrus cycle in vaginal smear of a mouse containing large number of leukocytes and very few nucleated epithelial cells. Which one of the following will be the *correct* stage of estrous cycle?
- Early estrus, late proestrus.
 - Late estrus, early metestrus.
 - Late metestrus, early diestrus.
 - Late diestrus, early proestrus.
48. Which one of the following neurotransmitters is secreted by the pre-ganglionic neurons of sympathetic nervous system?
- Epinephrine
 - Acetylcholine
 - Dopamine
 - Norepinephrine
49. Following is a hypothetical biochemical pathway responsible for pigmentation of leaves. The pathway is controlled by two independently assorting genes 'A' and 'B' encoding enzymes as shown below. Mutant alleles 'a' and 'b' code for non-functional proteins.



What is the expected progeny after selfing a plant with the genotype AaBb?

- Green (9) : White (4) : Yellow (3)
 - Green (9) : Yellow (4) : White (3)
 - Green (9) : Yellow (6) : White (1)
 - Green (9) : White (7)
50. Mutation in gene 'X' leads to lethality in a haploid organism. Which one of the following is best suited to analyse the function of gene 'X'?
- Pleiotropic mutants
 - Temperature-sensitive mutants
 - Recessive mutants
 - Mutants with low penetrance
51. The following pedigree chart shows inheritance of a given trait:



The trait can be called

- autosomal dominant
 - autosomal recessive
 - X-linked dominant
 - sex limited
52. In a heterozygous individual for a given gene, if a crossing over has occurred between the gene locus and the centromere of the chromosome, the segregation of the two alleles of the given gene will occur during meiosis at
- either anaphase I or anaphase II
 - anaphase I only
 - anaphase II only
 - both anaphase I and II

53. Most members of bryophyte phylum Anthocerophyta are characterized by
- gametophyte with single chloroplast per cell and multicellular rhizoids; sporophyte without stomata.
 - gametophyte with single chloroplast per cell and unicellular rhizoids; sporophyte with stomata.
 - gametophyte with multiple chloroplasts per cell and unicellular rhizoids; sporophyte without stomata.
 - gametophyte with single chloroplast per cell and multicellular rhizoids; sporophyte with stomata.
54. Identify the *correct* match between the animal (flatworm, earthworm, roundworm) and its body cavity type (acoelomate, coelomate, pseudocoelomate):
- Roundworm — pseudocoelomate; Earthworm — acoelomate; Flatworm — coelomate
 - Roundworm — acoelomate; Earthworm — coelomate; Flatworm — acoelomate
 - Roundworm — pseudocoelomate; Earthworm — coelomate; Flatworm — acoelomate
 - Roundworm — coelomate; Earthworm — pseudocoelomate; Flatworm — acoelomate
55. Which one of the following gymnosperm phyla produces motile sperms, bears ovulate and microsporangiate cones on separate plants and has fleshy, coated seeds?
- Coniferophyta
 - Cycadophyta
 - Ginkgophyta
 - Gnetophyta
56. According to 2014 IUCN Red List, which of the following vertebrate classes has the largest percentage of threatened species?
- Mammals
 - Birds
 - Reptiles
 - Amphibians
57. In the following equations
- P. $\frac{dN}{dt} = rN$
- Q. $N_t = N_0 e^{rt}$
- R. $\frac{dN}{dt} = rN \left(\frac{K-N}{K} \right)$
- S. $\frac{dN}{dt} = rN \times \frac{N}{K}$
- exponential population growth is described by
- P and Q
 - P only
 - R only
 - Q and S
58. Which gas *does not* contribute to global warming through its greenhouse effect?
- Nitrous oxide
 - Methane
 - Carbon dioxide
 - Nitric oxide
59. A red coloured tubular flower without any odour is most likely to be pollinated by
- beetles
 - bees
 - butterflies
 - birds
60. Which one of the following conditions is *not* likely to favour male monogamy?
- When the male has to guard his mate against mating by another male.
 - When the male wants to spend more time for foraging.
 - When the male has to assist the mate in brood and nestling care.
 - When the female guards her mate against seeking other females to mate.

61. The origin and diversification of Angiosperms was during which geological period?
- Permian
 - Triassic
 - Jurassic
 - Cretaceous
62. Which of the following statements about evolution is *not* true?
- Evolution is the product of natural selection.
 - Evolution is goal-oriented.
 - Prokaryotes evolve faster than eukaryotes.
 - Evolution need not always lead to a better phenotype.
63. Which among the following is the simplest method to estimate the concentration of glycerol in an aqueous solution of glycerol?
- UV absorption spectroscopy
 - Gas chromatography
 - pH measurement
 - Viscosity measurement
64. Application of gene therapy in clinical trials did not succeed due to
- poor integration of a gene in the host genome.
 - lack of expression of integrated gene in cells.
 - degradation of gene inside the cell.
 - activation of oncogenes consequent to integration of the gene.
65. A gene expressing a 50 kDa protein from an eukaryote was cloned in an *E. coli* plasmid under the *lac* promoter and operator. Upon addition of IPTG, the 50 kDa protein was not detected. Which one of the following explains the above observation?
- The cloned sequence lacked the Kozak sequence.
 - E. coli* does not make proteins larger than 40 kDa.
 - Differences in codon preference.
 - 50 kDa protein contains a nuclear localization signal.
66. Neomycin phosphotransferase gene, frequently used as a selection marker during plant transformation, inactivates which one of the following antibiotics?
- Hygromycin
 - Ampicillin
 - Streptomycin
 - Kanamycin
67. Which one of the following techniques will you use to identify more than 1000 differentially expressed genes in normal and tumor tissues in one experiment?
- RAPD
 - Genome sequencing
 - ChIP assay
 - Transcriptome analysis
68. For identification of three proteins moving together (as a single band) upon loading in a single lane of a SDS-PAGE gel, the best method is
- one step Western blot
 - NMR spectroscopy
 - Western blot followed by stripping and reprobing
 - ESR spectroscopy
69. Which isotope below is best suited for metabolic labelling of glyceraldehyde-3-phospho-dehydrogenase?
- ^{14}C
 - ^{125}I
 - ^{32}P
 - ^{131}I

