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Test Booklet Code

21



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Answers & Solutions

for

Indian Olympiad Qualifiers (Part I) Biology (IOQB) 2020-21

INSTRUCTIONS TO CANDIDATES

- (1) There are 32 objective type questions. Out of 32 questions, 24 questions in **Part A1** and 8 questions in **Part A2**. All questions are compulsory.
- (2) In **Part A1**, each question has four alternatives out of which only one is correct.
- (3) In **Part A2**, each question has four alternatives out of which any number of alternative(s) (a, b, c or d) may be correct.
- (4) For **Part A1**, each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer.
- (5) For **Part A2**, each correct answer carries 6 marks if all correct answers are marked and no incorrect. No negative marking for this part.

4. Abundance of trees bearing buttress roots indicates that the soil is :
- (a) shallow and nutrient-poor. (b) shallow and dry
 (c) deep and nutrient rich (d) deep and clayey.

Answer (a)

Sol. Buttress roots stabilize the tree especially in shallow saturated soil. Typically, they are found in nutrient poor tropical forest soils.

5. The identification tags on the cell membranes for cell-to-cell recognition are:
- (a) Glycoproteins. (b) Lipoproteins.
 (c) Glycolipids. (d) Nucleoproteins.

Answer (a)

Sol. Some integral membrane proteins are glycoproteins. The attached carbohydrate tags on glycoproteins aid in cell to cell recognition.

6. Independent assortment has the possibility of producing different gametes. How many different gametes could possibly be produced in humans?
- (a) 2^{46} (b) 23^2
 (c) 46^2 (d) 2^{23}

Answer (d)

Sol. Types of gametes = $(2)^n$

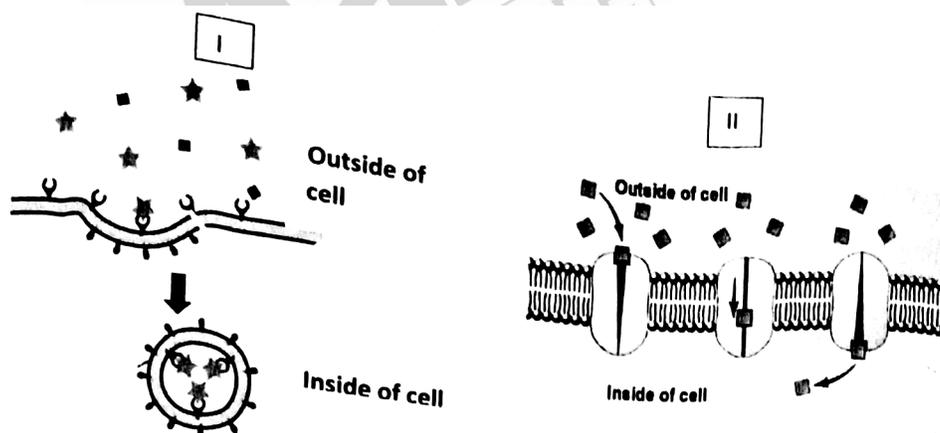
n = number of heterozygous pairs

In human = 46 chromosomes = 23 pairs

Since 23 heterozygous pairs are possible.

Then = $(2)^n = (2)^{23}$

7. Two processes of transport (I and II) are depicted. These processes respectively represent:



- (a) Active transport and passive transport (b) Active transport for both
 (c) Passive transport for both (d) Passive and active transport

Answer (a)

Sol. Endocytosis (I) is active transport whereas II is passive transport as it is facilitated diffusion.

