INDIAN NATIONAL BIOLOGY OLYMPIAD – 2010
SECTION A

CELL BIOLOGY (6)

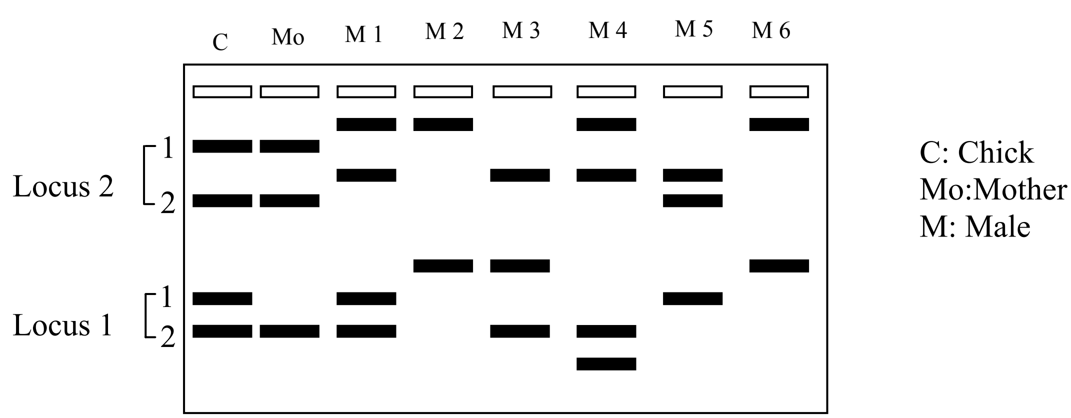
1. (1 point) Mammals contain white adipose tissue (WAT) and brown adipose tissue (BAT). WAT is the primary source of lipid used to produce energy in the form of ATP whereas BAT is the primary source of thermogenesis under cold stress. Which of the following features of the mitochondrial inner membrane of BAT contribute to this effect?

a. Increased permeability for protons.
b. Less of ATP synthase embedded in the membrane.
c. Absence of electron transport chain.
d. Presence of inhibitors of electron transport chain.

2. (1 point) Among carbohydrates, lipids, proteins and ATP, the relative energy yield in kcal per gram is best represented by:

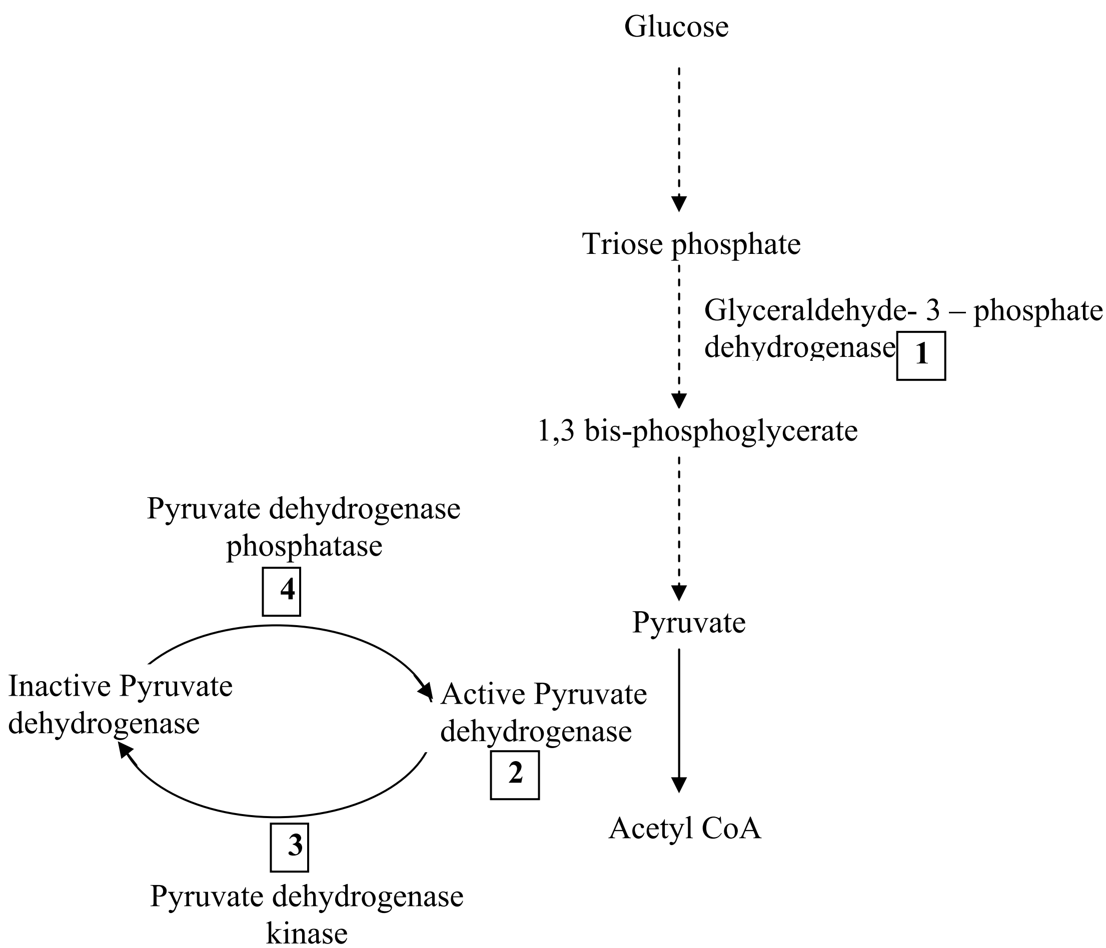
a. lipids > carbohydrates > ATP
b. ATP > lipids > proteins
c. lipids > ATP > carbohydrates
d. lipids > proteins > ATP

3. (1 point) Following is the picture of a microsatellite gel of two loci from a chick, its mother and 6 males from a population. Can the biological father of the chick be ascertained from the data?



a. Yes, the biological father is male 5.
b. Yes, the biological father is male 1.
c. Yes, the biological father could either males 2 or 3.
d. No, at least three loci need to be shown for the decision.

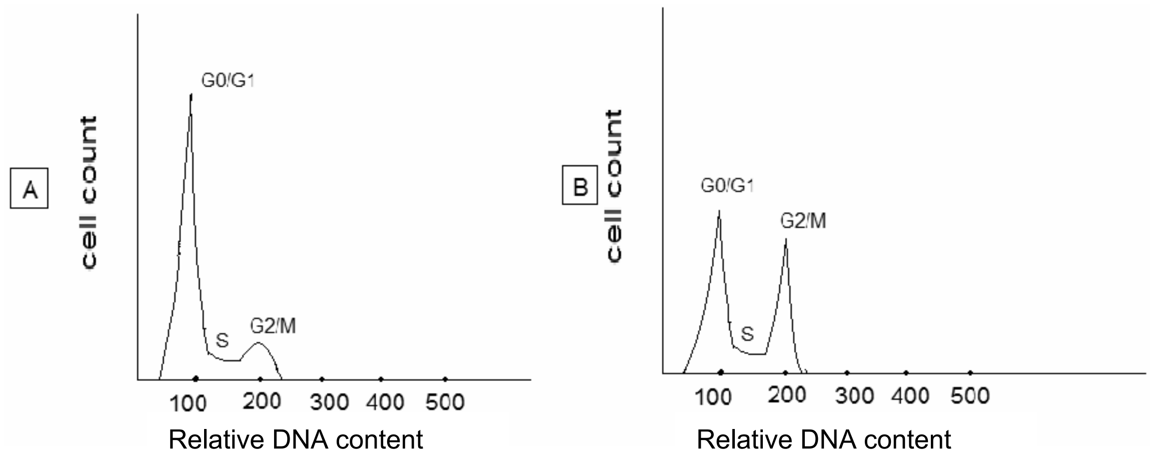
4. (1 point) Consider the glycolytic pathway.



In a hibernating animal, the enzymes that will be up- and down-regulated will respectively be:

a. (3) and (2)
b. (1, 2, 4) and (3)
c. (1, 2) and (3, 4)
d. (2) and (1)

5. (1 point) Graph (A) represents a typical histogram of normally dividing cells in a cell cycle analysis study. The graph (B) represents the histogram of cells treated for 24 h with a protein ‘x’ of unknown function.



The protein ‘x’ here acts as a:

a. $G_O \longrightarrow G_1$ phase inhibitor.

b. G2 $\longrightarrow$ M phase inhibitor.

c. Apoptosis inducer.

d. G1 $\longrightarrow$ S phase inhibitor.

6. (1 point) Analysis of a protein sequence from a recently mutated gene showed that the newly expressed protein had a completely different sequence from the wild-type protein. This was due to a:

a. missense mutation.
b. nonsense mutation.
c. silent mutation.
d. frameshift mutation.

PLANT SCIENCES (8)

7. (1 point) The factors that enhance the transition of apical bud into floral bud are:
    1. low light conditions.
    2. attaining threshold apical bud size.
    3. reduction in the availability of carbohydrates to the apex.
    4. exogenous application of gibberellins.

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

8. (1 point) Guttation is common among the plants of this climate:

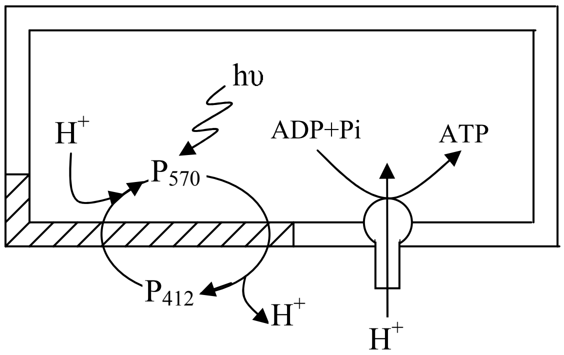
a. hot and wet.
b. hot and windy.
c. cold and humid.
d. cold and windy.

9. (1 point) Turgor pressure is required to maintain the shape of all cells except:

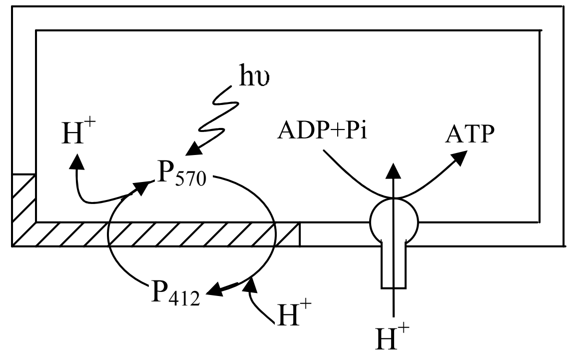
a. meristematic cells.
b. root cells.
c. collenchyma cells.
d. lignified cells.

10. (1 point) Bacteriorhodopsin absorbs a quantum of light by P_{570} which is transformed into P_{412} accompanied by release of H^+. It is also known that F_0-F_1 system generates ATP through the movement of H^+. What should be the appropriate diagram for a photosynthetic *Halobacterium halobium*?