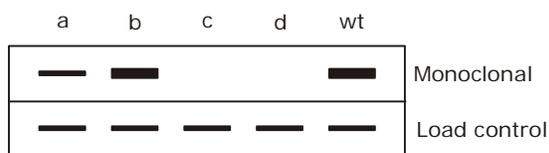
70. Which one of the following would contribute to intrinsic fluorescence to a protein?
- Aromatic amino acids
 - Disulfide bonds
 - charged amino acids
 - Branched chain amino acids

PART – C

71. Which one of the following statements is *correct*?
- In all L-amino acids, only the C^α carbon atom is chiral.
 - Deoxyribose is optically inactive.
 - The specific rotation of sucrose will be the sum of the specific rotations of D-glucose and D-fructose.
 - Phosphatidylcholine isolated from biological membranes is optically active.
72. Membrane proteins are synthesized on endoplasmic reticulum and transported to various organelle membranes. One hypothesis for membrane protein sorting is hydrophobicity matching i.e., the proteins with a shorter transmembrane portion would partition into thinner membranes. You are given the following three observations:
- It was found that transmembrane portions of proteins in Golgi membranes are shorter than those in plasma membranes.
 - Presence of cholesterol increases the thickness of the bilayer.
 - The phospholipid composition of Golgi and plasma membranes are same.

Which of the following statements is *correct*?

- Proteins in plasma membrane have longer transmembrane portion than proteins in Golgi membranes.
 - Proteins in Golgi membranes have longer transmembrane portion than proteins in plasma membranes.
 - Proteins of both Golgi and plasma membranes have same length of transmembrane portion.
 - Cholesterol is more in Golgi membrane than in plasma membrane.
73. Four single amino acid mutants (a to d) of a protein in the epitope-region of a monoclonal antibody X were made and expressed in *E. coli*. The lysates from the four *E. coli* cultures expressing these four proteins were run on an SDS-PAGE gel and subsequently transferred to nitrocellulose membrane and Western blotted using a monoclonal antibody X raised against the wild type protein. The results are presented in the figure below



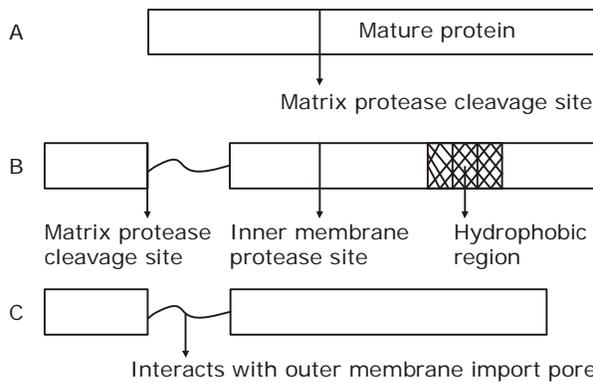
The four single mutation, upon sequencing, were found to be Valine (V) to Alanine (A); Glycine (G) to Proline (P); Alanine (A) to Aspartic acid (D) and isoleucine (I) to leucine (L).

Which one of the following statements is *correct*?

- b is due to V → A and c is due to G → P.
 - b is due to G → P and d is due to V → A.
 - d is due to I → L and a is due to A → D.
 - c is due to V → A and a is due to I → L.
74. The exact backbone dihedral angles in a folded protein can be obtained by
- deconvolution of its circular dichroism spectra obtained at different pH and temperature.
 - estimating the number of protons that exchange with deuterium on treating the protein with D₂O.
 - forming fibres of the protein and analyzing the fibre diffraction pattern.
 - analysis of the crystal structure of the protein obtained by X-ray diffraction at high resolutions.

75. The following are the statements about pyruvate kinase (PK):
 P. ATP is an allosteric inhibitor of PK.
 Q. Fructose 1,6 bisphosphate is an activator of PK.
 R. ADP is an allosteric inhibitor of PK.
 S. Alanine is an allosteric modulator of PK.
 Which of the above statement(s) are *true*?
- a. P, Q, R
 b. P, Q, S
 c. Q, R, S
 d. Only P
76. A practical class was going on where the students were demonstrating ATP synthesis *in vitro* using active mitochondria. Some students added one of the following to their tubes:
 P. Dinitrophenol (DNP), an uncoupler
 Q. Mild acidification of the medium
 R. Glutathione, that permeabilizes both the membranes
 S. An outer membrane permeable H⁺ quencher compound, Elila
 In which one of the above, ATP synthesis will be detected?
- a. P
 b. Q
 c. R
 d. S
77. A culture medium contains two carbon sources, one is preferred carbon source (glucose) and the second is a non-preferred source (lactose). Which one below is *correct* regarding the nature of growth curve of *E. coli* cultured in this medium?
- a. Growth curve will be same as when grown in presence of only glucose.
 b. Growth curve will be same as when grown in presence of only lactose.
 c. A lag phase will be observed between the two exponential phases.
 d. Two lag phases will be observed between the two exponential phases.
78. Which one of the following statements *correctly* applies to proteins which are translated on the rough endoplasmic reticulum?
- a. Cytoplasmic proteins which are targeted to the nucleus in response to hormone stimuli.
 b. Proteins targeted to lysosomes, plasma membrane and cell exterior.
 c. Proteins which are targeted to the nucleus through endoplasmic reticulum lumen as the lumen is in direct connection with the intermembrane space of the nucleus.
 d. All proteins which get targeted to peroxisomes.
79. Lipid rafts are rich in both sphingolipids and cholesterol. Cholesterol plays a central role in raft formation since lipid rafts apparently do not form in its absence. Why do you think cholesterol is essential for the formation of lipid rafts?
- a. Cholesterol decreases the mobility of sphingolipids in the lipid bilayer.
 b. Large head groups of sphingolipids repel each other in presence of cholesterol.
 c. Cholesterol interacts with fatty acid tails in the membrane.
 d. The planar cholesterol molecules are postulated to fill the voids that form underneath the large head groups of the sphingolipids.

