CSIR-NET JUNE 2021
LIFE SCIENCE
QUESTION PAPER
Shift 1

## SECTION A

1.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 $\frac{\mathbf{1}}{\mathbf{2}}$ litre back to $A$ from $B$ half an hour later. The earliest $A$ will get empty in:
A. 5 hours
B. 4 hours
C. 3 hours
D. 2 hours

Ans. C
2. What is the volume of soil in an open pit of size $2 \mathrm{~m} \times 2 \mathrm{~m} \times 10 \mathrm{~cm}$ ?
A. $40 \mathrm{~m}^{3}$
B. $0.4 \mathrm{~m}^{3}$
C. $0 \mathrm{~m}^{3}$
D. $4.0 \mathrm{~m}^{3}$

## Ans. C

3. What is the minimum number of moves required to transform figure 1 to figure 2? A move is defined as removing a coin and placing it such that it touches two other coins in its new position.

Fig-1

## Fig- 2

A. 1
B. 2
C. 3
D. 4

Ans. B
4.The distance from city $P$ to city $Q$ is 27 km . $A$ and $B$ start walking from $P$ towards $Q$ at speeds of $5 \mathrm{~km} / \mathrm{hr}$ and $7 \mathrm{~km} / \mathrm{hr}$, respectively. $B$ reaches $Q$, returns immediately, and meets $A$ at R. What is the distance between $P$ and $R$ ? (assume all three cities to be in one straight line)
A. 12.5 km
B. 22.5 km
C. 4.5 km
D. 13.5 km

Ans. B
5. How many times starting at 1:00 pm would the minute and hour hands of a clock make an angle of $40^{\circ}$ with each other in the next 6 hours?
A. 6
B. 7
C. 11
D. 12

## Ans. C

6. 



The graph shows cumulative frequency percentage of research scholars and the number of papers published by them. Which of the following statements is true?
A. Majority of the scholar published more than 4 papers
B. $60 \%$ of the scholar published at least 2 papers
C. $80 \%$ of the scholar published at least 6 papers $80 \%$
D. $30 \%$ of the scholars have not published any paper

## Ans. B

7. Density of a rice grain is $1.5 \mathrm{~g} / \mathrm{cc}$ and bulk density of rice heap is $0.80 \mathrm{~g} / \mathrm{cc}$. If a 1 litre container is completely filled with rice, what will be the approximate volume of pore space in the container?
A. 350 cc
B. 465 cc
C. 550 cc
D. 665 cc

## Ans. B

8. $A B$ is the diameter of a circle. The chord $C D$ is perpendicular to $A B$ intersecting it at $P$. If $C P-2$ and $P B-1$, the radius of the circle is

A. 1
B. 2.5
C. 2
D. 5

## Ans. B

9.If a plant with green leaves is kept in a dark room with only green light on, which one of the following would we observe?
A. The plant appears brighter than the surroundings
B. The plant appears darker than the surroundings
C. we cannot distinguish the plant from the surroundings
D. It will have above normal photosynthesis activity

Ans. A
10.


Pre-Ph.D. exam score of 10 students are plotted against their M.Sc. marks. Which of the following is true?
A. Two students have scored better in Pre-Ph.D. then their M.Sc. exam
B. All those students who scored 50 in Pre-D. scored more marks in their M.Sc. exam
C. Two students scored the same marks in their Pre-Ph.D. ad M.Sc. exams
D. The students who scored maximum in M.Sc. is the only students to get maximum in Pre-Ph.D. exam
Ans. C
11.The random errors associated with the measurement of $P$ and $Q$ are $10 \%$ and $2 \%$, respectively. What is the maximum percentage random error in $P / Q$ ?
A. 12.0
B. 9.8
C. 8.0
D. 10.2

Ans. A
12.Starting from a point A you fly one mile south, then one mile east, then one mile north which brings you back to point A. Which of the following MUST be true?
A. You are at the north pole
B. You are in the Eastern hemisphere
C. You are in the western hemisphere
D. You are at the South pole

## Ans. C

13.The product of the perimeter of a triangle, the radius of its in-circle, and a number gives the area or the triangle. The number is
A. $1 / 4$
B. $1 / 3$
C. $1 / 2$
D. 1

Ans. C
14.What is the average value of $y$ for the range of $x$ shown in the following plot?

A. 0
B. 1
C. 1.5
D. 2

Ans. C
15.It takes 5 days for a steamboat to travel from $A$ to $B$ along a river. It takes 7 days to return from $B$ to $A$. How many days will it take for a raft to drift from $A$ to $B$ (assuming all speeds are constant)?
A. 13
B. 35
C. 6
D. 12

## Ans. C

16.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. Rs. 1
D. Rs. 20

## Ans. B

17.Three boxes are coloured red, blue and green and so are three balls. In how many ways can one put the balls one in each box such that no ball goes into the box of its own colour?
A. 1
B. 2
C. 3
D. 4

## Ans. B

18.A floor of size $13 \times 24$ is to be paved using square tiles only. What is the smallest number of tiles needed to do this?
A. 6
B. 15
C. 8
D. 9

Ans. D
19.A fair die was thrown three times and the outcome was repeatedly six. If the die is thrown again what is the probability of getting six?
A. $1 / 6$
B. $1 / 216$
C. $1 / 1296$
D. 1

## Ans. A

20.If a person traves $x \%$ faster than normal, he reaches $y$ minutes earlier than normal. What is his normal time of travel?
A. $\left(\frac{100}{x}+1\right) y$ minutes $\left(\frac{100}{x}+1\right) y$
B. $\left(\frac{x}{100}+1\right)$ y minutes $\left(\frac{x}{100}+1\right)$ y
C. $\left(\frac{y}{100}+1\right)$ y minutes $\left(\frac{y}{100}+1\right)$ y
D. $\left(\frac{100}{y}+1\right)$ y minutes $\left(\frac{100}{y}+1\right) y$

## Ans. C

## SECTION B

1. Which one of the following combinations represents the major protein or protein complex involved in chromatin condensation in yeast and human, respectively?
A. HP1 and SIR Complex HP1
B. SIR complex and HP1 SIR
C. HP1 and Su(var)
D. SIR complex and Su(var) SIR

## Ans. B

2.Historical frequencies of fires in an area can be determined by
A. Radioactive dating of the tree remains.
B. Examining the fire scars in growth rings of living trees.
C. Measuring carbon content on the soil surface after fire.
D. Examining records of evacuation history of the nearby villages.

Ans. B
3. Select the correct statement related to phylogeny of primates.
A. Lemurs are more closely related to lorises than to gibbons.
B. Orangutans are closer to lorises than to gibbons.
C. Tarsiers are the same as old-world monkeys.
D. Humans are closer to new world monkeys than to orangutans.

Ans. A
4.Consider the following four geological periods.
A) Quaternary
B) Cretaceous
C) Jurassic
D) Cambrian

Which one of the following options represents the correct arrangement of these geological periods from earliest to recent:
A. A-B-D-C,
B. D-C-B-A
C. C-B-D-A
D. $B-A-C-D$

## Ans. B

5.Consider the following ecosystems
A. Tropical rain forests
B. Open ocean
C. Algal beds and Coral reefs
D. Marshes and Swamps

Ans. D
6. Which of the following combinations would best characterize the dominant phase of the life cycle of a pteridophyte?
A. Diploid gametophyte
B. Haploid gametophyte
C. Diploid sporophyte
D. Haploid sporophyte

Ans. C
7.Mimicry where deceptiveness of the mimic's signal is high and fitness consequences signaled to the receiver by the mimic is also high (and negative) is
A. Batesian mimicry
B. Müllerian mimicry
C. Fisherian mimicry
D. Millerian mimicry

## Ans. A

8.The cytoplasmic domain of the receptor of which of the following proteins does NOT function as tyrosine kinase?
A. Epidermal growth factor
B. Platelet derived growth factor
C. Insulin
D. Asialoglycoprotein

## Ans. D

9. Which one of the following regions of the target gene is NOT used for making an RNAi
construct to knock down its expression?
A. 5' UTR of the mature transcript
B. 3' UTR of the mature transcript
C. Exonic region
D. Intronic region

## Ans. D

10.The enzyme alkaline phosphatase was tested for its catalytic activity using the substrate papa-nitrophenylphosphate. The KM obtained was 10 mM and Vmax was $100 \mu \mathrm{~mol} / \mathrm{min}$. Which one of the following options represents the initial velocity of the reaction at a substrate
concentration at 10 mM ?
A. $50 \mu \mathrm{~mol} / \mathrm{min}$
B. $100 \mu \mathrm{~mol} / \mathrm{min}$
C. $500 \mu \mathrm{~mol} / \mathrm{min}$
D. $20 \mu \mathrm{~mol} / \mathrm{min}$

## Ans. A

11.All of the following statements about bacterial transcription termination are true EXCEPT
A. Some terminator sequences require Rho protein for termination.
B. inverted repeat and ' $T$ ' rich nontemplate strand define intrinsic terminators.
C. Rho-dependent terminators may possess inverted repeat elements.
D. Nus A is necessary for intrinsic transcription termination.

