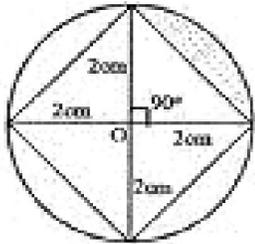


PART-A

1. The area of shaded region in cm^2 is:

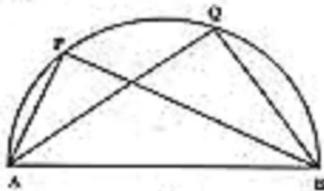


- a. $(\pi - \sqrt{2})$ b. $(\pi - 2)$
 c. $\left(\frac{\pi}{4} - \frac{\sqrt{2}}{2}\right)$ d. $(\pi + 2)$

2. The angles of a right-angled triangle shaped garden are in arithmetic progression and the smallest side is 10.00 m. The total length of the facing of the garden in m is:

- a. 60.00 b. 47.32 c. 12.68 d. 22.68

3. AB is the diameter of the semicircle as shown in the diagram. If $AQ = 2AP$ then which of the following is correct?



- a. $\angle APB = 1/2 \angle AQB$ b. $\angle APB = 2 \angle AQB$
 c. $\angle APB = \angle AQB$ d. $\angle APB = 1/4 \angle AQB$

4. The rabbit population in community A increases at 25% per year while that in B increases at 50% per year. If the present populations of A and B are equal, the ratio of the number of the rabbits in B to that in A after 2 years will be:

- a. 1.44 b. 1.72 c. 1.90 d. 1.25

5. Two moles each of O_2 and H_2 are in two separate containers, each of volume V_0 and at 150°C and 1 atmosphere. The two are made to react in a third container to form water vapour until H_2 is exhausted. When the temperature of the mixture in the third container was restored to 150°C , its pressure became 1 atmosphere. The volume of the third container must be:

- a. V_0 b. $5V_0/4$ c. $3V_0/2$ d. $2V_0$

6. Helium and argon gases in two separate containers are at the same temperature and so have different root-mean-square (r.m.s.) velocities. The two are mixed in a third container keeping the same temperature. The r.m.s. velocity of the helium atoms in the mixture is:

- a. More than what it was before mixing
 b. Less than what it was before mixing
 c. Equal to what it was before mixing
 d. Equal to that of argon atoms in the mixture

7. The mineral talc is used in the manufacture of soap because it:

- A. gives bulk to the product
 B. kills bacteria
 C. gives fragrance
 D. is soft and does not scratch the skin

Which of the above statements is/are correct?

- a. only D b. A and C
 c. A and B d. A and D

8. 100 g of an inorganic compound $\text{X} \cdot 5\text{H}_2\text{O}$ containing a volatile impurity was kept in an oven at 150°C for 60 minutes. The weight of the residue after heating is 8 g. The percentage of impurity in X was:

- a. 10 b. 8 c. 20 d. 80

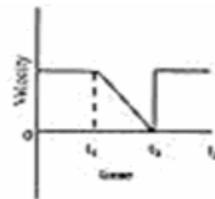
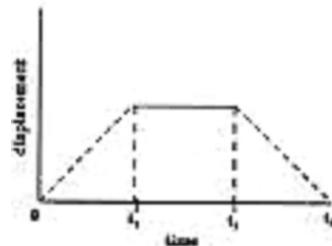
9. On a certain night the moon in its waning phase was a half-moon. At midnight the moon will be:

- a. on the eastern horizon
 b. at 45° angular height above the eastern horizon
 c. at the zenith d. on the western horizon

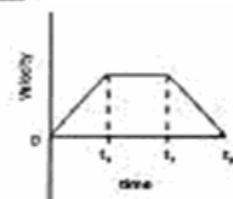
10. A gemstone is irradiated in a nuclear reactor for 5 days. Ten days after irradiation, the activity of the chromium radioisotope in the gemstone is 600 disintegrations per hour. What is the activity of chromium radioisotope 5 days after irradiation if its half life is 5 days?

- a. 300 b. 150 c. 2400 d. 1200

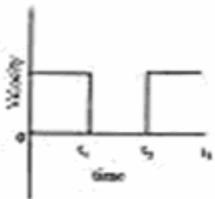
11. Displacement versus time curve for a body is shown in the figure. Select the graph that correctly shows the variation of the velocity with time:



a.



b.

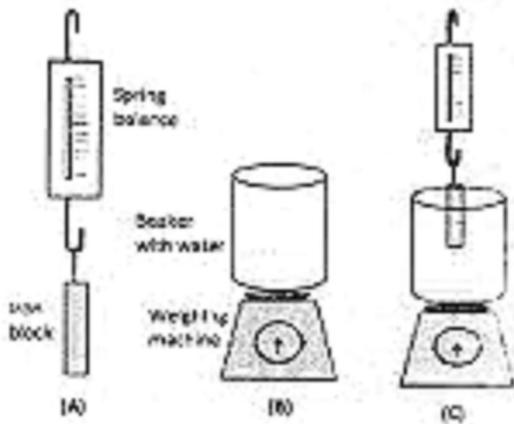


c.



d.

12.



The spring balance in Fig. A reads 0.5 kg and the pan balance in Fig. B reads 3.0 kg. The iron block suspended from the spring balance is partially immersed in the water in the beaker (Fig. C). The spring balance now reads 0.4 kg. The reading on the pan balance in Fig. C is:

- a. 3.0 kg b. 2.9 kg c. 3.1 kg d. 3.5 kg

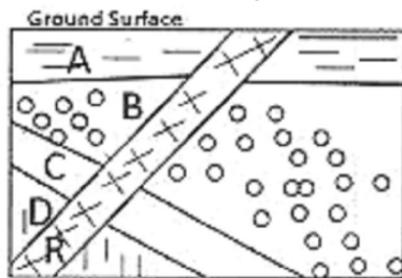
13. The ends of a rope are fixed to two pegs, such that the rope remains slack. A pencil is placed against the rope and moved, such that the rope always remains taut. The shape of the curve traced by the pencil would be a part of:

- a. a circle b. an ellipse
c. a square d. a triangle

14. During ice skating, the blades of the ice skater's shoes exert pressure on the ice. Ice skater can efficiently skate because:

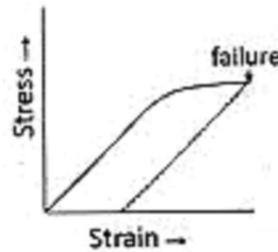
- a. ice gets converted to water as the pressure exerted on it increases.
b. ice gets converted to water as the pressure exerted on it decreases.
c. the density of ice in contact with blades decreases.
d. blades do not penetrate into ice.

15. Four sedimentary rocks A, B, C and D are intruded by an igneous rock R as shown in the cross-section diagram. Which of the following is correct about their ages?



- a. A is the youngest followed by B, C, D and R.
b. R is the youngest followed by A, B, C and D.
c. D is the youngest followed by C, B, A and R.
d. A is the youngest followed by R, B, C and D.

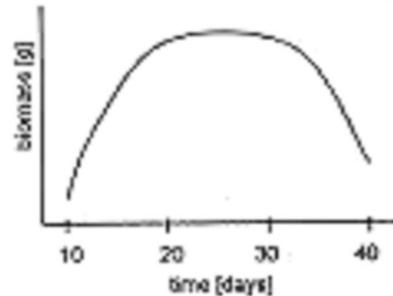
16. The strain in a solid subjected to continuous stress is plotted.



Which of the following statements is true?

- a. The solid deforms elastically till the point of failure.
b. The solid deforms plastically till the point of failure.
c. The solid comes back to original shape and size on failure.
d. The solid is permanently deformed on failure.

17. Growth of an organism was monitored at regular intervals of time, and is shown in the graph below. Around which time is the rate of growth zero?



- a. Close to day 10 b. On day 20
c. Between days 20 and 30
d. Between days 30 and 40

18. A tall plant with Red seeds (both dominant traits) was crossed with a dwarf plant with white seeds. If the segregating progeny produced equal number of tall red and dwarf white plants, what would be the genotype of the parents?

- a. TtRr × TtRR b. TtRr × ttrr
c. TTRR × ttrr d. TTRR × TtRr

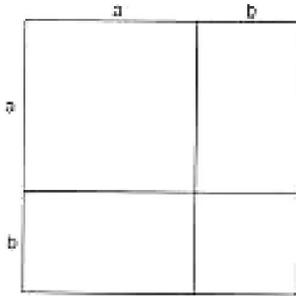
19. Three sunflower plants were placed in conditions as indicated below:

- Plant A:** still air
Plant B: moderately turbulent air
Plant C: still air in the dark

Which of the following statements is correct?