80. Following is the domain organization of three proteins that are targeted to the mitochondria.



Based on the domain organization in the above figure and assuming the left box to be having the mitochondrial sorting signal, predict the most likely sub-compartment of the mitochondria in which the protein will be found.

- A in matrix; B in inner membrane; C in inter-membrane space.
 - A in inner membrane; B in inter-membrane space; C in outer membrane.
 - A and B are in matrix; C in outer membrane.
 - A in matrix; B and C are in inter-membrane space.
81. You have labelled DNA in a bacterium by growing cells in medium containing either ^{14}N nitrogen or the heavier isotope, ^{15}N . Furthermore, you have isolated pure DNA from these organisms, and subjected it to CsCl density gradient centrifugation leading to their separation of light (^{14}N) and heavy (^{15}N) forms of DNA to different locations in the centrifuge tube. In the next experiment, bacteria were regrown first in medium containing ^{15}N , so that all the DNA made by cells will be in heavy form. Then these cells were transferred to medium containing only ^{14}N and allowed the cells to divide for one generation. DNAs were extracted and centrifuged as above in the CsCl gradient. A hybrid DNA band was observed at a position located between and equidistant from the ^{15}N and ^{14}N DNA bands. Based on the above observation, which one of the following conclusions is *correct*?
- Replication of DNA is conservative.
 - Replication of DNA is semi-conservative.
 - Replication of DNA is dispersive.
 - Replication by rolling circle mode.
82. The frequency of cells in a population that are undergoing mitosis (the mitotic index) is a convenient way to estimate the length of the cell cycle. In order to measure the cell cycle in the liver of the adult mouse by measuring the mitotic index, liver slices are prepared and stained to easily identify cells undergoing mitosis. It was observed that only 3 out of 25,000 cells are found to be undergoing mitosis. Assuming that M phase lasts 30 minutes, calculate the approximate length of the cell cycle in the liver of an adult mouse?
- 76 hours
 - 50 hours
 - 42 hours
 - 21 hours
83. Although ribonucleoside triphosphates (rNTPs) are present at approximately 10-fold higher concentration than deoxyribonucleoside triphosphates (dNTPs) in the cell, but they are incorporated into DNA at a rate that is more than 1000-fold lower than dNTPs. This is because
- DNA polymerase cannot discriminate between dNTPs and rNTPs. But as soon as rNTPs are incorporated in the DNA chain, they are hydrolyzed due to the presence of 2'-OH group.
 - DNA polymerase cannot discriminate between dNTPs and rNTPs. But as soon as rNTPs are incorporated in the DNA chain, they are excised by the proofreading activity of DNA polymerase.
 - DNA polymerase efficiently discriminates between rNTPs and dNTPs, because its nucleotide binding pocket cannot accommodate a 2'-OH on the incoming nucleotide.
 - DNA polymerase cannot discriminate between rNTPs and dNTPs. Since the rate of transcription in cell is 10^6 times faster than replication, it cannot compete with RNA polymerase for rNTPs.

84. The mismatch repair activity of *E. coli* repairs misincorporated bases which is not removed by the proofreading activity of DNA polymerase. However, while doing so, it has to decide which strand of the DNA is newly synthesized and which one is parental. Mismatch repair system does it by which one of the following ways?
- It recognizes nearby GATC sequence.
 - It recognizes any nearby palindromic sequence.
 - It recognises a specific repetitive sequence.
 - It recognises the hemi-methylated GATC sequence nearby.
85. Enlisted below are different types of RNAs produced in the cell (Column A) and their functions (Column B), but not in the same order.

Column A

Column B

- | | |
|-------------|--|
| P. Sn RNAs | i. turn off gene expression by directing degradation of selective mRNAs. |
| Q. si RNAs | ii. regulate gene expression by blocking translation of selective mRNAs. |
| R. mi RNAs | iii. function in a variety of processes including splicing of pre-mRNA. |
| S. Sno RNAs | iv. used to process and chemically modify rRNAs. |

Choose the *correct* combination.

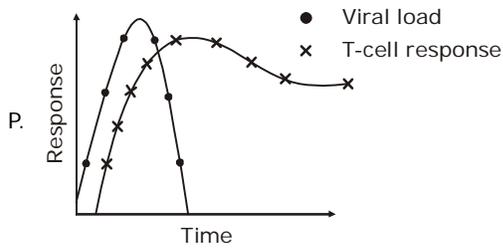
- | | |
|-----------------------------------|-----------------------------------|
| a. P-(iv), Q-(ii), R-(i), S-(iii) | b. P-(iii), Q-(i), R-(ii), S-(iv) |
| c. P-(iv), Q-(i), R-(ii), S-(iii) | d. P-(iii), Q-(ii), R-(i), S-(iv) |
86. In prokaryotes, the initiator tRNA is first charged with a methionine, followed by the addition of a formyl group to the methionine by the enzyme Met-tRNA transformylase. Given below are several statements in this context.
- All prokaryotic proteins have formyl methionine at their amino terminal end.
 - Deformylase removes the formyl group from the amino terminal methionine.
 - All prokaryotic proteins have methionine at their amino terminal end.
 - Aminopeptidases often remove the amino terminal methionine.
 - Aminopeptidases remove amino terminal formyl methionine.
- Which of the above statement(s) are most likely to be *true*?
- | | |
|-----------|------------|
| a. 1 only | b. 2 and 3 |
| c. 5 only | d. 2 and 4 |
87. A hypothetical operon involved in the synthesis of an amino acid 'X' is 'ON' (transcribing) in the presence of low levels of 'X' and 'OFF' (not transcribing) in presence of high level of 'X'. The symbols a, b and c (in the table below) represents a structural gene for the synthesis of X (X- synthase), the operator region and gene encoding the repressor — but not necessarily in that order. From the following data, in which superscripts denote wild type or defective genotype, identify which are the genes for X-synthase, operator region and the repressor.

