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Test Booklet Code

25

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Answers & Solutions

for

Indian Olympiad Qualifiers (Part II)

Biology (IOQB) 2020-21

INSTRUCTIONS TO CANDIDATES

(1) This question paper is divided into **Section-A** and **B**.

(2) **Section-A** consists of 30 questions carrying 1 point each.

(3) All 30 questions are of multiple choice type with only one correct answer for each question.

(4) Each wrong answer will have negative marking as indicated in the scoring key.

(5) **Section-B** consists of 22 questions with a total of 50 points.

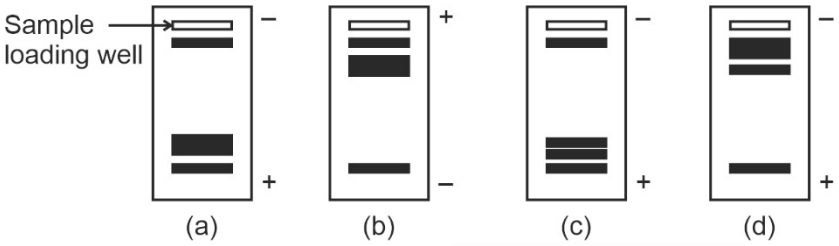
(6) The points for the questions in **Section-B** vary depending on the number of answers and the complexity of the question. These points have been indicated along with the question.

(7) Contradictory answers will not be considered for marking.

Section-A

Cell Biology (5 points)

1. (1 point) Circular plasmid DNA in a tube was treated with restriction enzymes such that fragments of size 200 bp, 400 bp, 400 bp and 900 bp were obtained. This treated sample was loaded in an agarose gel and electrophoresis was carried out to separate the fragments. The expected result showing relative positions of bands obtained would be:



Answer (a)

Sol. During gel electrophoresis, DNA (negatively charged) move towards anode (positive electrode). Smaller the fragment farther it moves. As we treat the DNA with restriction enzyme, different sized (200 bp, 400 bp, 400 bp and 900 bp) fragments were obtained. Since, more number of fragments are of 400 bp so, thickness of band will be more than other bands. As difference in the size of 200 bp and 900 bp fragments is quiet large so their band will relatively far apart.

2. (1 point) Match the processes (A – D) listed in Group I with the correct descriptions given in Group II and choose the correct answer.

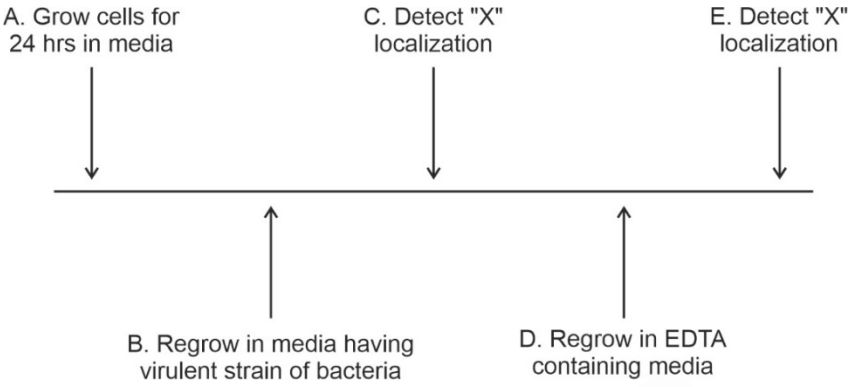
	Group I		Group II
A.	Osmosis	i.	Diffusional space outside plasma membrane
B.	Guttation	ii.	Diffusional space within plasma membrane
C.	Apoplast	iii.	Movement of water across membrane
D.	Symplast	iv.	Fluid exudate

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

Answer (a)

Sol.
- Osmosis refers to movement of water across membrane.
- Guttation is the process of exudation of liquid drops from the margin of leaves. It can be also said as fluid exudate.
- Apoplast refers to the pathway via which plants absorb water. It consists of non-living parts of plant body, *i.e.*, a diffusional space outside plasma membrane.
- Symplast is a diffusional space within plasma membrane.

3. (1 point) While studying eukaryotic cell lines, it was found that nuclear localization signals in these cells mediate nuclear localization of proteins. Transcription factor, X in these cells, moves inside the nucleus and activates transcription of defense genes when a bacterial infection is detected by the cell. A virulent strain of bacteria injects a calcium-dependent toxin that inhibits the nuclear transport of 'X'. Carefully study the experimental set up.



Which of the following outcomes can be expected?

(i) At step C, 'X' will be inside the nucleus to induce defense gene expression.

(ii) At step E, 'X' will be inside the nucleus to induce defense gene expression.

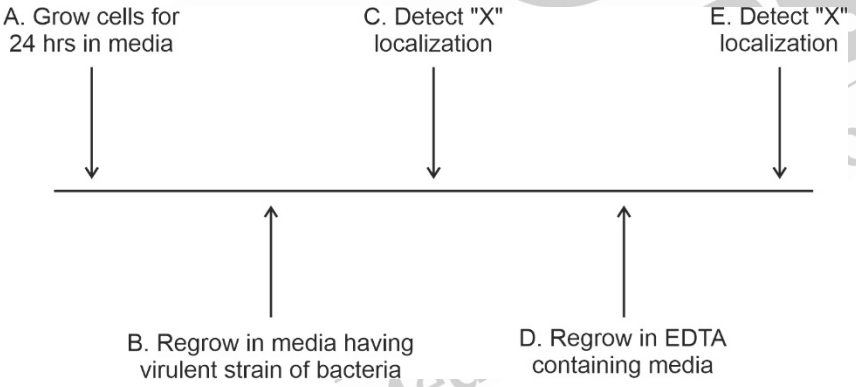
(iii) At step E, 'X' defense gene expression will be at its lowest levels.

(iv) Nuclear levels of "X" at step C are always lesser than at step E.

(a) Only (i) and (ii)
(b) Only (i), (iii), and (iv)
(c) Only (ii) and (iv)
(d) Only (ii), (iii), and (iv)

Answer (c)

Sol.



According to the given question, 'X' is the transcription factor, activates transcription of defense genes when a bacterial infection is detected by cell.

When a virulent strain of bacteria injects a Ca-dependent toxin that inhibits nuclear transport of 'X'.

The given interpretations/outcomes can be expected:

A. At step E, 'X' will be inside the nucleus to induce defense gene expression because of the activity of EDTA.

B. Nuclear level of 'X' at step C are always lesser than at step E.

C. At step C, 'X' will unable to get transported in the nucleus as the cell is regrowing in media having virulent strain of bacteria.

D. At step E, 'X' defense gene expression will be higher because of the activity of EDTA.

Thus, option 'c' only (ii) & (iv) is correct.

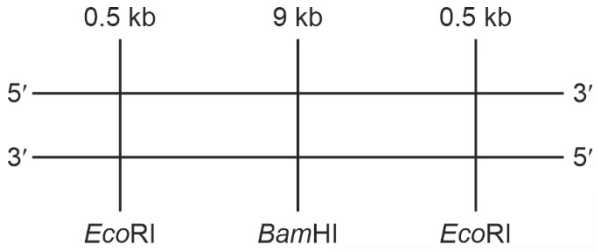
4. (1 point) A researcher is working on a 10 kb pure DNA fragment. This DNA has restriction sites for *Eco*RI and *Bam*HI. *Eco*RI sites are located at 0.5 kb from each end in the DNA while *Bam*HI site is at the centre of the DNA fragment. If both the enzymes are used by the researcher to digest the DNA, how many bands are expected in the agarose get (considering complete digestion)?

(a) 2 (b) 3

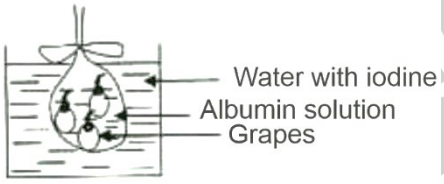
(c) 4 (d) 5

Answer (c)

Sol. Option (c) is the correct answer. A 10 kb linear fragment of DNA is digested by *Bam*HI & *Eco*RI. Total 3 restriction sites are present and 4 fragments will be obtained after double digestion.



5. (1 point) A dialysis bag was filled with concentrated albumin solution and then a few grapes were added. The bag was tied with thread to make it leakproof and then suspended in a beaker containing water (as shown in the diagram). A few drops of iodine were added to the water. Which of the following results can be expected after 12 hr?



(a) Increase in the total weight of the bag.

(b) Solution in the bag will turn blue.

(c) Water in the beaker will test positive for protein.

(d) Rise in the level of water in the beaker.

Answer (a)

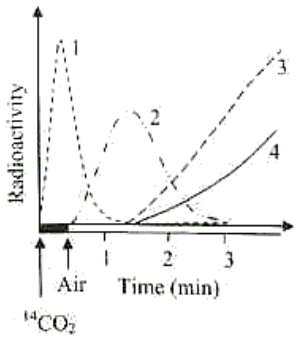
Sol. As dialysis bag membrane is semipermeable. Hence, water from beaker diffuses to dialysis bag and causes an increase in total weight of bag.

Albumin does not show any reaction once it interacts with iodine.

Hence, correct option should be (a)

PLANT SCIENCES (7 points)

6. (1 point) Appearance of ^{14}C containing compounds during photosynthesis in a sugarcane plant are depicted in the graph.



1, 2, 3 and 4 respectively represent:

(a) 3-phosphoglyceric acid, malic acid, starch, sucrose.

(b) Malic acid, 3-phosphoglyceric acid, sucrose, starch.

(c) Malic acid, 3-phosphoglyceric acid, starch, sucrose.

(d) 3-phosphoglyceric acid, malic acid, sucrose, starch.

Answer (b)

Sol. According to given question; Sugarcane is a C_4 plant.

The graph in the question shows appearances of ^{14}C containing compounds during photosynthesis in C_4 plant (sugarcane) w.r.t. time. According to graph, different peaks are obtained which reflects various compounds:

Peaks	Compound
1	Malic acid
2	3-phosphoglyceric acid
3	Sucrose
4	Starch

7. (1 point) 'Mostly male' hypothesis of Michael and Frohlich states that bisexual flower organization derives more from the male structures of ancestral gymnosperms than from female structures. From which of the following facts in this hypothesis derived?