## Ans. D

12. Which one of the following statements with respect to development in amphibians is correct?
A. Gastrulation begins with the invagination of bottle cells, followed by coordinated involution of the mesodermal precursors and the epiboly of the prospective ectoderm.
B. The organizer induces the Nieuwkoop centre
C. The organizer is formed by the accumulation of $\beta$-catenin
D. In the absence of BMP inhibitors ectodermal cells form neural tube BMP

## Ans. A

13.Some cells possess peptides which contain D- form of amino acids. How do they arise?
A. These peptides are produced by ribosomes by incorporating $D$-amino acids at specific positions.
B. Ribosome makes peptides with L-amino acids only. However, some of the amino acids in the peptides are replaced by $D$ - amino acids by a pathway that involves excision of the L- amino acids.
C. The peptides with the D -amino acids are produced in a ribosome independent manner.
D. Peptides with D-amino acids exist only in archeae where they are made by the presence of racemase.

## Ans. C

14. Which one of the following statements is correct?
A. If a transgenic plant heterozygous for an insert segregates into $1: 1$ ratio for the transgenic phenotype on backcrossing then it contains two unlinked copies of the insert.
B. ANOVA allows a plant breeder to test whether measurements from three or more treatments show statistically significant differences.
C. Comparative genomics allows scientists to identify regions of collinearity but not synteny between different species
D. For genetic mapping of a quantitative trait in plants, an RIL mapping population comprising of individuals that are heterozygous at most loci is preferred.
Ans. C
15.Fluorescence microscope that requires photoactivatable probes to obtain super resolution is
A. Structured illumination microscope (SIM)
B. dSTORM - stochastic optical reconstruction microscopy dSTORM
C. Stimulated emission depletion microscopy (STED)
D. Laser scanning confocal microscope

## Ans. B

16. In a transplantation experiment, the area of presumptive ectoderm from an early frog gastrula was transplanted to a region of the newt gastrula destined to become parts of the mouth. The resulting salamander larvae had frog like mouth parts (frog tadpole suckers) instead of balancers as observed during development of wild type newt embryo. This is an example of
A. Determination
B. Genetic specificity of interaction
C. Regional specificity of interaction
D. Autonomous specification

## Ans. B

17.In eukaryotic cells, covalently attached lipids help to anchor some watersoluble proteins to the plasma membrane. One group of cytosolic proteins is anchored to the cytosolic face of the membrane by a fatty acyl group (e.g.myristate or palmitate). Which amino is covalently attached to these groups and present at the polypeptide chain's N -terminus?
A. Glycine
B. Tyrosine
C. Serine
D. Lysine

Ans. A
18. Which of the following is the causative agent of filariasis?
A. Listeria monocytogenes
B. Cryptococcus neoformans
C. Francisella tularensis
D. Brugiya malayi

## Ans. D

19.A fly with apricot coloured eye was crossed with a sepia eyed fly of opposite sex. In F1 all flies were wild type. The genes responsible for the two phenotypes were
A. Allelic
B. Non-allelic
C. Pseudo-allelic
D. Paralogous genes

## Ans. B

20.The basic difference between direct repair and base excision repair is
A. Direct repair restores the original structure of altered nucleotide without replacement, while in base excision repair the section of DNA containing the distortion is removed, the correct base is added and resealed.
B. In direct repair, homologous recombination repairs the broken region while base excision repair restores original structure of altered nucleotide by modification.
C. Direct repair restores original structure by non-homologous end joining without using homologous template while in base excision repair the section of DNA containing the distortion is repaired by using homologous recombination.
D. In direct repair, an exonuclease, a DNA polymerase and a ligase are used, while in base excision repair a translesion polymerase that bypasses the bulky lesions is used by the cell.

## Ans. B

21.Following statements are made about uncompetitive inhibition of an enzyme. Which one of the following options represents the correct combination of the statements?
A) Uncompetitive inhibitor binds to both free enzyme as well as an enzymesubstrate complex.
B) Addition of an uncompetitive inhibitor lowers the Vmax of the reaction.
C) Apparent KM of the enzyme is lowered.
D) Apparent KM of the enzyme remains unchanged.
A. B and C
B. A and C
C. A and B
D. A and D

Ans. A
22.A protein Solution ( 0.2 ml ) of unknown concentration was diluted with 0.8 ml of water. To 0.5 ml of this diluted Solution 4.5 ml of biuret reagent was added and the color allowed to develop. The absorbance of this mixture taken in a test tube of 1 cm diameter at 540 nm was observed to be 0.20 .0 .5 ml of BSA ( $4 \mathrm{mg} / \mathrm{ml}$ ) Solution plus 4.5 ml of biuret gave an absorbance of 0.20 when measured as above. What is the protein concentration ( $\mathrm{mg} / \mathrm{ml}$ ) in the undiluted unknown Solution?
A. 20
B. 40
C. 50
D. 80

## Ans. A

23. Given below are statements on 'living fossils'. Select the correct statements.
A. Living fossils are impressions of extant organisms in old rocks.
B. Living fossils show high morphological divergence from fossil records.
C. Living fossils are always an evolutionary link between two classes of organisms.
D. Living fossils are organisms that have remained unchanged for millions of years.

Ans. D
24. Which one of the following is not present in the filtration slit diaphragm?
A. NEPH1
B. Paxillin
C. Nephrin
D. NEPH2

## Ans. B

25. Which of the following 'R' gene products do not contain NBS-LRR domain?
A. RPS2 protein of Arabidopsis
B. Xa1 protein of rice
C. N protein of tobacco
D. Mlo protein of barley

Ans. D
26.Dirigent proteins predominantly play an important role in biosynthesis of:
A. Lignans
B. Alkaloids
C. Terpenoids
D. Amino acids

## Ans. A

27.During normal development of sea urchin, $\beta$-catenin accumulates predominantly in the micromeres, which are fated to become endoderm and mesoderm. If GSK- 3 is blocked in the developing embryo:
A. $\beta$-catenin accumulation in the nuclei of large micromeres will be inhibited leading to formation of ectodermal ball.
B. $\beta$-catenin will accumulate in the nuclei of all blastula cells leading to an ectodermal ball.
C. $\beta$-catenin will accumulate in the nuclei of all blastula cells leading to animal cells getting specified as endoderm and mesoderm.
D. None of these

## Ans. C

28.A breakthrough in cancer therapy is expected where T- cells are taken from a patient are modified in the laboratory to attack cancer cells before reinfusion in the patient. These $T$ cells are called
A. Cancer associated receptor $T$ cells
B. Chimeric antigen-receptor T cells
C. Chimeric B and T cell
D. Cancer antigens recognition T cells

## Ans. B

29.Iron-sulphur clusters [Fe-S] are the key prosthetic groups that carry electrons in all of the below EXCEPT:
A. NADH - CoQ reductase NADH - CoQ
B. Succinate - CoQ reductase
C. Cytochrome C oxidase
D. CoQH 2 -Cytochrome C reductase CoQH 2

## Ans. C

30.Widal test, a widely used serological test for enteric fever, is a type of
A. Precipitation reaction
B. Agglutination reaction
C. Complement fixation test
D. Immunofluorescence detection

Ans. B
31. Which one of the following protein complex activation promotes progression across the G1/S boundary followed by entry into S-phase?
A. Cdk4/Cyclin D
B. Cdk2/Cyclin E
C. Cdk4,6/Cyclin
D. Cdk4,6/Cyclin D, E

Ans. B
32. The movement of proteins bigger than 50 kDa across the nuclear envelope requires $\qquad$ .
A. Sec 61
B. Tom 20
C. Importin $\beta$
D. Tim 44

## Ans. C

33. Which one of the following combinations of terms is matched INCORRECTLY?
A. Nanopore: DNA sequencing
B. Pyrosequencing: Protein primary structure
C. Homologous recombination: chloroplast transformation
D. SSRs: Co-dominant markers SSRs

## Ans. B

34. Which one of the following proteins is essential for both the initiation of DNA replication as well as the continued advance of the replication fork?
A. ORC
B. Geminin
C. Cdc45
D. Cdc6

## Ans. C

35.Photochemically generated ATP is consumed in which one of the following phases of Calvin-Benson cycle?
A. Only carboxylation
B. Only regeneration
C. Carboxylation and reduction
D. Reduction and regeneration

## Ans. D

36.The graph below shows the change in the size of four populations(A-D) over time. Which among the four populations(A, B, C, and D) would have the lowest intrinsic rate of the population growth(r)?