- a. Transpiration rate of plant B > that of plant A.
b. Transpiration rate of plant A > that of plant B.
c. Transpiration rate of plant C – that of plant A.
d. Transpiration rate of plant C > that of plant A > that of plant B.

20. Which of the following is indicated by the accompanying diagram?



- a. $a + ab + ab^2 + \dots = a/(1-b)$ for $|b| < 1$
 b. $a > b$ implies $a^3 > b^3$
 c. $(a + b)^2 = a^2 + 2ab + b^2$
 d. $a > b$ implies $-a < -b$

PART-B

21. Which nitrogen of adenosine gets protonated if the pH of the nucleoside is lowered from 7 to 3?

- a. N1 b. N3 c. N7 d. N9

22. The oligopeptide, F-A-R-P-M-T-S-R-P-G-F, is treated with trypsin, chymotrypsin and carboxypeptidase-B. Apart from the original peptide, the number of fragments obtained will be:

- a. 4 b. 3 c. 2 d. 0

23. Which one of the following interaction plays a major role in stabilizing B-DNA?

- a. Hydrogen bond b. Hydrophobic interaction
 c. Van der Waal's interaction d. Ionic interaction

24. Phosphatidyl serine, an important component of biological membrane, is located in:

- a. the outer leaflet but flipflops to inner leaflet under specific conditions.
 b. both the leaflets.
 c. the middle of the bilayer.
 d. the inner leaflet but flipflops to outer leaflet under specific conditions.

25. Major disadvantage of using liposome as a targeted drug delivery vehicle is that:

- a. it gets internalized by phagocytosis inside lysosomes.
 b. it is very unstable and has low shelf-life.
 c. it gets intercalated in cell membranes.
 d. it's drug entrapment efficiency is very low.

26. Major stimulus for spore formation in bacteria is:

- a. nutrition limitation b. heat stress
 c. cold stress d. pH stress

27. ATP-binding cassette (ABC) transporters:

- a. are all P-glycoproteins.
 b. are found only in eukaryotes.

c. are both a membrane-spanning domain that recognizes the substrate and an ATP-binding domain.

d. affect translocation by forming channels.

28. All cytosolic proteins have nuclear export signals that allow them to be removed from the nucleus when it reassembles after:

- a. meiosis b. mitosis
 c. both meiosis and mitosis d. DNA replication

29. Site-specific recombination results in precise DNA rearrangements, which is limited to specific sequences. The enzymes that are important to carry out the process are:

- a. restriction endonuclease and DNA polymerase.
 b. nuclease and ligase.
 c. DNA polymerase and ligase.
 d. DNA polymerase and DNA gyrase.

30. Which of the following statements is **NOT** true about small interfering RNA (siRNA)?

- a. siRNA has a 21-25 nucleotide sequence with 2 nucleotide overhanging at the 3' end.
 b. siRNA is processed by the RNA-protein complex RISC.
 c. siRNA is often induced by viruses.
 d. siRNA does not generally act at the level of transcription.

31. Which of the following statements is **INCORRECT** in relation to treatment of pre-B cells with phorbol esters?

- a. phorbol esters activate NFκB for translocation into the nucleus.
 b. phorbol esters activate protein kinase C.
 c. phorbol esters lead to phosphorylation of NFκB.
 d. phorbol esters remove the inhibitor from inactive NFκB complex in the cytoplasm.

32. Presence of an internal ribosome entry site (IRES) in mRNA:

- a. inhibits its translation
 b. promotes its post-transcriptional processing.
 c. has no impact on its translation.
 d. promotes its translation under adverse conditions.

33. Regulatory elements for expression of ribosomal RNA genes reside in the:

- a. transcribed spacer region.
 b. non-transcribed spacer region.
 c. 5' flanking region of individual ribosomal RNA genes.
 d. internal regions within the genes.

34. *Mycobacterium tuberculosis* is an intra-cellular bacterium. It prefers to inflict:

- a. macrophages
- b. B-cells
- c. T-cells
- d. Neutrophills

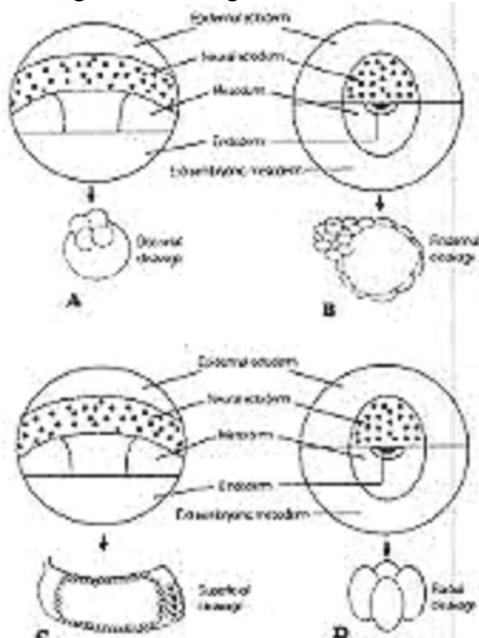
35. Integrin molecules link extracellular matrix (ECM) to the actin cytoskeleton of cell. Integrin binds to which of the following ECM macromolecules?

- a. Laminin
- b. Collagen
- c. Fibronectin
- d. Vitronectin

36. CD19 is marker for:

- a. B-cells
- b. T-cells
- c. Macrophages
- d. NK cells

37. Given below are fate maps of two organisms and the patterns by which embryos undergo cleavage. Which of the following is/are the right combination(s)?



- a. B only
- b. B and A
- c. A and C
- d. B and D

38. Which one of the following matches of oncogene-protein product is **NOT** correct?

- a. *erbA* – thyroid hormone receptor.
- b. *erbB* – epidermal growth factor receptor.
- c. *ras* – guanine nucleotide binding protein with GTPase activity.
- d. *fos* – platelet-derived growth factor receptor.

39. Spermatogonial stem cell undergoes extensive metamorphosis to become a spermatozoan. Meiosis leads to the formation of spermatid containing 22 autosomes and one sex chromosome. A male mouse was found in a colony which always produced only female pups upon mating. Which one of the following is a possible reason?

- a. Spermiogenesis was defective.

b. All spermatogonial stem cells contained only X and no Y chromosome.

c. Activation of Y chromosome linked post-meiotic death related gene may lead to such a situation.

d. activation of X chromosome linked post-meiotic death related gene may lead to such a situation.

40. In case of *Xenopus laevis*, which cells make up the Nieuwkoop centre and Spemann's organizer?

- a. Endodermal and mesodermal, respectively.
- b. Mesodermal and endodermal, respectively.
- c. Endodermal and ectodermal, respectively.
- d. Ectodermal and endodermal, respectively.

41. The *ced-9* gene appears to be a binary switch that regulates cellular survival and apoptosis in nematodes. Considering that CED-9 protein can bind to and inactivate CED-4, which of the following would lead to apoptosis?

- a. activation of *ced-9* gene
- b. loss of function of CED-3
- c. loss of function of *ced-9* gene
- d. loss of function of CED-4

42. Photosystem II functions as a light-dependent water-plastoquinone oxidoreductase. What are the names of two reaction center proteins that bind electron transfer prosthetic groups, such as P680, phenophytin and plastoquinone?

- a. CP43 and CP47
- b. D1 and D2
- c. 33 kDa and 23 kDa
- d. F_A and F₀

43. Plants have evolved with multiple photo-receptors, which can perceive specific wave-length of light. Which one of the following statements is correct about the photoreceptors?

- a. Phytochrome A can perceive far red and blue light.
- b. Phytochrome C can perceive far red light.
- c. Cryptochrome I and phytochrome B are responsible for perceiving blue light.
- d. Phytochrome B can predominantly perceive far red light.

44. Which one of the following statement describes the process of phloem loading?

- a. Triose phosphate is transported from the chloroplast to cytosol.
- b. Sugars are transported into the sieve elements and companion cells.
- c. Sugars are transported from producing cells in the mesophyll to cells in the vicinity of the sieve elements.
- d. Solutes are transported from roots to the shoots.

45. Which one of the following combinations of secondary metabolite biosynthetic pathways result in the biosynthesis of terpenes?

- a. Mevalonic acid and MEP pathways
- b. Malonic acid and MEP pathways
- c. Shikimic acid and Malonic acid pathways
- d. Shikimic acid and Mevalonic acid pathways

46. Which one of the following changes will occur in the cell membrane of nodal tissue of heart, which results in an increased heart rate due to stimulation of sympathetic nerves?

- a. Opening of sodium channels is facilitated
- b. Potassium conductance is increased
- c. Opening of L-calcium channels are facilitated
- d. 'h' channels are inhibited

47. A person takes 1.0 ml of insulin injection daily at 8.00 AM. His son gave him 1.5 ml insulin at 8.00 AM considering the father will go to party and eat more during lunch. The father also avoided breakfast, as he planned to eat more during lunch. Which one of the following events will occur?