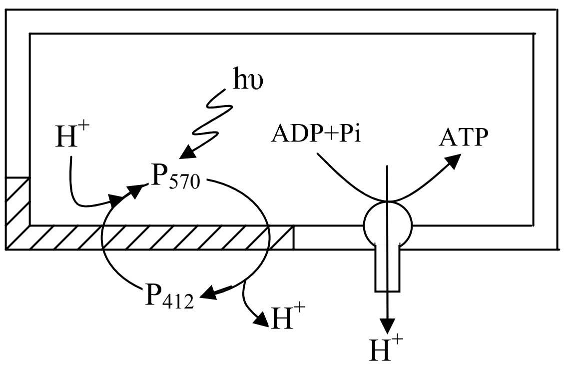
a.



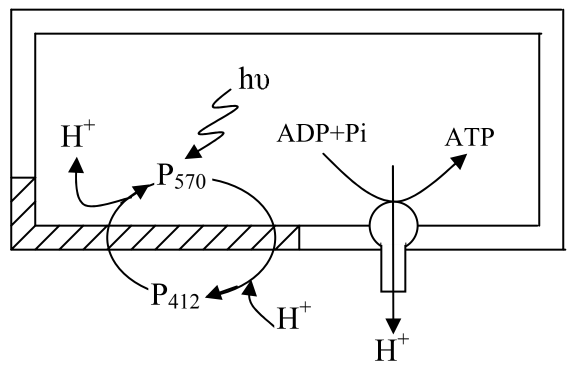
b.

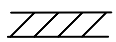


c.



d.



 Indicates pigment.

11. (1 point) Mark the odd pair out.

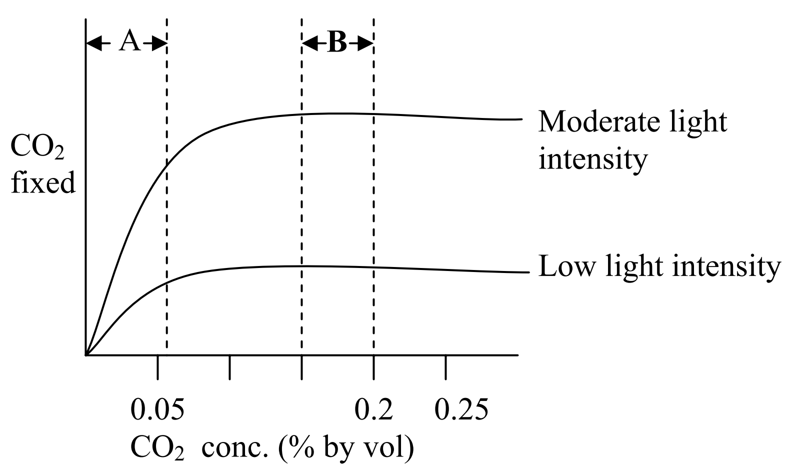
a. Totipotency: parenchyma

b. Secondary growth: cambium

c. Dermal cells: trichomes

d. Periderm: collenchyma

12. (1 point) The limiting factor/s for photosynthesis in regions A and B in the graph is/are:

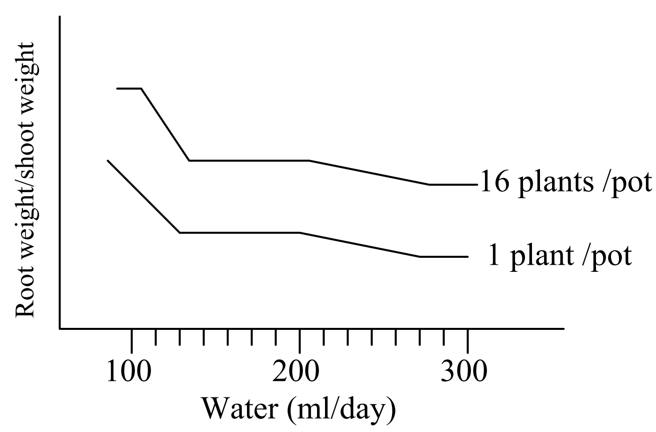


a. A: light intensity B: CO_2 concentration
b. A: light intensity B: Light intensity
c. A: CO_2 concentration B: Light intensity
d. A: CO_2 concentration B: CO_2 concentration

13. (1 point) If a plant is grown only in sand (S), only in clay (C) or only in humus (H), which of the following will be true?
    i. Water availability to the roots will be more in (C) and (H) as compared to (S).
    ii. Nutrient availability will be more in (C) and (H) as compared to (S).
    iii. Oxygen availability will be low in (C) as compared to (S) and (H).
    iv. The ability of roots to penetrate (S) and (H) will be low as compared to (C).

a. i only
b. both ii and iii
c. both i and iv
d. i, ii and iii

14. (1 point) In order to study the effect of water availability on plant growth, broadleaf peppermint seedlings were grown under two conditions (I and II) in a greenhouse and the supply of water to the plants was varied.
    Condition I: one seedling potted per pot
    Condition II: 16 seedlings potted per pot
    When the root to shoot biomass was calculated, the following graph was obtained.

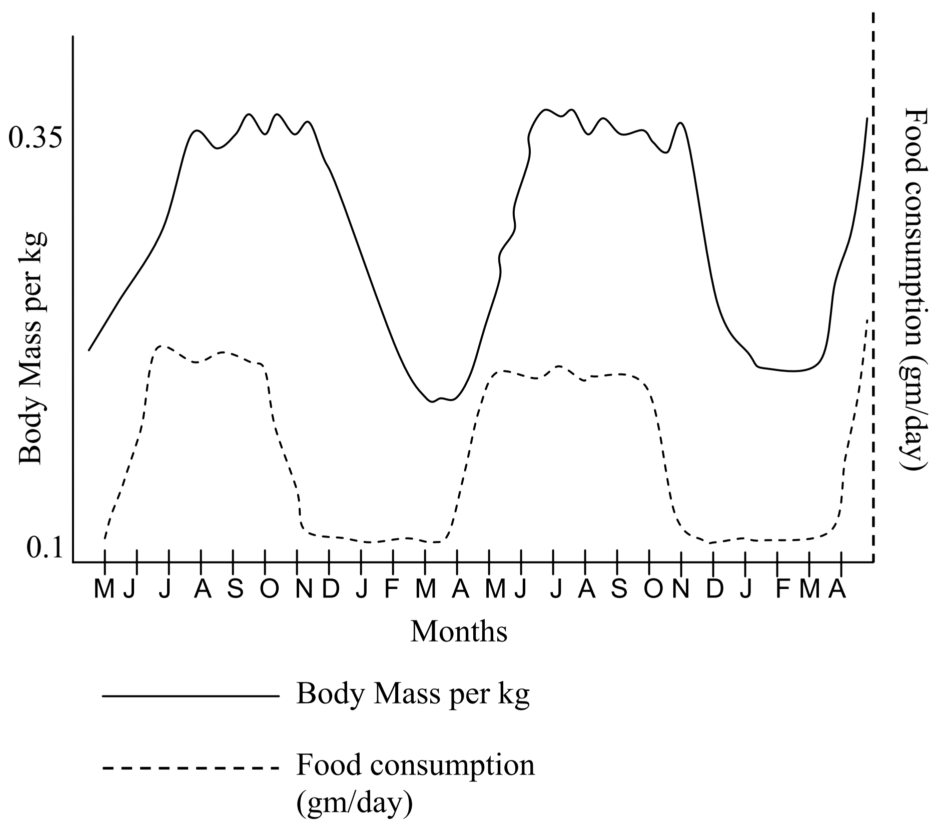


Mark the correct interpretation.

a. Water availability and competition both increase the root to shoot weight ratio in plants.
b. Shortage of water leads to increase in root to shoot weight ratio. This effect is enhanced when there is competition.
c. Water availability increases root to shoot weight ratio. This effect can be countered by competition.
d. Competition leads to decrease in root biomass while scarce supply of water tends to counterbalance this effect.

<u>ANIMAL SCIENCES</u> (6)

15. (1 point) The data below was obtained from an experiment when a golden mantled squirrel was kept in the laboratory for 2 years under constant light and dark condition (12 hrs. light and 12 hrs. dark) and temperature (22°C).



The graph indicates that the animal is:

a. an obligate hibernator with exogenous signals for entry into hibernation.
b. a facultative hibernator with endogenous signals for entry into hibernation.
c. an obligate hibernator with endogenous signals for entry into hibernation.
d. a facultative hibernator with exogenous signals for entry into hibernation.

16. (1 point) In vertebrates the long bones are always hollow. The advantages that this anatomy provides are that:
    1. they harbour and protect marrow.
    2. they provide attachment to tendons.
    3. they are stronger than solid structures made of same amount of material.
    4. only hollow bones can articulate better with one another.

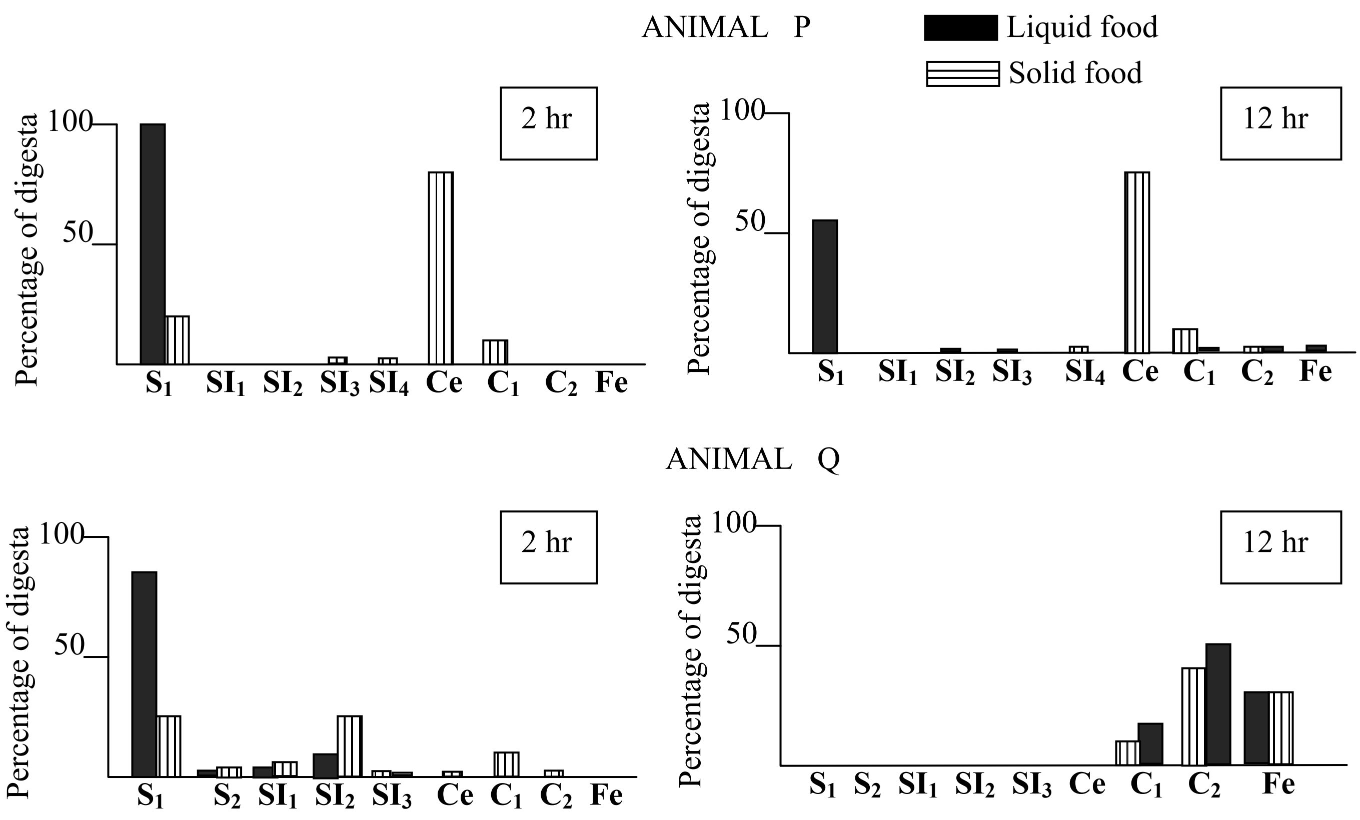
a. Only 1, 2 and 4
b. Only 1 and 3
c. Only 1, 3 and 4
d. 1, 2, 3 and 4