(a) Male cones of certain pteridophytes and gymnosperms resemble primitive flowers like lotus.

(b) Genes for flower development in angiosperms and microsporophyll development in gymnosperms are closely related.

(c) Position of flowers resembles that of male cones.

(d) All the above

Answer (b)

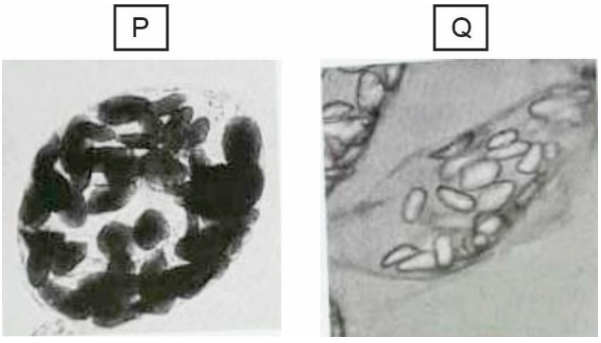
Sol. The 'mostly male' hypothesis of Michael and Frohlich is the first to use evidence from gene phylogenies, genetics, modern plant morphology and fossils to explain the evolutionary origin of flowers. It proposes that flower organization derives more from the male structures of ancestral gymnosperms than from female structures.

The hypothesis is derived from the following facts that

Genes for flower development in angiosperm and microsporophyll development in gymnosperms are closely related.

Hence, option (b) should be correct.

8. (1 Point) Cells of two banana fruits stained with iodine solution are shown. Black filled colour indicates blue colouration.



Mark the correct statement.

(a) P is a ripe banana as it has well developed organelle structure.

(b) Q is a ripe banana as it shows no stored starch.

(c) P is an unripe banana as it shows enhanced amylase activity.

(d) Q is an unripe banana as the cellular structures have not fully developed.

Answer (b)

Sol. According to given question,

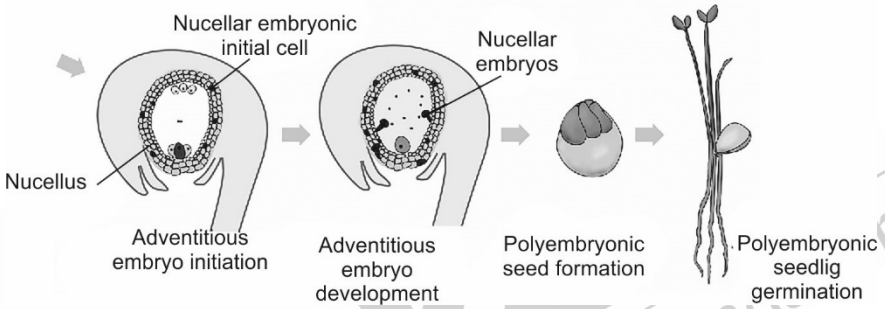
P $\rightarrow$ unripe banana cell, Q $\rightarrow$ ripe banana cell.

In 'P', staining with iodine solution turns the starch blue.

In 'Q', there is no reaction with the solution, because the amount of starch is reduced and amyloplasts are no longer present.

Hence, Q is ripe banana and it shows no stored starch.

9. (1 point) In many citrus fruits, poly-embryonic seed formation takes place where, one or two nucellar cells start growing as embryos along with the zygotic embryo. As a result, seed germinates to give rise to as many as two or three plantlets. If one wants to grow the plant with same characteristics of fruit from which the seed is obtained, which of the plantlets can be used?



(a) The one from zygotic embryo is the best choice as it has hybrid vigour.

(b) The nucellus embryo plantlet as it is a clone of the mother plant.

(c) As there will be competition for survival among the three plantlets, the most healthy and largest in size is the best choice.

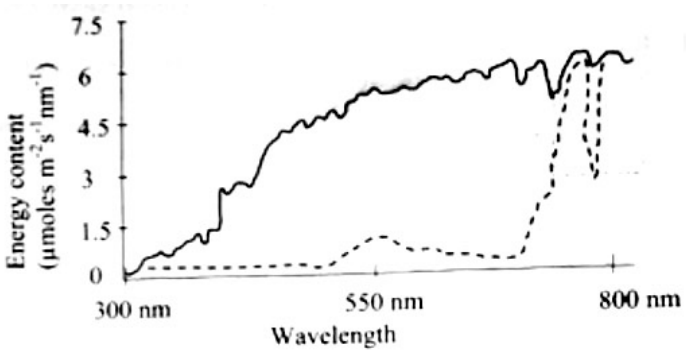
(d) Any of the three as all will have the same phenotypes.

Answer (b)

Sol. Apomictic embryos or nucellar embryos will be identical to the mother plant.

Hence option (b) should be correct.

10. (1 point) Most of the solar radiation that reaches earth is made up of visible and infrared light. Full sunlight spectrum with energy content is depicted in the graph by a solid line.



The broken line indicates:

(a) Action spectrum of photosynthesis in shade plants.

(b) Absorption spectrum of pigments in shade plants.

(c) Photooxidation efficiency of visible spectrum.

(d) Transmitted light under a canopy.

Answer (d)

Sol. Shade plants are able to capture and use radiation in the yellow and green regions of the spectrum but not in the infra red region.

The broken line indicates transmitted light from the canopy. Hence maximum transmission is seen under 800 nm as it is not absorbed by plants.

11. (1 point) "Girdling" is the process of removal of outer tissues around the branch or trunk of a woody plant. Girdling can be shallow (i.e., only bark is removed) or deep (i.e., bark along with xylem is removed). Which one of the following will result if a grapes-bearing branch of a plant is girdled?

(a) If the girdling is shallow, it will not have any effect on the plant.

(b) If the girdling is deep, the leaves on the branch will become turgid as transpiration will halt.

(c) If the girdling is deep, the plant will die.

(d) If the girdling is shallow, the fruits on the branch will be sweeter.

Answer (d)

Sol. The phloem is responsible for translocation of food and xylem for water.

If the girdling is shallow, then the phloem is removed. So, phloem will not transport sugars to other parts of the plants anymore. Hence there will be accumulation of sugars in the upper region only and the fruits on the branch will be sweeter.

12. (1 point) Harshad accidentally found a slide of a preserved plant specimen without a label. He placed the slide under a compound microscope to identify the specimen. He observed the following features:

i. Multicellular structure

ii. Outermost periderm

iii. Primary xylem tetrarch

iv. Primary vascular tissues widely separated due to the activity of cambium

v. Primary xylem showing metaxylem elements at the center

The specimen most likely represents:

(a) Young dicot stem

(b) Mature dicot root

(c) Young monocot stem

(d) Mature monocot root

Answer (b)

Sol. According to the given features obtained on identification of specimen, it can be observed that when plant has periderm which means it shows secondary growth. Monocots and young dicot stem do not show secondary growth.

Hence, the specimen most likely represents mature dicot root. This, option (b) should be correct.

ANIMAL SCIENCES (5 points)

13. (1 point) Individuals with diabetes are prescribed a low glycemic index diet. The reason this is that:

(a) Their dietary carbohydrate requirement is lower than that of non-diabetic individuals.

(b) They cannot assimilate complex carbohydrates such as starch.

(c) They need to have slow but sustained release of glucose in their blood.

(d) They can tolerate lower, but not higher than normal blood sugar levels.

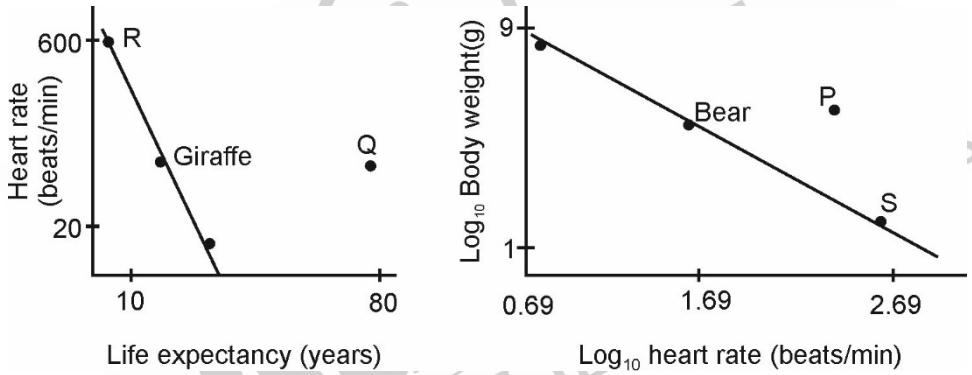
Answer (c)

Sol. Option (c) is the correct answer as carbohydrate metabolism is majorly maintained by hormones insulin and glucagon.

Carbohydrate requirement of a diabetic normally similar to that of a non-diabetic individual and they can assimilate starch through proper digestion and hormone activity.

Diabetes require slow but sustained release of glucose in their blood.

14. It has been known that among mammals, there is a characteristic relationship between the heart rate and body weight as well as heart rate and life expectancy as shown in the graph. Although these relationships are valid for most mammals, a few animals do deviate from the pattern due to a variety of reasons, e.g., body plan.



P, Q, R and S respectively, represent:

(a) Whale, horse, rat and elephant

(b) Shrew, dog, whale and mouse

(c) Dolphin, elephant, rat and cat

(d) Giraffe, human, rat and mouse

Answer (d)

Sol. P = Giraffe, as body weight of giraffe (P) is more than bear.