A. A
B. B
C. C
D. D

Ans. D
37. Which one of the following is used in organification of tyrosine residues in thyroglobulin protein, during thyroid hormone biosynthesis?
A. Iodine
B. Reduced iodine
C. Oxidized iodine
D. Hydrogen iodide

Ans. C
38. Which one of the following gases is present in the stratosphere at a concentration higher than its concentration in the troposphere?
A. Nitrogen
B. Oxygen
C. Ozone
D. Carbon dioxide

## Ans. C

39.What is the pattern of cleavage observed in mammals?
A. Radial
B. Spiral
C. Rotational
D. Bilateral

## Ans. C

40.DNA was isolated from a strain of bacterium with genotype $a+b+c+d+e+$ and transformed into a bacterial strain a-b-c-d-. The transformants were tested for the presence of the donated genes. The contransformed genes were found as follows: $a+$ and $b+; c+$ and $e+; d+$ and $c+; b+$ and $d+$
What is the order of genes on the bacterial chromosome?
A. abcde
B. $a c b e d$
C. abced
D. $a b d c e$

## Ans. D

41.The dark current in retina is due to
A. Closing of $\mathrm{Na}+$ channels in the outer segment of photoreceptors
B. Opening of $\mathrm{K}+$ channels in the inner segment of photoreceptors
C. Opening of $\mathrm{Na}+$ channels in the outer segment of photoreceptors
D. Closing of $\mathrm{K}+$ channels in the outer segment of photoreceptors.

## Ans. C

42.Following are the pKa's of the ionizable groups in lysine
pKa1 = 2.16( a-carboxylic group)
pKa2= 9.06( a-amino group)
pKa3 $=10.54(\varepsilon$ - amino group)
Which one of the following options represents the pI of lysine?
A. 7.25
B. 5.61
C. 6.35
D. 9.8

## Ans. D

43. Human polydactyly traits having extra fingers or toes are caused by a dominant allele. In a screening it was found that out of 42 individuals having an allele for polydactyly, only 38 of them were polydactylus. Which of the following is the correct interpretation of the observation?
A. The penetrance of polydactyly is estimated to be $90 \%$
B. The expressivity of polydactyly is $90 \%$
C. This is an example of variable expressivity
D. The polydactyly trait is showing complete penetrance

Ans. A
44.Eukaryotes are classified into 5-6 super groups based on phylogenomic studies. Which one of the following statements about eukaryotic supergroups is FALSE?
A. Fungi and animals are more closely related to each other than either group is to plants.
B. Amoebozoa and opisthokonts are unikonts.
C. Land plants and green algae belong to Archaeplastida.
D. Alveolates and amoeba belong to the same super group.

## Ans. D

45. In which of the following stages of Arabidopsis embryogenesis do the visible distinctions
between the adaxial and abaxial tissues of the cotyledons become initially apparent?
A. Globular stage
B. Zygotic stage
C. Torpedo stage
D. Mature stage

## Ans. C

46.In bacteria many of the tRNA genes do not contain the CCA sequence found at the 3'end of tRNA. In this context which one of the following statements represents the correct explanation?
A. In these tRNAs amino acylation occurs at the $3^{\prime}$ end of the tRNA irrespective of the presence of the - CCA sequence.
B. CCA sequence is added to these tRNA transcripts in a DNA templateindependent manner.
C. These tRNAs exploit the process of trans- splicing to include a CCA sequence at their 3' end.
D. The absence of CCA sequence occurred only in the last common ancestor (LCA) during the course of evolution and the current day tRNA genes always possess a sequence to encode the CCA end of the tRNA.

## Ans. B

47.For nuclear spin of spin quantum number ( $\mathrm{I}=1 / 2$ ) processing in a magnetic field at a larmor frequency of 300 MHz the wavelength of incident radiation required to excite the nuclear spins must be approximately
A. 1 nm
B. 1 cm
C. 1 m
D. 10 m

Ans. C
48. Which one of the following options represents a combination of terms that are matched INCORRECTLY?
A. ddNTPs: Chain termination
B. South Western blot: Physical interaction between DNA and proteins
C. 5'-3' exonuclease activity : Proofreading polymerase for PCR
D. Yeast two hybrid system: Interaction between proteins

## Ans. C

49.Tumors are generally classified by
A. the virus which caused them
B. the person who discovered them
C. their metastatic ability
D. the tissue or cell of origin

Ans. D

## SECTION C

1.A schematic representation of a metabolic pathway is shown below


Under which of the following conditions stoichiometric amounts of end products K and $L$ would be obtained if a concerted feedback mechanism were in operation?
A. K inhibits FàG and $L$ inhibits FàH; DàE is inhibited at equal amounts of $K$ and $L$.
B. Dà $E$ is inhibited at equal amounts of $K$ and $L ; K$ inhibits Fà $H$ and $L$ inhibits Fà
C. DàE is inhibited at equal amounts of $G$ and $H$; $K$ inhibits FàH and $L$ inhibits FàG
D. K inhibits FàH and L inhibits FàG

Ans. A
2.The following statements are being made to define the Michaelis constant (Kw). It is:
A). Independent of enzyme concentration [E] and substrate concentration (S)
B). Equal to the dissociation constant when the [ES] complex dissociates more rapidly than product formation
C). Equal to the dissociation constant when product formation is more rapid than (ES) complex dissociation
D). An intrinsic property of an enzyme and does not depend on pH , temperature and ionic strength

Which one of the following combination of statements is correct?
A. A and B only
B. A, B and D only
C. C and D only
D. A and D only

## Ans. A

3.The table below lists the biochemical characteristics of proteins and experimental procedures used to determine them. Match the characteristics with the experimental procedure.

| List I | List II |
| :--- | :--- |
| Biochemical Characteristics | Experimental Procedure |
| A. 3-dimensional structure | I. Nuclear magnetic <br> resonance |
| B. Ionic Charge | II. Isoelectric focusing |
| C. Binding specificity | III. Affinity <br> Chromatography |
| D. Molecular Size | IV. Ultracentrifugation |

Which one of the following matches is correct?
A. A - III, B - I, C - II, D - IV
B. A - I, B - II, C - III, D - IV
C. A - II, B - I, C - III, D - IV
D. A - IV, B - II, C - I, D - III

Ans. B
4.


A circular dichroism spectrum in the far-UV region informs on the kind and content of secondary structures in a protein. Near-UV and tryptophan emission spectra inform on the tertiary structure. Shown in the panels above are (A) Intrinsic fluorescence emission spectra of protein ' X ', (B) Far-UV CD spectra of protein ' X ', (C) Near-UV CD spectra of protein X recorded under different conditions. Curves represent the spectra of protein ' X ' at pH 7.0 (black), pH 3.0 (green), and pH 7.0 in the presence of 6.0 M guanidine hydrochloride (red). What does the experiment report?
A. Protein is fully folded at pH 7.0 , acid-induced molten globule at pH 3.0 and unfolded in 6M guanidine hydrochloride.
B. Protein secondary structure is reduced at pH 7.0 and the protein has formed beta fibrils at the other two conditions.
C. The changes in fluorescence and near-UV CD indicate an increase in hydrodynamic radius at pH 3.0 and in 6M guanidine hydrochloride.
D. There is extensive denaturation of the protein both at pH 3.0 and in 6 M guanidine hydrochloride.

## Ans. A

5.The pI of four proteins ( $\mathrm{A}, \mathrm{B}, \mathrm{C}, \mathrm{D}$ ) are shown in the table below:


To purify ' $D$ ' from a mixture of these four proteins in a single step, using ionexchange chromatography, what combination of buffer pH and ion-exchange resin would you select?
A. pH 11, cation exchanger resin pH 11
B. pH 2 , anion exchanger resin pH 2
C. pH 6, anion exchanger resin pH 6
D. pH 8, cation exchanger resin pH 8

Ans. D
6.The curve B in the figure below shows the oxygen dissociation profile at physiological concentration of $\mathrm{CO}_{2}$ at pH 7 .


An increase in pH would lead to an oxygen dissociation profile indicated by:
$A$ curve $B$ (no change in the dissociation profile)
B. curve $A$
C. curve C
D. curve $D$

## Ans. B

7.Following statements were made about chromosome cohesion during mitosis and meiosis.
A. Though cohesin is essential for pairwise alignment of the chromosomes on the mitotic spindle, it is not crucial for generating tension across the centromere.
B. Cohesin binds to the chromosome even before the initiation of the S-phase.
C. In fission yeast, centromere-specific localization of Moa1 and Rec8 regulates the orientation of kinetochores at meiosis-I.
D. Cohesin exhibits a uniform distribution/localization pattern across the chromosomal length.
E. Polo/Cdc5 is a positive regulator of Separase, an endopeptidase that facilitates the opening of the cohesin ring.
Which one of the following combinations contains all correct statements?
A. A, B and D only
B. A, C and E only
C. B, C and D only
D. B, C and E only

## Ans. D

8. Which one of the following is valid with respect to, the one-step growth experiment developed by Ellis and Delbruck in 1939?
A. The reproduction of large phage population is synchronized.
B. A culture is directly developed by inoculation of a single bacterial colony from the agar plate into a liquid medium
C. Involves only a single step of overnight culture development followed by inoculation of a fresh medium with $1 \%$ inoculum.
D. Only a single carbon source such as glucose is used in the medium.