17. (1 point) Collagenase is an enzyme that breaks the peptide bonds in collagen. Excessive secretion of this enzyme will lead to weakening of:
    1. bones
    2. tendons
    3. intervertebral discs
    4. hair shafts
    5. nails & claws

a. 1, 4, & 5
b. 2, 3 & 5
c. 1, 2, & 4
d. 1, 2, & 3

18. (1 point) Predominant chitinase activity will be detected in the gastric mucosa and pancreas of:
a. sheep.
b. rabbit
c. pigeon
d. salamander

19. (1 point) The percentage of digesta fluids and particulate markers recovered from the gastrointestinal tract of two animals is shown in the figures below. (S= stomach, SI=Small intestine, Ce= Cecum, C= colon, Fe= Feces)



P and Q respectively are:
a. herbivore and carnivore.
b. omnivore and herbivore.
c. foregut fermentor and hindgut fermentor.
d. piscivore and herbivore.

20. (1 point) The percentage of blood (by volume) occupied by corpuscles in two animals (1 and 2) which can survive at low as well as high altitudes is shown in the table:

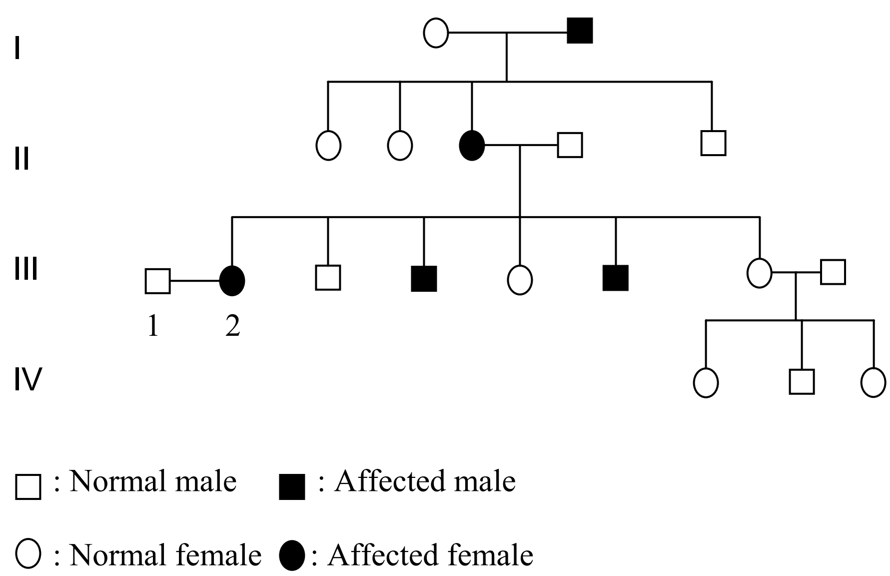
	Altitude	Corpuscles (%)
Animal 1	Sea level	34
Animal 2	Sea level	33
Animal 1	4700 m	50
Animal 2	4700 m	34

Mark the correct interpretation.

a. Animal 1 is poorly adapted at high altitude as compared to animal 2.
b. Animal 2 is poorly adapted at high altitude as compared to animal 1.
c. Affinity of hemoglobin for oxygen in animal 1 is higher at lower altitude.
d. Haemoglobin of animal 2 shows higher affinity for oxygen as compared to animal 1.

GENETICS & EVOLUTION (6)

21. (1 point) Study the following pedigree for an autosomal recessive trait.



The probability that the couple III-1 and III-2 will have an affected child is:

a. 1 / 8
b. 1 / 2
c. 1 /16
d. 1/4

22. (1 point) How many different kinds of (i) F_1 gametes (ii) F_2 genotypes and (iii) F_2 phenotypes would be expected from the cross AABBCC x aabbcc?
a. (i) 16 (ii) 24 (iii) 16
b. (i) 8 (ii) 27 (iii) 8
c. (i) 8 (ii) 64 (iii) 16
d. (i) 8 (ii) 32 (iii) 16

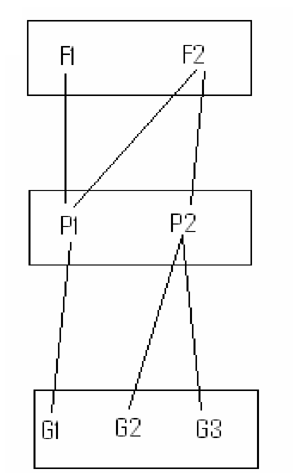
23. (1 point) In grasshopper, rosy body colour is caused by a recessive mutation. The wild-type body colour is green. If the gene for body colour is on the X chromosome, what kind of progeny would be obtained from a mating between a rosy female and a wild-type male?
a. All the daughters will be green and all the sons will be rosy.
b. 50% daughters will be green and 50% sons will be rosy.
c. All offspring will be green irrespective of sex.
d. All offspring will be rosy irrespective of sex.

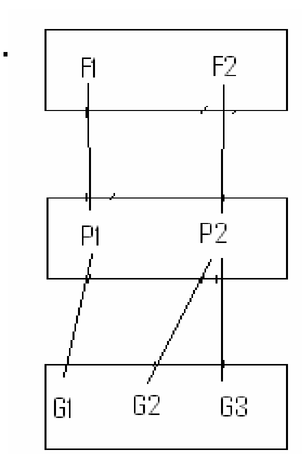
24. (1 point) Along the length of a river exists a species of *Catla* fish. In order to provide electricity to the adjoining villages, a hydroelectric dam is built that separates the lower river area from a newly formed lake above. After many, many years, the *Catla* fish in the river and lake are sampled and found to be phenotypically very different. Which of the scenarios listed below is the best hypothesis to explain the observed changes?
a. The presence of the dam increased the amount of random mating that occurred between the river and lake fish, and natural selection selected for the best-fit organisms in both the populations.

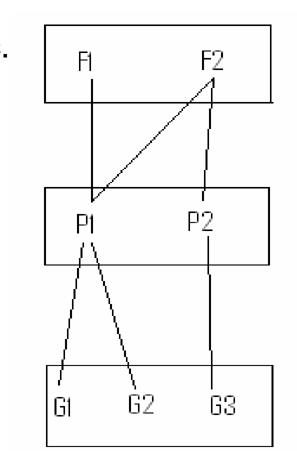
b. The newly built dam caused a genetic drift and the two different founder populations diverged extensively leading to the appearance of two different species.
c. The electricity produced in the dam caused mutations in the river fish, and natural selection selected for the best-fit organisms in both locations.
d. The dam caused different environmental conditions to be formed in the lake versus the river, populations accumulated mutations, and natural selection selected for the best-fit organisms, which survived in both environments.

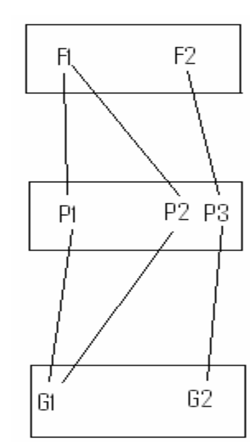
25. (1 point) Silky fur is a recessive trait in a breed of cats. An amateur breeder has procured a stock of 1000 cats of which 160 are silky-furred. As he is away, his wife happily sells all these 160 cats for a handsome price. On his return, the husband is upset and has no option but to breed the remaining stock. What percentage of the next generation will be silky-furred?
a. 16%
b. 8%
c. 4%
d. 2%

26. (1 point) Genotypic variation (G), phenotypic variation (P) and fitness (F) are closely related to each other. The figures below show the possible relationship between these three parameters under constant environmental conditions. Choose the most appropriate representation of this relationship from the following figures.

a.


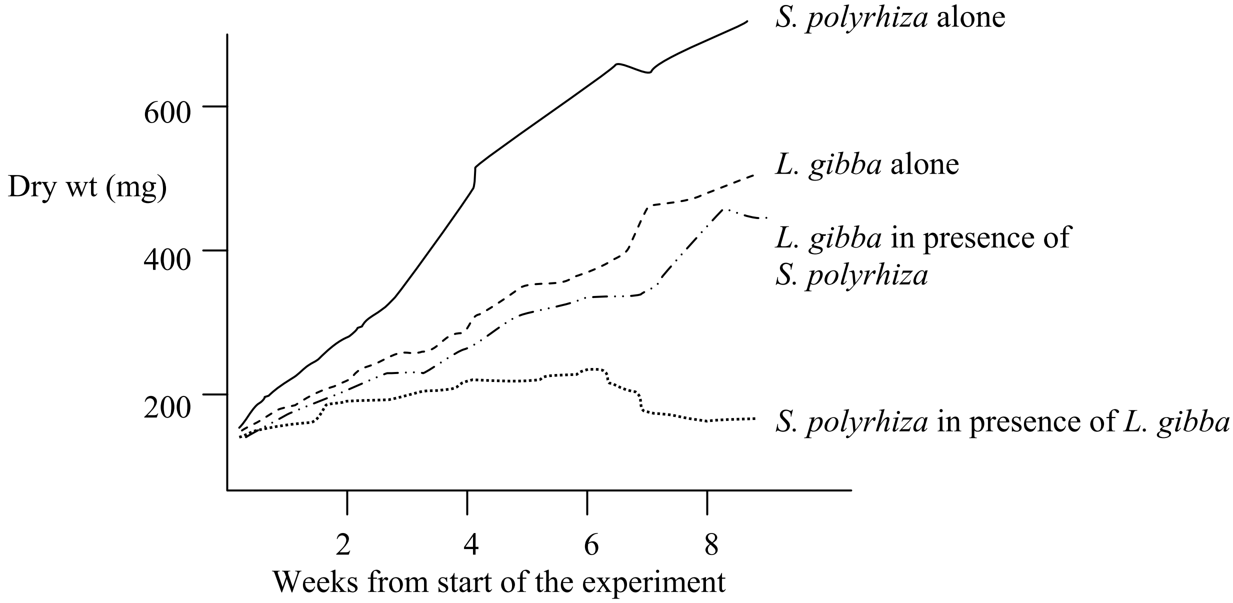
b.


c.


d.