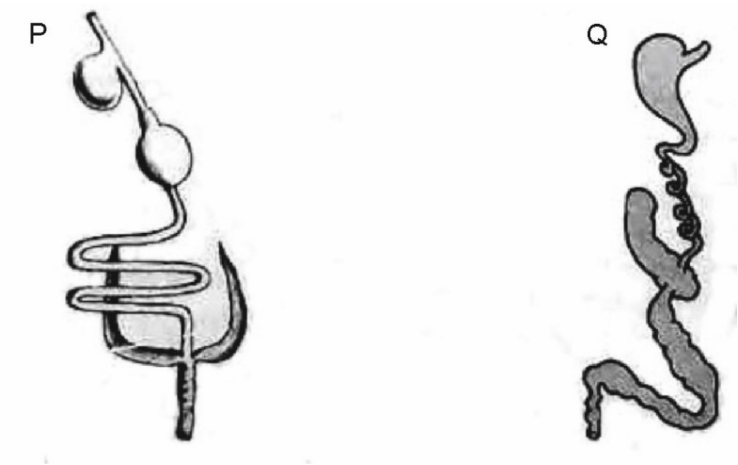
Q = Human, as life expectancy of human is around 70 years. There is large difference in the life expectancy of giraffe and human though their heart rate is nearly same.

R = Rat, as heart rate of rat is more because its body size is less.

$$\text{Heart rate} \propto \frac{1}{\text{size}}$$

S = Mouse, as body weight of mouse is very less as compared to bear and animal 'P' i.e. giraffe.

15. (1 point) The digestive systems of two animals P and Q are shown.



P and Q respectively represent:

(a) Ruminant and non-ruminant mammal

(b) Foregut fermenter and hindgut fermenter

(c) Monogastric and ruminant animal

(d) Bird and hindgut fermenter

Answer (d)

Sol. Option (d) is the correct answer.

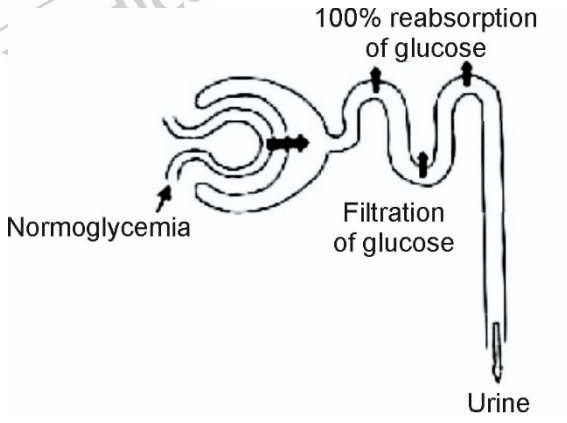
P = birds, their digestive system comprises additional chambers crop and gizzard.

Q = hindgut fermenter which have enlarged fermentation compartments in the cecum and/or colon.

Foregut fermenter such as cow exhibit pre-gastric fermentation.

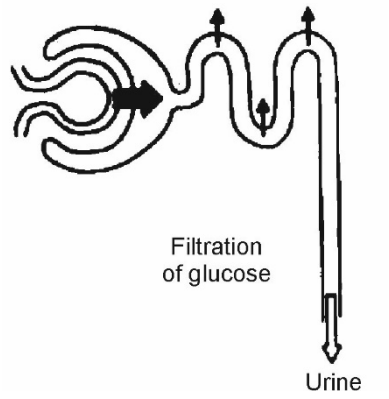
16. (1 point) Normal glucose filtration pattern by kidneys is shown in the diagram:

(Note that the filled arrows in the figures indicate the relative quantities of glucose while the unfilled arrows indicate relative volumes of urine.)

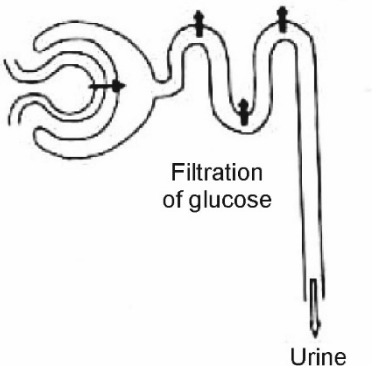


Which of the following figures correctly depicts the condition of diabetes mellitus?

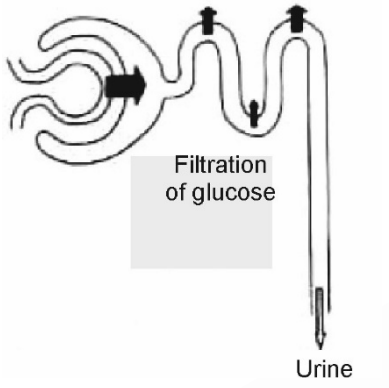
(a)



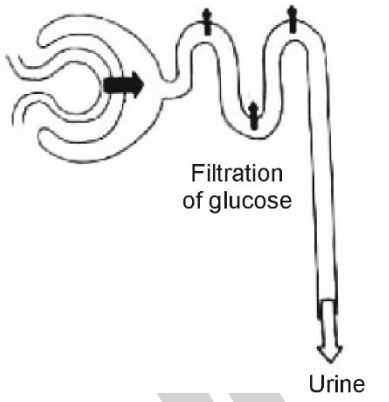
(b)



(c)



(d)



Answer (d)

Sol. Option (d) is the correct answer.

Diabetes mellitus is characterised by high glucose levels in urine (glycosuria), large amounts of urine (polyuria) and ketonuria.

Option (d) is indicating polyuria as relative volume of urine increases as per size of unfilled arrow. Amount of urine is nearly similar or slightly reduced in option (b) and (c) relative to a non-diabetic person.

17. (1 point) Ward Watt and co-workers were working on butterflies of genus *Colias*. The population of these butterflies are polymorphic for a gene *phosphoglucose isomerase*. This gene encodes the enzyme PGI, which affects the heat tolerance limit of the insect. It was found that males heterozygous for *pgi* could mate more successfully than homozygous males.

This could be because :

(a) Heterozygous males have longer life span than homozygous ones.

(b) Heterozygous males can fly at any time of the day and irrespective of season.

(c) Heterozygosity leads to hybrid vigour giving rise to large sized butterflies.

(d) Homozygous individuals produce excessive enzyme which impairs body temperature control mechanism.

Answer (d)

Sol. According to given question :

PGI affects heat tolerance limit of insect. Male heterozygous for *pgi* could mate more successfully than homozygous males because, the individuals with homozygous allele produces excessive enzyme which impairs body temperature control mechanism.

Allele frequency at the enzyme locus PGI vary across a climatic latitudinal gradient in these populations, with PGI allele 1 being most common in cooler region and PGI allele 4 in warmer ones. PGI genotype differ in heat and cold tolerance in expression of a 70 kDa heat shock protein.

GENETIC & EVOLUTION (6 points)

18. (1 point) Consider a population of 100 cats of which 84 are black cats and 16 are white. Assuming that coat colour is a single gene inheritance, calculate the number of heterozygous cats.

(a) 36 (b) 40

(c) 48 (d) 84

Answer (c)

Sol. Option (c) is the correct answer

Under HWE, $p + q = 1$; $(p + q)^2 = 1$

$$\left.\begin{array}{ll} q^2 = 0.16 & \therefore q = 0.4 \\ p^2 = 0.84 & p = 0.6 \end{array}\right\} p + q = 1$$

Number of heterozygous cats = 2 pq

$= 2 \times 0.4 \times 0.6$

$= 0.48 = 48$ cats

19. (1 point) Two closely related species A and B show genotypes $A_{\alpha\beta}$ and $B_{\alpha\beta\gamma}$. Considering α, β and γ are homologs that have diverged functionally, the most probable events that would have occurred to yield species A and B from a common ancestor is :

(a) Gene duplication event 1 $\rightarrow$ gene functional divergence 1 $\rightarrow$ speciation $\rightarrow$ gene duplication event 2 $\rightarrow$ gene functional divergence 2.

(b) Speciation $\rightarrow$ gene duplication event 1 $\rightarrow$gene functional divergence 1 $\rightarrow$ gene duplication event 2 $\rightarrow$ gene functional divergence 2.

(c) Gene duplication event 1 $\rightarrow$ gene functional divergence 1 $\rightarrow$ gene duplication event 2 $\rightarrow$ gene functional divergence 2 $\rightarrow$ speciation.

(d) Simultaneous occurrence of gene duplication and speciation.

Answer (a)

Sol. Option (a) is the correct answer. If using the principle of Parsimony where we choose the simplest scientific explanation that fits the evidence. The best hypothesis is the one that requires fewest evolutionary changes.

Gene duplication 1 $\rightarrow$ Divergence $\rightarrow$ speciation $\rightarrow$ Duplication 2 $\rightarrow$ functional divergence 2.

20. (1 point) The probability of the progeny having *AaBbccDd* genotypes from the cross between *AaBbCcDd* and *AaBbCcDd* is :

(a) 1/16 (b) 1/32

(c) 1/256 (d) 1/2

Answer (b)

Sol. According to given question

AaBbCcDd × *AaBbCcDd*

$\downarrow$

AaBbccDd

The probability of progeny with genotype $\underset{\Rightarrow \frac{1}{2} \times}{\underset{\downarrow}{Aa}}\ \underset{\downarrow}{Bb}\ \underset{\downarrow}{cc}\ \underset{\downarrow}{Dd} \quad \frac{1}{2} \times \frac{1}{4} \times \frac{1}{2}$

$$= \frac{1}{32}$$

21. (1 point) The coat colour in rabbits is determined by a polymorphic gene with four alleles (C, c, c^{ch}, c^{h}). The genotypes and the corresponding phenotypes are listed in the table.