## Ans. A

9.Given below are a few statements about nuclear transport.
A). RanGTP levels are higher in the nucleus than in the cytoplasm.
B). Nuclear import receptors can shuttle between the nucleus and cytoplasm.
C). NTF2 transports RanGDP into the cytosol.
D). Export of mRNA is not directly dependent on Ran.
E). tRNA and miRNA export is mediated by exportins.

Which one of the following combinations contains all correct statements?
A. A, B, C, D only
B. B, C, D only
C. A, B, D, E only
D. A, C, E only

## Ans. C

10.During cytokinesis, a small GTPase, RhoA, localizes to the equatorial membrane above the spindle midzone. The localization/activity of RhoA is potentially modulated by:
A). RhoGEF Ect2
B). Aurora B kinase
C). PLK1 kinase
D). MKLP1 kinesin
E). ATM and ATR

Which one of the following combinations contains all correct statements?
A. A, B and D only
B. A, B, C and D only
C. B, C, D and E only
D. A, C and D only

## Ans. B

11.Cellular actin levels can be as high as $100-400 \mu \mathrm{M}$. Of this, unpolymerized actin concentration can be as much as $50-200 \mu \mathrm{M}$. However, the critical concentration for actin polymerization in-vitro is about $0.2 \mu \mathrm{M}$. Some of the following proteins inhibit the polymerization of actin in cells.
A). Thymosin - 34
B). Capping protein CapZ
C). Tropomodulin
D). XMAP215

Which one of the following options lists all inhibitors?
A. A, B and C only
B. B, C and D only
C. C, D and A only
D. D, A and B only

## Ans. A

12.To delineate the steps in endoplasmic reticulum (ER) transport, a PhD student homogenized pancreatic acinar cells to isolate microsomes, which retain most of the biochemical properties of the ER. For this experiment, the student has planned a number of controls as mentioned below.
A). Treat one set of microsomes first with detergent and then with protease.
B). Treat one set of microsomes with protease only.
C). Treat one set of microsomes with micrococcal nuclease.
D). Treat one set of microsomes with detergent only.

Select the option that represents the best combination of the controls.
A. A, B and D only
B. B, C and D only
C. A and C only
D. B and D only

Ans. A
13. Following statements were made about imprinting in the human genome.
A). Imprinting control centre (IC) harbours part of the SNRPN gene.
B). Imprinting of genes in an individual cannot be tissue-specific.
C). Sperms and eggs exhibit an identical pattern of genome methylation, except in the sex chromosomes.
D). At imprinted loci, expression depends on the parental origin.

Select the option with all the correct statements.
A. A and D
B. B and D
C. A and C
D. B and C

Ans. A
14.Mitochondrial protein synthesis is of prokaryotic origin. Following statements are being made about the ribosomes from bacteria and mitochondria:
A). The bacterial ribosome consists of small and large subunits of the 30 S and 50 S respectively, whereas in mitochondria of mammals these subunits are 28 S and 39 S
B). In the bacterial ribosomes the RNA: protein ratio is about 2:1 whereas in mitochondria ribosomes this ratio is usually $1: 2$
C). Both the bacterial and mitochondrial ribosomes consist of the 30 S and 50 S subunits
D). Both the bacterial and mitochondrial ribosomes consist of RNA and protein in the ratio of $1: 1$

Choose the option that represents all correct statements.
$A$. A and B only
B. B and C only
C. C and D only
D. A and D only

## Ans. A

15.Given below are a few statements about the $\lambda$ infection cycle
A). Competition between cI and cII gene products determines the establishment of lysogeny versus lysis.
B). CI binds $O_{R} 1$ first while cro binds to $O_{R} 3$ first
C). Cro binding to $O_{R}$ represses $C I$ transcription
D). Rich medium favours lytic cycle because cII is protected from cellular proteases
Which one of the following options represents all correct statements?
A. B and C
B. A and B
C. C and D
D. A and C

## Ans. A

16.Reproduction of $\varphi$ 174, a single stranded DNA phage involves several steps. A few statements are given below to explain the mechanism.
A). The single stranded $\varphi 174$ DNA is converted into a double-stranded replicative form (RF)
B). Replication of double stranded replicative form results in the production of single stranded phages, about $50 \%$ of which are $+{ }^{\text {ve }}$ sense phages and the remaining are -ve sense phages
C). Replication of the double stranded replicative form results in the production of only -ve sense phages
D). Replication of the double stranded replicative form results in the production of only $+{ }^{\text {ve }}$ sense phages
Choose the option that correctly describes the process
A. A only
B. A and B
C. A and C
D. A and D

## Ans. D

17. Which one of the following schematics depicts the potential relationship among the subunits IIo, IIa, and IIb of RNA polymerase II?
IIa $\stackrel{\text { Kinase }}{\rightleftharpoons}$ IIo
A.

B.


C.



## Ans. A

18.DNA replication occurs in the $S$ phase. The entry of cells into the $S$ phase is regulated by the tumour suppressor protein Rb . The statements below are made with reference to the role of Rb .
A). Rb binds to E2F in the cytosol and prevents E2F entry into the nucleus.
B). $R b$ is phosphorylated by cyclin A/ cdk 4
C). Phospho Rb activates E2F.
D). E2F activates cyclin E production which promotes the G1/S transition.

Which one of the following options represents all correct statements?
A. A, B and C only
B. B, C and D only
C. A, C and D only
D. C and D only

Ans. *
19.The following statements are made with reference to DNA replication:
A). Camptothecin causes intra- strand and inter-strand crosslinks in DNA, leading to stalling of replication forks.
B). Prevention of reinitiation of DNA replication during the same cell cycle is mediated by regulating the loading of the initiator complex ORC.
C). A glu $\rightarrow$ ala mutation in the nucleotide building pocket of DNA polymerase III could lead to the incorporation of ribonucleotides in the extending DNA chain.
D). A mutation in the gene encoding Topoisomerase II could lead to entanglement of DNA daughter strands during replication.
Which one of the following options represents all correct statements?
A. A and B only
B. B and C only
C. C and D only
D. B, C and D only

## Ans. C

20.The population that is at the highest risk of influenza infection should be immunized annually. Which one of the following is the most important reason for this?
A. Influenza virus can change its surface antigen very frequently.
B. Influenza virus has a very short incubation period.
C. Influenza virus has a reasonably longer incubation period giving memory B cells time to respond by producing high levels of serum antibody.
D. Repeated immunization interferes with the differentiation of plasma cells from memory cells thereby decreasing levels of neutralizing antibody.

## Ans. B

21. Localized increases in the cytosolic level of free $\mathrm{Ca}{ }^{2+}$ are critical to its function as a second messenger. Calmodulin, a small cytosolic protein, mediates many cellular effects of $\mathrm{Ca}^{2+}$. Which of the following is NOT CORRECT for $\mathrm{Ca}^{2+}{ }^{2+}$ calmodulin interaction?
A. Each calmodulin molecule binds six $\mathrm{Ca}^{2+}$ ions in a cooperative fashion.
B. Binding of $\mathrm{Ca}^{2+}$ causes calmodulin to undergo a conformational change leading to active calmodulin.
C. Since binding of $\mathrm{Ca}{ }^{2+}$ is cooperative, a small change in the level of cytosolic $\mathrm{Ca}{ }^{2+}$ leads to a large change in the level of active calmodulin.
D. One of the many enzymes activated by $\mathrm{Ca}^{2+}$ calmodulin is cAMP phosphodiesterase, which degrades cAMP and links $\mathrm{Ca}^{2+}$ and cAMP signaling.

## Ans. A

22.Some cellular and extracellular proteins are enlisted in List I and their typical characteristics are enlisted in List II

| List I | List II |
| :--- | :--- |
| A. Nidogen | I. In human genome, one gene of this protein is present but <br> many different isoforms are there due to alternative splicing |
| B. Fibronectin | II. An intermediate filament protein that is typically <br> expressed in epithelial and mesenchymal cells |
| C. Integrin | III. One of the principal structural proteins of basal Iaminae. |
| D. Vimentin | IV. Heterodimer of a and $\boldsymbol{\beta}$ subunit and binds to extracellular <br> matrix proteins. |

Which one of the following is the most appropriate match?
A. A - I, B - II, C - III, D - IV
B. A - II, B - III, C - IV, D - I
C. A - III, B - I, C - IV, D - II
D. A - II, B - IV, C - I, D - III

Ans. C
23.Following statements have been proposed for cancer cells and cancer stem cells:
A). Cancer cells mostly have mutations whereas cancer stem cells do not.
B). Cancer cells divide to form two different populations of cells whereas cancer stem cells do not divide.
C). Cancer stem cells can undergo self-renewal whereas cancer cells cannot.
D). Cancer cells are predominantly resistant to chemotherapy and radiation.
E). Cancer stem cells are found only in the bone marrow and placenta.