Strain	Genotype	X-synthase activity in the presence of	
		Low level of 'X'	High level of 'X'
1.	a ⁻ b ⁺ c ⁺	Detected	Detected
2.	a ⁺ b ⁺ c ⁻	Detected	Detected
3.	a ⁺ b ⁻ c ⁻	Not detected	Not detected
4.	a ⁺ b ⁺ c ⁺ / a ⁻ b ⁻ c ⁻	Detected	Not detected
5.	a ⁺ b ⁺ c ⁻ / a ⁻ b ⁻ c ⁺	Detected	Not detected
6.	a ⁻ b ⁺ c ⁺ / a ⁺ b ⁻ c ⁻	Detected	Detected

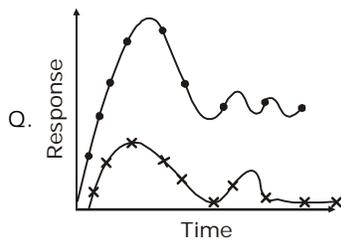
93. The relation between cellular immune response generated against hepatitis C virus is the critical determinant of the outcome of infection. Given below are the representative figures of cellular immune response in column I and various outcome of infection in column II.

Column I

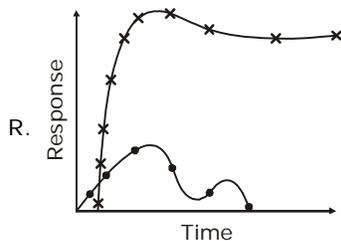
Column II



i. Acute



ii. Resolution



iii. Chronic

Choose the best possible combination.

- a. P-(ii), Q-(iii), R-(i)
c. P-(iii), Q-(ii), R-(i)

- b. P-(i), Q-(iii), R-(ii)
d. P-(i), Q-(ii), R-(iii)

94. There are various subclasses of antibodies found in body fluids and body secretion. Many different functions may be attributed to these subclasses. Given below in column I is major functions of different subclasses and column II consists of the name of subclass.

Column I

Column II

P. Binds to macrophages by F_c

i. IgA

Q. Binds to mast cells and basophils

ii. IgD

R. First B cell receptor

iii. IgE

S. No major specific function known other than antigen binding

iv. IgG

T. Protector of mucous membrane

v. IgM

Select the correct combination:

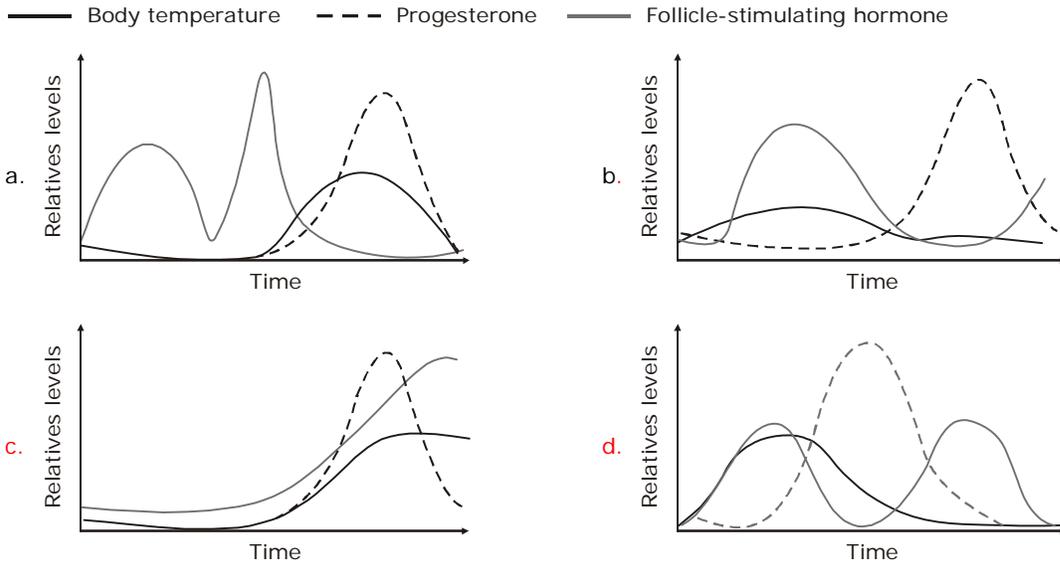
- a. P-(i), Q-(ii), R-(iii), S-(iv), T-(v)
c. P-(iii), Q-(iv), R-(v), S-(i), T-(ii)

- b. P-(ii), Q-(iii), R-(iv), S-(v), T-(i)
d. P-(iv), Q-(iii), R-(v), S-(ii), T-(i)