Genotypes	Phenotypes
$c^h\ c^h$, $c^h\ c$	Himalayan
$c^{ch}\ c^{ch}$	Dark grey
CC, Cc^{ch}, Cc^h, Cc	Brown
cc	Albino
$c^{ch}\ c^h$, $c^{ch}\ c$	Light grey

The correct order of dominance of the alleles is

(a) $c^h > c > C > c^{ch}$ (b) $C > c^h > c^{ch} > c$

(c) $C > c^{ch} > c^h > c$ (d) $C > c^h > c > c^{ch}$

Answer (c)

Sol. In coat colour of rabbit;

- Allele C is dominant over all others (c^{ch}, c^h and c)
- Allele c^{ch} is dominant over c^h and c
- Allele c^h is dominant over c
- Allele c is recessive to all others (C, c^{ch} and c^h)

Hence, correct order of dominance of the allele is

$$\boxed{C > c^{ch} > c^{h} > c}$$

Thus, correct option should be (c)

22. (1 point) The lac operon is a cluster of genes consisting of *lac* Z, *lac* Y and *lac* A genes. If there is a loss of function mutation in the *lac* Y gene, the consequence will be that

(a) The *lac* genes will be expressed constitutively

(b) The *lac* genes will be expressed only if lactose is absent

(c) The *lac* genes will be expressed only if lactose is provided in the medium

(d) The *lac* genes will not be expressed even if lactose is present in the medium

Answer (d)

Sol.

	lac z	*lac* y	*lac* a genes
	↓	↓	↓
Codes for	β-galactosidase	Permease	Transacetylase

If gene *lac* y is mutated, there will be no permease which is responsible for the entry of lactose into the cell.

Hence even in presence of lactose there will be no expression of genes as *lac* y is mutated.

23. (1 point) A compound 'X' inhibits the enzyme required for the regeneration of Vitamin K. Mice treated with 'X' often bleed to death from a minute injury. A mutation confers resistance by altering the enzyme to a form that is less sensitive to 'X', but also less efficient in regenerating vitamin K. Thus, higher dietary intake of the vitamin will be needed. Under exposure to 'X', resistant mice have a strong survival advantage. This is an example of

(a) Directional selection (b) Stabilizing selection

(c) Niche diversification (d) Disruptive selection

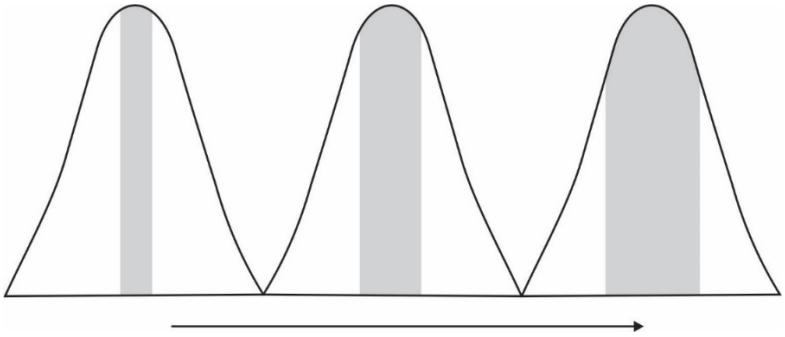
Answer (a)

Sol. Option (a) is the correct answer.

This is an example of directional or progressive selection since in a directional change more individuals acquire value other than the mean character value. Directional selection is ensuring survival advantage to resistant mice in context of inhibitor 'X' of enzyme required for regeneration of vitamin K.

ECOLOGY (5 points)

24. (1 point) The diagram represents transition in the spread of individuals of a population of birds under the influence of a species interaction. Which type of interaction will lead to the change in pattern of distribution of birds indicated by the shaded region (as indicated by the arrow)?



(a) Predation
(b) Parasitism
(c) Interspecific competition
(d) Intraspecific competition

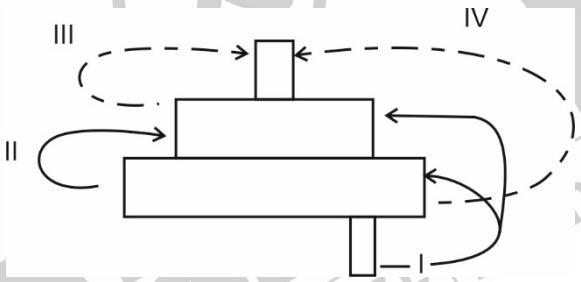
Answer (d)

Sol. According to given question,

A progressive change is observed in pattern of distribution of birds.

Intraspecific competition leads to such event where individuals of same species are competing for the same resource. The birds being dominant survives and increases their population while the inferior one(s) are eliminated hence, (d) should be correct option.

25. (1 point) Biomass pyramid of a terrestrial ecosystem is shown. Arrows indicate energy transfer at various levels.

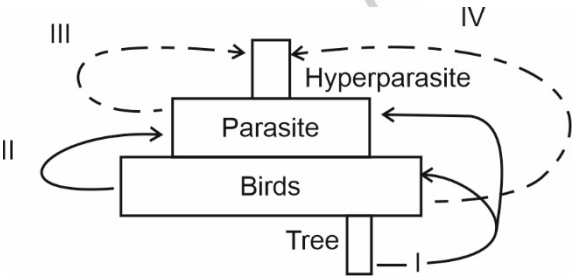


The major energy transfer occurs at:

(a) I
(b) II
(c) III
(d) IV

Answer (a)

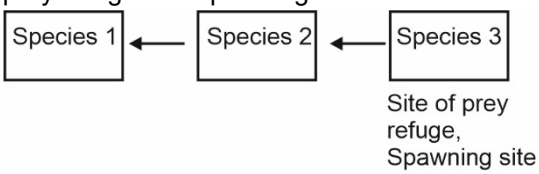
Sol. According to the given question, the pyramid is of single tree ecosystem.



I refers to flow of energy from producers. Hence, the major energy transfer occurs at I.

$\therefore$ The correct option should be (a)

26. (1 point) Possible interactions between three species near a sea shore are depicted. Among the three species, species 3 also acts as a site of prey refuge and spawning.



Introduction of Species 1 to the site will:

(i) decrease the biodiversity.

(ii) decrease the habitat complexity.

(iii) prevent dominance of species which would otherwise lead to loss of biodiversity.

(a) i and ii
(b) ii and iii
(c) i and iii
(d) iii only

Answer (d)

Sol. According to given question, species 3 also acts as site of prey refuge and spawning.

- Prey refuge can be broadly defined to include any strategy that decreases predation risk.
- Spawning is the process of releasing the eggs and sperm, and the act of both sexes is called spawning.

If species 1 are introduced to the site, it will lead to

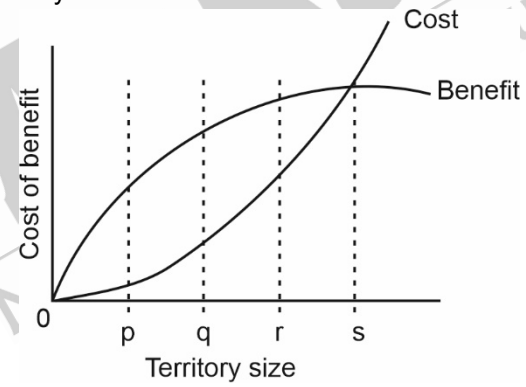
(1) Increase in biodiversity

(2) Increase in habitat complexity

(3) Prevent dominance of species which would otherwise lead to loss of biodiversity.

Hence, only option (d) should be correct

27. (1 point) Territorial behaviour is exhibited by animals in order to protect the territory from intrusion by other members of its species. There is cost and benefit associated with this behaviour. The cost and benefit vary depending on the size of the territory defended.



In which of the following situations is territorial behaviour to be observed?

(a) Territory with abundant resources.

(b) Habitat with limited availability of resources and high renewal rate.

(c) Availability of resources unpredictable in space and time.

(d) Habitat where conspecifics are almost absent.

Answer (b)

Sol. Option (b) is correct because territorial behaviour is likely to be observed when benefit is more than the cost. Defending a territory requires time and energy and, if aggressive defense is needed, may pose some risk of injury (or, in extreme cases, even death). So, time, energy, and risk of injury are the 'costs' of territory defense. The improved access to resources represents the benefit(s) of territory defense.

28. (1 point) Refer to Question No. 27, where different territory sizes are denoted as p, q, r and s in the graph. Which territory size is optimum for an animal to defend?

(a) p (b) q

(c) r (d) s

Answer (b)

Sol. Option (b) is correct because 'q' is optimum territory size as benefit gained is more as compared to other territory sizes.

BIOSYSTEMATICS (2 points)

29. (1 point) The presence (1) or absence (0) of certain features in four animals (M – P) is shown below.

	Jaws	Lungs	Amniotic membrane	Hair	Tail
M	1	1	1	0	1
N	1	1	1	1	1
O	1	1	1	1	0
P	1	0	0	0	1

M, N, O and P respectively represent:

(a) Tiger, Lizard, Gorilla, Shark (b) Lizard, Gorilla, Tiger, Shark

(c) Lizard, Tiger, Gorilla, Shark (d) Shark, Tiger, Gorilla, Lizard

Answer (c)

Sol. Option (c) is the correct answer.

M = Lizard as it lacks hair but has jaws, lungs, amnion and a tail.

N = Tiger as it has all the given features

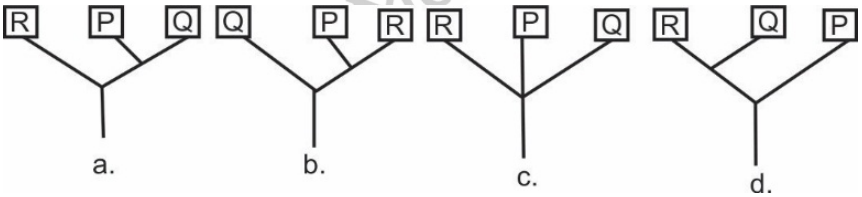
O = Gorilla, it's an ape & lacks a tail

P = Shark, a cartilaginous fish & has gills for respiration not lungs.

30. (1 Point) The molecular/organelle characteristics of three organisms P, Q and R belonging to the three domains of life are tabulated below.

	Introns	Membrane-bound organelles	Peptidoglycan in cell wall	Nuclear envelope
P	Present in some genes	Absent	Absent	Absent
Q	Absent	Absent	Present	Absent
R	Present	Present	Absent	Present

Choose the correct cladogram that depicts their probable evolutionary lineage.



Answer (b)

Sol. P - Archaea
Q - Bacteria } These are three domains proposed by Carl Woese.
R - Eukarya

Archaebacteria show more similarities with eukaryotes than bacteria. It has introns in same genes too.