<u>ECOLOGY</u> (6)

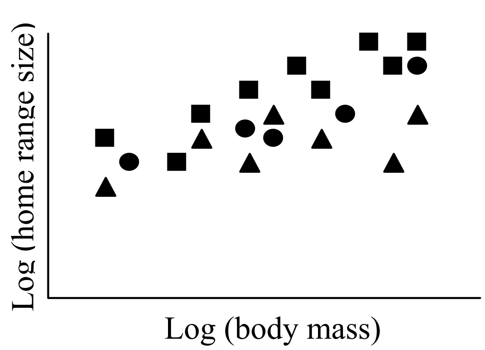
27. (1 point) *Spirodela polyrhiza* and *Lemna gibba* are two small monocotyledons, which float on the surface of quiet fresh water bodies. When these were grown in nutrient culture media, the following data were obtained.



The type of interaction between the two species is most likely to be:

a. commensalism.
b. amensalism.
c. parasitism.
d. competition.

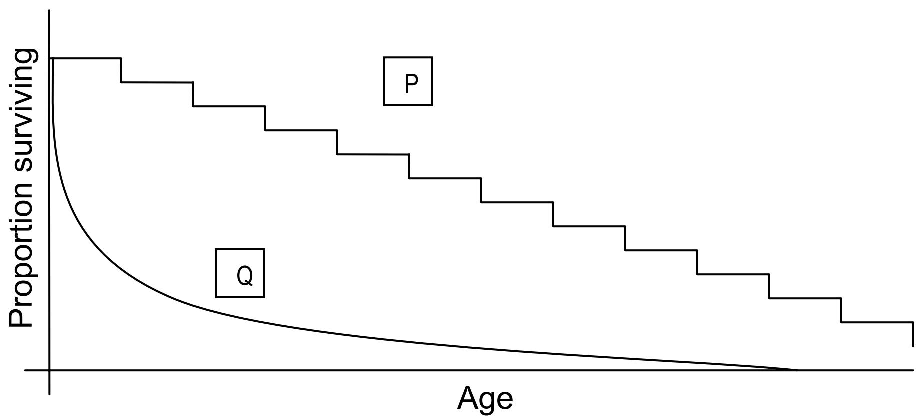
28. (1 point) The relationship between the home range size and body weight of three kinds of mammals is depicted in the graph.



The three symbols are likely to represent mammals exhibiting:

Option	▲	●	■
a.	carnivory	herbivory	omnivory
b.	herbivory	omnivory	carnivory
c.	omnivory	carnivory	herbivory
d.	omnivory	herbivory	carnivory

29. (1 point) The following survivorship curves are of two different animals, P and Q. Choose the correct pair that respectively identifies P and Q.



i. Mouse
ii. Crab
iii. Oyster
iv. Lizard

a. i and ii
b. ii and iii
c. iii and iv
d. i and iv

30. (1 point) In an experiment, three bottles were filled with water from an aquatic ecosystem. This water contained tiny plants and animals of the ecosystem. The following experiments were done with the bottles.

Bottle Number	Condition	Oxygen measurement	Oxygen (mg/L)
1	Control	Done immediately	9
2	Light for one hour	Done after one hour	10
3	Dark for one hour	Done after one hour	4

The gross primary productivity for this ecosystem is:

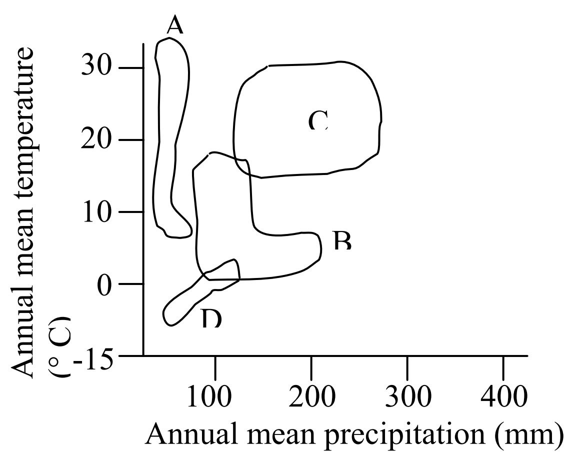
a. 1 mg/L/h

b. 5 mg/L/h

c. 6 mg/L/h

d. 14 mg/L/h

31. (1 point) A climograph of various biomes is given below.The biomes A, B, C and D represent:



Option	A	B	C	D
a.	Coniferous forest	Tundra	Temperate broadleaf forest	Desert
b.	Desert	Coniferous forest	Temperate broadleaf forest	Tundra
c.	Coniferous forest	Desert	Temperate broadleaf forest	Tundra
d.	Desert	Tundra	Coniferous forest	Temperate broadleaf forest

32. (1 point) What is the correct match of example to ecological term?

	Community	Ecosystem	Population	Niche
a.	Freshwater shrimps	All lake organisms	Pond weed as primary producer	Freshwater lake
b.	Freshwater lake	Pond weed as primary producer	Freshwater shrimps	All lake organisms
c.	All lake organisms	Freshwater lake	Freshwater shrimps	Pond weed as primary producer
d.	Freshwater shrimps	Freshwater lake	All lake organisms	Pond weed as primary producer

BIOSYSTEMATICS (2)

33. (1 point) What feature is common between earthworm, millipede and squid?

a. Segmentation pattern.
b. Type of coelom.
c. Circulatory system.
d. Excretory system.

34. (1 point) Which of the following **cannot** usually be inferred from conventional phylogenetic analysis?

a. Establishment of evolutionary relationships.
b. Determination of isolating mechanisms.
c. Determination of how rapidly traits evolve.
d. Inference of mode of evolutionary trends.

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INDIAN NATIONAL BIOLOGY OLYMPIAD – 2010

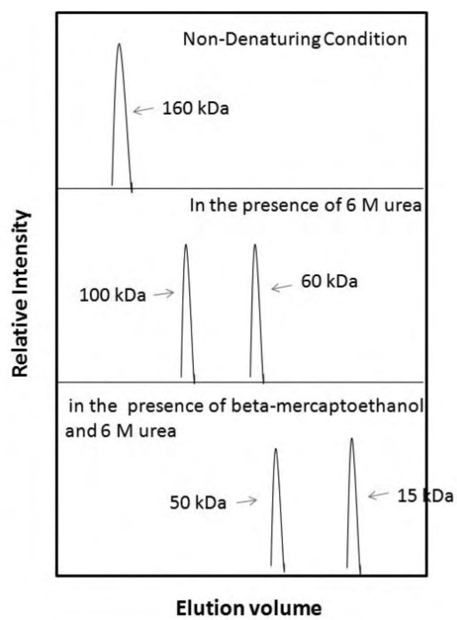
SECTION B

NOTE:

- Write all answers in the **ANSWERHEET ONLY.**
- Only the answer sheets will be collected at the end of the exam.

CELL BIOLOGY (20.5)

35. (2 points) The chemicals such as urea and beta-mercaptoethanol denature proteins. Beta-mercaptoethanol oxidizes disulphide linkages, while urea breaks all the non-covalent bonds found in the native protein molecule. To understand the quaternary structure of a protein, the purified protein was treated with different agents and separated using a gel-filtration column and the following results were obtained:



Which of the following statements would be true for the above experiment? Put tick mark/s (√) in the appropriate box/es in the table.

a. The protein was contaminated with smaller peptides that got separated in denaturing conditions.

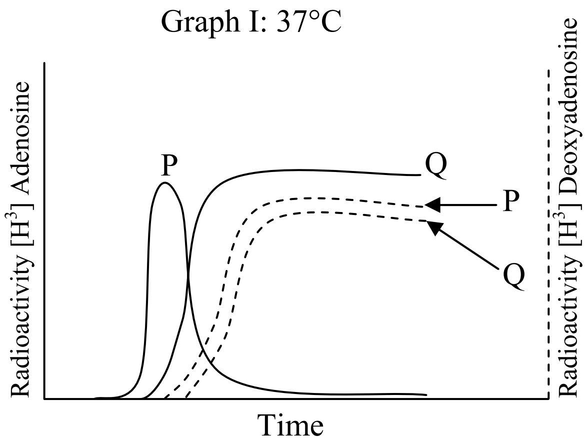
b. The protein is heteromeric.

c. The protein is a dimer of two polypeptide chains that have relative molecular mass of 100 and 60 kDa each.
d. The 100 kDa subunit is a homodimer of 50 kDa polypeptide, whereas the 60 kDa subunit is a homotetramer of 15 kDa polypeptide.
e. In the native proteins, the two subunits, that is, the 100 and 60 kDa subunits are held together by disulfide bonds.
f. Disulfide bonds are responsible for multimerization of 50 and 15 KDa polypeptides in to 100 and 60 kDa subunits, respectively.
g. The native protein is a hexamer.

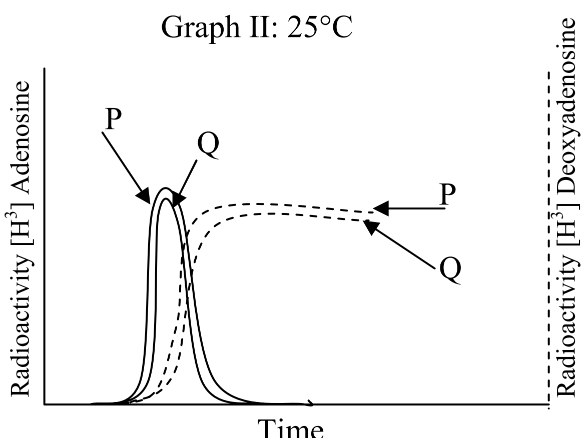
a.	b.	c.	d.	e.	f.	g.

36. (6 points) A researcher has isolated two strains of a bacterium and named them as strains P and Q. Both the strains grew happily at 25°C. However, at 37°C only P grew well while Q grew only for a very short period. Therefore, he decided to study the DNA synthesis by first growing both at 25°C and then shifting to 37°C, and measuring the incorporation of radioactive tracer for a short period of time.