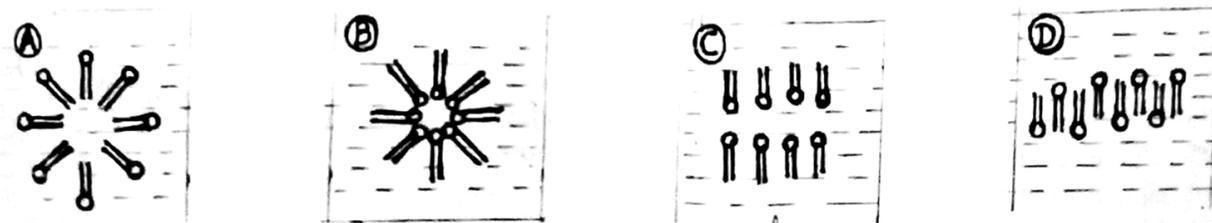
8. The Eastern meadow lark and Western meadow lark are distinct biological species with similar body shape and coloration but different breeding songs which prevents members of these species from mating. This is an example of:

- (a) Pre-zygotic isolation (b) Reduced hybrid viability
(c) Hybrid breakdown (d) Temporal isolation

Answer (a)

Sol. Option (a) is the correct answer. Different breeding songs prevent mating between the Eastern meadow larks and Western meadow larks, such that zygote does not form. It is a method of pre-zygotic reproductive isolation. Temporal isolation is seasonal isolation that is also a method of pre-zygotic isolation. Option (b) & (c) are methods of post zygotic isolation.

9. Which of the following structures represents a stable lipid-water interaction in protoplasm?



- (a) Structure A (b) Structure B
(c) Structure C (d) Structure D

Answer (a)

Sol. Lipid has $\left\{ \begin{array}{l} \text{Hydrophilic head} \\ \text{Hydrophobic tail} \end{array} \right.$

So in lipid – water interaction, lipid will occupy the shape that protects hydrophobic tail from water. Hence the structure A will be seen.

10. A group of hens was observed for 300 minutes and the aggressive pecking behaviour was recorded. The numbers indicate the frequency with which the hen in the row pecks the hen in the column.

		P	Q	R	S
Row 1	P	-	0	0	0
Row 2	Q	59	-	17	92
Row 3	R	8	0	-	7
Row 4	S	6	0	0	-

The data obtained indicates the correct pecking order as:

- (a) P > S > R > Q (b) Q > S > R > P
(c) Q > R > S > P (d) S > Q > R > P

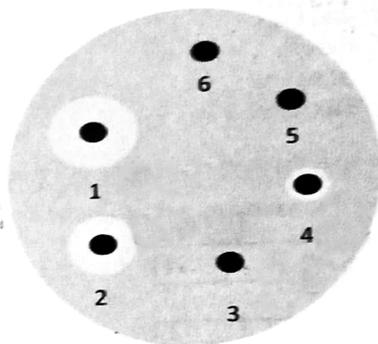
Answer (c)

Sol. Option (c) is the correct answer as hens in row Q peck the hens in other columns maximum number of times.

$$\therefore Q > R > S > P$$

	Q	R	S	P
	59	8	6	0
	17	7	0	0
	92	0	0	0
Total	168	15	6	0

11. In order to study the digestive activity, samples from different parts of the gastro-intestinal tract were placed on an agar containing crab shell powder. The clearance zones numbered 1, 2, 3 and 4 indicate effect of liquids from stomach, duodenum, ileum and colon respectively of an animal 'X'. Distilled water was added to positions 5 and 6 as control.



The results indicate that the animal X is :

- (a) A ruminant (b) A non-ruminant
(c) A hindgut fermenter (d) An insectivore

Answer (d)

Sol. Option (d) is the correct answer as insectivores feed on insects that are classified under phylum Arthropoda. Their body wall is composed of chitin constituted by N-acetyl glucosamine (NAG). Acidic chitinase are highly expressed in stomach part of alimentary canal

Maximum clearance zones in (1) indicate high digestive enzyme activity.