Peptidoglycan is present in cell wall of bacteria only.

Section-B

CELL BIOLOGY (6 points)

31. (2 Points) Proteins and phospholipids from major parts of several cellular structures such plasma membranes. Properties of four structures found in living cells are listed in the table.

Structure	Cholesterol	Protein/lipid ratio (w/w)
1	Present	1.2
2	Present	4.6
3	Present	0.25
4	Absent	3.0

1-4 respectively most likely represent:

Choose the correct option and put a tick mark (✓) in the appropriate box.

(a) Erythrocyte membrane, membrane of gram positive bacterium, myelin, membrane of gram negative bacterium.

(b) Erythrocyte membrane, myelin, membrane of liver cell, membrane of kidney cell.

(c) Membrane of intestinal epithelial cell, myelin, membrane of gram positive bacterium, membrane of liver cell.

(d) Membrane of liver cell, membrane of intestinal epithelial cell, myelin, membrane of gram positive bacterium.

Answer (d)

Sol. Cholesterol is absent in membrane of gram positive becterium.

Following are protein/lipid ratio (w/w) of different cellular strurctures :-

Protein/lipid ratio (w/w)	Structure
1.2	Membrane of liver cell, Erythrocyte membrane
4.6	Membrane of intestinal epithelial cell
0.25	Myelin
3.0	Membrane of gram positive bacterium

32. (2 Points) During an excavation, graves of five children were discovered. A couple is suspected to be parents of three of the children. STR (short tandem repeats) obtained in DNA fingerprint analysis of all of them are as follows:

	Number of repeats	
	Parent I	**Parent 2**
STR-1	15,16	15, 18
STR-2	8, 8	7, 10
STR-3	3, 5	7, 7
STR-4	12,13	12, 12
STR-5	32, 36	11. 32

Children	Number of repeats				
	1	2	3	4	5
STR-1	15, 16	15, 18	16, 18	15, 15	15, 18
STR-2	8, 10	7, 8	8, 10	7, 8	8, 8
STR-3	3, 5	3, 7	5, 7	3, 7	5, 7
STR-4	12, 13	12, 12	12, 12	12, 13	12, 12
STR-5	11, 32	32, 32	11, 36	32, 36	32, 32

Which of the three children belong to the couple?

Choose the correct option and put a tick mark (✓) in the appropriate box.

(a) 1, 2 and 3 (b) 2, 3 and 4

(c) 3, 4 and 5 (d) 1, 2 and 4

Answer (b)

Sol. STR is a co-dominant marker. The alleles of different STR loci are inherited like any other Mendelian genetic markers.

Diploid parents, each pass on one of their two alleles of their offspring.

Children 2, 3 & 4 receive STR markers from both the parents.

Hence, option (b) should be correct.

33. (2 points) During an immune response, it has been shown that for many antigens, the antibody production depends on the cooperation between T lymphocytes and B lymphocytes. Some antigens are, however, capable of stimulating B cells for the synthesis and secretion of specific antibodies in the absence of functional T cells.

Two antigens namely, TNP-LPS (TNP covalently conjugated to bacterial lipopolysaccharide) and TNP-KHL (TNP conjugated to snail hemocyanin) were used to study the response in-vivo as well as in-vitro.

In an in-vivo experiment, when these antigens were tested in athymic mice, they showed a response as indicated in figure 1.

In an in-vitro experiment, spleen lymphocytes were collected and antibody response was studied by culturing the cells at two different temperatures (27ºC and 37ºC) with or without addition of Oleic acid to the cultures. The results of this experiment are shown in Figure 2.

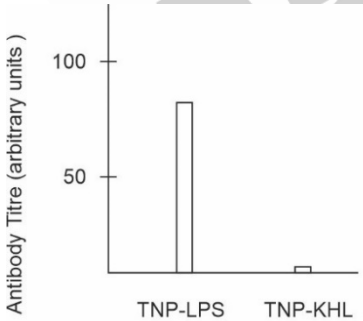


Figure 1

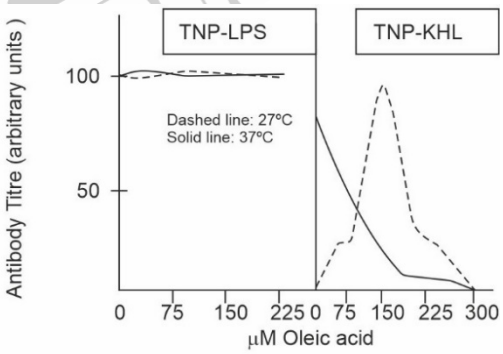


Figure 2

Based on the results, indicate whether each of the following can or cannot be deduced by putting tick marks in the appropriate boxes (✓).

(a) TNP-LPS invokes T-dependent antibody response.

(b) B lymphocytes are likely to lose the membrane fluidity at high temperatures.

(c) Inclusion of oleic acid in the culture medium leads to antigen specific suppression of immune response at 37ºC.

(d) It is likely that T lymphocytes lack the ability to synthesise unsaturated fatty acids.

Answer (c, d)

Sol. Option (c) & (d) are correct.

Option (a) is incorrect as even in athymic mice, TNP-LPS invokes T-independent antibody response as indicated by antibody titre.

Option (b) cannot be deduced as antibody formation/titre is nearly similar at 27ºC & 37ºC, for TNP-LPS antigen.

Option (c) is correct as one can observe antigen dependent/specific suppression of immune response in TNP-LPS and TNP-KHL with regards to antibody titre.

PLANT SCIENCES (4 points)

34. (2 points) Many flowers that appear to be uniform in colour to the human eye show dark and light patterns when viewed under ultra-violet light. Usually the dark region or "the bulls-eye" region is the centre of the flower. Moreover, these dark areas are found to be larger in flowers which grow in regions closer to the equator.

A few statements about the adaptive value of this trait in such flowers are made. Mark the statements as true or false by putting tick marks (✓) in the appropriate boxes.

(a) The darker regions of flower absorb UV radiation and play a protective role.

(b) Many insect pollinators have good vision in the UV region of light, thus the dark region helps attract the pollinators by acting as nectar guide.

(c) Larger area of bulls-eye region of flowers growing near equator compensates for the reduced frequency of pollinating insects near equator.

(d) Larger the area of the dark regions, less accurate is the signal as a nectar guide.

Sol. Many flowers show patterns in ultraviolet spectrum characterised by dark areas in centre called bull's eye. Bull's eye increases towards equator.

(a) These dark areas absorb ultraviolet rays and play a protective role. (T)

(b) Many insect pollinators have good vision in the UV region of light, thus the dark region helps attract the pollinator acting as nectar guide. (T)

(c) Larger area of bull's-eye region of flowers growing near equator compensates for reduced frequency of pollinating insects near equator. (F)

(d) Larger the area of dark regions, less accurate is the signal as a nectar guide. (T)

35. (2 points) Plant have evolved to sense and respond to changes in daylight as seasons shift. Plant growing near street lights can be affected in several ways. Mark the following statements as true or false by putting tick marks (✓) in the appropriate boxes.

(a) A deciduous green plant, if grown very close to a street light is likely to show delayed senescence.

(b) A long day plant is likely to show reduced days of flowering if grown close to a street light.

(c) If grown close to street lights, insect pollinated plants are less likely to be affected than bird pollinated plants.

(d) Flowering of a plant native to equatorial region is least likely to be affected if grown under the influence of a street light.

Sol. (a) Deciduous plants measure light and detect when days are getting shorter or longer and decide the fall and get senesced. So planting them close to street light is likely to show delayed senescence. (T)

(b) Long day plant if grown under light may have interrupted night period and thus show reduced flowering. (F)

(c) If grown close to street lights, insect pollinated plants are more likely to be affected than bird pollinated plants because day and night pollinated insects are adapted particular flower colour. (F)

(d) Flowering of plant native to equatorial region is least likely to be affected if grown under the influence of a street light. (T)

ANIMAL SCIENCES (10 points)

36. (2 points) In a research on red-eared slider turtle, it was observed that:

(i) Eggs incubated below 28.6ºC give rise to male hatchlings while those incubated above 29.4ºC lead to formation of female hatchlings.

(ii) Incubation temperature of the embryo affects the expression of the enzyme aromatase, which converts testosterone to estrogen.

Fill in the table with the appropriate experimental conditions and the outcomes that can confirm the link between the two observations. Choose from the options provided. *Only an entirely correct row will be awarded points.*

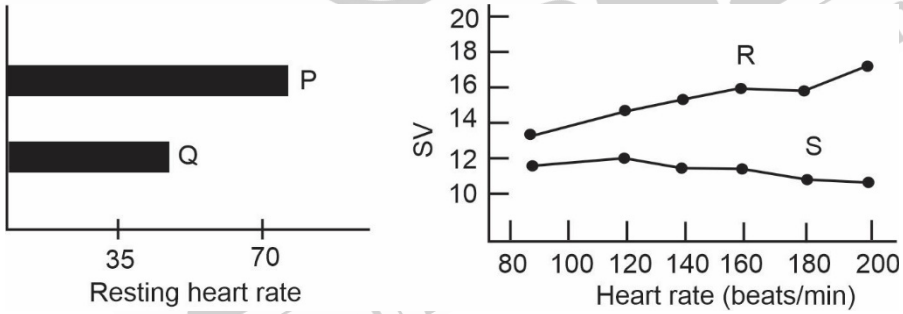
Answer

Experimental conditions	Temperature (Options 28ºC / 30ºC)	Effect Options : All Males /All Females/ Both males and females /Sterile females
Addition of aromatase inhibitor	30ºC	All Males

Sol. In presence of aromatase inhibitor testosterone to estrogen conversion will not occur and rise in temperature increases aromatase activity.

All hatchlings will be males around 30ºC.

37. (2 points) Resting heart rates (P and Q) and stroke volumes (SV) during exercise (R and S) for two individuals are depicted.



Parameters P, Q, R and S are characteristic of

Choose the correct option and put a tick mark (✓) in the appropriate box.