By mistake, he used [^{3}H] adenosine as tracer instead of [^{3}H] deoxyadenosine. However, to his surprise, he got a transient incorporation of [^{3}H] adenosine in the strain P, but continuous incorporation in the strain Q. Later, when he repeated the experiment with [3H] deoxyadenosine as tracer, he got almost equal and continuous incorporation in both the strains.



He repeated the experiments by growing the culture at 25°C. There was no difference in the pattern of incorporation of [^{3}H] adenosine ie there was transient incorporation in both of [^{3}H] adenosine and continuous incorporation of [3H] deoxyadenosine.



(A) The transient incorporation of [^{3}H]-adenosine in the strain P can be explained as:

(Put a tick mark (√) in the appropriate box in the table.)

a. synthesis of short-lived RNA in the bacteria required for protein synthesis.
b. synthesis of some RNA required for initiation of DNA replication that is subsequently removed.
c. initiation of replication being an error-prone process, the DNA polymerase is unable to differentiate between ribo- and deoxyribonucleotides.

a.	b.	c.

(B) At 37^0C, the strain Q incorporates [^{3}H]-adenosine continuously, the most likely reason could be that:

(Put a tick mark (√) in the appropriate box in the table.)

a. the strain Q does not require RNA for initiation of DNA synthesis, and the incorporation of [^{3}H]-adenosine represents the activity of RNA polymerase.
b. due to mutation, the enzyme that removes RNA from DNA has lost the catalytic activity.
c. due to mutation the DNA polymerase has acquired the ability to incorporate ribonucleotides as well.

a.	b.	c.

(C) At 25^0C, both the strains show identical results for the incorporation of [3H]-adenosine, because:

(Put a tick mark (√) in the appropriate box in the table.)

a. the mutant gene transcribes RNA only at higher temperature.
b. the mutant gene is expressed at both the temperatures, but only at higher temperature the protein synthesized does not show proper 3-D structure.
c. the mutant could convert adenosine to deoxyadenosine so that it gets incorporated in DNA.

a.	b.	c.

37. (3 points) UCP (Uncoupling protein) is a unique protein found on the mitochondria present in brown adipose tissue. In order to obtain this protein in large quantities, one can use molecular biology techniques. Choose from the following steps and arrange them in the correct order to obtain this protein in large quantities. (Write only the appropriate alphabets in the space provided.)

a. Cut the DNA into smaller fragments using restriction enzyme.
b. Allow the cells to grow on culture plates to form colonies.
c. Extract mRNA from adipose cells.
d. Introduce the recombinant vector in the cells.
e. Synthesize cDNA using reverse transcriptase.
f. Perform polymerase chain reaction to amplify the mRNA fragments.
g. Insert into bacterial expression plasmids.
h. Cut the mRNA into smaller fragments.
i. Extract the genomic DNA from adipose cells.
j. Extract the mitochondrial DNA from adipose cells.
k. Screen using antiUCP antibodies.

Answer: ________________________________

38. (2 points) Four DNA molecules are shown below. These molecules were denatured by heating and then cooled and allowed to renature.

a. ATATATATATATATAT
   TATATATATATATATA

b. CT CT CTCTCTC TCT C
   GAGAGAGAGAGAGAG

c. AAAAAAAAAAAAAAA
   TTTTTTTTTTTTTTTT

d. GGAAAAAGGAAGGGA
   CCTTTTTTCCTTCCCT

(A) Which of the four molecules is least likely to return to the original structure?

Answer: ______

(B) Which of the four molecules will show highest melting temperature?

Answer: ______

39. (3 points) Two biomolecules (P and Q) which can act as carbon sources were added to a bacterial culture. When their initial rates of entries into the bacterial cell were measured, the following data was obtained.

Carbon Source (mM)	Initial rate of transport (μmoles / min)	
	P	Q
0.1	2	18
0.3	6	46
1.0	20	100
3.0	60	150
10.0	200	162

(A) What can be deduced from the data? Put a tick mark (√) in the appropriate box in the table.

a. P is transported by a channel protein while Q is transported by a carrier protein.
b. P is transported by a carrier protein while Q is transported by passive diffusion.
c. Both P and Q are transported by active transport.
d. Both P and Q are transported by carrier proteins.

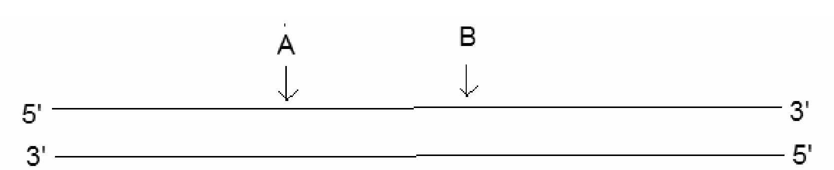
a.	b.	c.	d.

(B) Which of the following can be correlated with the above deduction? Put a tick mark (√) in the appropriate box in the table.

a. P: charged molecule   Q: uncharged molecule
b. P: polar molecule   Q: non-polar molecule
c. P and Q: both uncharged but Q is smaller than P.
d. P and Q: both uncharged molecules but P is smaller than Q.

a.	b.	c.	d.

40. (2.5 points) A large DNA molecule is subjected to amplification by the polymerase chain reactions. How many copies of the segment A-B, without any additional DNA sequences, will be obtained after 4 cycles of the reaction? (The primers used anneal to the 3' ends of the 2 strands of the A-B segment.)



Answer: _________

41. (2 points) In serial dilutions of a cell culture, 1 ml of the original culture is added to 9 ml of the medium (10^1 dilution). After vortexing, 1 ml of the diluted culture is similarly used for the next dilution and so on. A 0.1 ml aliquot from each dilution is then spread on nutrient agar plates. After incubation, the number of colonies, which is equivalent to the number of cells in the aliquot, is counted. If a count of 90 colonies is obtained for the 10^8 dilution, what is the cell density (number of cells per ml) in the 10^4 dilution?

Answer: ______________

PLANT SCIENCES (4)

42. (2 points) The following flowering patterns were obtained when three varieties (I, II and III) of soybean plants were subjected to varying day lengths.

Day length (h)	Time in days from germination to blossoming		
	I	II	III
5	23	23	27
7	21	21	26
12	21	21	28
15	26	62	110

Mark the correct interpretation.

(Put a tick mark (√) in the appropriate box in the table.)

a. I: Long-day Plant II: Short-day Plant III: Day-neutral Plant

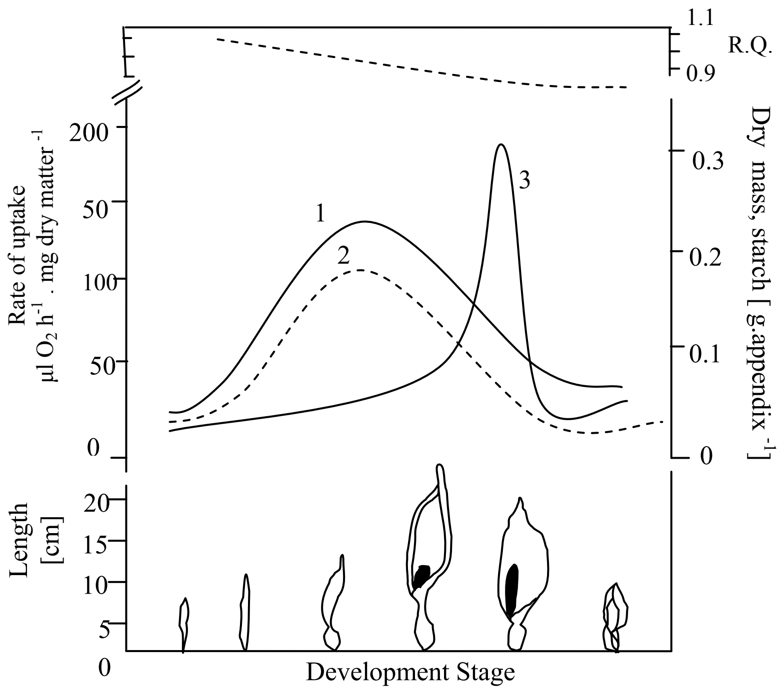
b. I: Day-neutral Plant II: Short-day Plant III: Long-day Plant

c. I: Short-day Plant II: Short-day Plant III: Short-day Plant

d. I: Day-neutral Plant II: Short-day Plant III: Short-day Plant

a.	b.	c.	d.

43. (2 points) Blossoms of some plant species are known to warm up during the sequence of blooming. This heat production is thought to enhance the dispersal of floral scents to attract the pollinators. Some parameters measured in the course of development of such a spadix are depicted in the accompanying graph.



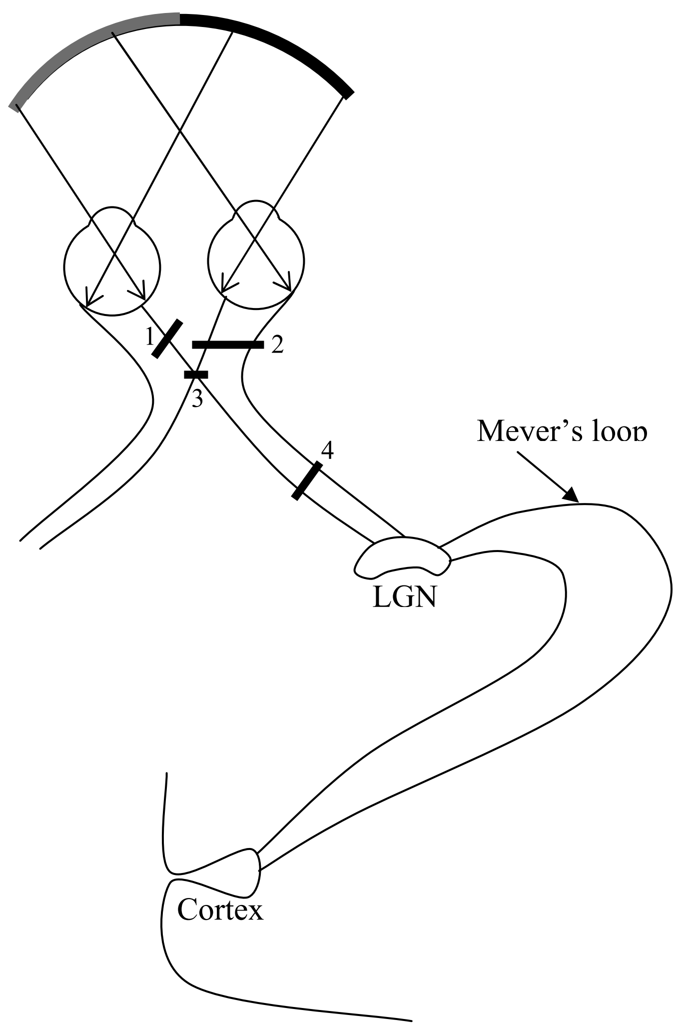
Ascribe the curves 1, 2 and 3 sequentially to respiration, dry mass and starch content. Put a tick mark (√) in the appropriate box in the table.