12. In 1914, McCollum and his co-workers showed that a factor isolated from butter fat (X) was non-saponifiable and when added to diet, could cure xerophthalmia in young rats and bone deformities in puppies. These conditions could not be cured by yeast suspension (Y) or orange juice (Z) and also by heated butter fat. The likely factors present in X, Y and Z are respectively:

- (a) Vitamin (A and D), B, C (b) Vitamin A, D, E
(c) Vitamin B₁, B₂, B₁₂ (d) Vitamin A, C, D

Answer (a)

Sol. Option (a) is the correct answer. Butterfat is rich in calories, and is a good source of fat soluble vitamin A.

X = Vitamin A whose deficiency can lead to Xerophthalmia.

Bone deformities can be cured by providing precursors for Vitamin D.

Orange juice is rich in Vitamin C = Z.

Y is likely to be source of Vitamin B complex found in abundance in yeast suspension.

13. A comparison of certain cell structures in three types of cells P, Q and R are tabulated below.

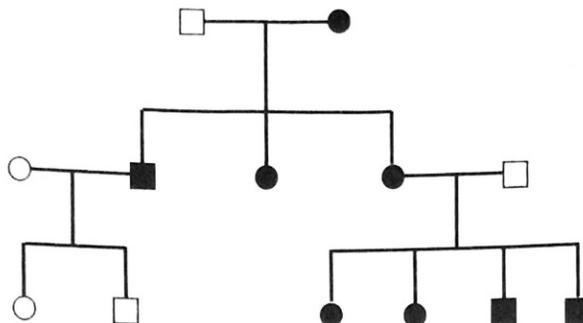
	Cell wall	ER	Nucleus	Mitochondria
P	Absent	Present	Present	Present
Q	Present	Absent	Absent	Absent
R	Present	Present	Present	Present

P, Q and R could respectively represent:

- (a) Onion cell, E. coli, Mushroom cell (b) Mouse cell, E. coli, Amoeba
(c) E. coli, Mushroom cell, Onion cell (d) Amoeba, E. coli, Onion cell

Answer (d)

17. Inheritance of a disease trait observed in a family is represented below. It most likely indicates:



- (a) Autosomal dominance. (b) Mitochondrial inheritance.
 (c) Autosomal recessive trait. (d) X-linked recessive trait.

Answer (b)

Sol. In the given pedigree, in every generation only female is transferring its features to progeny. So the pedigree shows the maternal inheritance or cytoplasmic inheritance.

18. The drug cytochalasin B blocks the function of actin. Which of the following aspects of the cell cycle would be more disrupted by cytochalasin B?

- (a) Spindle attachments to kinetochores. (b) DNA synthesis.
 (c) Cell elongation during anaphase (d) Cleavage furrow formation.

Answer (d)

Sol. Cytochalasin B bind the plus end of microfilaments and blocks its polymerisation. Thus its mainly known for inhibition of actin based function. It will affect the cleavage furrow formation.

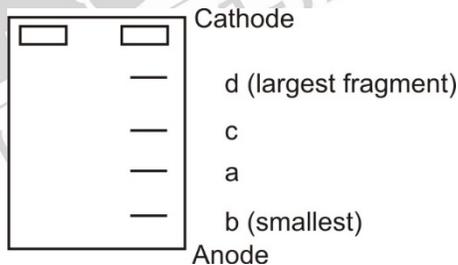
19. A mixture of samples containing DNA fragments a, b, c and d with molecular weights $a + b = c$, $a > b$ and $d > c$, was subjected to agarose gel electrophoresis. What would be the sequence of bands from anode to cathode?

- (a) b, a, c, d (b) d, c, a, b
 (c) a, b, d, c (d) c, d, b, a

Answer (a)

Sol. DNA is negatively charged and migrates towards anode, upon applying electric field. Smaller the fragment farther it travels from the cathode to the anode.

Since, $b = c - a$ as $[a + b = c, \text{ given}]$ and $d > c$ and $a > b$



20. Lack of permeability to water is very rare among biological membranes but is critical to the functioning of which of the following regions of a nephron?

- (a) Descending limb of the loop of Henle (b) Ascending limb of the loop of Henle
 (c) Distal tube (d) Collecting duct

Answer (b)

Sol. Option b is the correct answer as ascending limb of loop of Henle is impermeable to movement of water but permeable to salts.