(a) P and S: Trained athlete, Q and R: Untrained healthy individual.

(b) P and R: Trained athlete, Q and S: Untrained healthy individual.

(c) P and S: Untrained healthy individual, Q and R: Trained athlete.

(d) Q and R: Normal healthy individual, P and S: Individual with cardiac dysfunction.

Answer (c)

Sol. Option (c) is correct because trained athletes have a low resting heart rate and a high stroke volume than untrained healthy individual as represented by Q and R.

P and S indicate data corresponding to untrained healthy individual.

38. (2 Points) For an individual 'X' blood sample was collected by two methods, namely, by finger- prick and by venepuncture. The samples were collected twice in a day once before breakfast (fasting blood sugar) and then 30 minutes after lunch (post-prandial blood sugar). The results are shown in the table.

Time	Method	Sugar levels mg/dL
Fasting	Finger-prick	91
	Venipuncture	87
Post-prandial	Finger-prick	163
	Venipuncture	122

Choose the correct statement and put a tick mark (✓) in the appropriate box.

(a) Finger-prick method gives erroneous values as small volumes of blood are drawn as compared to venous sample.

(b) Capillaries in the finger being closer to arteries carry greater amount of glucose after food absorption.

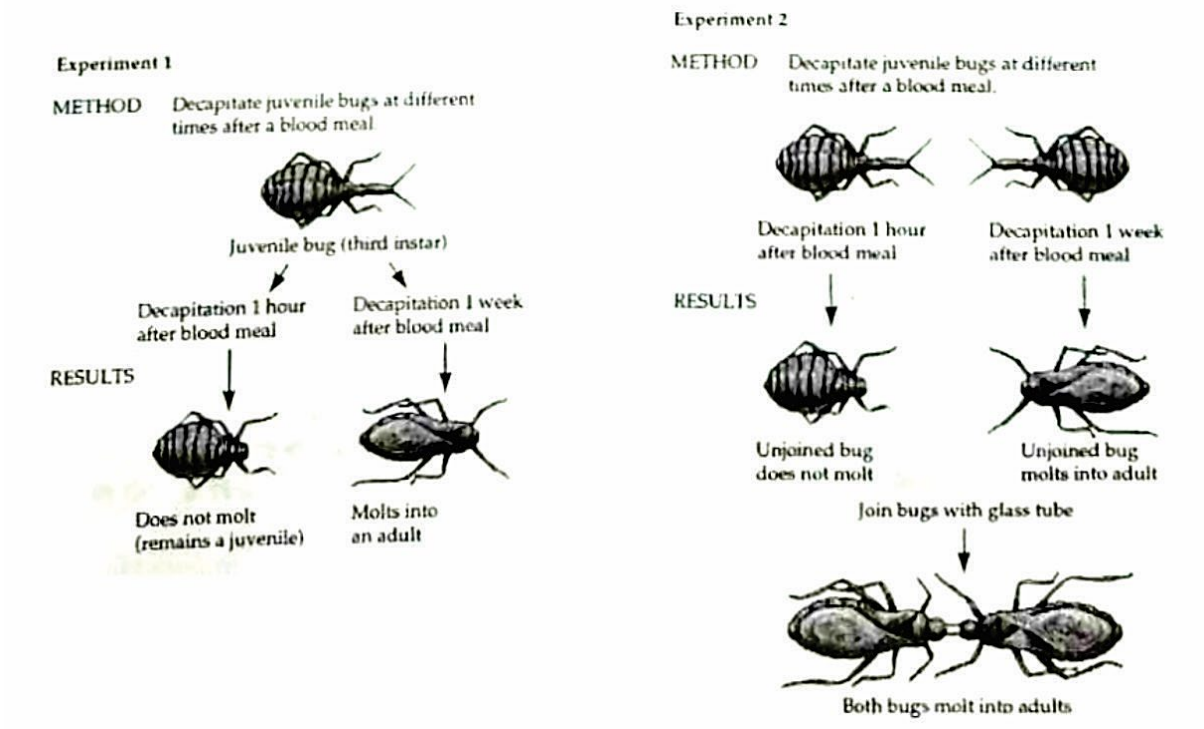
(c) Finger-prick method gives high reading after food intake as most of the unabsorbed glucose is returning to venules.

(d) Post-prandial results indicate that the person is suffering from over-secretion of insulin and reduced secretion of glucagon in the blood.

Answer (b)

Sol. Option (b) is correct as finger-prick method gives values of glucose higher than that obtained from venipuncture method because arteriole end of capillaries carry more glucose. As blood passes through capillary bed, some amount of glucose diffuses out into tissue fluid and eventually taken up by the body cells. So, venule end of capillaries have relatively less amount of glucose in comparison to arteriole end of capillaries. Hence, blood glucose level in veins is comparatively less than the blood glucose level in arteries.

39. (2 Points) Following two experiments were performed to understand hormonal control on moulting in *Rhodnius* insect.



Based on the results, indicate whether each of the following can or cannot be concluded by putting tick marks (✓) in the appropriate boxes.

(a) Substances must diffuse from head to body for moulting in *Rhodnius*.

(b) The abdomen part is more crucial for moulting as compared to head.

(c) The obtained results are not sufficient to locate the body part responsible for moulting in *Rhodnius*.

(d) Time lapsed after the decapitation is crucial for moulting.

Answer (a)

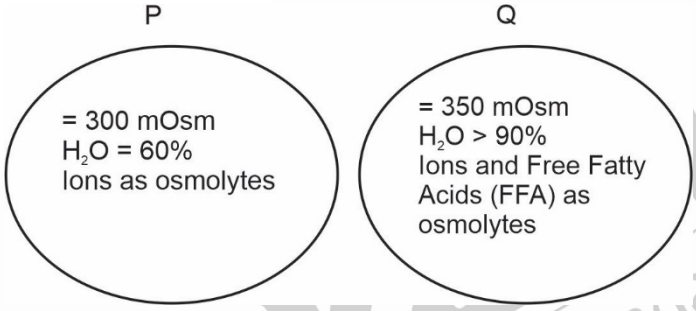
Sol. Statement (a) is correct because substances diffuse from head to body for moulting in *Rhodnius* insect.

Statement (b) is incorrect because the head part is more crucial for moulting as compared to abdomen.

Statement (c) is incorrect because the information given is sufficient to deduce the body part which is responsible for moulting in *Rhodnius.*

Statement (d) is incorrect because the time lapsed after the decapitation is not crucial for moulting.

40. (2 points) Teleost fish, after dwelling for several million years in fresh water, made re-entry into sea water. Thus, they are found in both marine as well as fresh water habitats. In both these environments, there are several challenges of osmoregulation. The blood osmolarity of these fishes in either environment lies between 300 to 350 mOsm. Eggs and early embryos of these fishes show special adaptation to overcome these problems. Composition of two developing embryos (P and Q) are represented below:



Choose the correct interpretation and put a tick mark (✓) in the appropriate box.

(a) In P, the composition will allow slow osmotic water gain within the limits of rigid chorionic membranes.

(b) In Q, the excess water content and free fatty acids will prevent any osmotic water loss to the environment.

(c) P shows adaptation to marine environment as ions found in the sea water are the only osmolytes present in the embryo.

(d) Q shows that it is adapted for fresh water habitat as its large content of water will prevent any further influx of water in the cells.

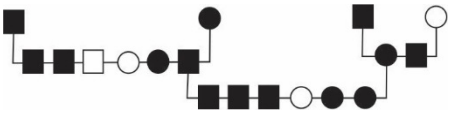
Answer (a)

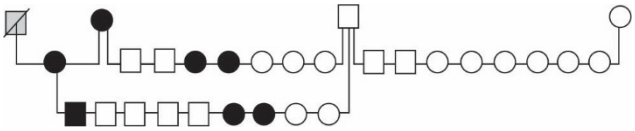
Sol. Option (a) is the correct answer.

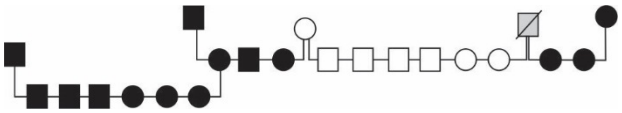
- Net movement of water molecules always occur from lower concentration to higher concentration of osmolytes.
- Embryo P is present in hypotonic medium, so, the composition of P embryo will allow slow osmotic water gain within the limits of rigid chorionic membrane.
- Option (b) is incorrect because excess water content in body will allow osmotic water loss in hypertonic medium.
- Option (c) is incorrect because only sea water ions are not the only osmolytes present in the embryo.
- Option (d) is incorrect because as osmolarity of 'Q' embryo is on higher side as compared to 'P' embryo, hence, it is adapted to marine water.

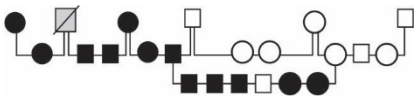
GENETICS & EVOLUTION (13.5 points)

41. (1.5 points) An erythrocyte antigen *dal* has been identified in Dalmatian and Doberman Pinschers which causes *dal* related incompatibilities during blood transfusion. The results of pedigree analysis of several dogs are depicted.

A.


B


C


D


Squares indicate males and circles indicate females. Filled structures indicate(s) Dal^+ phenotype while unfilled structures indicate Dal^- phenotype. ☒ Indicates status unknown.

The probable mode of inheritance of Dal+ phenotype is:

Choose the correct option and put a tick mark (✓) in the appropriate box.

(a) Autosomal recessive
(b) X-linked recessive
(c) Autosomal dominant
(d) X-linked dominant

Answer (c)

Sol. Square indicates – males

Circle indicates – females.

☒ indicates – states unknown for dal phenotype.

Filled square and filled circle – Dal^+

Unfilled square and unfilled circle – Dal^-

Given pedigree is autosomal dominant as it is seen in every generation.