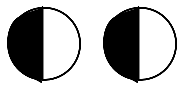
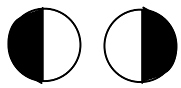
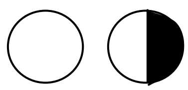
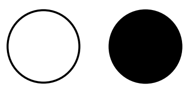
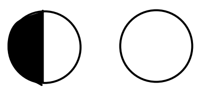
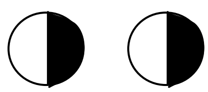
a. 3, 1, 2
b. 3, 2, 1
c. 2, 3, 1
d. 1, 3, 2

a.	b.	c.	d.

<u>ANIMAL SCIENCES</u> (9)

44. (4 points) Vision is generated by photoreceptors in the retina. The information leaves the eye by way of the optic nerve. The visual pathway from eye to cortex region is depicted in the diagram. A lesion in the optic nerve fibre can lead to partial or complete loss of vision depending on the site of the lesion. Lesions in four different sites are indicated by black lines. Match them against the corresponding visual field defect and fill in the number in the appropriate box in the table.



Visual Field defect (Black portion in the circle indicates loss of vision)	Lesion site
	
	
	
	
	
	

45. (5 points) *Rhodinus*, a blood-sucking bug shows five instars before it metamorphoses into an adult. It has a very long head with the brain located at its tip and an organ called Corpora Cardiaca (CC) behind it. The hormone that ensures the continuum of the juvenile stages is called a juvenile hormone. Behind the head is a pro-thoracic gland, which gets triggered by the Pro-Thoracico-Tropic Hormone (PTTH) to release ecdysone required for molting into an adult.

    The following observations were made when the juveniles of this insect were subjected to various conditions:

1. Starved juveniles (any instar) when decapitated → remained juveniles and did not molt into adults.

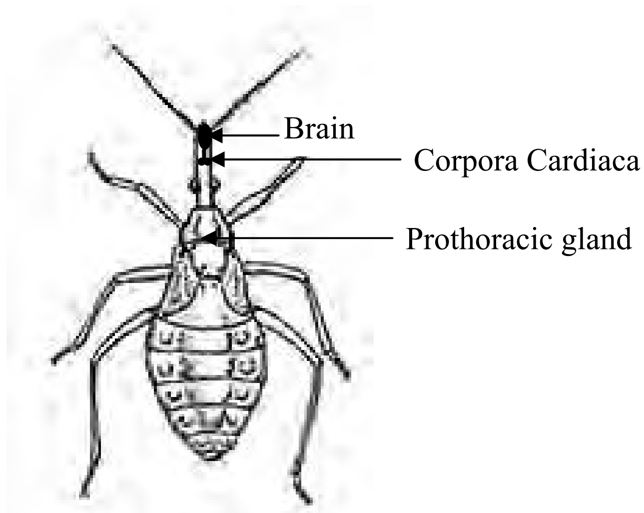
2. Well-fed juveniles (any instar) when decapitated → molted into adults.
3. Starved juveniles (any instar) when partially decapitated to remove the brain cells → remained juveniles and did not molt into adults.
4. Well-fed juveniles (any instar) when partially decapitated to remove the brain cells → did not molt into adults.

(A) Can the following conclusions be drawn from these data? Fill in the table by putting a tick mark (√) in the appropriate box against each conclusion number.

a. Ecdysone hormone is produced irrespective of the level of feeding.
b. CC is the site of production of juvenile hormone.
c. PTTH is produced irrespective of the level of feeding.
d. Increase in juvenile hormone is an important trigger for production of PTTH.
e. Absence of CC alone is a trigger for molting into adult form.
f. Well-fed larvae in absence of juvenile hormone can molt into adults.

Conclusion	Yes	No
a.		
b.		
c.		
d.		
e.		
f.		

(B). If an unfed, completely decapitated, fifth (final) instar juvenile is connected to a well-fed, decapitated fourth instar juvenile by a glass tube so that fluids can be exchanged, what will be the expected result? Put a tick mark (√) in the appropriate box in the table.



a. Both bugs will continue to remain juveniles.
b. Both bugs will molt into adult forms.
c. The bug in the fourth instar will remain as a juvenile while the one in the fifth instar will molt into an adult.
d. The bug in the fourth instar will molt into an adult and the one in the fifth instar will remain as a juvenile.

a.	b.	c.	d.

<u>GENETICS & EVOLUTION</u> (9)

46. (3 points) Mendel studied the inheritance patterns of 12 different characters of the pea plant. He could ascertain the independent assortment of only 7 of these 12 characters by repeated experiments.

(A) What can be deduced from this? Put a tick mark (√) in the appropriate box in the table.

a. The pea plant could have at least seven pairs of chromosomes.
b. The pea plant can have a maximum of seven pairs of chromosomes.
c. The pea plant has exactly seven pairs of chromosomes.
d. The pea plant can have a haploid chromosome number between 7 and 12.

a.	b.	c.	d.

(B) It was later found that genes responsible for these 7 traits were located on four different chromosomes. This indicates that:
(Put a tick mark (√) in the appropriate box in the table.)

a. the pea plant has only 4 pairs of chromosomes.
b. as genes are often linked, the independent assortment of the traits observed by Mendel was due to chance alone.
c. although some genes were linked, they were located so far apart that they behaved as if they were present on separate chromosomes.
d. although some genes are linked, they showed results of independent assortment mainly because no meiotic recombination occurred.

a.	b.	c.	d.

(C) The genes for the seven traits were located as follows:

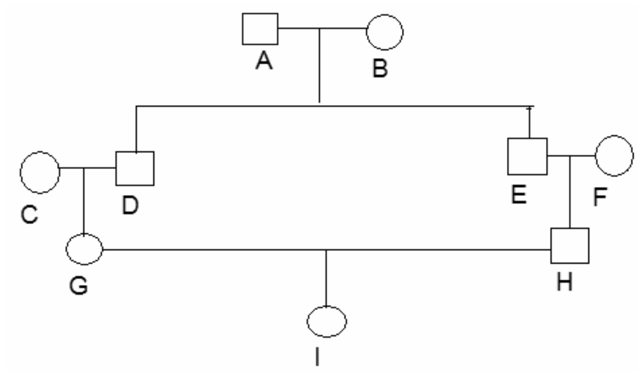
1. gene for seed texture (smooth/wrinkled): located on one chromosome
2. gene for pod color (yellow/green) : located on one chromosome
3. genes for cotyledon color and seed coat color: located on one chromosome
4. gene determining pod texture, flower position and stem length were located on one chromosome.

Which of these traits, if studied simultaneously, would give results that will **not** indicate independent assortment? Put a tick mark (√) in the appropriate box in the table.

a. Seed texture and pod texture.
b. Pod color and cotyledon color.
c. Flower position and stem length.
d. Seed coat color and pod texture.

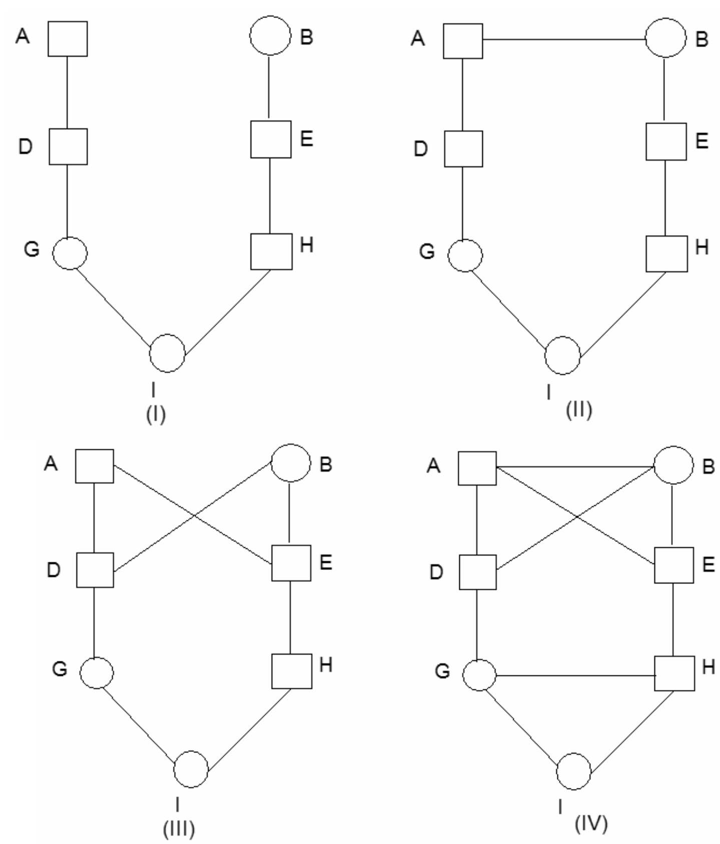
a.	b.	c.	d.

47. (2 points) Following is a pedigree with marriage between first cousins:



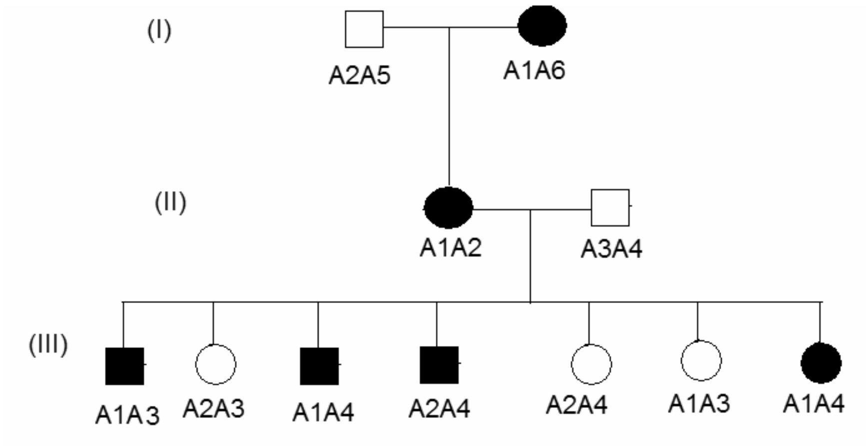
Choose the correct diagram representing the inheritance of alleles in this pedigree.

(Put a tick mark (√) in the appropriate box in the table.)



I	II	III	IV

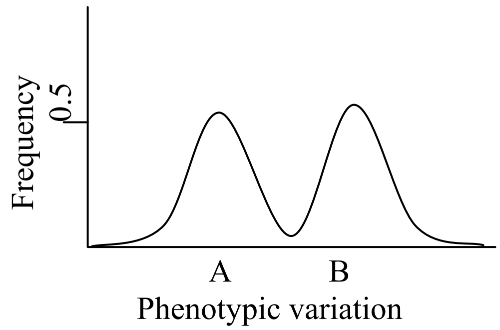
48. (2 points) Following is a pedigree for a family for Variable Number Tandem Repeats (VNTRs) A1 to A6 and a genetic disorder (shaded symbols).