Which one of the following combination of statements is correct?
A. A and C
B. A and B
C. C and E
D. C and D

Ans. A
24. Which of the following is/are associated with the presentation of endogenous antigens by Class I MHC molecule by an Antigen Presenting Cell (APC), given the condition that there is no cross-presentation of antigens by the APC?
A. TAP1 and TAP2 proteins only
B. Invariant chain (Ii)
C. Proteosome-like subunits LMP2 and LMP7 only
D. TAP1, TAP2 proteins and proteosome-like subunits LMP2, LMP7 TAP1, TAP2

## Ans. D

25. Which one of the following statements is NOT correct regarding the tetrapod limb development?
A. As the limb grows outward, the stylopod forms first, then the zeugopod and the autopod are formed last. Each phase is characterized by a specific pattern of Hox gene expression.
B. The zone of polarizing activity (ZPA) is maintained by the interaction of the FGFs from the AER and Shh expressed from the mesenchyme.
C. Although cell death in the limb is necessary for the formation of digits and joints, it is never mediated by the BMPs, which are only responsible for differentiating mesenchyme cells into cartilage.
D. The dorsal-ventral axis is formed in part by the expression of Wnt7a in the dorsal portion of the limb ectoderm, which maintains the expression level of Shh in the ZPA and Fgf4 in the posterior AER.

## Ans. C

26.The Dorsal protein is involved in generating the dorsal-ventral (DV) polarity in Drosophila. The following statements were made regarding the activity of the Dorsal protein in establishing the DV polarity.
A). In embryos that lack Gurken protein, the Dorsal protein is not translocated to the nucleus of the follicle cells which then causes ventralization of the embryo
B). Though Dorsal protein acts as a morphogen, it is found throughout the syncytial blastoderm of the early Drosophila embryo.
C). In embryos that lack Cactus protein the Dorsal protein can be found in the nucleus of cells with a ventral fate.
D). If the Dorsal protein is blocked from entering the nucleus, the genes responsible for specifying dorsal cell types are not transcribed.
Which of the above statements are correct?
A. A and B
B. B and C
C. C and D
D. A and C

Ans. B
27.Following are certain statements regarding root growth and differentiation in plants:
A). Root hair, endodermis, xylem and phloem reach maturation in the elongation zone of a developing root.
B). The root epidermal cells that are incapable of forming root hairs are called atrichoblasts.
C). Quiescent centre is present just above root cap.
D). In Arabidopsis, an auxin transporter (ABCB4) plays a role in root hair emergence by maintaining intracellular auxin concentration.
Which one of the following combination of statements is correct?
A. A, B and C
B. B, C and D
C. A, C and D
D. A, B and D

## Ans. B

28.Match the terms used in vertebrate limb development in List I with their descriptions in List II:

| List I | List II |
| :--- | :--- |
| A. EMT | I. The cells found within the most posterior region of the <br> limb bud |
| B. Mesenchyme | II. The thickening of ectoderm at the apex of the developing <br> limb |
| C. AER | III. A loosely organized, mainly mesodermal embryonic <br> tissue |
| D. Progress <br> zone | IV. Epithelial cells making up the mesoderm of the early <br> somatopleure undergo this transition and get included in <br> mesenchyme cell pool |
| E. ZPA | V. The proliferative mesenchyme that fuels limb bud <br> growth |
| F. Autopod | VI. The distal part of tetrapod limb |

Which one of the following combinations of the statements is correct?
A. A - IV, B - III, C - II, D - V, E - I, F - VI
B. A - I, B - II, C - III, D - IV, E - V, F - VI
C. A - V, B - IV, C - II, D - VI, E - III, F - I
D. A - II, B - V, C - I, D - III, E - IV, F - VI

Ans. A
29.Given below are some of the statements in connection with neural tube formation in vertebrates:
A. In primary neurulation, the cells surrounding the neural plate direct the neural plate cells to proliferate, invaginate and separate from the surface ectoderm to form an underlying hollow tube.
B. In secondary neurulation, the neural tube arises from the aggregation of mesenchyme cells into a solid cord that subsequently forms cavities to create a hollow tube
C. In birds, primary neurulation generates the neural tube from the anterior up to the hind limb developing region
D. In mammals, secondary neurulation begins at the level of sacral vertebrae

E . Anencephaly results when a failure to close the neural tube occurs, resulting in the forebrain remaining in contact with amniotic fluid.

Which one of the following options gives all correct statements?
A. A, B, C, D and E
B. A only
C. B and E only
D. C, D and E only

## Ans. A

30.Following are certain statements regarding tracheary elements of vascular plants
A). Xylem tracheids are highly elongated tapered cells that conduct water
B). Xylem vessel elements are less elongated and narrower than tracheids
C). Angiosperms may have both tracheids and vessel elements
D). Vessel elements are the only tracheary elements in almost all gymnosperms

Which one of the following options represents the combination of correct statements?
A. A, B and C only
B. A and C only
C. B and C only
D. B and D only

## Ans. B

31.Following are certain statements regarding phytochrome interacting factors (PIFs), a family of proteins that regulates photomorphogenic response in plants:
A). PIFs promote skotomorphogenesis by serving as transcriptional activators of dark-induced genes.
B). PIFs on interaction with $P_{r}$ get phosphorylated, followed by degradation via the proteasome complex.
C). The degradation of PIFs takes place in the presence of light.
D). PIF-induced genes are not expressed in light.

Which one of the following options represents the combination of correct statements?
A. A, B and C
B. A, C and D
C. A, B and D
D. B, C and D

## Ans. B

32.The phytohormones ethylene (ET), methyl jasmonate (MeJA) and salicylic acid (SA) play important roles in plant defence. The following statements were made regarding the induction of defensin PDF1.2 and pathogenesis-related protein PR1:
A). ET/MeJA activates PDF1.2
B). ET/MeJA activates PR-1
C). SA activates PDF1.2
D). SA activates PR-1

Which one of the following options represents the combination of correct statements?
A. A and B
B. A and D
C. B and C
D. C and D

Ans. B
33.A researcher has obtained an Arabidopsis mutant defective in strigolactones (SLs), a novel plant hormone. The following statements were made regarding the mutant phenotype:
A). Shoot branching gets enhanced in the mutant plant
B). Hyphal branching of arbuscular mycorrhizal fungi (AM-fungi) gets enhanced during colonization in the mutant plants
C). Shoot branching gets inhibited in the mutant plants
D). Germination of seeds of the parasitic plant is prevented near the mutant plant Which one of the following options represents the combination of correct statements?
A. A and B
B. B and C
C. B and D
D. A and D

## Ans. D

34.During light reaction in photosynthesis, electron is transported in electron transport chain (ETC) and produces ATP and NADPH in the process. Following are certain statements regarding ETC during light reaction:
A). Electron from P680 moves first to quinone and then to the pheophytin
B). P700 can receive electrons from plastocyanin
C). NADPH is produced at the end of the light reaction
D). The hydrogen ions produced during light reaction get concentrated in the thylakoid lumen
Choose the correct answer from the options given below:
A. A, B and C
B. A, B and D
C. A, C and D
D. B, C and D

Ans. D
35.Given below are various plant natural products and their basic structural unit:

| List I | List II |
| :--- | :--- |
| Natural products | Basic unit |
| A. Phenolics | I. Five-carbon isoprene unit |
| B. Alkaloids | II. Glucose unit attached by O-ß-D- <br> glucosyl linkage |
| C. Terpenoids | III. Nitrogen containing |
| D. Cyanogenic glycoside | IV. Aromatic arene ring with OH group |

Which of the following options represents the correct match of natural product and the basic unit?
A. A - IV, B - I, C - III, D - II
B. A - III, B - II, C - I, D - IV
C. A - III, B - I, C - IV, D - II
D. A - IV, B - III, C - I, D - II

Ans. D
36.The mechanisms of thermogenesis in brown adipose tissue (BAT) in cold are described in the following proposed statements:
A). A thermogenic uncoupling protein, UCP1 helps in the heat production in BAT
B). Norepinephrine secretion from sympathetic nerve endings in BAT is decreased
C). Lipolysis is increased by a low level of norepinephrine in BAT
D). A high content of mitochondria in BAT helps in the oxidation of fatty acids
E). Oxidation produces much heat as ATP synthase activity is low

Which one of the following options represents the combination of correct statements?
A. A, B and C
B. A, D and E
C. B, C and D
D. $B, D$ and $E$

## Ans. B

37.The pressure in the 'space' between the lungs and chest wall is known as intrapleural pressure. The following statements are related to the intrapleural pressure at different phases of respiration:
A). At the end of quiet expiration the tendency of the lung to recoil from the chest wall is balanced by the recoil of the chest wall in opposite direction, and intrapleural pressure is sub atmospheric.
B). At the start of inspiration the intrapleural pressure is sub atmospheric.
C). The intrapleural pressure becomes more negative during inspiration.
D). The intrapleural pressure attains value above atmospheric pressure during expiration.
E). The intrapleural pressure becomes positive (relative to atmospheric pressure) during strong inspiratory efforts.