- a. Father will be normoglycemic.
- b. Father will be in hypoglycemic condition before lunch.
- c. Father will be in hyperglycemic condition before lunch.
- d. Blood glucose of father will be low after taking lunch.

48. How many genetically different gametes can be made by an individual of genotype AaBbccDDEe, assuming they are independently assorting?

- a. 3
- b. 5
- c. 8
- d. 32

49. Mutation at two different loci of the same gene X results in altered functions. These two mutated versions of the gene X are called:

- a. alleles
- b. complementation groups
- c. interrupted genes
- d. linkage groups

50. A gene encoding tRNA undergoes a mutational event in its anticodon region that enables it to recognize a mutant nonsense codon and permit completion of translation. Such a mutation is known as:

- a. silent mutation
- b. neutral mutation
- c. reversion
- d. nonsense suppressor

51. Two pure lines of corn have mean cob length of 9 and 3 inches, respectively. The polygenes involved in this trait exhibit additive gene action. Crossing these two lines is expected to produce a progeny population with mean cob length (in inches) of:

- a. 12.0
- b. 7.5
- c. 6.0
- d. 2.75

52. Which of the following organism is widely used as a biocontrol agent in organic farming?

- a. *Rhizobium tropici*
- b. *Trichoderma viridis*
- c. *Fusarium oxysporium*
- d. *Nostoc muscorum*

53. A paraphyletic group:

- a. contains unrelated organisms.
- b. includes the most recent common ancestor but not all of its descendents.
- c. includes all the representatives of a clade but not the most recent common ancestor.
- d. contains all the representatives of a clade and the most recent common ancestor.

54. Which of the following is NOT an adaptive modification in a xerophytic plant?

- a. Strongly developed sclerenchyma
- b. Sunken stomata
- c. Sparse stomata
- d. Presence of lacunar tissues

55. If milk is left open, lactose is fermented first to produce acid. This is followed by proteolytic bacterial activity which increases the pH. Ultimately milk fats are degraded to produce rancidity. This is an example of:

- a. ecological succession
- b. microbial succession
- c. interference competition
- d. microevolution

56. Symbiotic biological nitrogen fixation takes place with the association between a plant and a nitrogen fixing prokaryote as shown in the following table:

List of Plants	Nitrogen fixin
A. Soybean	(i) <i>Frankia</i>
B. Casuarina	(ii) <i>Bradyrhizobium</i>
C. Gunnera	(iii) <i>Anabaena</i>
D. Azolla	(iv) <i>Nostoc</i>

The correct combination is:

- a. A – i, B – ii, C – iii, D – iv
- b. A – ii, B – i, C – iv, D – iii
- c. A – iii, B – ii, C – i, D – iv
- d. A – iv, B – iii, C – ii, D – i

57. Secondary sewage treatment involves:

- a. physical removal of solids from polluted water by filtration and sedimentation.
- b. removal of chemical remains by precipitation.
- c. removal of dissolved organic compounds by activated sludge or trickling filter.
- d. removal of microbial pathogens by chlorination or ozonization.

58. Based on per molecule, which of the following gas has the most powerful greenhouse effect?

- a. CO₂
- b. CH₄
- c. N₂O
- d. CFCs

59. Sexual selection results in variation in the reproductive success of males, often due to female choice with particular phenotypes. This type of sexual selection occurs because:

- a. males cannot compete with other males.

b. cost of breeding is higher for females as compared to males

c. inappropriate mating results in a similar reduction in fitness of females and males.

d. males are a limiting resource for females.

60. Among the following events in the history of life:

A – prokaryotic cell

B – eukaryotic cell

C – natural selection

D – organic molecules

E – self-replicating molecules

Which of the correct chronological order?

a. D, E, C, A, B

b. D, E, A, B, C

c. E, D, A, C, B

d. D, E, A, C, B

61. The Hardy-Weinberg principle comes from considering what happens when Mendelian genes act in a population. The model predicts that there will be no change in allele frequencies when:

a. migration into the population occurs at a steady rate.

b. the population suffers a bottleneck.

c. a rate new mutation is associated with a sharp increase in fitness.

d. no evolutionary process is at work.

62. Which of the following is responsible for initiation of maternal behaviour in the first-time pregnant rats after parturition?

a. Higher prolactin levels in blood.

b. Stimulation of sensory receptors during delivery.

c. Changes of uterine volume.

d. Presence of male rats.

63. To replace animal use in testing hepatic toxicity of a drug on trial, which one of the following would be used *in vitro* to be closest to the *in vivo* scenario?

a. Liver cells

b. Hepatic cell lines

c. Liver slices

d. Co-culture of liver parenchymal cells and Kupfer cells.

64. Which of the following does not represent a strategy for phytoremediation?

a. Phytodegradation

b. Phytomining

c. Continuous removal through hyper accumulators

d. Chelate-mediated extraction of pollutants

65. The word “fermentation” is used in biochemistry and microbial technology to denote different phenomena. If the

former is called C and latter is called T, which of the following statements is true?

a. All C is T but all T is not C.

b. All T is C but all C is not T.

c. T is always a producer of genetic engineering while C is not.

d. C is always an aerobic process, while T can be aerobic or anaerobic.

66. Which of the following statements is NOT true during the infection of plant cells with *Agrobacterium*?

a. The protein products of virulence genes *virA* and *virG* perceive acetosyringone.

b. The *virB* protein forms a connection between *Agrobacterium* and the plant cell and facilitates T-DNA transfer into the plant.

c. The T-DNA is excised and bound to *VirD2* protein.

d. The T-DNA, after becoming coated with *VirF* binds to phosphorylated *VIP1*, which, allows the complex to enter the plant’s nucleus.

67. Among existing technologies, which of the following vector systems would you prefer to use for generating a library for 140 kb eukaryotic genomic DNA fragments, while giving due consideration to size as well as stability of the insert?

a. Phage

b. Cosmid

c. Bacterial Artificial Chromosome (BAC)

d. Yeast Artificial Chromosome (YAC)

68. If r denotes correlation coefficient and m denotes the slope of regression line, interchanging X and Y axes would:

a. change m but not r

b. change both r and m

c. change both r and m

d. not change r or m

69. The use of biotinylated secondary antibody in ELISA:

a. increases the sensitivity of the assay but compromises the specificity

b. increases the sensitivity of the assay without compromising the specificity

c. does not alter either sensitivity or specificity

d. decreases both sensitivity and specificity

70. Which of the best method for checking mycoplasma contamination in a mammalian cell line?

a. Southern hybridization

b. ELISA

c. PCR

d. Western hybridization

PART-C

71. Phosphorylation of ADP to ATP occurs through energy metabolism, comprising oxidative phosphorylation or substrate-level phosphorylation or photo-phosphorylation (in plants). ATP can also be formed from ADP through the action of adenylate kinase. Crystal structure determination of adenylate kinase shows that the C-terminal region has the sequence:

– Val – Asp – Asp – Val – Phe – Ser – Gln – Val – Cys – Thr – His – Leu – Asp – Thr – Leu – Lys

What can be a possible conformation of the sequence?

- a. A helix that is not amphipathic
- b. Amphipathic helix
- c. Leucine zipper helix
- d. Beta hairpin

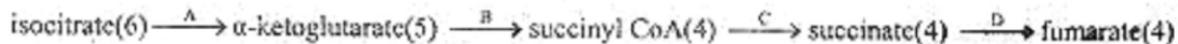
72. Consider a 51-residue long protein containing only 100 bonds about which rotation can occur. Assume that 3 orientations per bond are possible. Based on these assumptions, how many conformations will be possible for this protein?

- a. 3^{100}
- b. 100^3
- c. 3^{51}
- d. $51 \times 100 \times 3$

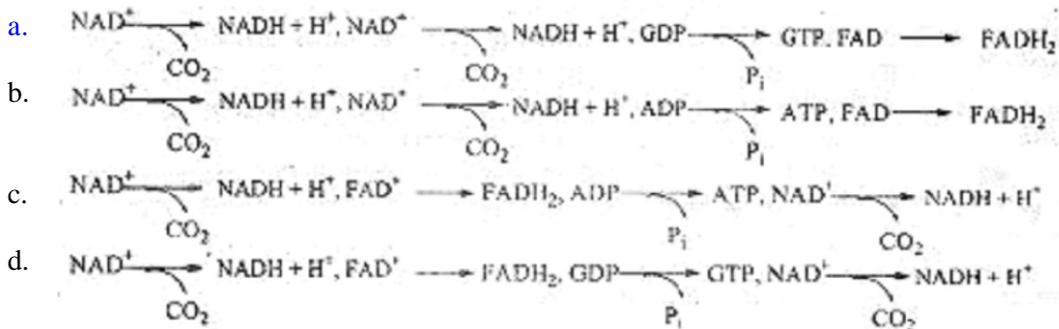
73. A plot of $V/[S]$ versus V is generated for an enzyme catalyzed reaction, and a straight line is obtained. Indicate the information that can be obtained from the plot:

- a. V_{max} and turnover number K_m can be obtained only from a plot of $1/V$ versus $1/[S]$
- b. K_m/V_{max} from the slope
- c. V_{max} , K_m and turnover number
- d. Only K_m and turnover number

74. The following reactions are part of the citric acid cycle. The numbers in parenthesis indicate the number of carbon atoms in each molecule.