42. (6.5 points) A population of fruit files (*Drosophila pseudoobscura*) that were growing in a standard corn meal agar medium was divided into four groups. Two groups of 100 flies each were transferred to a medium containing maltose (Mal and MalI) while the remaining two groups of 100 flies each were transferred to a medium containing starch as food source (Stl and StlI). The flies were then maintained in the respective medium for a period of one year after which, flies from all four groups were transferred to standard corn meal agar medium for one generation. Flies from each group were tested against the other to study mating preference behaviour. The results are shown below.

Data Set 1		
Males	Females	
	Mal	Stl
Mal	25	7
Stl	8	16

Data Set 2		
Males	Females	
	MalI	StlI
MalI	29	9
StlI	10	26

Data Set 3		
Males	Females	
	MalI	StlI
Mal	29	9
Stl	10	26

Data Set 4		
Males	Females	
	Mal	StlI
Mal	12	12
StlI	15	14

The data can be analyzed by finding isolation index(I) as follows:

I = (homogametic mating – heterogametic mating)/total matings.

(A) Find I value for data sets 1,2 and 4 and fill in the respective blanks. *Note that the final answers will be given marks only if calculations are shown in the box given. Give your answer upto 3 decimal places.*

(B) Mark the following interpretations as true of false by putting tick marks (✓) in the appropriate boxes.

(a) The behaviour of flies observed in the experiment was due to conditioning of flies to the respective media.

(b) The isolating mechanism to which flies are exposed in the experiment is pre-zygotic isolation.

(c) Apart from the type of medium used, the physical isolation of flies could also be responsible for the results obtained.

(d) The experimental design is erroneous as males from one type of flies behave differently to the females of the same population as seen in data set 1 versus data set 4.

(e) The behavior observed in the experiment is an example of sympatric speciation.

(f) The data indicates that the two media regimes have affected sexual activity of the flies reared in them.

(g) If one obtains significantly high value of I for data set 4, it will be an indication of effect of segregation of flies.

Sol. (A) $I = \dfrac{\text{Homogametic mating} - \text{Heterogametic mating}}{\text{Total mating}}$

Data Set-1	Data Set-2	Data Set-4
Homogametic mating $= 25 + 16 \Rightarrow 41$ Heterogametic mating $= 7 + 8 \Rightarrow 15$ $\therefore$ Total mating $= 41 + 15 = 56$ $\therefore I = \dfrac{41-15}{56}$ $= \dfrac{26}{56} = 0\cdot46428$ $= 0{\cdot}464$	Homogametic mating : $29 + 26 \Rightarrow 55$ Heterogametic mating $10 + 9 \Rightarrow 19$ $\therefore$ Total mating $= 55 + 19 = 74$ $\therefore I = \dfrac{55-19}{74}$ $= \dfrac{36}{74} = 0\cdot48648$ $= 0{\cdot}486$	Homogametic mating $= 12 + 14 \Rightarrow 26$ Heterogametic mating $15 + 12 \Rightarrow 27$ $\therefore$ Total mating $= 26 + 27 = 53$ $\therefore I = \dfrac{26-27}{53}$ $= \dfrac{-1}{53}$ $= 0{\cdot}486$ $\Rightarrow -0{\cdot}018867$ $\Rightarrow -0{\cdot}0188$

(B)

	a	b	c	d	e	f	g
True		✓					✓
False	✓		✓	✓	✓	✓	

Following are the interpretations from set of experiment :

(a) The behavior of flies observed in the experiment does not depend on conditioning of flies to the respective media

(b) The isolating mechanism to which flies are exposed in the experiment is pre-zygotic isolation as it prevents mating and fertilization.

The overall experiment is based on habitat isolation, behavioral isolation, and gametic isolation.

(c) The physical isolation of flies will not be responsible for result obtained.

(d) The experimental design is non-erroneous.

(e) The behaviour observed in the experiment is an example of allopatric speciation as groups from an ancestral population evolve into separate species due to a period of geographical separation.

(f) The data indicates that two media regimes have not affected sexual activity of flies reared in them.

(g) If there would be segregation of flies, then I for data set 4 would have significantly higher.

43. (4 points) Statements describing traits that have different patterns of inheritance are given below. Identify the type of trait from the options listed and match them against the appropriate statement. Fill in the blanks with correct alphabets corresponding to the correct option.

(i) The trait appears with equal frequency in males and females. Affected children are commonly born to unaffected parents.

(ii) The trait appears with equal frequency in males and females. Affected persons have an affected parent and the trait does not skip generations.

(iii) Trait appears more often in males and is passed from mother to son. Affected sons are usually born to unaffected mothers and the trait tends to skip generations.

(iv) The trait appears with equal frequency in males and females. However, it cannot be passed on from father to son. Single copy of a gene is enough for the trait to appear.

Options:

(a) X-linked recessive (b) X-linked dominant

(c) Autosomal recessive (d) Autosomal dominant

Sol. (i) – c Autosomal recessive

(ii) – d Autosomal dominant

(iii) – a X-linked recessive

(iv) – b X-linked dominant

44. (1.5 points) In a population at Hardy-Weinberg equilibrium, 19% show dominant phenotype. Calculate the dominant allele frequency and fill in the blank. *Note that the final answer will be given marks only if calculations are shown in the box given.*

Sol. Dominant phenotype = 19%

Recessive phenotype = (100 – 19) % = 81%

$$q^2 = \frac{81}{100}$$

$$q = \frac{9}{10} = 0.9$$

$\because$ $p + q = 1$

$p = 1 - q$

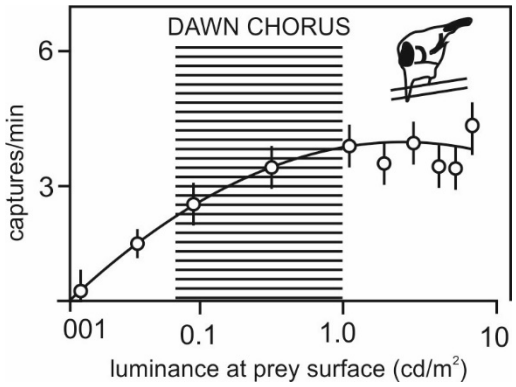
$= 1 - 0.9$

$= 0.1$

$\therefore$ $\boxed{p = 0.1}$

ECOLOGY (16.5 points)

45. (2 points) The graph depicts the behaviour of birds as the day breaks.



It can be deduced from the graph that the dawn chorus:

(Choose the correct option and put a tick mark (✓) in the appropriate box.)

(a) in birds communicates the increased prey availability.

(b) is linked to low visibility and the consequent low prey captures.

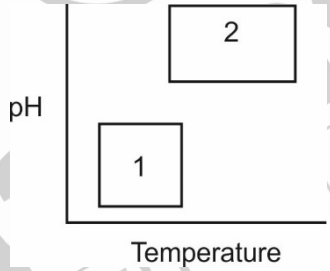
(c) could be linked to the lower abundance of prey during dawn.

(d) announces better visibility of prey and better food source.

Answer (b)

Sol. Dawn chorus is characterised by singing of bird at the beginning of day. At the beginning of day the visibility is low and so is the low prey captures.

46. (2 points) Water backswimmer (*Notonecta* sp.) and water boatman (*Corixa* sp.) are two insects that are found wherever there are shallow vegetation-choked areas in a pond or lake. Their temperature and pH tolerance limits are shown in the graph.



Which of the following is/are correct?

i. Bot species share the same habitat.

ii. It is likely that species 1 feeds on decaying vegetation.

iii. The two species have overlapping fundamental niche.

iv. Both the species share the same realised niche.

Choose the correct option and put a tick mark (✓) in the appropriate box.

(a) i and iii (b) ii only

(c) ii and iv (d) i and ii

Answer (d)

Sol. As both species are found in the shallow vegetation choked areas in a pond or lake. So, both species share the same habitat.

Species 1 feeds on decaying vegetation as it survives in optimum temperature. Most of the species do not have overlapping fundamental niche.

So, the correct option is (d) i and ii.

47. (2 points) Ecologists use the mark-recapture method to estimate population sizes in natural habitats. In this method, a portion of the population is captured, marked and released back to mix with the rest of the population. After some time, another portion is captured and the number of marked individuals within this sample is counted. From this captured proportion, the total population size is estimated.

A scientist was using this method to count fish in a large pond, He used baited hooks to capture the fish not realizing that some fish are more attracted to baits than others. He initially captured 60 fish, marked them and released them back into the river. After a week, he captured a group of 80 fish using the same type of bait used for the initial capture. What would be the expected outcome of this method?

Choose the correct option and put a tick mark (✓) in the appropriate box.

(a) He would be able to estimate the exact population size of the fish.

(b) He would underestimate the population size.

(c) He would overestimate the population size.

(d) He would get the same population size estimate as he would have got if he had used any other capture technique.

Answer (b)

Sol. We can not count the exact population size of the organism in mark-recapture method. Any mark - recapture method would get you the same population size.

48. (2.5 points) Intensive urbanization of past several decades has destroyed several native habitats or fragmented them into smaller patches. When 28 patches of such a habitat where studied for its natural inhabitants such as coyotes, opossum, raccoon and birds and diversity of birds, following common observations were made.

i. Absence of coyotes (dominant predator): bird diversity decreases.

ii. Absence of raccoon (mesopredator) and skunks : bird diversity increases.

iii. Smaller area of patch : bird diversity decreases.

Based on the information given, indicate whether the following statements can be deduced or cannot be deduced by putting tick marks (✓) in the appropriate boxes.

(a) Bird population size is affected only by mesopredator.

(b) Greater fragmentation leads to capture of mesopredator by dominant predator.

(c) Coyotes thrive on mesopredator and not on birds.

(d) Bird diversity can be improved if dominant predator is introduced in the fragmented habitat.

(e) The greater the time of disconnect of the patch from its mainland, more protected are the bird species.

Answer (c, d)

Sol. Statement (a) can not be deduced as bird population size is also affected by absence of dominant predator.

Statement (b) can not be deduced as reason for absence of raccoon and skunks can be other than capture by dominant predator on greater fragmentation.

Statement (c) can be deduced as bird diversity is indirectly affected by absence of coyotes.