Loop of Henle and collecting duct play an important role in concentration of nephric filtrate & urine respectively.

21. This fruit is a rich source of lycopene, contains 92% water by weight and pH of its pulp varies between 5 to 7. This fruit is likely to be
- (a) Lime (b) Tomato
(c) Apple (d) Watermelon

Answer (d)

Sol. Lycopene is a carotenoid found in all apple, tomato and watermelon. Tomato has 94% water whereas watermelon has 92% water content by weight. Watermelon pH ranges from 5-6 while tomato is slightly acidic 4-5 pH.

22. Shingle beaches (or pebble beaches) have low animal biodiversity mainly because of
- (a) Very high wave effects (b) High salinity
(c) Unstable substratum (d) Steep slope

Answer (a)

Sol. Shingle beaches or pebble beaches are rich in sand, gravel, shingle or pebbles. These areas are physically dynamic habitat and are frequently subjected to high tides.

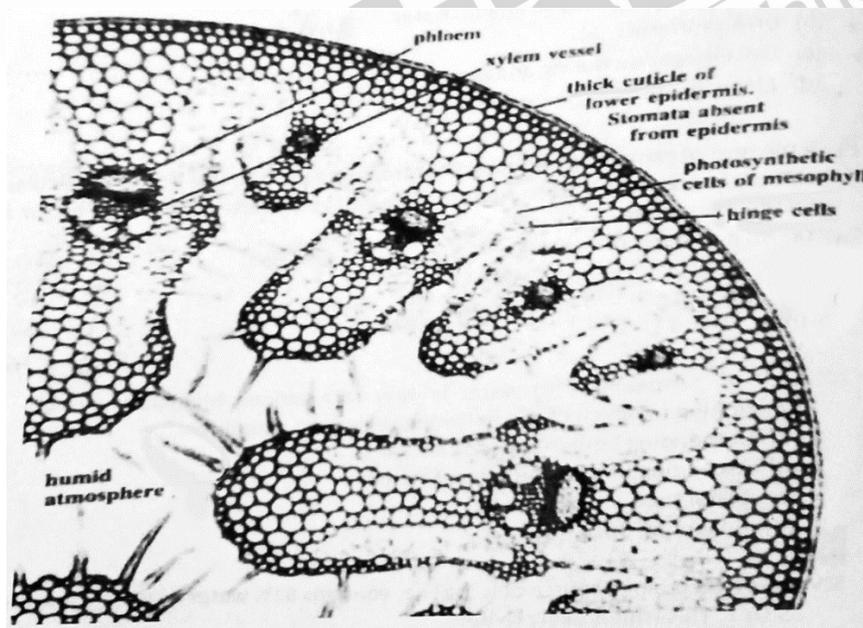
23. In flowering plants, self-pollination is often prevented through self-incompatibility. It is controlled by multiple alleles. Assuming that there are three alleles S_1 , S_2 and S_3 for this and that self-incompatibility occurs if the pollen and tissue of stigma-style have an allele in common, what proportion of pollen produced by S_1S_2 plant would germinate on plants with genotype S_2S_3 ?
- (a) 0% (b) 25%
(c) 50% (d) 75%

Answer (c)

Sol. Pollen produced by $S_1 S_2$ plant can be = S_1 or S_2

The stigma of plant is with genotype = $S_2 S_3$, so out of 2, only one S_1 type pollen can germinate on stigma. So, probability is 50%

24. The accompanying diagram represents a cross section of leaf blade of a grass. The anatomical features suggest it to be a



- (a) Xerophyte (b) Hydrophyte
(c) Hygrophyte (d) Mesophyte

Answer (a)

Sol. Hinge cells are specialised motor cells that become flaccid during excessive loss of water and folds the leaf. There leaves have thick cuticle and well adapt to xerophytic atmosphere eg. *Poa*, *Spartina*..