Which one of the following combinations is correct?
A. A, B and C
B. B, C and D
C. C, D and E
D. A, C and D

## Ans. A

38. Hemoglobin ( Hb ) transports CO 2 in venous blood as carbamates. The following statements refer to the formation of these carbamates:
A). CO 2 interacts with amino-terminal nitrogens of Hb polypeptide chains
B). CO2 interacts with carboxyl-terminal carbons of Hb polypeptide chains
C). Carbamates help formation of salt bridges between a and $B$ chains of Hb
D). Carbamates help formation of disulfide bridges between a and $B$ chains of Hb Which one of the following options is a combination of correct statements?
A. A and C
B. B and D
C. B and C
D. A and D

## Ans. A

39.Following statements are given for the ovarian hormones:
A). $17^{\beta}$-estradiol, estrone and estriol are naturally occurring estrogens
B). They are 18 C steroids which do not have methyl group at 10th positions
C). They are 21 C steroids which have methyl group at 10th position
D). They are primarily synthesized by granulosa cells of the ovarian follicles
E). Their biosynthesis does not depend on the enzyme aromatase

Which one of the following options represents the combination of correct statements?
A. A, B and C
B. A, B and D
C. B, C and D
D. C, D and E

Ans. B
40.Below are given a set of statements for the glucocorticoid hormones:
A). They bind to cell surface receptors and influence stress adaptation
B). They bind to intracellular receptors and influence stress adaptation
C). They inhibit ACTH secretion from the anterior pituitary
D). Prolonged treatment with glucocorticoids leads to atrophic and unresponsive adrenals
E). Their secretion does not show circadian variations

Which one of the following combinations of the statements is correct?
A. A, C and E
B. B, C and D
C. C, D and E
D. A, D and E

## Ans. B

41.The pedigree given below represents the genotype at four different loci for the children in generation III.


Which one of the given genotypes is likely to represent the genotype of individual II-1?
A.

$$
\left.\begin{aligned}
& \mathrm{A}^{2} \\
& \mathrm{~B}^{2} \\
& \mathrm{C}^{2} \\
& \mathrm{D}^{1}
\end{aligned} \right\rvert\, \begin{aligned}
& \mathrm{A}^{2} \\
& \mathrm{~B}^{1} \\
& \mathrm{C}^{2} \\
& \mathrm{D}^{1}
\end{aligned}
$$

B.

| $\mathrm{A}^{1}$ |  |
| :--- | :--- |
| $\mathrm{~B}^{1}$ |  |
| $\mathrm{C}^{1}$ |  |
| $\mathrm{D}^{1}$ | $\mathrm{~A}^{1}$ |
| $\mathrm{~B}^{2}$ |  |
| $\mathrm{C}^{2}$ |  |
| $\mathrm{D}^{2}$ |  |

C.

$$
\left.\begin{aligned}
& \mathrm{A}^{1} \\
& \mathrm{~B}^{1} \\
& \mathrm{C}^{1} \\
& \mathrm{D}^{1}
\end{aligned} \right\rvert\, \begin{aligned}
& \mathrm{A}^{2} \\
& \mathrm{~B}^{2} \\
& \mathrm{C}^{2} \\
& \mathrm{D}^{2}
\end{aligned}
$$

D. $\left.\quad \begin{aligned} & A^{1} \\ & B^{1} \\ & C^{1} \\ & D^{1}\end{aligned} \right\rvert\, \begin{aligned} & A^{2} \\ & B^{2} \\ & C^{1} \\ & D^{1}\end{aligned}$

## Ans. C

42.A Drosophila mutant (line A) with vestigial wings are isolated in a laboratory. The vestigial wing phenotype was observed to be recessive and mapped to gene ' X '. Three other laboratories also isolated vestigial mutants, called lines B, C and $D$. In order to test if the mutation in lines $B-D$ also mapped to gene ' $X$ ', the following crosses were made and phenotype of F1 progeny was observed.

| Cross | F1 progeny (wing morphology) |
| :--- | :--- |
| A X B | Vestigial |
| A X C | Vestigial |
| A X D | Normal |
| B X C | Vestigial |
| B X D | Normal |
| C X D | Normal |

Based on the above identify the line(s) which is most likely NOT to have a mutation in gene ' $X$ '.
A. Both lines B and C
B. Line C only
C. Line D only
D. Both lines B and D

Ans. C
43.22 transduction was used to map the fadLgene. The result of two-factor crosses between fadLand two linked markers, purFand aroCare shown below.

| Donor | Recipient | Recombinants |  | Numbers obtained |
| :---: | :---: | :---: | :---: | :---: |
|  |  | Selected marker | Second marker |  |
| fadL purF+ | $\begin{aligned} & \text { fadL+ } \\ & \text { purF } \end{aligned}$ | purF+ | fadL | 200 |
|  |  |  | fadL+ | 800 |
| fadL aroC+ | $\begin{aligned} & \mathrm{fadL+} \\ & \mathrm{aroc} \end{aligned}$ | aroC+ | fadL | 400 |
|  |  |  | fadL+ | 600 |
| aroc+ purF | aroc purF+ | aroC+ | purF | 500 |
|  |  |  | purF+ | 500 |

Which one of the following is the correct map for the three genes?


Ans. B
44.Wheat plants can have kernels of white colour or in shades of red i.e. light red, red, dark red and very dark red (purple). A researcher made the following cross:

| P | wheat plants with white <br> kernels | xheat plants with purple (very dark <br> red) kernels |
| :--- | :--- | :--- |
| F $_{1}$ All plants with red kernels |  |  |
| F $_{2}$ | $1 / 16$ | Plants with purple kernels |
| $4 / 16$ | Plants with dark red kernels |  |
| $6 / 16$ | Plants with red kernels |  |
| $4 / 16$ | Plants with white kernels |  |
| $1 / 16$ |  |  |

The following conclusions are made from the results obtained:
A). It is a dihybrid cross where the white colour is coded by gene $A$ and the purple colour is coded by gene $B$
B). Two genes, both coding for the colour of the kernel and each gene having two alleles, one that produced red pigment and the other that produced no pigment.
C). Four genes, one coding for no pigment, which is epistatic over the other genes. The remaining three genes have 2 alleles each, one that produced red pigment and the other that produced no pigment.
D). The trait is influenced by the environment leading to the observed variation in kernel colour.

Which of the above conclusion(s) is/are correct?
A. A only
B. B only
C. C only
D. C and D only

## Ans. B

45.A group of transposable elements described as 'retroelements' encompass
A. P elements in Drosophila; LINES but not SINES in humans
B. Copia element in Drosophila; SINES but not LINES in humans
C. Copia element in Drosophila; LINES as well as SINES in human
D. P elements in Drosophila; LINES as well as SINES in human

## Ans. C

46. Given below are two columns listing angiosperm families and their groups

| List I | List II |
| :--- | :--- |
| Group | Family |
| A. Basal angiosperms | I. Brassicaceae |
| B. Fabids | II. Cucurbitaceae |
| C. Malvids | III. Solanaceae |
| D. Lamids | IV. Nympheaceae |

Which one of the following options represents the correct match of the two columns?
A. A - IV, B - II, C - I, D - III
B. A - IV, B - I, C - III, D - II
C. A - III, B - IV, C - II, D - I
D. A - II, B - III, C - I, D - IV

Ans. A
47. Given below are the names of diseases caused in rice in Column $X$ and the names of the disease-causing organisms in Column Y.

| Column X | Column Y |
| :--- | :--- |
| A. Bacterial blight | I. Entyloma oryzae |
| B. Grain rot | II. Rhizoctonia solani |
| C. Sheath blight | III. Xanthomonas oryzae pv. oryzae |
| D. Leaf smut | IV. Sclerophthora macrospora |
| E. Downy mildew | V. Burkholderia glumac |

Which one of the following options represents the match of columns $X$ and $Y$ ?
A. A - II, B - I, C - V, D - IV, E - III
B. A - III, B - IV, C - II, D - V, E - I
C. A - IV, B - III, C - I, D - II, E - V
D. A - III, B - V, C - II, D - I, E - IV

Ans. D
48. The table given below lists the conservation areas and the major group of organisms that they are best known for.

| Column X | Column $Y$ |
| :--- | :--- |
| Conservation areas | Organisms |
| A. Hemis National Park | I. Orchids |
| B. National Chambal Sanctuary | II. Gharial |
| C. Nokrek National Park | III. Nepenthes |
| D. Sessa Sanctuary | IV. Snow leopard |
| E. Baghmara wildlife sanctuary | V. Endemic citrus species |

A. A - I, B -II, C - III, D - IV, E - V
B. A - IV, B -II, C - V, D - I, E - III
C. A - III, B -I, C - V, D - II, E - IV
D. A - V, B -IV, C - III, D - II, E - I