Which one of the following sequence of reaction systems A → D is correct?



75. Phosphoglucumutase is added to 0.1 M glucose-1-phosphate (G-6-P). The standard free energy change of the reaction, $\text{G-6-P} \leftrightarrow \text{G-1-P}$ is 1.8 kcal/mole at 25°C. The equilibrium concentrations of G-6-P and G-1-P, respectively, are:

- a. 96 mM, 45 mM
- b. 100 mM, 0 mM
- c. 45 mM, 96 mM
- d. 0 mM, 100 mM

76. Differential scanning calorimetric study of calf thymus DNA was carried out to measure midpoint of thermal denaturation (T_m), ΔH_m (enthalpy change at T_m) and ΔC_p (constant – pressure heat capacity change). It has been observed that $\Delta C_p = 0$, $T_m = 75.5^\circ\text{C}$ and $\Delta H_m = 50.4$ kcal/mole. The Gibbs free energy change at 37°C is:

- a. 25.5 kcal/mole
- b. 2.6 kcal/mole
- c. 0.6 kcal/mole
- d. 5.6 kcal/mole

77. Cystic fibrosis (CF) transmembrane conductance regulator (CFTR) protein is known as to be a cAMP-dependent Cl^- channel. CF patients (with mutant CFTR proteins) show reduced Cl^- permeability and as a result exhibit elevated Cl^- level in sweat. To prove this, CFTR proteins (both wild type and mutant) are inserted in a model membrane (liposome) and Cl^- transport is followed with radioactive Cl^- . It is known that topology of CFTR in membrane is very important for its function. Despite no proteolytic degradation or denaturation of CFTR proteins, wild type CFTR failed to transport Cl^- in liposome.

Which of the following is the correct explanation of this?

- a. CFTR protein gets mutated during insertion in liposomes
- b. CFTR protein losses affinity with Cl^- ions
- c. CFTR protein gets wrongly inserted in liposomes
- d. CFTR protein loses channel forming property in liposomes

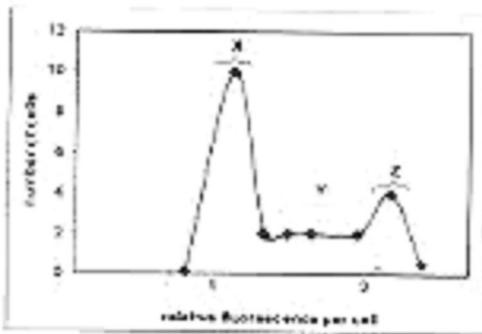
78. The respiratory chain is relatively inaccessible to experimental manipulation in intact mitochondria. Upon disrupting mitochondria with ultrasound, however, it is possible to isolate functional submitochondrial particles, which consist of broken cristae that have resealed inside out into small closed vesicles. In these vesicles the components that originally faced the matrix are now exposed to the surrounding medium. This arrangement helps in studying of electron transport and ATP synthesis because:

- a. it is difficult to manipulate the concentration of small molecules (NADH, ATP, ADP, Pi) in the matrix of intact mitochondria.
- b. in broken cristae, the enzymes and other molecules responsible for electron transport are more active.
- c. intact mitochondria are more unstable than broken cristae.
- d. purification of intact mitochondria is not possible.

79. Assuming that the histone octamer forms a cylinder 9 nm in diameter and 5 nm in height and that the human genome forms 32 million nucleosomes, what fraction (approximately) of the volume of nucleus (6 μm diameter) is occupied by histone octamers?

- a. 1/21
- b. 1/11
- c. 10/21
- d. 10/11

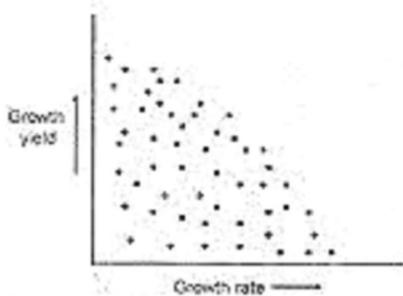
80. Hoechst 33342 is a membrane-permeant dye that fluoresces when it binds to DNA through a intercalating process. If a population of cell is incubated briefly with Hoechst dye and sorted in a flow cytometer, the cells display various levels of fluorescence in different phases of cell cycles as shown in figure below (marked as X, Y and Z).



Which of the following is correct?

- a. X is G₁, Y is G₂ + M and Z is S
- b. X is G₁, Y is S and Z is G₂ + M
- c. X is S, Y is G₂ + M and Z is G₁
- d. X is S, Y is G₁ and Z is G₂ + M

81. The scatter plot of growth rate and growth yield for 100 random environmental isolates of bacteria is shown below:

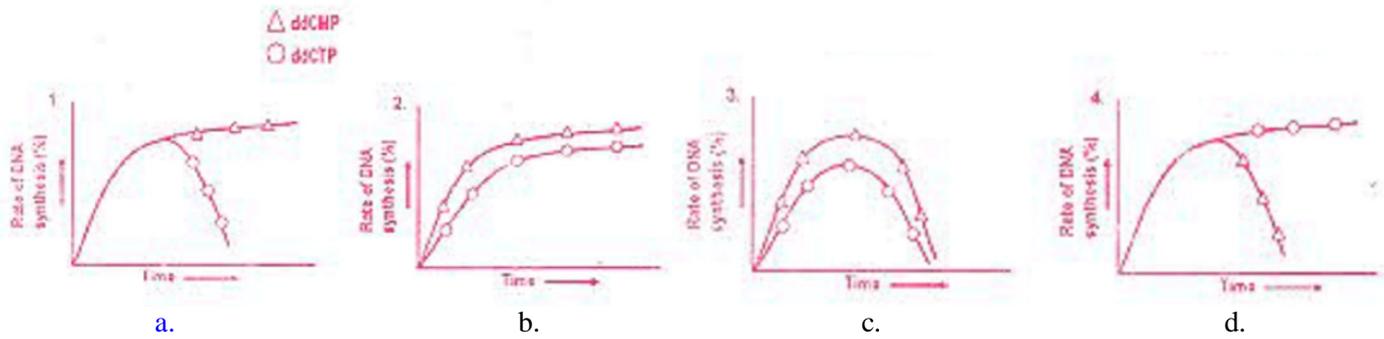


Which of the following can be inferred from the data?

- a. The two parameters are not related
- b. Growth rate is inversely proportional to growth yield
- c. Growth is negatively correlated with growth rate
- d. High growth rate cannot be accompanied by high growth yield

82. Double stranded DNA replicates in a semi-conservative manner. In an in vitro DNA synthesis reaction, dideoxy CTP and dideoxy CMP were individually added in excess (in separate reaction tubes) in addition to dNTPs and other necessary reagents. Rate of DNA synthesis was measured by incorporation of ³H-thymidine. The four graphs drawn below represent the rate of DNA synthesis in two separate reaction tubes.

Which of the following graphs represents the expected data?



83. In semi-conservative mode of DNA replication, two parental strands unwind and are used for synthesis of new strands following the rule of complementary base pairing. Synthesis of complementary strands require that DNA synthesis proceeds in opposite direction, while the double helix is progressively unwinding and replicating in only one direction. One of the DNA strands is continuously synthesized in the same direction as the advancing replication fork and is called leading strand whereas the other strand is synthesized discontinuously in segments and is referred to as lagging strand. These short fragments made discontinuously are labeled as Okazaki fragments. These Okazaki fragments need to be matured into continuous DNA strand by which one of the following combination of enzymes?