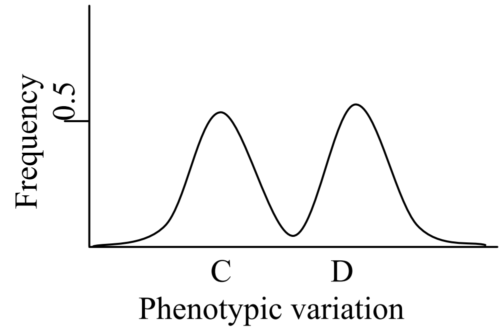


What is the percent recombination frequency between the VNTR and disease loci? Write your answer only upto two decimal places.

Answer: _______ %

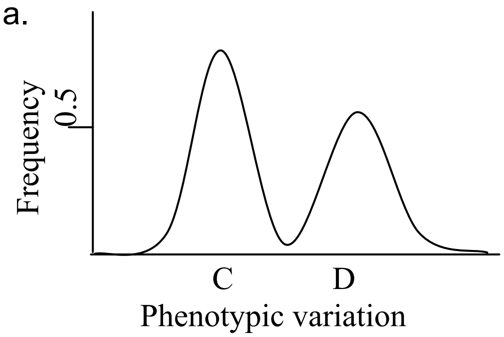
49. (2 points) The environment in which a species lives exerts selective pressure on its individuals. In a patch of forest, many different species of butterflies exist. Among these, two butterfly species A and B exhibits two different colour patterns and both are very distasteful to their predators. There also exist two more butterfly species, C and D, that exhibit very similar colour patterns as that of A and B, respectively, but are highly palatable. The frequency distribution of these butterflies is shown in the two graphs below.



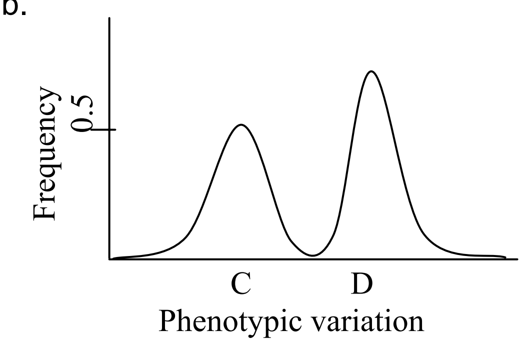


(A) In one situation, butterflies of species A become much more common than species B. What is the most likely effect of this on species C and D after many generations? Put a tick mark (√) in the appropriate box in the table.

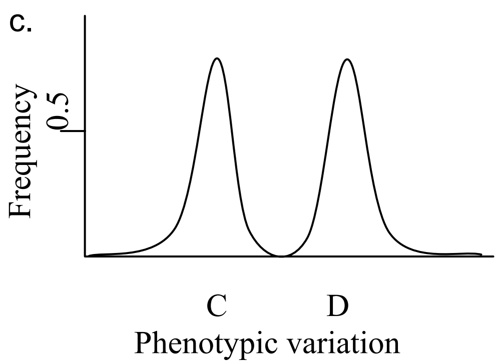
a.



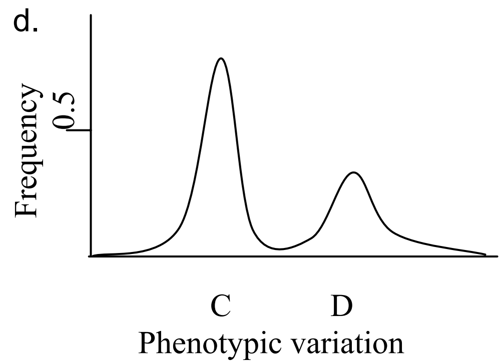
b.



c.

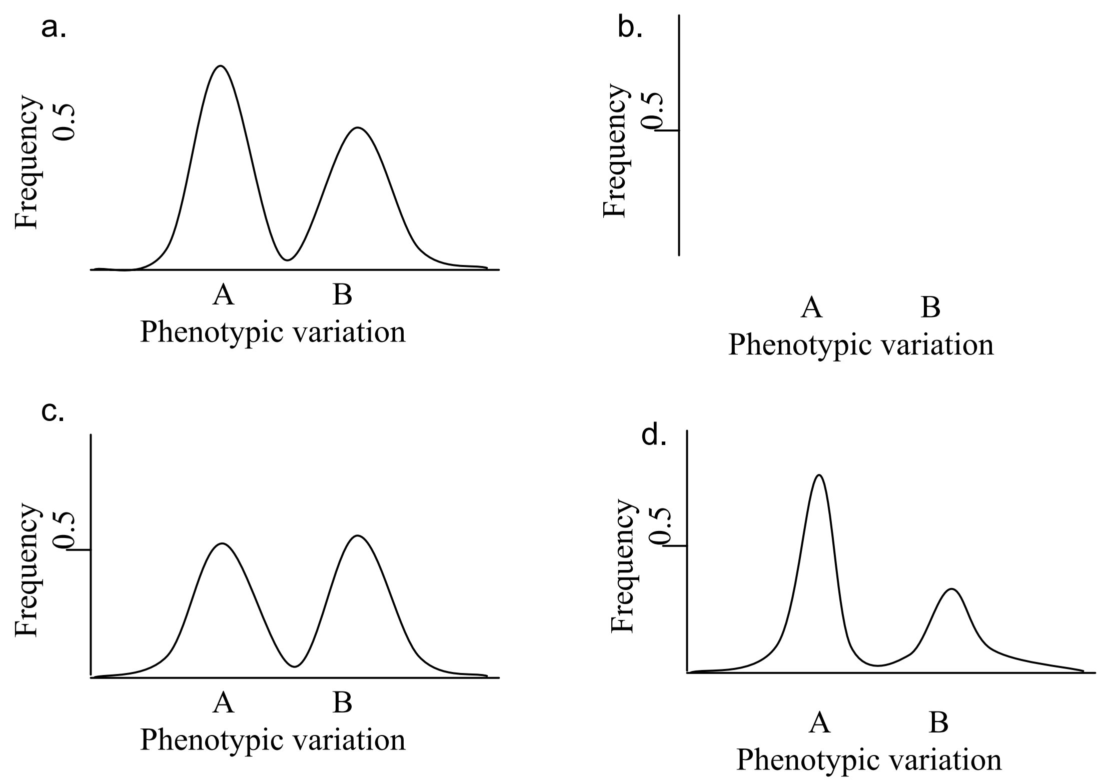


d.



a.	b.	c.	d.

(B) In another situation, number of butterflies of species C suddenly came down in one generation. What is the most likely effect of this on species A and B after many generations? Put a tick mark (√) in the appropriate box in the table.



a.	b.	c.	d.

ETHOLOGY (6.5)

50. (3.5 points) Some species of animals exhibit territoriality behaviour, ie. they defend their territory so as to gain access to the resources available, while some species do not exhibit such behaviour. Costs and benefits associated with it ultimately decide whether this behaviour will evolve or not. Consider the following variables:

E_B: Basic cost of living
E_T: Cost of defending a territory
P: Total production in the territory (resources)
aP: Fraction of resources available without defending territory
(1-a)P: Additional fraction of resources available as a result of defending territory
e: Efficiency of defending territory (this can vary from 0 to 1)

(A) The behaviour of territoriality is **not** likely to evolve when:
Put tick mark/s (√) in the appropriate box/es in the table.

a. $E_B = aP$
b. $E_B = P$
c. $E_T < E_B$
d. $P >> E_B$
e. $P < E_B + E_T$
f. $E_B < aP$

a.	b.	c.	d.	e.	f.

(B) The behaviour is likely to evolve when:

Put a tick mark (√) in the appropriate box in the table.

a. $E_B + E_T < aP + e\ (1\text{-}a)P$

b. $E_B + E_T < e\ (1\text{-}a)P/aP$

c. $E_B + E_T < aP + eP$

d. $E_B + E_T > aP$

a.	b.	c.	d.

51. (3 points) Hamilton proposed a quantitative measure for predicting when natural selection would favour altruistic acts among related individuals. According to this rule, altruism is favoured when,

$rB > C$

where,

r is the genetic relatedness between the altruist and the beneficiary,

B is the benefit to the beneficiary in terms of number of offspring gained, and

C is the cost to the altruist in terms of number of offspring lost.

Now consider a hypothetical situation where a young boy goes out surfing with his maternal uncle of similar age, none of whom have any children yet. The boy is about to drown in heavy surf. Assuming that the members of the human population average two children each and that the uncle is a fairly good swimmer with only a 20% chance of drowning, would he attempt to save his nephew?

(A) In order to predict his decision, calculate the following values:

rB = ________________

C = ______________

(B) In accordance with Hamilton's rule, would the uncle in this situation save his nephew? Put a tick mark (√) in the appropriate box in the table.

a. Yes
b. No
c. May or may not
d. Cannot say, as data are insufficient.

a.	b.	c.	d.

ECOLOGY (10)

52. (5 points) Defending a territory requires time and energy. Any animal should only defend territories if the benefits of defense outweigh the costs.

Consider a sunbird that feeds only on the nectar of flowers.

When the sunbird obtained an average of 1 microlitre of nectar per flower, it needed 8 hours of foraging to meet its daily energy requirements. This time was reduced to 4 h if it gained 2 microlitres of nectar per flower and to 2.7 h if it gained 3 microlitres of nectar per flower.

Metabolic costs associated with various activities of sunbird are as follows:

Foraging for nectar: 1000 cal/h
Sitting on a perch: 400 cal /h
Territory defence: 3000 cal/h

If the bird defends the territory the its net gain of nectar per flower increases from 2 microliters to 3 microliters but the bird needs to spent 0.28 h per day for defense.

Calculate the following:

(A) If the bird does not defend the territory,

1. the daily energy spent in foraging = ________

2. the daily energy spent in defending = ________

3. the daily energy spent in perching = ________

(B) If the bird defends its territory,

1. the daily energy spent in foraging = ________

2. the daily energy spent in defending = ________

3. the daily energy spent in perching = _________

(C) Mark the correct interpretation. Put a tick mark (√) in the appropriate box in the table.

a. In the above situation, the bird is likely to show territory defense as the net perching cost is reduced.

b. In the above situation, the bird is not likely to show territory defense as the cost associated with it is greater than the energy spent in foraging.

c. In the above situation, the bird is likely to show territory defense as the net benefit by defending a territory is higher than by not defending it.

d. In the above situation, the bird is not likely to show territory defense as the cost associated with perching and defense both overcome the energy saved in foraging.

a.	b.	c.	d.

53. (2 points) The life history of an organism is a result of differential allocation of resources towards survival and reproduction. In order to study the impact of predation on the life history of guppies, following three sites were chosen. These three sites differed only with respect to the predator species and the type of predation as follows:

i. Site 1 had a cichlid (*Crenicichla alta*) as a predator with high predation intensity, predominantly feeding on adult guppies.
ii. Site 2 had a killifish (*Rivulus hartii*) as a predator with moderate predation, predominantly feeding on juvenile guppies.
iii. Site 3 had a killifish (*Aequidens pulcher*) as a predator with low predation, on all size classes of guppies.