95. Instructive and permissive interactions are two major modes of inductive interaction during development. The following compares some properties of cell lines and cord blood stem cells. Cell lines, which are stored in liquid nitrogen, can be retrieved for experiments, where they behave as per their original self. Cord blood can also be retrieved from liquid nitrogen for procuring stem cells. Unlike cell lines, the stem cells can be additionally induced to undergo differentiation into desired lineages, which are very different from their original self. The behaviour of cell lines and stem cells is analogous to which of the interactions?
- Both cell lines and stem cells show instructive interaction.
 - Cell lines show instructive interaction whereas stem cells show permissive interaction.
 - Cell lines show permissive interaction whereas stem cells show instructive interaction.
 - Both types of cells show permissive instruction.
96. Following are certain statements regarding morphogen gradients and cell specification.
- P. Morphogens are always transcription factors.
- Q. Morphogens can be paracrine factors that are produced in one group of cells and travel to another population of cells.
- R. When the concentration of a morphogen drops below a certain threshold cells stop differentiating and never get determined to another fate.
- S. Morphogen gradients are involved in conditional specification.
- Which combination of the above statements is *true*?
- P and Q
 - Q and S
 - R and S
 - P and R
97. Successful fertilization in sea urchin demands specific interaction between proteins and receptors of sperms and eggs. In view of the above, which one of the following combinations is *correct*?
- Bindin in acrosomes and bindin receptors on egg vitelline membrane.
 - Bindin in egg membrane and bindin receptors in acrosomes.
 - Resact on egg jelly and bindin on sperm membrane.
 - Proteasomes on egg membranes and complex sugars on sperm membranes.
98. Following statements are made in relation to the five widely recognized stages of *Arabidopsis* embryogenesis:
- P. The fusion of haploid egg and sperm takes place in globular stage.
- Q. Rapid cell division in two regions on either side of the future shoot apex forms heart stage.
- R. The cell elongation throughout the embryo axis and further development result in Torpedo stage.
- S. The embryo loses water and becomes metabolically inactive in the zygotic stage.
- Which combination of the above statements is *correct*?
- P and Q
 - Q and R
 - R and S
 - S and P
99. The following are statements regarding the development and maintenance of anterior and posterior compartments in each segment of *Drosophila*:
- Expression of *wingless* and *engrailed* is activated by pair-rule genes.
 - Continued expression of *wingless* and *engrailed* is maintained by interaction between the cells expressing engrailed and wingless proteins.
 - Hedgehog is expressed wingless expressing cells and forms short range gradient.
 - Hedgehog is a transcription factor.
 - Engrailed is a secretory factor and binds with the patched receptor of the wingless expressing cells.

103. Following are certain statements regarding CO₂ assimilation in higher plants:
- P. The action of aldolase enzyme during Calvin-Benson cycle produces fructose 1,6-bisphosphate.
 - Q. The conversion of glycine to serine takes place in mitochondria during C₂ oxidative photosynthetic carbon cycle.
 - R. During C₄ carbon cycle, NAD-malic enzyme releases the CO₂ from the 4-carbon acid, malate yielding a 3-carbon acid, pyruvate.
 - S. Malic acid during crassulacean acid metabolism (CAM) is stored in mitochondria during dark and released back to cytosol during day.
- Which one of the following combinations of above statements is *correct*?
- a. P, Q and R
 - b. P, R and S
 - c. Q, R and S
 - d. P, Q and S
104. Many factors related to the role of abscisic acid (ABA) in contributing to drought, cold and salt resistance in plants are listed below:
- P. The transcription factors DREB 1 and DREB2 bind to the cis-acting elements of the promoter of ABA responsive genes in an ABA dependent manner.
 - Q. ABA induces many genes such as LEA and RD29.
 - R. ABA-responsive genes contain six nucleotide ABRE elements in the promoter.
 - S. Nine-nucleotide dehydration-responsive elements (DRE) are present in ABA responsive genes.
- Which one of the following combinations of the above statements is *correct* with respect to ABA?
- a. P, Q and R
 - b. P, R and S
 - c. Q, R and S
 - d. P only
105. Examples of many factors that regulate plant height in response to gibberellic acid (GA) are listed below:
- P. Binding of a GA-bound repressor to the promoter of the DELLA domain-containing GRAS protein gene and blocking its expression.
 - Q. Binding of the GA receptor complex to GRAS.
 - R. Directing GRAS for ubiquitination and degradation by the 26S proteasome.
 - S. Micro RNA directed down regulation of the GRAS protein expression.
- Which one of the following combinations is *correct*?
- a. P and Q
 - b. Q and R
 - c. R and S
 - d. P and S
106. Ethylene is an important plant hormone that regulates several aspects of plant growth and development. Some statements are given below in relation to ethylene signalling pathways:
- P. Unbound ethylene receptors work as positive regulators of the response pathway.
 - Q. There are more than two ethylene receptors known to date.
 - R. The carboxy terminal half of the ethylene receptor, ETR1 (Ethylene response 1), contains a domain homologous to histidine kinase catalytic domain.
 - S. EIN2 (Ethylene insensitive 2) encodes a transmembrane protein. The *ein2* mutation promotes ethylene responses in both seedlings and adult *Arabidopsis* plants.
- Which combination of the above statements is *correct*?
- a. P and Q
 - b. Q and R
 - c. R and S
 - d. S and P

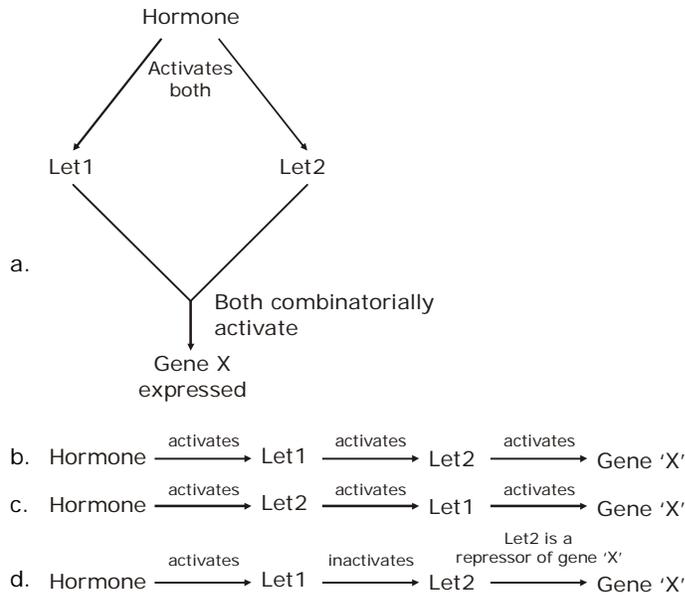
112. A convenient and reasonably reliable indicator of the time of ovulation is usually a rise in the basal body temperature, possibly because progesterone is thermogenic. Of the four situations given below, which one is ideal for ensuring pregnancy after intercourse?