- a. DNA Pol III and DNA ligase
- b. DNA Pol I and DNA ligase
- c. DNA Pol II and DNA ligase
- d. DNA gyrase and DNA ligase

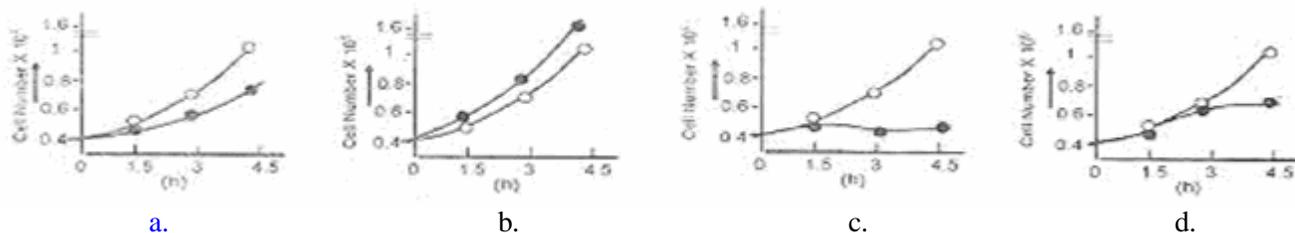
84. A reporter cell line with stably integrated retroviral promoter-luciferase construct was transfected with an expression vector for a cellular protein. The protein seems to regulate the activation of the retroviral promoter as analyzed by luciferase activity assay. Which one of the following techniques will you use to show “*in vivo*” recruitment of the cellular protein on the integrated retroviral promoter?

- a. Electrophoretic mobility shift assay
- b. RNase protection assay
- c. DNase hypersensitivity assay
- d. Chromatin immunoprecipitation assay

85. A synthetically prepared mRNA contains repetitive AU sequences. The mRNA was incubated with mammalian cell extract which contains ribosomes, tRNAs and all the factors required for protein synthesis. Assuming no initiation codon is required for protein synthesis, which of the following peptides will most likely be synthesized?

- a. A single peptide composed of the same amino acid sequence.
- b. A single peptide with alternating sequence of two amino acids.
- c. A single peptide with alternating sequence of three amino acids.
- d. Three different peptides each sequence composed of a single amino acid.

86. During cell cycle regulation in eukaryotes, there are post-translational modifications of protein factors, which act as switches for different phases of cell cycle. A cell population of yeast was transfected with gene for Weel kinase (modifies Cdc2 protein). Assuming that the transfection efficiency was 50% only, which of the following graphical representation of the results is most appropriate?



87. The lac operon in E.coli, is controlled by both the lac repressor and the catabolite activation protein CAP. In an *in vivo* experiment with lac operon, the following observations were made:

- A. cAMP levels are high.
- B. Repressor is bound with allolactose.
- C. CAP is interacting with RNA polymerase.

Which one of the following conclusions is most appropriate based on the above observations?

- a. Glucose and lactose are present
- b. Glucose is present and lactose is absent
- c. Both are absent
- d. Glucose is absent and lactose is present

88. Upon ligand binding, cell surface receptors move laterally to be capped and internalized. *Leishmania*, a protozoan parasite, can use several receptors on macrophages to get internalized. One of them is Toll-like receptor 2 (TLR2) that binds lipophosphoglycan on *Leishmania*. Once internalized, the parasite is destroyed in the phagolysosome. Which of the following treatments of *Leishmania*-infected macrophages will result in lowest parasite number in macrophages?

- a. membrane cholesterol-depleting drug, β -methyl cyclodextrin (β -MCD)
- b. ammonium chloride that increases lysosomal pH
- c. both β -MCD and ammonium chloride
- d. anti-TLR2 antibody

89. Level of follicle stimulating hormone (FSH) during infancy and adulthood is the same but spermatogenesis is seen only during adulthood. mRNA levels coding for FSH receptor are also found to be the same in testis of both age groups. Which of the following investigations will clarify this paradox a little more?

- a. Culture testicular cells and add LH to see testosterone production.
- b. Culture testicular cells and add testosterone to see comparative rise in FSH mRNA from both age groups.
- c. Culture testicular cells and add FSH to see comparative rise in cAMP production by both age groups.
- d. Add both LH and FSH to testicular cells and evaluate cAMP production.

90. In a tissue, cells are bound together by physical attachment between cell to cell or between cell to extracellular matrix. Following are some of the characteristics of cell junctions:

- A. Adherens junctions are cell-cell anchoring junctions connecting actin filament in one cell with that in the next cell.
- B. Desmosomes are cell-matrix anchoring junctions connecting actin filament in one cell to extracellular matrix.
- C. Gap junctions are channel forming junctions allowing passage of small water soluble molecules from cell to cell.
- D. Tight junctions are occluding junctions, which seal gap between two cells.
- E. Hemidesmosomes are cell-matrix anchoring junctions connecting intermediate filament in one cell to extracellular matrix.

Which of the following combination of statements is NOT correct?

- a. A and B
- b. A and C
- c. C and D
- d. D and E

91. Oncogenes and tumor suppressor genes are termed as cancer-critical genes. Increasingly powerful tools are now available for systematically searching the DNA or mRNAs of cancer cells for either significant mutations or altered expression. To identify independently an oncogene or a tumor suppressor gene, which of the following would be the most convincing tests to use?

- a. Transgenic mice that overexpress the candidate oncogene and knockout mice that lack candidate tumor suppressor gene.
- b. Transgenic mice that overexpress the candidate tumor suppressor gene and knockout mice that lack candidate oncogene.
- c. Transgenic mice that overexpress the candidate oncogene and tumor suppressor gene.
- d. Knockout mice that lack the candidate oncogene and tumor suppressor gene.

92. A large protein of a pathogenic bacterium has been enzymatically digested to generate a mixture of peptides ranging in size from 3 to 8 amino acids in length. Peptide mixtures were then administered in experimental animals to generate peptide-specific antibodies. In order to develop diagnostics for the bacteria, the antisera were used for Western blotting to detect bacterial antigen. Western blot failed despite the use of a wide range of antisera concentrations. What is the most probable cause of the problem?

- a. Peptide-specific antibody mixture is unstable.
- b. Peptide-specific antibodies were not generated as adjuvant was not administered.
- c. Peptide-specific antibodies were not generated as they were not coupled to a protein carrier.
- d. Peptide-specific antibodies could not recognize the bacterial antigen.

93. A mouse was primed with trinitrophenyl-lipopolysaccharide (TNP-LPS) whereas another mouse was primed with TNP-Keyhole limpet hemocyanin (TNP-KLH). After three weeks, these mice were sacrificed and splenic cells were fractionated to B cells and T cells. B cells from TNP-LPS primed mice were co-cultured with T cells from TNP-LPS- of TNP-KLH-primed mice. Similarly, B cells from TNP-KLH primed mice were co-cultured with the T cells from TNP-LPS- or TNP-KLH-primed mice. So, we have four co-cultures:

- A. $B^{TNP-LPS} \times T^{TNP-LPS}$
- B. $B^{TNP-LPS} \times T^{TNP-KLH}$
- C. $B^{TNP-KLH} \times T^{TNP-LPS}$
- D. $B^{TNP-KLH} \times T^{TNP-KLH}$

Among these co-cultures, where do you expect the highest IgG production?

- a. A
- b. 2 B
- c. C
- d. D

94. The functionality of the *pax6* gene in the formation of optic and nasal structures may be attributed to the following:
A. Pax6 makes the optic vesicle competent and allows lens formation.
B. The optic vesicle can induce any part of the head ectoderm to form the nasal and optic structures, due to presence of Pax6.
C. Pax6 renders the head ectoderm competent to receive signals from the optic vesicle.
D. Apart from the optic vesicle, the head ectoderm may also be induced by BMP4 and FGF8, so Pax6 is not exclusive for lens formation.

Which of the above attributions are true?

- a. A and D b. C and D c. B and C d. C only

95. In an experiment, sperm removed from epididymis of a male mouse was added in a dish containing appropriate media and oocyte. No fertilization was seen. However, when sperm from epididymis were directly placed in uterus of an ovulated female, she became pregnant. These observations suggest that:

- a. the sperm needs to travel some distance to attain fertilizing ability.
b. the oocyte secretes some biochemicals or factors which help sperm to fertilize.
c. the hormones in body help sperm to attain fertilizing ability.
d. the contents of female reproductive tract interact with sperm and activate it for fertilization.

96. The following statements have been proposed for plant vegetative development:

- A. Lateral roots develop from epidermal cells.
B. Shoot axillary meristem develops from shoot apical meristem during differentiation of leaf primordium.
C. Root cap is made up of dead cells.
D. Lateral meristems and cylindrical meristems found in roots and shoots result in secondary growth.

Which of the above statements are true?

- a. A and B b. B and D c. A, B and D d. C and D

97. The pattern of embryonic cleavage specific to a species is determined by two major parameters.

- A. The amount and distribution of yolk protein within the cytoplasm.
B. The factors in the egg cytoplasm that influence the angle of mitotic spindles and the timing of its formation.

Which of the following statements is true?