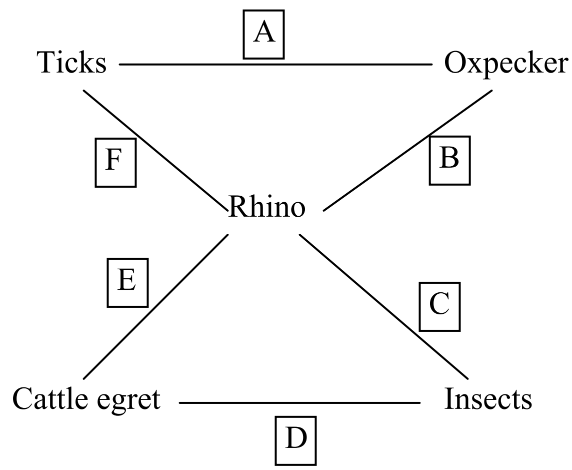
Indicate whether each of the following strategies will lead to maximum survival of the guppies at each site. Fill in the table by putting a tick mark (√) in the appropriate box against each strategy number.

1. More allocation of resources towards reproduction in guppies at site 1 as compared to site 2 and 3.
2. Reduced time between the two successive reproductive cycles in guppies at site 2 as compared to site 1.
3. Large number of offspring in Site 1 as compared to site 2.
4. Each offspring of larger size in site 1 as compared to site 2 and 3.

Strategy	Yes	No
1.		
2.		
3.		
4.		

54. (3 points) On the African plain, large herbivores like black rhinoceros disturb insect communities as they move. Birds like cattle egret feeds on the displaced insects. Neither the displacement of insects nor the activity of birds has any effect on the rhino. Oxpecker (a small dark bird) removes ticks from the skin of the rhino. The bird gets food & the mammals get relief from parasites.
An outline of these inter-relationships in given below.
Match the alphabets with the relationship that the organisms possess among themselves and then write only appropriate number in the space against each alphabet.

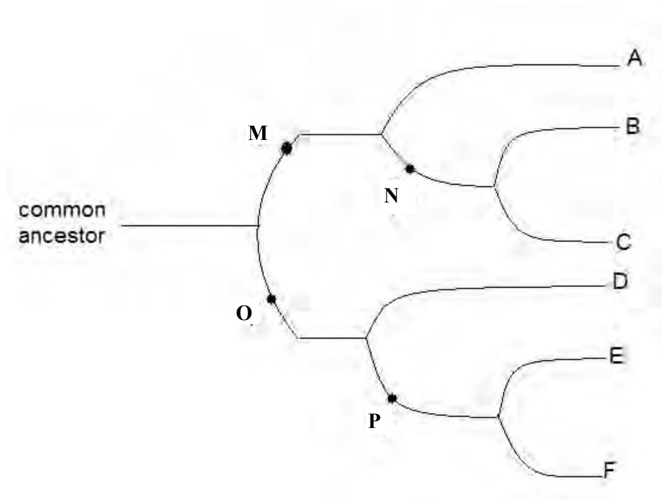
1. Predation
2. Parasitism
3. Commensalism
4. Amensalism
5. Mutualism
6. Competition



A. ______
B. ______
C. ______
D. ______
E. ______
F. ______

BIOSYSTEMATICS (7)

55. (1 point) A phylogenetic tree is shown below.



Deduce the appropriate inferences from the phylogenetic tree. Put a tick mark (√) in the appropriate box in the table.

a. Differences between A and D will be of same degree as B and C.
b. Differences between B and D will be more than A and C.
c. A and C includes all the descendants of a single ancestor.
d. Reproductive isolation between A and N ultimately led to speciation of B and C.

a.	b.	c.	d.

56. (2 points) From palaeontological samples, scientists isolate mitochondrial DNA to compare extinct species with non-extinct ones. Which of the properties of mitochondrial DNA are useful for this analysis?
Put tick mark/s (√) in the appropriate box/es in the table.

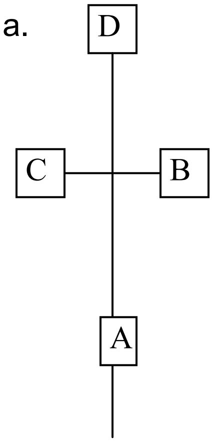
a. Mitochondrial DNA being circular is more stable and degrades slowly as compared to nuclear DNA.
b. Each cell contains many copies of mitochondrial DNA as compared to only one copy of nuclear DNA.
c. Mitochondrial DNA sequences do not recombine.
d. Some sequences in the mitochondrial DNA that mutate at a faster rate can be used to study closely related species.

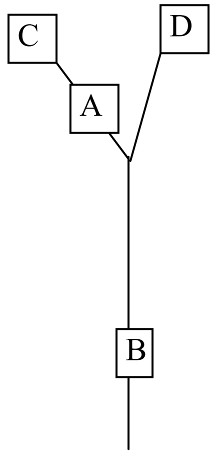
a.	b.	c.	d.

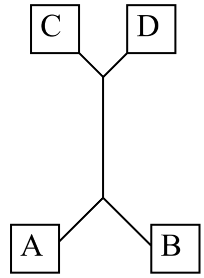
57. (4 points) The following data reveals pair-wise genetic distance between four species A, B, C and D. Each number indicates % difference between the pair.

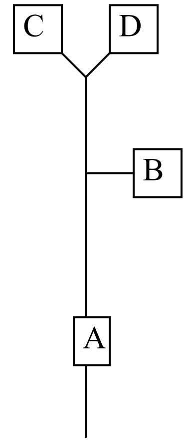
	A	B	C	D
A	-	11%	15%	15%
B	-	-	10%	10%
C	-	-	-	4%
D	-	-	-	-

(A) Which of the following tree structures represent the matrix data most appropriately? The lengths of the lines in the following figures approximate the genetic differences between them. Put a tick mark (√) in the appropriate box in the table.

a. 

b. 

c. 

d. 

a.	b.	c.	d.

(B) Based on the answer selected in the previous question and using the data given in the table, construct the cladogram that correctly shows the genetic distances of the four species. Indicate the distances by writing the numbers on the respective lines.

****

INDIAN NATIONAL BIOLOGY OLYMPIAD- 2010

ANSWER KEY: SECTION A

Q. No.	a	b	c	d	Q. No.	a	b	c	d
1	■				18				■
2	■			■	19	■			
3	■				20				■
4	■				21				■
5		■			22		■		
6				■	23	■			
7		■			24				■
8			■		25		■		
9				■	26		■		
10	■				27				■
11				■	28		■		
12		■	■		29		■		
13				■	30			■	
14		■			31		■		
15			■		32			■	
16		■			33		■		
17				■	34		■		

ANSWER KEY: SECTION B

CELL BIOLOGY (20.5)

35. (2 points)

a.	b.	c.	d.	e.	f.	g.
	√		√		√	√

36. (6 points)

(A)

a.	b.	c.
	√	

(B)

a.	b.	c.
	√	

(C)

a.	b.	c.
	√	

37. (3 points)

Answer: ____________________________________c, e, g, d, b, k

38. (2 points)

(A) Answer: ______a

(B) Answer: ______b

39. (3 points)

(A)

a.	b.	c.	d.
√			

(B)

a.	b.	c.	d.
√			

40. (2.5 points)

Answer: _____8

41. (2 points)

Answer: ________9×10^6

PLANT SCIENCES (4)

42. (2 points)

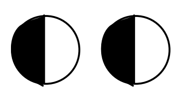
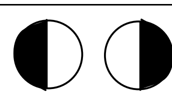
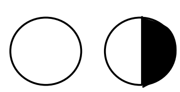
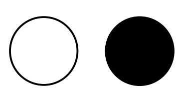
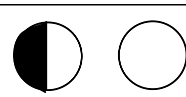
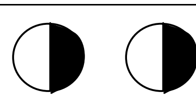
a.	b.	c.	d.
			√

43. (2 points)

a.	b.	c.	d.
√			

ANIMAL SCIENCES (9)

44. (4 points)

Visual Field defect (Black portion in the circle indicates loss of vision)	Lesion site
	4
	3
	
	2
	1
	

45. (5 points)

(A)

Conclusion	Yes	No
a.		√
b.	√	
c.		√
d.		√
e.		√
f.	√	

(B).

a.	b.	c.	d.
	√		

GENETICS & EVOLUTION (9)

46. (3 points)

(A)

a.	b.	c.	d.
√			

(B)

a.	b.	c.	d.
		√	

(C)

a.	b.	c.	d.
		√	

47. (2 points)

I	II	III	IV
		√	

48. (2 points)

Answer: ________28.571% or 29%

49. (2 points)

(A)

a.	b.	c.	d.
			√

(B)

a.	b.	c.	d.
		√	√

ETHOLOGY (6.5)

50. (3.5 points)

(A)

a.	b.	c.	d.	e.	f.
√				√	√

(B)

a.	b.	c.	d.
√			

51. (3 points)

(A)

rB = ____________ 0.5

C = _____________ 0.4

(B)

a.	b.	c.	d.
√			

ECOLOGY (10)

52. (5 points)

(A)

1. ________4000 cal

2. ________0 cal

3. ________8000 cal

(B)

1. ________2700 cal

2. ________840 cal

3. _________8408 cal

(C)

a.	b.	c.	d.
		√	

53. (2 points)

Strategy	Yes	No
1.	√	
2.		√
3.	√	
4.		√

54. (3 points)

A. ______ 1
B. ______ 5
C. ______ 4
D. ______ 1
E. ______ 3
F. ______ 2

BIOSYSTEMATICS (7)

55. (1 point)

a.	b.	c.	d.
	√		

56. (2 points)

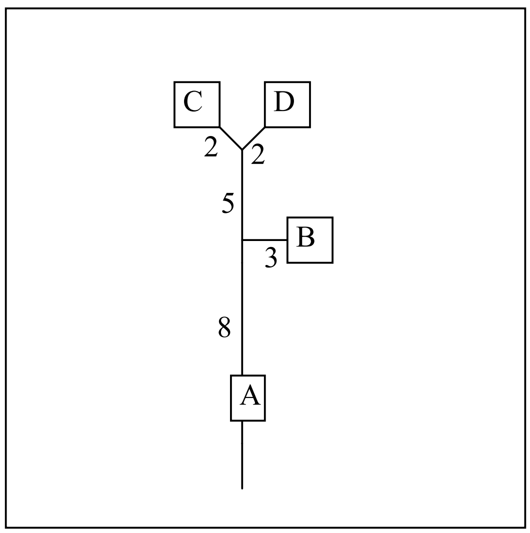
a.	b.	c.	d.
√	√	√	√

57. (4 points)

(A)

a.	b.	c.	d.
			√

(B)



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