113. In an organism, expression of gene 'X' is induced in the presence of a hormone. Genetic analysis showed that the hormonal signal is transduced through two proteins Let1 and Let2. The expression of gene 'X' was studied in lines overexpressing (OE) the active Let proteins, knockout (KO) of the Let proteins or combination of both. Results of expression of gene 'X' in presence of the hormone is summarized below:

Lines	Expression of Gene 'X'
WT	++
Let1 OE	++++
Let2 OE	++++
Let1 KO	—
Let2 KO	—
Let1 OE	—
Let2 KO	
Let1 KO Let2 OE	++++

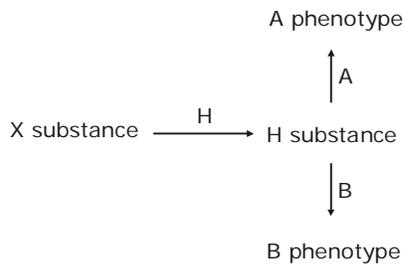
Based on the above, which one of the following pathways best fits the observation made?



114. Two siblings who inherit 50% of the genome from the mother and 50% from the father show lot of phenotypic differences. Which one of the following events during gametogenesis of the parents will maximally contribute to this difference?

- a. Mutation
- b. Recombination
- c. Independent assortment
- d. Environment

115. Consider the following hypothetical pathway:



H allele converts X substance to H substance.

h allele cannot convert X to H substance and leads to phenotype 'O'.

A allele converts H substance leading to A phenotype.

a allele cannot convert H substance.

B allele converts H substance leading to B phenotype.

b allele cannot convert H substance.

An individual with 'A' phenotype when crossed with that of 'B' phenotype has a progeny with 'O' phenotype. Which one of the following crosses can lead to the above observation?

- a. Aahh × BbHH
- b. AaHh × BBHh
- c. AaHh × BBHh
- d. AAHH × BbHh

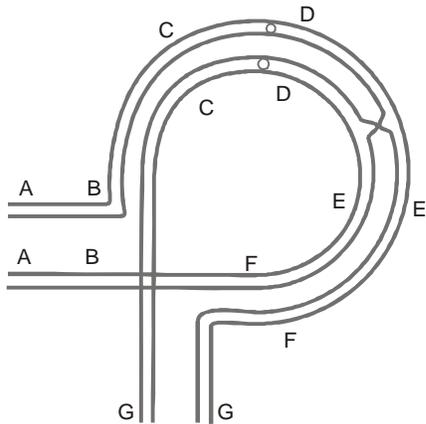
116. Three somatic hybrid cell lines, designated as X, Y and Z, have been scored for the presence or absence of chromosomes 1 through 8, as well as for their ability to produce the hypothetical gene product A, B, C and D as shown in the following table:

Hybrid cell lines	Human chromosomes present								Gene products expressed			
	1	2	3	4	5	6	7	8	A	B	C	D
X	+	+	+	+					-	+	-	+
Y	+	+			+	+			+	-	-	+
Z	+		+		+		+		+	+	-	+

Which of the following option has most appropriately assigned chromosomes for each of the given genes?

- Gene A on chromosome 5, Gene B on chromosome 3, Gene C on chromosome 8 and Gene D on chromosome 1.
- Gene A on chromosome 5 and Gene B on chromosome 3 only.
- Gene D on chromosome 8, Gene C on chromosome 1, Gene B on chromosome 5 and Gene A on chromosome 4.
- Gene A on chromosome 5, Gene B on chromosome 3 and Gene D on chromosome 1.

117. The following diagram shows meiotic pairing in an inversion heterozygote and a point where single crossing over has occurred



The resulting gametes produced may have

- the chromosome having normal gene sequence.
- the chromosome having inverted gene sequence.
- a dicentric chromosome with duplication and deletion.
- an acentric chromosome having duplication and deletion.
- the chromosome having duplication and deletion.

Which of the following combination will be most appropriate for the diagram shown?

- A, B, C and D
- A, B and E
- B, C, D and E
- A, C, D and E

118. Of the following, which one of the individuals *will not* necessarily carry the allele responsible for the mentioned trait?
- A woman in a family where an autosomal dominant trait is segregating and her mother and son are affected.
 - A daughter of a man who is affected by an X-linked dominant trait.
 - A father of a child who is affected with an autosomal recessive trait.
 - A father of a boy affected with X-linked recessive trait.

119. Which of the following is the *correct* match of the algal group with its food reserve?

Algal group	Carbohydrate reserve
P. Bacillariophyceae	i. Oil
Q. Xanthophyceae	ii. Floridean starch
R. Phaeophyceae	iii. Laminarin
S. Rhodophyceae	iv. Chrysolaminarin
	v. Starch

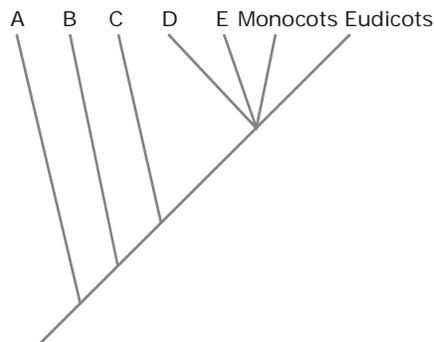
- P-(iv), Q-(i), R-(iii), S-(ii)
- P-(ii), Q-(i), R-(iii), S-(iv)
- P-(iv), Q-(i), R-(ii), S-(v)
- P-(i), Q-(v), R-(iii), S-(ii)

120. A researcher conducts a standard test to identify enteric bacteria (A, B, C) on the basis of their biochemical properties. The result is given in the following table:

Test	Bacteria		
	A	B	C
Indole	+	-	-
Methyl Red	+	+	+/-
Voges-Proskauer	-	-	+

Based on the above, the identified bacteria A, B and C are most probably

- Enterobacter, Salmonella, Escherichia.*
 - Escherichia, Salmonella, Enterobacter.*
 - Salmonella, Enterobacter, Escherichia.*
 - Escherichia, Enterobacter, Salmonella.*
121. Following is a cladogram of the major taxonomic groups of the angiosperms:



Groups A-E represent respectively:

- Astrobaileyales, Nymphaedales, Amborellales, Chloranthaceae, Magnoliids.*
- Amborellales, Astrobaileyales, Nymphaedales, Magnoliids, Chloranthaceae.*
- Amborellales, Nymphaedales, Astrobaileyales, Chloranthaceae, Magnoliids.*
- Amborellales, Nymphaedales, Chloranthaceae, Magnoliids, Astrobaileyales.*

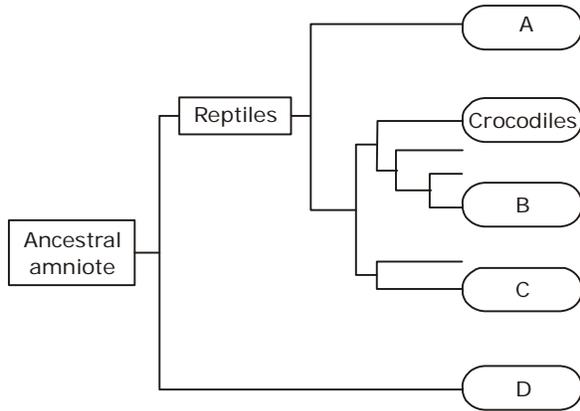
122. The following are some important features which are commonly associated with animal development:

- P. Position of anus development with respect to blastopore.
- Q. Method of cell division.
- R. Mechanism of coelom formation.
- S. Cleavage pattern during egg development.

Based on the above, which one of the following combinations differentiate the development of deuterostomes from that of protostomes?

- a. P, Q and R
- b. Q, R and S
- c. P, R and S
- d. P and Q

123. The phylogenetic tree of amniote vertebrates is given in diagram



The groups labeled A, B, C, D are

- a. A-Snakes, B-Turtles, C-Birds, D-Mammals.
- b. A-Snakes, B-Turtles, C-Mammals, D-Birds.
- c. A-Turtles, B-Birds, C-Snakes, D-Mammals.
- d. A-Birds, B-Turtles, C-Snakes, D-Mammals.

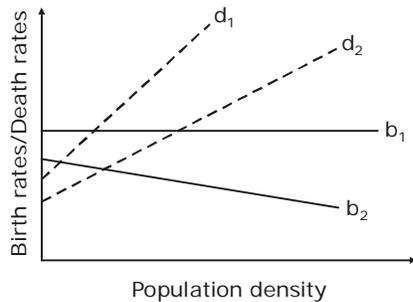
124. The following are matches made between adult animals and their larval forms:

- 1. Copepods — Nauplius
- 2. Sea cucumber — Zoea
- 3. Sea urchin — Echinopleuteus
- 4. Crabs — Auricularia
- 5. Star fish — Bipinnaria
- 6. Brittle star — Ophiopleuteus

Which one of the combinations below reflects *incorrect* matches?

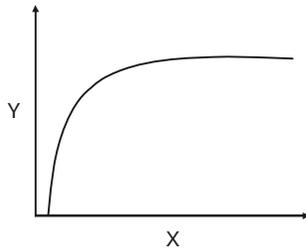
- a. 1, 3, 5
- b. 2 and 4
- c. 2 only
- d. 6 only

125. Which of the following statements about the birth rates (b_1 , b_2) and death rates (d_1 , d_2) of species 1 and 2 indicated in the figure is *not* true?



- a. Birth rates of species 1 are density-independent.
 b. Death rates of both species are density-dependent.
 c. Birth rates of species 2 are density-dependent.
 d. Density-dependent effects on death rates are similar for both the species.
126. Important chemical reactions involved in nutrient cycling in ecosystems are given below:
 P. $\text{NO}_2^- \longrightarrow \text{NO}_3^-$
 Q. $\text{N}_2 \longrightarrow \text{NH}_3$
 R. $\text{NH}_4^+ \longrightarrow \text{NO}_2^-$
 S. $\text{NO}_3^- \longrightarrow \text{N}_2$
- The organisms associated with these chemical reactions are
- a. P - *Nitrosomonas*, Q - *Pseudomonas*, R - *Nostoc*, S - *Nitrobacter*.
 b. P - *Pseudomonas*, Q - *Nitrobacter*, R - *Nostoc*, S - *Nitrosomonas*.
 c. P - *Nitrobacter*, Q - *Nostoc*, R - *Nitrosomonas*, S - *Pseudomonas*.
 d. P - *Nostoc*, Q - *Nitrosomonas*, R - *Nitrobacter*, S - *Pseudomonas*.
127. A population is growing logistically with a growth rate (r) of 0.15/week, in an environment with a carrying capacity of 400. What is the maximum growth rate (number of individuals/week) that this population can achieve?
- a. 15
 b. 30
 c. 22.5
 d. 60
128. In a field experiment, autotrophs are provided a ^{14}C -labeled carbon compound for photosynthesis. Radioactivity (^{14}C) levels were then monitored at regular intervals in all the trophic levels. In which ecosystem is the radioactivity likely to be detected fastest at the primary carnivore level?
- a. Open ocean
 b. Desert
 c. Deciduous forest
 d. Grassland

129. Which of the following X-Y relationships *does not* follow the pattern shown in the graph?



- a. Number of prey killed (Y) in relation to prey density (X).
- b. Photosynthetic rate (Y) in relation to light intensity (X).
- c. Species richness (Y) in relation to area (X).
- d. Tree species richness (Y) in relation to actual evapotranspiration.