- a. Species having telolecithal egg follow a holoblastic cleavage.
b. Species having isolecithal egg follow a holoblastic cleavage.
c. Species having centrolecithal egg follow a holoblastic cleavage.
d. Species having isolecithal egg follow a meroblastic cleavage.

98. The fate of a cell or a tissue is “specified” when it is capable of differentiating autonomously on being placed in a neutral environment with respect to the developmental pathway. An embryo will show a developmental pattern based on its type of specification:

Based on the above facts it can be said that the potency of a cell is:

- A. equal to its normal fate in regulative development. B. greater than its normal fate in regulative development.
C. equal to its normal fate in mosaic development. D. greater than its normal fate in mosaic development.

Which of the above statements are true?

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

99. In the context of the proximal-distal growth and differentiation of a tetrapod limb following experiments were visualized:

- A. If the apical ectodermal ridge (AER) is removed at any time during the limb development, further development of distal limb skeletal elements ceases.
B. If leg mesenchyme is placed directly beneath the wing AER, distal hindlimb structures develop at the end of the limb.
C. If an extra AER is grafted into an existing limb bud, supernumerary structures are formed usually at the distal end of the limb.
D. If leg mesenchyme is placed directly beneath the wing AER, proximal hindlimb structures develop at the end of the limb.

Which of the above experiments would show the possible interactions between the AER and the limb bud mesenchyme directly beneath it during limb development?

- a. A and B only b. B and C only c. C and D only d. A, B and C

100. Following are some facts regarding localization of photosynthetic supramolecular complexes on plastid lamellae:

- A. PSII is preferentially located on granal lamellae.
- B. ATP synthase and PSI are preferentially located on stromal lamellae.
- C. PSI and PSII are located adjacent to each other on stromal lamellae.
- D. Cyt b6/f complex is not a membrane-bound complex.

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

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

101. Upon absorption of a photon, a chlorophyll molecule gets converted to its excited state when the energy of the photon is:

- a. more than that of a ground state of the pigment molecule.
- b. equal to that of the pigment molecule's excited state.
- c. more than that of the ground state but less than that of the excited state of the pigment molecule.
- d. equal to the energy gap between ground state energy and the excited state energy.

102. Following are certain facts about the effect of abscisic acid (ABA) on the development and physiology effect of plants:

- A. ABA promotes leaf senescence independent of ethylene.
- B. ABA promotes shoot growth and inhibits root growth at low water potentials.
- C. ABA inhibits gibberellin induced enzyme production.
- D. Seed dormancy is controlled by the ratio of ABA and gibberellin.

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

- a. A, B and C
- b. B, C and D
- c. A, B and D
- d. A, C and D

103. Red and far-red lights are perceived by plants through various photoreceptors including phytochromes. The activation of phytochrome is caused by:

- a. conversion of Pr to Pfr form through the effect of red light.
- b. repression of Pr form through the effect of far-red light.
- c. equal proportion of red and far-red lights at same fluence rates.
- d. presence of red and far-red light at different fluence rates.

104. While studying the primary effects of different abiotic stresses on plants, a researcher observed water potential (ψ_p) reduction and cellular dehydrations. Which of the following combination of abiotic stresses may cause the observed effect?

- a. Water deficit, salinity and chilling
- b. Salinity, high temperature and flooding
- c. Freezing, salinity and water deficit
- d. Freezing, chilling and flooding

105. Phenylalanine ammonia-lyase (PAL) and chalcone synthase (CHS) are involved in biosynthesis of phenolic compounds in plants. Following are some statements regarding the actions of PAL and CHS:

- A. Substrates for PAL and CHS are phenylalanine and chalcone, respectively.
- B. PAL converts phenylalanine to trans-cinnamic acid.
- C. PAL converts phenylalanine to *p*-coumaric acid.
- D. *p*-coumaroyl-CoA is converted to chalcones by CHS.

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

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

106. The intestinal absorption of glucose is impaired by the use of ouabain, an inhibitor of Na^+/K^+ ATPase. Indicate the correct explanation:

- a. The inhibitor has blocked the transport of Na^+ from intestinal lumen to epithelial cells.
- b. The inhibitor has blocked the transport of Na^+ from epithelial cells to the intestinal lumen.
- c. The inhibitor has blocked Na^+ transport from epithelial cells to interstitial space.
- d. The inhibitor has blocked Na^+ transport from the interstitial space to epithelial cells.

107. The stereocilia of auditory hair cells are arranged in rows but the heights of stereocilia are not the same in all the rows. Through the height of stereocilia is the same within a particular row, the heights increase in subsequent rows. When the stereocilia of shorter rows are mechanically pushed towards the taller rows, the hair cells are depolarized but a push in opposite direction hyperpolarizes them. The significance of this graded height of stereocilia is:

- A. Each row of stereocilia may be displaced independent of other rows in physiological conditions.
- B. The tip of the taller stereocilia will show greater displacement as compared to shorter ones when all the rows are moving in the same axis.
- C. The hair cells will be depolarized or hyperpolarized in different grades when the axis of displacement is changed.
- D. The taller stereocilia are involved with depolarization and shorter ones are responsible for hyperpolarization.

Which one of the following is correct?

- a. A only
- b. B only
- c. B and C
- d. A and D

108. GnRH is secreted during infancy (0-6 months) and puberty onwards (4 years and above) in monkeys. However, *i.v.* injection of GnRH during pre-pubertal period (about 2 years of age) led to elevated LH and FSH in blood compared to untreated 2 years old monkey. This suggests that:

- A. hypothalamus is active during pre-pubertal period.
- B. GnRH action on pituitary is age dependent.
- C. pituitary matures during adulthood.
- D. pituitary is active in all the stages of development in monkey.

Which one of the following is true?

- a. A and B
- b. B and C
- c. C only
- d. D only

109. A person has been suffering from night blindness. On consultation, the doctor advised the person to eat carrots and/or cod fish oil. After some time having seen no improvement, the doctor gave the person Vitamin A injection. Still no marked improvement was seen. The doctor mooted several suggestions indicating lack of the following enzymes for the failure of treatment:

- A. Retinol dehydrogenase
- B. Retinal reductase
- C. Retinal isomerase
- D. Retinal synthase

Which one of the following is correct?

- a. A only
- b. B only
- c. B and C
- d. C and D

110. A person suffering from thyrotoxicosis has extremely high level of thyroid hormone in blood. There is a failure of feedback regulation in hypothalamic-pituitary-thyroid axis. The detailed blood investigation exhibited high level of the following:

- A. Thyroid stimulating hormone (TSH)
- B. Thyroid stimulating immunoglobulin (TSI)
- C. Thyrotropin releasing hormone (TRH)
- D. Parathyroid hormone (PTH)

In your opinion, which one of the following is the reason for such thyrotoxicosis?

- a. A only
- b. B only
- c. A and C
- d. C and D

111. Which of the following statements regarding aquaporins or water channel is **NOT** correct?

- a. Aquaporins are found in both plant and animal membranes.
- b. Aquaporins cannot transport unchanged molecules like NH_3 .
- c. Phosphorylation and calcium concentration regulate aquaporin activity.
- d. Activity of aquaporin is regulated by pH and reactive oxygen species.

112. When two independent pure lines of pea with flowers are crossed, the F_1 progeny has purple flowers. The F_2 progeny obtained from selfing shows both purple and white flower in a ratio of 9 : 7. The following conclusions were made:

- A. Two different genes are involved, mutations in which lead to formation of white flowers.
- B. These two genes show independent assortment
- C. This is an example of complementary gene action.
- D. This is an example of duplicate genes.

Which of the above conclusions are correct?

- a. A and C only
- b. A and D only
- c. A, B and D
- d. A, B and C

113. A cell undergoing meiosis produces four daughter cells, two of which are aneuploids, while two are haploid. This can occur due to:

- a. non-disjunction during first meiotic division only.
- b. non-disjunction during second meiotic division only.
- c. non-disjunction during either first or second meiotic divisions.
- d. non-disjunction during both first and second meiotic divisions.

114. Three E.coli mutants are isolated which require compound 'A' for their growth. The compound B, C and D are known to be involved in the biosynthetic pathway to A. In order to determine the pathway, the mutants were grown in a medium supplemented with **ONE THE COMOUNDS, A TO D**. The results obtained are summarized below:

Mutant	Medium supplemented with compound			
	A	B	C	D
1	+	0	0	0
2	+	0	0	+
3	+	0	+	+

'+' indicates growth; '0' indicates lack of growth

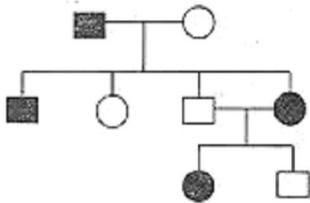
Which of the following equations represents the biosynthetic pathway of A?