## Ans. B

49.The table given below lists the morphological features and groups of plants.

| List I | List II |
| :--- | :--- |
| Plant group | Morphological characters |
| A. Liverwort | I. Unicellular rhizoids |
|  | II. Multicellular rhizoids |
| B. Moss | III. Presence of pyrenoids |
|  | IV. Stomata on sporophyte |
|  | V. Dominant gametophyte |

Which one of the followings options represents the correct match between the two columns?
A. A - I, III and V ; B - II, III, and V
B. A - I, III and IV ; B - II and IV
C. A - II and V ; B - I and III
D. A - I and V ; B - II, IV, and V

Ans. D
50.The table given below lists the types of extremophiles and the environments that they are adapted to.

| List I | List II |
| :--- | :--- |
| Type of extremophile | Environment |
| A. Psychrophile | I. High salinity |
| B. Hyperthermophile | II. High pressure |
| C. Alkaliphile | III. High alkaline environment |
| D. Hyperpiezophile | IV. Extreme high temperature |
| E. Halophile | V. Extreme cold temperatures |

Which one of the following options represents the correct match of the columns?
A. A - I, B - II, C - III, D - IV, E - V
B. A - V, B - II, C - III, D - IV, E - I
C. A-V, B - IV, C - III, D - II, E - I
D. A - V, B-II, C - IV, D - III, E - I

Ans. C
51.The table given below lists fossils and the major group of plants to which they belong.

| List I | List II |
| :--- | :--- |
| Fossil | Plant group |
| A. Naiadita lanceolata | I. Angiosperm |
| B. Rhynia gwyne-vaughanii | II. Pteridophyte |
| C. Antarticycas schopfii | III. Bryophyte |
| D. Tricolpites minutus | IV. Bryophyte |

Which one of the following options represents the correct match between columns?
A. A - I, B -III, C - IV, D - II
B. A - III, B -II, C - IV, D - I
C. A - I, B-II, C - IV, D - III
D. A-II, B -III, C - I, D - IV
E. No correct answer

Ans. E
52.The table below shows the bird species and their abundance in three habitats P,Q and R

| Habitat P |  |
| :---: | :---: |
| Species <br> identity | Abundance |
| 1 | 120 |
| 2 | 20 |
| 3 | 5 |
| 4 | 1 |
| 5 | 1 |


| Habitat Q |  |
| :---: | :---: |
| Species <br> identity | Abundance |
| 1 | 20 |
| 2 | 20 |
| 3 | 20 |
| 4 | 20 |
| 5 | 20 |
| 6 | 15 |
| 7 | 15 |
| 8 | 15 |


| Habitat R |  |
| :---: | :---: |
| Species <br> identity | Abundance |
| 1 | 80 |
| 2 | 25 |
| 3 | 15 |
| 4 | 10 |
| 5 | 5 |
| 6 | 3 |
| 7 | 3 |
| 8 | 3 |

Which one of the combinations below best represents the habitats in decreasing order of diversity?
A. P, R, Q
B. $R, Q, P$
C. $R, P, Q$
D. $Q, R, P$

Ans. D
53.The following are a few statements on shade leaves vis-à-vis sun leaves in tree species
A). Higher amount of chlorophyll per dry weight
B). Lower density of stomata
C). Thicker leaves
D). Lower rates of dark respiration per unit area

Which one of the following combinations of the above statements is correct?
A. A and D
B. B and C
C. A, B and D
D. B and D

## Ans. C

54.The diagram below depicts energy flow within a single trophic level, where $I=$ amount ingested, $N A=$ amount not assimilated, $R=$ respiration, and $P_{n}=$ biomass production at trophic level.


Which one of the following options represents correct values for $\mathrm{P}_{\mathrm{n}}, \mathrm{NA}, \mathrm{R}$ and I in kcal respectively, if $P_{n}-1=1000 \mathrm{kcal}, 1 / P_{n}-1=20 \%, A / 1=35 \%$ and $P_{n} / A=20 \%$ ?
A. 5614130200
B. 1413056200
C. 2001305614
D. 5613020014

## Ans. B

55.The following graph shows the change in proportion of biomass in foliage (leaves), branch and stemwood (bole) for a tree species as a function of DBH (diameter at 1.5 m above ground)


Which one of the following options correctly matches the curves ( $A, B$, and $C$ ) with stemwood, foliage and branch, respectively?
A. A, B and C
B. A, C and B
C. B, C and A
D. B, A and C

## Ans. B

56.The graphs given below show the possible behavior of two species over the course of succession.




Possible effects observed during succession are:
i. Total suppression
ii. Convergence
iii. Sequential succession

Choose the correct option matching the graphs with the possible effect:
A. A-(i) B-(ii) C-(iii)
B. $A$-(ii) $B-$ (iii) $C-(i)$
C. A-(iii) B-(ii) C-(i)
D. A-(iii) B-(i) C-(ii)

## Ans. C

57.Consider the following graphs for per capita growth rate ( $1 / \mathrm{N}$ ) ( $\mathrm{dN} / \mathrm{dt}$ ) as a function of population density ( N ).

Population density

Population density
(iv)

(N)

(iv)

Which one of the plots correctly depicts strong Allee effect in a population?
A. A
B. B
C. C
D. D

Ans. C
58.In the Table below, Column I describes the movements of organisms and Column II describes the type of movement.

| Column I | Column II |
| :--- | :--- |
| A. A silk moth flies at an angle perpendicular to the <br> direction of the wind to pick up a scent trail | I. Mnemotaxis |
| B. Bacteria burrow down into mud in the northern <br> hemisphere in response to the earth's magnetic field | II. Klinotaxis |
| C. A girl reaches her school using a pharmacy and a <br> bookshop as landmarks | III. Magnetotaxis |

D. Planaria move towards the direction of higher
concentration of food by comparing the gradient of stimuli around it

Which one of the following options represents the correct match of column I with Column II?
A. A - IV, B - III, C - I, D - II
B. A - IV, B - III, C - II, D - I
C. A - I, B - III, C - IV, D - II
D. A - I, B - II, C - III, D - IV

## Ans. A

59.The following represents an equation for Bayesian statistics:

$$
\begin{gathered}
\text { B } \quad \mathrm{D} \\
\mathrm{P}(\mathrm{H} / \mathrm{E})=\mathrm{P}(\mathrm{H}) \mathrm{P}(\mathrm{E} / \mathrm{H}) \\
\mathrm{P}(\mathrm{E}) \\
\mathrm{A} \\
\mathrm{D}
\end{gathered}
$$

Which one of the following options correctly represents $A, B, C$ and $D$ in the above equation?
A. A-Evidence, B-Posterior probability, C-Likelihood, D-Prior probability
B. A- Likelihood, B-Prior probability, C-Posterior probability, D-Evidence
C. A-Posterior probability, B-Prior probability, C-Likelihood, D-Evidence
D. A-Prior probability, B-Evidence, C-Posterior probability, D-Likelihood

Ans. C
60.In a population that is in Hardy-Weinberg equilibrium, the frequency of the recessive homozygote genotype of trait q is 0.04 . The percentage of individuals homozygous for the dominant allele is?
A. 64
B. 40
C. 32
D. 16

## Ans. A

61.A researcher is interested in investigating if parental investment (PI, panel A) by male seahorses and pipefishes is correlated with their mating patterns (MPmonogamy and polygamy, panel B). For this, the researcher builds a phylogenetic tree of seahorses and pipefishes and maps PI and MP scores on to the tree as shown in figure below.


Based on the trees generated, which one of the following conclusions can the researcher correctly arrive at?
A. Polygamy is correlated with simpler brood pouches.
B. Monogamy is not correlated with elaborate brood pouches.
C. Monogamy is correlated with elaborate brood pouches.
D. Polygamy is correlated with elaborate brood pouches.

## Ans. B

62. Given below are graphs depicting two possible dynamics of gene duplication events over a period of time during genome evolution.



Based on the above figures, which one of the following options correctly represents the identity of $\mathrm{A}, \mathrm{B}, \mathrm{C}$ and D ?
A. A-Gene duplication event, B-random loss of duplicated genes, C-remaining pairs of duplicated genes, D-additional gene duplication events
B. A-remaining pairs of duplicated genes, B-gene duplication event, C-random loss of duplicated genes, D -additional gene duplication events
C. A-additional gene duplication events, B-random loss of duplicated genes, Cremaining pairs of duplicated genes, $D-$ Gene duplication event
D. A-Random loss of duplicated genes, B-additional gene duplication events, Cgene duplication event, $D$-remaining pairs of duplicated genes

## Ans. A

63.A researcher working on island biogeography mapped how isolation-controlled immigration (1), and area-controlled extinction (E), will act on number of species present on the islands. He forgot to label the size of the islands (small or large) and the location of the islands (near or far) on the graph.