Statement (d) can be deduced because presence of dominant predator can decrease population of mesopredators which are predators of birds. Hence, bird diversity can be improved.

Statement (e) can not be deduced from the given information.

49. (2 points) The amount of chemical energy in a consumer's food that is converted to their own new biomass during a given period is called the secondary production. Consider a bird that eats plant seeds containing 300J of energy and excretes 150J in feces. If the secondary production of this bird is 20% then calculate the energy used for respiration. Note that the final answer will be given marks only if calculations are shown in the box given.

Sol. Energy of seed = 300 J

Secondary productivity is 20% so = $\frac{20}{100} \times 300 \text{ J} = 60 \text{ J}$

Respiration = $300 - (150 + 60)$

$= 300 - 210 = 90 \text{ J}$

50. (2points) In many species competition for mates and territories among males results in some individuals remaining unpaired and without a territory, despite being physically capable of breeding. Such birds are called floaters. Contours of movement of three birds in the habitat and graphs indicating the reproductive success of birds are shown below.

Mark the following statements as true or false by putting tick marks (✓) in the appropriate boxes.

(a) Floaters can reproduce through extra-pair paternity. Increasing the number of breeders and contributing to the population's reproductive output.

(b) Floaters can act as buffers or a reservoir against population size changes.

(c) Contour 1 indicates floater species while 2 indicates a territorial bird.

(d) Graph 1 represents reproductive success of floating birds while graph 2 represents reproductive success of territorial birds.

Sol. Floater birds have lower reproductive success than terrestrial males and their relative impact on population's reproductive performance is low.

Graph 1 – Territorial male, Graph 2 – Floater male, Floaters show through extra pair reproduction and mainely show reproductive success in middle age (2-4 years) > 1 year old > old (post 5 years of age).

So

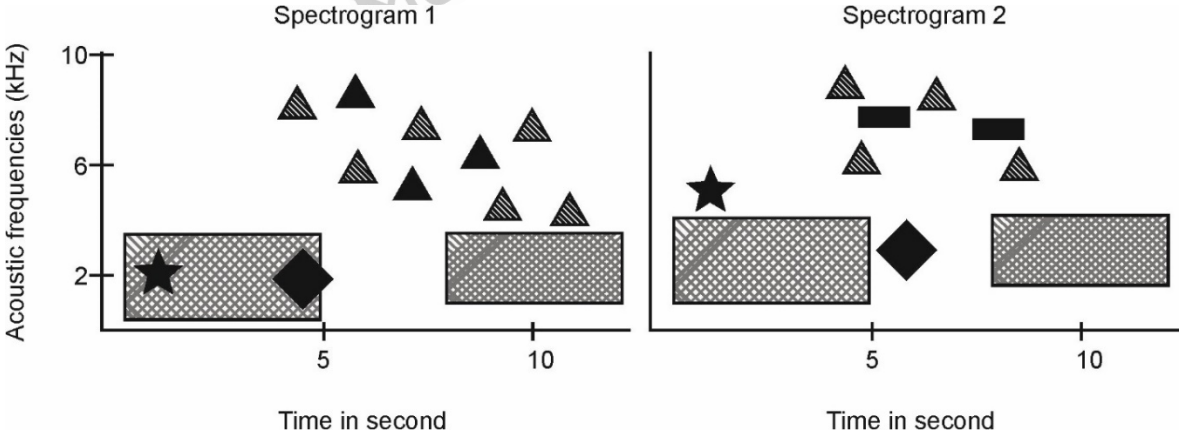
a – T

b – T

c – T

d – F

51. (2 points) Animals have evolved in the context of their environment. How they are perceived by other animals can affect their survival as well as their reproductive success. The spectrograms below show the acoustic frequencies versus time in two different situations. The textured structures indicate the acoustics of the surrounding in which the animals exist while the solid structures indicate acoustic signals of the animals in these surroundings.



Four types of sounds emitted by animals are listed below

(i) Rustling sounds of potential prey insects

(ii) Wing sound of a hunting owl

(iii) Begging calls of young chicks

(iv) Sound of doves taking flight on alarm.

Choose the correction statement and put a tick mark (✓) in the appropriate box.

(a) Filed structures in spectrogram 1 indicate (i)

(b) Filled structure in spectrogram 2 indicate (ii)

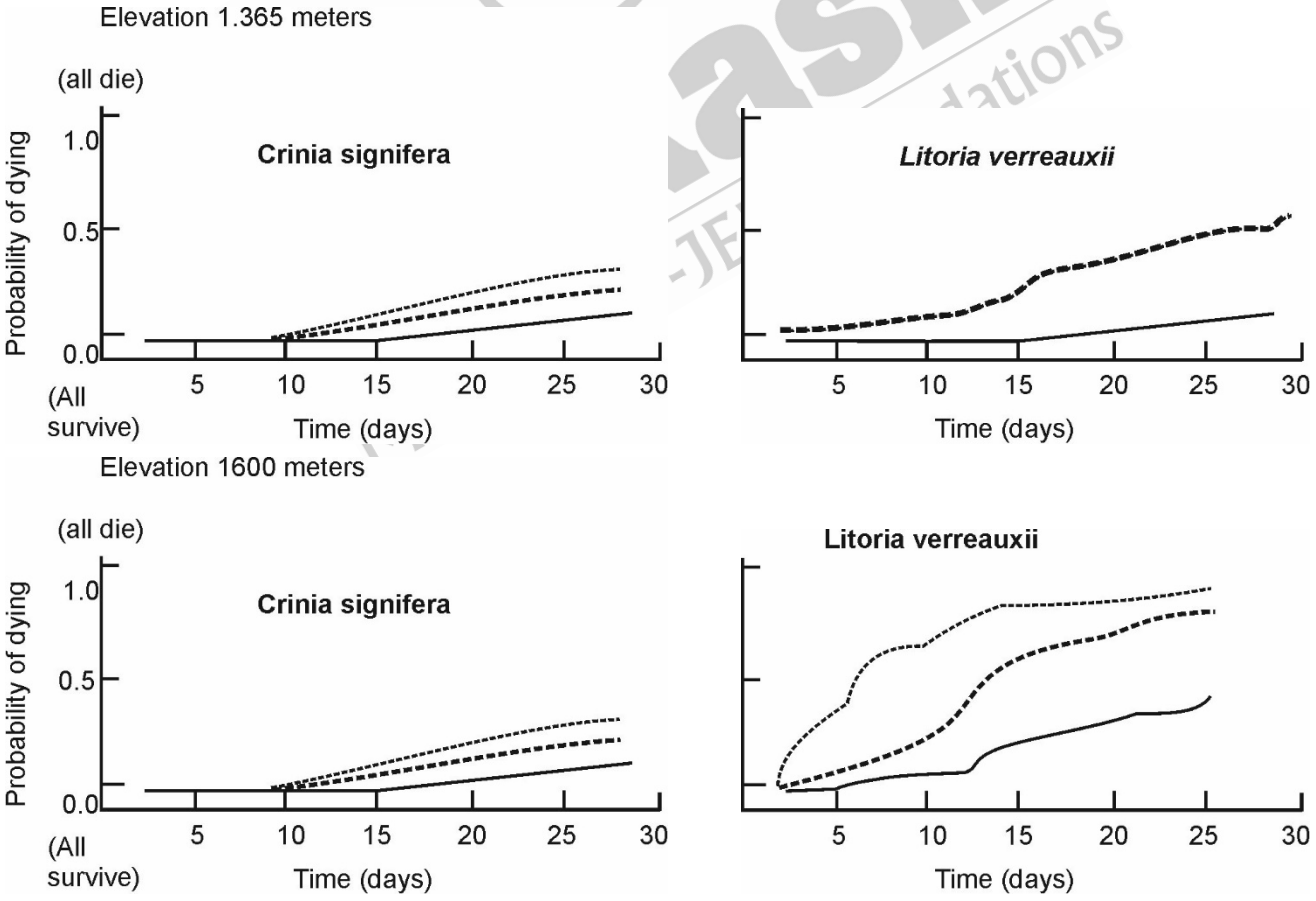
(c) Filled structure in spectrogram 2 indicate (iii)

(d) Filled structure in spectrogram 2 indicate (iv)

Answer (a)

Sol. Option (a) is correct as filled structure in spectrogram 1 indicates rustling sounds of potential prey insects that possibly have high frequency. Wing sounds of a hunting owl will be relatively lower while approaching its prey. Likewise, sound of doves taking flight on alarm will be lower so as to escape from the predator.

52. (2 points) In order to study the effect of radiation on two amphibian species (*Crinia signifera and Litoria verreauxii*) in an area, the following experiment was carried out. Three identical artificial tanks were established at each of 2 elevations (1365 meters and 1600 meters). 6 trays were set up in each tank. Equal number of embryos of one of the two frog species was placed in each tray. In each tank, 2 trays received unfiltered sunlight; 2 received sunlight filtered to remove UV-B and 2 received filtered sunlight that allowed UV-B transmission. The number of surviving individuals was counted thrice a week for 4 weeks. The result of the experiment are shown in the graphs.



Which of the following can be deduced from the results obtained?

Choose the correct option and put a tick mark (✓) in the appropriate box.

(a) Both *Crinia signifera* and *Litoria verreauxii* are most susceptible to UV-B in all conditions

(b) UV-B could lead to greater decrease in *Crinia signifera* population at higher elevation

(c) Wavelengths other the UV_B affect amphibian populations the most at all elevations

(d) Susceptibility to UV-B could contribute to disappearance of *Litoria verreauxii* from higher elevations

Answer (d)

Sol. Option (d) is correct because at higher elevation (1600 meters) probability of dying of *Litoria* species on exposure of UV-B increases.

Option (a) is incorrect because as the conditions vary, the susceptibility of *Litoria* to UV-B changes.

Option (b) is incorrect because as the elevation increases there is hardly any change in the susceptibility of *Crinia* species for UV-B.

Option (c) is incorrect because response of different amphibian population varies with change in elevation on exposure of wavelength other then UV-B

❑ ❑ ❑