- a. $B \rightarrow C \rightarrow D \rightarrow A$ b. $C \rightarrow D \rightarrow B \rightarrow A$ c. $B \rightarrow D \rightarrow C \rightarrow A$ d. $A \rightarrow C \rightarrow D \rightarrow B$

115. Following are four modes of inheritance:

- A. X-linked recessive B. X-linked dominant
C. Autosomal recessive D. Autosomal dominant

Which of the above modes of inheritance can explain the pedigree show below?



- a. A and C b. B and C c. C and D d. D only

116. The auxotrophic strains of E.coli: A ($met^- bio^- thr^+ leu^+ thl^+$) and B ($met^+ bio^+ th^- leu^- thl^-$) were incubated together for 18 hours in a liquid complete medium and then $\sim 10^8$ cells were plated on a minimal medium. Prototrophs were observed at a frequency of 1×10^{-7} cells. This may have happened by a process of genetic recombination between the two strains or by mutation of the strains. Which of the following control experiments would help rule out the possibility of mutation?

- a. Plating strains A and B directly on minimal medium.
b. Growing the mixture of strains A and B for 18 hours and then plating on complete medium.
c. Growing strains A and B individually in a liquid complete medium for 18 hours and then plating them on a minimal medium.
d. Growing the obtained prototrophs in a liquid complete medium for 18 hours and then plating them on a minimal medium.

117. Four different mutant lines showing similar phenotype were identified from a genetic screen. When genetic crosses among these mutants were carried out, the first mutant was found to complement the second, third and fourth mutant lines. However, no other complementation was observed. How many complementation groups do the four mutant lines belong to?

- a. One b. Two c. Three d. Four

118. A species has the following population characteristics:

- A. Reduction in population size $\geq 90\%$ over the last 10 years or 3 generations.
B. Geographic range: Extent of occurrence: $< 100 \text{ km}^2$ and Area of occupancy: $< 10 \text{ km}^2$
C. Population size less than 50 matured individuals
D. Probability of extinction in the wild is at least 50% within the next 10 years or 3 generations

To which of the following categories the species will be assigned according to IUCN categorization of threatened species (version 3.1)?

- a. Endangered b. Vulnerable c. Critically endangered d. Extinct in the wild

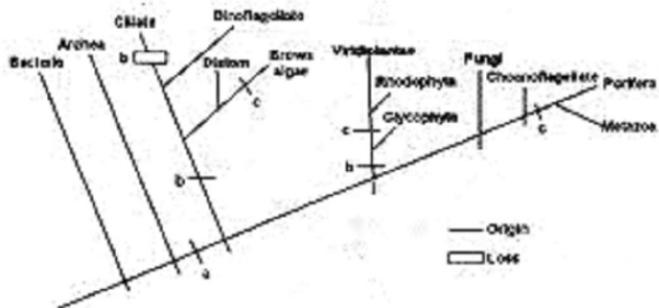
119. Which of the following hypothesis best explains the occurrence of Himalayan floral elements in Western Ghats of India?

- a. Continental drift theory b. Deccan trap theory
c. Himalayan glaciation theory d. Coromandel coast hypothesis

120. Why lysogenic cycle is more beneficial to a virus than lytic cycle under certain circumstances?

- a. The lysogenic cycle prevents local extinction of the host while still retaining its infection potential.
- b. By integrating with the bacterial chromosomes, the genetic instructions for the virus become refreshed after one or more replication events during binary fission.
- c. Lysogenic infection cycles do not harm their host cells, so they can produce virus particles indefinitely.
- d. Lysogeny causes more mutations to occur in the virus, creating more variants upon which natural selection can operate.

121. Identify a, b and c in the figure:



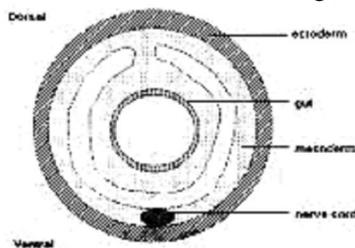
- a. a = mitochondria; b = multicellularity; c = chloroplast
- c. a = chloroplast; b = multicellularity; c = mitochondria

- b. a = mitochondria; b = chloroplast; c = multicellularity
- d. a = chloroplast; b = nuclease; b = multicellularity

122. In which of the following classes of vertebrates there are groups of animals without limbs?

- a. Fish, reptiles and mammals
- b. Reptiles only
- c. Reptiles and amphibians
- d. Amphibians only

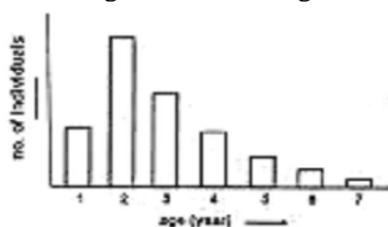
123. The schematic section given below of an animal indicates that the animal is:



- a. triploblastic, coelomic, invertebrate
- c. diploblastic, coelomic, invertebrate

- b. triploblastic, acoelomic, invertebrate
- d. triploblastic, coelomic, vertebrate

124. At a given time, the age class distribution of a population was as shown in the figure:



Which of the following can be inferred from the figure?

- a. Age class 2 has maximum fecundity
- b. Age class 2 has maximum survival
- c. Age class distribution is at equilibrium
- d. Age class distribution is not at equilibrium

125. While studying the density of 4 communities, 5 species and 50 individuals were recorded from each community. The number of individuals under each species was listed as mentioned in the following Table. In which of the following communities Pielou's Evenness Index (e) will be 1?

	Community	Species				
		1	2	3	4	5
a.	A	20	8	7	-5	10
b.	B	10	10	10	10	10
c.	C	10	12	10	8	10
d.	D	1	1	1	1	46

126. Average annual precipitation and temperature are two important determinants of world's major biomes. Which of the following combinations is correct?

Temperature and precipitation		Biome	
A	25°C temperature and 255 cm precipitation	i.	Temperate forest
B	15°C temperature and 300 cm precipitation	ii.	Savannah
C	15°C temperature and 100 cm precipitation	iii.	Temperate rain forest
D	25°C temperature and 255 cm precipitation	iv.	Tropical rain forest

- a. A-ii, B-iii, C-i, D-ii b. A-iii, B-ii, C-iv, D-i c. A-ii, B-i, C-iii, D-iv d. A-i, B-iv, C-ii, D-iii

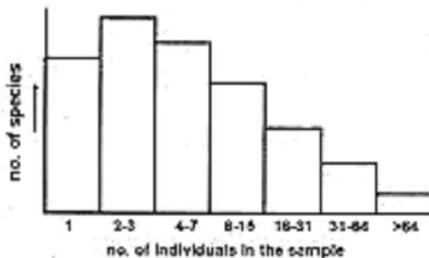
127. A researcher collected informations from four forest areas using a sensor to assess their green cover. Observed average average spectral values for each of the forests are given in the table below:

Forest	Spectral value	
	NIR	VIS
A	0.50	0.08
B	0.40	0.30
C	0.50	0.20
D	0.60	0.20

The forest green cover in the order of highest to lowest is:

- a. $A > C > B > D$ b. $A > D > C > B$ c. $B > C > D > A$ d. $D > A > B > C$

128. Biologists randomly sampled about 3000 insects from a newly found island. The distribution of their abundance in the sample was as in the figure given below:



Which of the following can be correctly inferred from the graph?

- a. Many species have only one individual each on the island.
 b. The bar on the extreme right represents a large number of species with very few individuals.
 c. Summation of the heights of all columns will be exactly equal to the total number of species present on the island.
 d. All species from the island may not be represented in the sample.

129. In Lotka and Volterra's two species competition model:

$$\frac{dN_1}{dt} = r_1 N_1 \left(\frac{K_1 - N_1 - N_2 \alpha_{12}}{K_1} \right) \text{ and } \frac{dN_2}{dt} = r_2 N_2 \left(\frac{K_2 - N_2 - \alpha_{21} N_1}{K_2} \right)$$

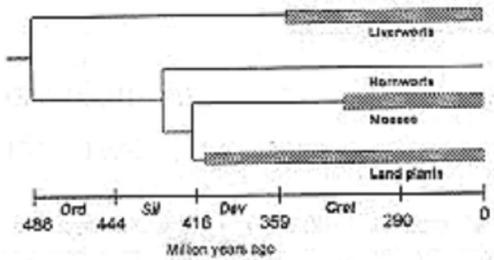
where N represents population size, r growth rate and K maximum carrying capacity for species 1 and 2. The inter specific competition coefficient $\alpha_{12} < 1$ will mean:

- a. individuals of species 2 have less inhibiting effect on individuals of species 1 than individuals of species 1 on others of their own species.
 b. individuals of species 2 have greater inhibiting effect on individuals of species 1 than individuals of species 1 on others of their own species.
 c. individuals of species 1 have less inhibiting effect on individual members of species 2 than individual of species 2 on others of their own species.
 d. individuals of species 1 have greater inhibiting effect on individuals of species 2 than individuals of species 2 on others of their own species.