130. Following table shows the number of individuals of five tree species in a community:

Tree species	Number of individuals
A	50
B	20
C	20
D	05
E	05

Based on the above, the Simpson's diversity (DS) index of the community will be

- a. 0.552
- b. 0.335
- c. 0.435
- d. 0.345

131. Following table shows the presence (+) or absence (-) of five species in three communities (A, B, C):

Species	Community		
	A	B	C
1	+	+	+
2	+	+	-
3	-	-	+
4	+	-	-
5	-	-	+

Based on the above, which of the following is the *correct* order of similarity between two pairs of communities?

- a. A and B > B and C > A and C
- b. A and B > A and C > B and C
- c. B and C > A and B > A and C
- d. A and C > A and B > B and C

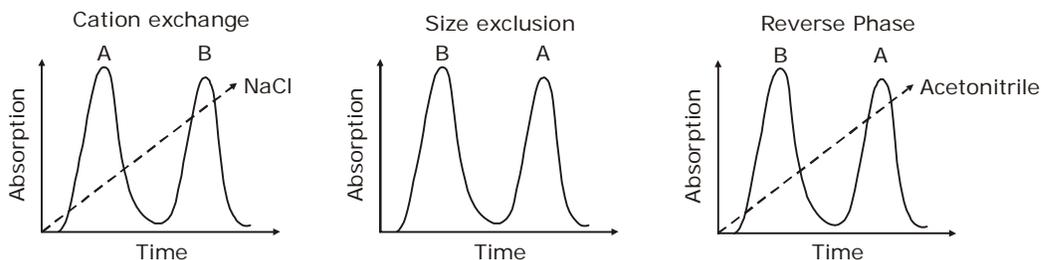
132. In several populations, each of size $N = 20$, if genetic drift results in a change in the relative frequencies of alleles.

- A. What is the rate of increase per generation in the proportion of populations in which the allele is lost or fixed?
- B. What is the rate of decrease per generation in each allele frequency class between 0 and 1?

The *correct* answer for A and B is

- a. A — 0.25, B — 0.125
- b. A — 0.025, B — 0.0125
- c. A — 0.0125, B — 0.025
- d. A — 0.125, B — 0.25

133. Individual A can derive 'fitness' benefit of 160 units by helping Individual B, but incurs a 'fitness' cost of 50 units in doing so. Following Hamilton's rule, A should help B only if B is his
- brother or sister
 - first cousin only
 - cousin or uncle
 - nephew or niece
134. The "Red Queen Hypothesis" is related to
- the mating order in the harem of a polygamous male.
 - the elimination by deleterious mutations by sexual reproduction.
 - mate selection process by a female in a lek.
 - the evolutionary arms race between the host and the parasite.
135. In a population of effective population size N_e , with rate of neutral mutation μ_0 , the frequency of heterozygotes per nucleotide per site at equilibrium between mutation and genetic drift is calculated as
- $\frac{2N_e\mu_0}{4N_e\mu_0 + 1}$
 - $\frac{4N_e\mu_0}{4N_e\mu_0 + 1}$
 - $\frac{N_e\mu_0}{4N_e\mu_0 + 1}$
 - $\frac{4N_e\mu_0}{(4N_e\mu_0 - 1)}$
136. As cancer progresses, several genome rearrangements including translocation, deletion, duplications etc. occur. If these rearrangements are to be identified, which of the following techniques would be most suitable?
- RAPD
 - Microarray
 - Multi-colour FISH
 - Flow cytometry
137. A student noted the following points regarding *Agrobacterium tumefaciens*:
- P. *A. tumefaciens* is a gram-negative soil bacterium.
- Q. Opine catabolism genes are present in T-DNA region of T₁-plasmid.
- R. Opines are synthesized by condensation of amino acids and α -ketoacids or amino acids and sugars.
- S. A callus culture of crown gall tissue caused by *A. tumefaciens* in plants can be multiplied without adding phytohormones.
- Which one of the combinations of above statements is *correct*?
- P, Q and R
 - P, Q and S
 - Q, R and S
 - P, R and S
138. A mixture of two proteins was subjected to following three chromatographic columns:
- Cation exchange,
 - Size exclusion (Sephadex 100) and
 - Reverse phase.
- Following elution profiles were obtained.



142. A researcher is studying the subcellular localization of a particular protein 'X' in an animal cell. The researcher performs successive centrifugation at increasing rotor speed. The researcher starts spinning the cellular homogenate at 600g for 10 min, collects the pellet, spins the supernatant at 10,000g for 20 min, collects the pellet, spins the supernatant at 100,000g for 1 hour, collects both the pellet and the final supernatant. On subjecting various pellets and the final supernatant to Western blotting with anti-protein-X antibody, the protein X is observed to be maximally expressed in pellet after centrifugation at 10,000g. Based on the above observation, what will be the most likely localization of protein X.
- Nucleus
 - Ribosomes
 - Mitochondria
 - Microsomes
143. Fluorescence recovery after photobleaching in live cells is used to determine
- co-localization of proteins
 - distance between two organelles
 - diffusion of proteins
 - nucleic acid compactness
144. You have transiently expressed a new protein (for which no antibody is available) in a cell line to establish structure function relationship. Which one of the following strategies is the most straight forward way to examine the expression profile of this new protein?
- By metabolic labeling using ^{35}S labeled amino acids.
 - Making a GFP fusion protein with this new protein.
 - Immunoprecipitating this protein with the help of another protein for which antibody is available.
 - Running SDS-PAGE and identify the protein.
145. During an experiment, a student found increased activity of a protein, for which there were three possible explanations, viz., increased expression of the protein, increased phosphorylation, or increased interaction with other effector proteins. After conducting several experiments, the student concluded that increased activity was due to increased phosphorylation. Which one of the following experiments will not support/provide the *correct* explanation drawn by the student?
- Western blot analysis
 - Analysis of transcription rate
 - Mass spectroscopy
 - Phosphoamino acid analysis