Number of species present
Using information from MacArthur and Wilson's equilibrium theory, select the option that correctly identifies $\mathrm{A}, \mathrm{B}, \mathrm{C}$ and D in the figure above.
A. A-large, B- small, C-near, D-far
B. A-small, B-large, C-far, D-near
C. A-near, B-far, C-small, D-large
D. A-far, B-near, C-large, D-small

## Ans. C

64.Given below are some terms and concepts related to phytoremediation in Columns A and B

| Column A | Column B |
| :--- | :--- |
| A. Excluders | I. Can absorb and transfer heavy metals to aerial <br> parts without phytotoxicity symptoms |
| B. Heavy metal protein <br> transporter | II. Salix sp. and Populus sp. |
| C. Hyperaccumulators | III. Transgenesis |
| D. High biomass, non- <br> accumulators | IV. Can restrict heavy metal ions to the roots and <br> detoxify them |

Which one of the following options represents the most appropriate match of all terms/concepts in columns A and B?
A. A - II, B - IV, C - I, D - III
B. A - III, B - IV, C - II, D - I
C. A - II, B - III, C - IV, D - I
D. A - IV, B - III, C - I, D - II

Ans. D
65.Given below are the various protein cleaving reagents (List I) and their recognition sites (List II) in the target protein.

| List I | List II |
| :--- | :--- |
| A. CNBr | I. -Asp-Ala- |
| B. Trypsin | II. -Phe-Ala- |
| C. Caspase | III. -Met-Ala- |
| D. Chymotrypsin | IV. -Arg-Gly- |

Which one of the following options represents the correct combination of items?
A. A - III, B - II, C - I, D - IV
B. A - IV, B - II, C - I, D - III
C. A - IV, B - I, C - II, D - III
D. A - III, B - IV, C - I, D - II

Ans. D
66.Given below are a few terms related to map-based sequencing of genomes:
A). Partial digestion with restriction enzymes.
B). Assembly of contigs
C). Pulsed-field gel electrophoresis
D). Cloning in cosmids/YACs/BACs
E). Sub-cloning and sequencing

Which one of the following options represents the correct order of steps (based on the above terms) in map-based sequencing?
A. C-B-D-E-A
B. C-A-D-B-E
C. E-A-B-D-C
D. $A-C-B-D-E$

## Ans. B

67.Given below are a few statements on technologies/concepts related to the development of transgenic plants:
A. Frequency of genetic transformation is influenced only by the genes of Agrobacterium and not by those of the host plants.
B. Transgenic plants containing a single copy of the transgene are preferred over those that contain multiple transgene copies for subsequent genetic analysis.
C. Supervirulent strains of Agrobacterium can be generated by increasing the copy number of virulence genes.
D. A nonconditional negative selection marker has to be necessarily used with a strong constitutive promoter for the development of transgenic plants.

Which one of the following options represents a combination of all INCORRECT statements?
A. A and D only
B. C only
C. B and C only
D. D only

Ans. A
68. Consider the four results that were obtained from immunophenotyping of human breast cancer cells.


FITC - anti CD44


FITC - anti CD44


FITC - anti CD44


FITC - anti CD44

Which one of the following option correctly depicts the above results?
$A$. ' $B^{\prime}$ represents a plot that denotes a high percentage of cancer stem cells in breast cancer cells.
B. ' D ' denotes a plot where dual positive cells predominate, representing the dead cells.
C. 'A' denotes a plot where only cells stained with CD44 and CD24 are observed.
D. 'C' represents a plot where only fibroblast cells are present.

## Ans. A

69.A culture was started by inoculating the medium with 100 cells having a generation time of 2 hours. Assuming the culture grows in ideal synchrony for at least 24 hours, what will be the number of cells in the culture at 2 hours and 9 hours?
A. $2.0 \times 10^{2}$ cells, $1.6 \times 10^{3}$ cells, respectively.
B. $2.0 \times 10^{2}$ cells, $2.4 \times 10^{3}$ cells, respectively.
C. $2.0 \times 10^{4}$ cells, $3.2 \times 10^{3}$ cells, respectively.
D. $2.0 \times 10^{4}$ cells, $1.6 \times 10^{8}$ cells, respectively.

## Ans. A

70.From the steps listed below, some are used to evaluate the goodness of fit using the chi-square test.
A). The mean, variance and standard deviation are calculated

## B). Variance calculated using $\Sigma\left(x_{1}-x\right)^{2} n-1$

C). Test statistic calculated using $\Sigma$ (observed expected) ${ }^{2}$ expected
D). The degree of freedom is calculated as $n-1$, where $n$ is the number of ways in which the expected classes are free to vary
E). The probability value is obtained

Which one of the following options provides the correct sequence of steps in this statistical analysis?
A. A, C, D
B. $C, D, E$
C. $B, A, D$
D. A, D, E

## Ans. B

71.Inverse PCR is performed for site-directed mutagenesis with complementary primers (having the desired mutation) using a plasmid having the cloned gene as a template. The following statements were made regarding the above experiment.
A). PCR is followed by the transformation of bacterial cells directly with the reaction mixture. A large number of the transformants will have the wild type gene.
B). The PCR mixture is treated with Dpn I and then used to transform bacterial cells. Most of the transformants will have the mutant gene.
C). PCR is followed by the transformation of bacterial cells directly with the reaction mixture. None of the transformants will have the mutant gene.
D). The PCR mixture is treated with Dpn I and then used to transform bacterial cells. Half of the transformants will have the mutant gene.
Which one of the following options represents a combination of all correct statements?
A. A and B
B. A and D
C. B and C
D. B only

Ans. A
72.The molecular ion peak [M] ${ }^{+}$of an analyte as measured by Electron Ionization Mass Spectrometry has an $\mathrm{m} / \mathrm{z}$ of 149 and a relative abundance of $100 \%$. The $[\mathrm{M}]^{\prime+}$ has a relative abundance of $6.7 \%$ and the $[M+2]^{\prime+}$ peak has a relative abundance of $5 \%$. The abundance of the major isotope of $\mathrm{H}, \mathrm{C}, \mathrm{N}, \mathrm{O}$, and S are ${ }^{1} \mathrm{H}$ $100 \%,{ }^{12} \mathrm{C}-98.9 \%,{ }^{13} \mathrm{C}-1.1 \%,{ }^{14} \mathrm{~N}-99.6 \%,{ }^{15} \mathrm{~N}-0.4 \%,{ }^{16} \mathrm{O}-99.8 \%,{ }^{18} \mathrm{O}-0.2 \%,{ }^{32} \mathrm{~S}-$ $95.0 \%,{ }^{33} \mathrm{~S}-0.75 \%$ and ${ }^{34} \mathrm{~S}-4.2 \%$. The most probable molecular formula of the compound is:
A. $\mathrm{C}_{7} \mathrm{H}_{21} \mathrm{~N}_{2} \mathrm{O}$
B. $\mathrm{C}_{5} \mathrm{H}_{11} \mathrm{NO}_{2} \mathrm{~S}$
C. $\mathrm{C}_{6} \mathrm{H}_{13} \mathrm{O}_{2} \mathrm{~S}$
D. $\mathrm{C}_{6} \mathrm{H}_{15} \mathrm{NOS}$

## Ans. B

73. Which one of the statements given below regarding the generation of monoclonal antibodies is INCORRECT?
A. Monoclonal antibodies are the product of a single stimulated B-lymphocyte.
B. To generate a large quantity of monoclonal antibodies, a normal stimulated antibody-producing $B$ cell is fused with a long-lived $B$ cell tumour.
C. The hybridoma generated for antibody production is selected on a HAT medium.
D. For HAT selection of hybridoma, the antibody-producing B-cells are pretreated with 8-azaguanine to block the salvage pathway of DNA synthesis.

## Ans. D

74.Optical remote sensing has been increasingly used to monitor vegetation globally. The table below lists different regions of the electromagnetic radiation (EMR) spectrum as well as different vegetation characteristics:

| List I | List II |
| :--- | :--- |
| Part of the EMR spectrum | Vegetation characteristics |
| A. Ultraviolet | I. Plant water content |
| B. Visible | II. Foliage density |
| C. Near Infrared | III. Plant photosynthetic <br> pigments |
| D. Shortwave Infrared |  |

Which one of the following combinations correctly matches the EMR region with the vegetation character analysed:
A. A - I, B - II, C - III
B. A - I, B - III, C - II
C. B - II, C - III, D - I
D. B - III, C - II, D - I

Ans. D
75. Pichia pastoris is a good host for producing human proteins for therapeutic use. Given below are some statements on the reasons for its utility.
A). It produces a large amount of recombinant protein
B). It has the property of secreting proteins into the medium.
C). It allows the formation of disulphide bonds similar to those in humans.
D). It carries out protein glycosylations identical to those found in humans.

Which one of the following options represents a combination of correct statements?
A. A and B only
B. A, B and C only
C. A, B and D only
D. B, C and D only

## Ans. B

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