130. The rates of mutation in *E. coli* from lac^- to lac^+ are determined using a medium containing lactose, as the only source of energy. The principle of spontaneity of mutations can be said to be violated if:

- a. the rate of mutation increases during starvation.
- b. in the presence of lactose, the rate of mutation from lac^- to lac^+ is increased but overall rate of mutation is not.
- c. the rate of mutation in *lac* gene is always greater than that in other genes.
- d. the rate of mutation in *lac* gene is always less than that in other genes.

131. According to fossil records, the earliest fossils of liverworts are found in the late Devonian, of mosses in the early Cretaceous, and vascular plants in the late Silurian/early Devonian. Anthoceros (hornworts) fossils have not been discovered. Reading fossil records we would say that vascular plants appeared first, then mosses and then liverworts.



However, phylogenetic relationships (shown in the figure) suggest otherwise. It may be that:

- A. evolutionary history can be read directly from the fossil record.
- B. the moss lineage goes back to at least early Silurian/early Devonian.
- C. fossils can only set a maximum age for a lineage.
- D. fossils can only set a minimum age for a lineage.
- E. the divergence between liverworts and the rest of land plants goes back to at least the early Ordovician.

Which of the following statements is correct?

- a. A, B, C, E
- b. B, D, E
- c. A, B, D, E
- d. B, C, E

132. Northern Elephant seals had been reduced to about 20 individuals in the 1800s. Biologists studied variation in proteins in the species. They found no genetic differences in the protein among different individuals. This lack of variation is due to:

- a. the fact that elephant seals live in a constant environment where there is no need for genetic variation.
- b. population bottleneck and genetic drift.
- c. natural selection resulting in a single best genotype.
- d. a very low rate of mutation.

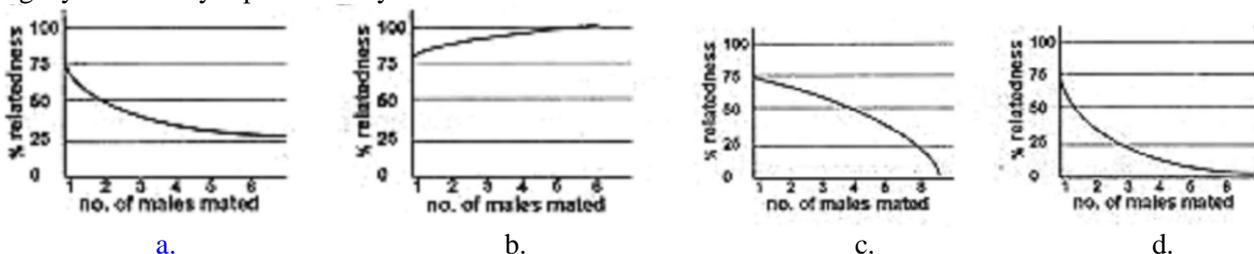
133. There are 'n' number of alleles for a given locus in a diploid population. The proportion of all homozygotes in the population (i) if all alleles are equally abundant and (ii) if all alleles are not equally abundant, will be:

- a. (i) $1/n$ (ii) $< 1/n$
- b. (i) $1/n$ (ii) $> 1/n$
- c. (i) $1/n^2$ (ii) $< 1/n^2$
- d. (i) $1/n^2$ (ii) $< 1/n^2$

134. Which of the following is a prediction of the neutral theory of molecular evolution that is supported by data?

- a. Human and chimps differ more in DNA sequences of pseudogenes than in coding regions of functional genes.
- b. Human and chimps differ more in DNA sequences of coding regions of functional genes than of pseudogenes.
- c. Humans have a faster evolution of most of their DNA sequences than chimps.
- d. The more advanced species have more number of functional genes.

135. In hymenopteran insects, males are haploid and females are diploid. All fertilized eggs give rise to females and unfertilized eggs give rise to males. As a result, if a female mates with a single male, the females in the progeny are related to each other by 75%. But if the mother had mated with many males, the mean genetic relatedness of female progeny is correctly represented by:



a.

b.

c.

d.

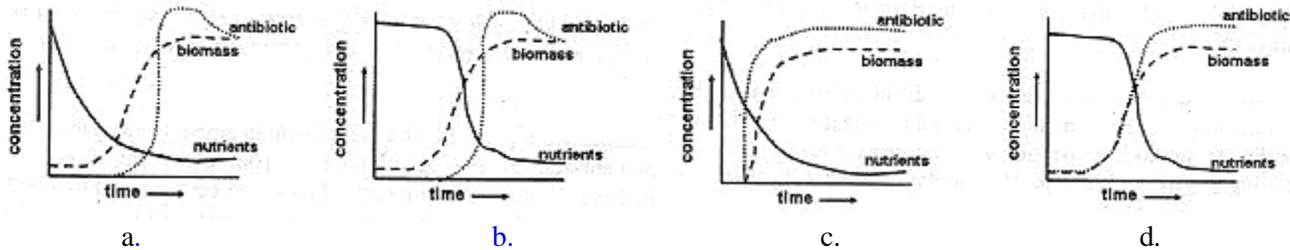
136. In a radio-immunoassay (RIA) for glucocorticoid hormone, radioactive glucocorticoid (tritiated) is added to the RIA cocktail. When the amount of bound hormone was measured no counts were observed. The following explanation(s) were proposed:

- A. The radioactive hormone was insufficient.
- B. The radioactive tag to the hormone completely dissociated during storage.
- C. Antibody was not added to the cocktail.
- D. The specific activity of the tritium was low.

Choose the correct option(s):

- a. A only
- b. C only
- c. B and C
- d. A and D

137. Which of the following curves correctly represents the process of antibiotic production by *Streptomyces* sp.:



138. For the generation of transgenic plants in crop improvement, one important regulatory gene X was overexpressed in a crop plant. Out of 30 transgenic rice plants generated, 22 showed high levels of gene X expression. However, rest 8 lines displayed low levels of expression. One explanation of such observation may be:

- a. suppression effect of the transgene
- b. knock-down effect of the gene X
- c. gene silencing effect
- d. co-suppression effect of the transgene

139. Ten different mouse strains were primed with whole keyhole limpet hemocyanin (KLH). KLH was broken into ten peptides for in vitro stimulation. The splenocytes from ten different primed mouse strains were measured restimulated with each of these ten peptides and the responsiveness to these peptides were measured in vitro. It was found that each of these mouse strains had responded to one of the peptides. When the peptide 3 responder was mated with peptide 4 responder, the splenocytes of F1 offspring responded to both the peptides. Which of the following is most appropriate?

- a. Mouse strains responding to peptide 3 or peptide 4 have different MHC haplotypes.
- b. Mouse strains responding to peptide 3 or peptide 4 have either of these T cell receptor.
- c. Mouse strains responding to peptide 3 or peptide 4 cannot process KLH.
- d. Mouse strains responding to peptide 3 or peptide 4 did not express MHC class-I molecule.

140. Stem cells are widely used for their regenerative property and capacity to differentiate into different lineages. A person with a damaged liver approaches a stem cell therapist. Which of the following therapeutic strategies would be the safest?

- a. Procuring adult liver cells from a healthy donor and grafting them into the patient.
- b. Transforming skin cells from the patient into iPS cells and using them for further differentiation and grafting in liver.
- c. Injecting embryonic stem cells into the damaged liver.
- d. Injecting cord blood cells into the liver directly.

141. If one wishes to design a microarray chip for whole genome expression analysis of an eukaryotic system, which region of the gene should be preferred for selection of unique target sequences?

- a. Any region of the coding DNA sequence (CDS)
- b. 3' regions of the CDS and 3' untranslated region (UTR)
- c. 5' region of the CDS and 5' UTR
- d. 1st intron only

142. For 5' end labeling of DNA, the following reactions are carried out sequentially as indicated.

5'-dephosphorylated DNA + $[\gamma^{32}\text{P}]\text{dATP}$ + T4 polynucleotidekinase (T4PNK) and incubated for 2 hour \rightarrow Ammonium acetate \rightarrow Tris-EDTA \rightarrow Ethanol.

If trace amount of NH_4^+ is present in the initial DNA mix, which of the following statements would most likely be true?

- a. NH_4^+ ion activates T4PNK, thereby increasing the labeling efficiency.
- b. NH_4^+ ion inhibits T4PNK, therefore should not be present in the DNA mix.
- c. NH_4^+ ion does not have any effect on T4PNK.
- d. NH_4^+ ion dephosphorylates DNA, thereby increasing the labeling efficiency.