PART-A2

25. Birdwatchers often take the count of different birds in the area to comment upon its biodiversity. The accompanying table gives such a data for three regions 1, 2 and 3. Assume that the three regions match in terms of environmental factors and equal time is spent for watching for all the three plots.

	Plot 1	Plot 2	Plot 3
Magpie Robin	2	2	2
Indian Robin	3	2	4
Ring Dove	2	2	2
Drongo	3	1	2
Sparrow	4	25	6
Crow	1	18	3
Oriole	0	1	2
Minivet	0	1	1
Flycatcher	0	1	1

Which of the following statements is correct?

- Greater variety of resources is available in plot 2 than plot 3.
- Biodiversity of plots 2 and 3 is the same.
- Resource utilization is more even in plot 3 than plot 2.
- More reliable data can be obtained if observations are made during nesting season of the birds.

Answer (c, d)

Sol. Diversity in plot 2 and 3 are not same and plot 2 does not have species evenness. Plot 3 is showing more even resource utilization as compared to plot 2 as there is more species evenness. However, the data will be more reliable when observation is made during nesting season as then these will be counting of emigration & immigration.

26. Within a population's geographic range, local densities may differ substantially creating contrast patterns of dispersion. Which of the following examples represent clumped dispersion?
- Mushrooms growing on rotting log.
 - Birds nesting on small islands exhibiting territoriality.
 - Mayfly adult populations which survive only for a day or two.
 - Growth of dandelion plants from wind-blown seeds.

Answer (a, c)

Sol. Clumped dispersion is seen when individuals in a population are clustered together creating differential patches.

e.g. Mushroom growing on rotting log. Mayfly adult population that survive only for a day or two also swim in clump to increase chance of mating.

27. In nature, species interact with its abiotic as well as biotic components. Biological interactions can be classified into different categories based on whether they are beneficial (+), harmful (–) or neutral (0) to each of the participating member. Interactions of two species are depicted at positions P and Q in the table.

Interaction	+	–	0
+			
–	P	Q	
0			

P and Q respectively indicate:

- (a) Competition, parasitism
(c) Predation, competition
(b) Predation, parasitism
(d) Parasitism, competition

Answer (c, d)

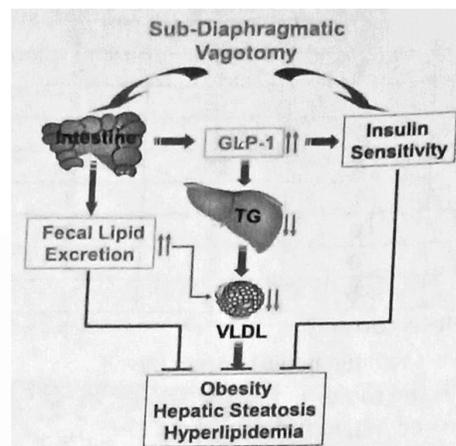
Sol. P = interaction is +, –

Q = interaction is – . –

So P can be predation or parasitism

Q can be competition or ammensalism.

28. The diagram depicts the regulatory mechanism mediated through Glucagon like Peptide 1 (GLP-1) in a mouse in which the vagus connection to hepatic – gut region has been served. Which of the following can be correctly deduced from the diagram?

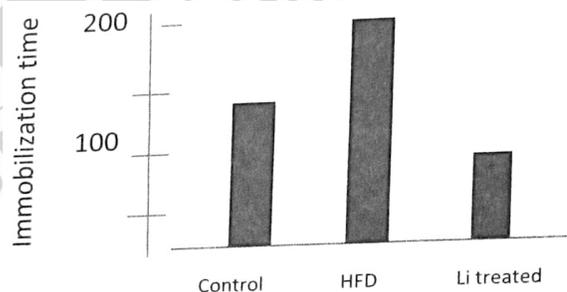


- (a) GLP-1 antagonists can increase steatorrhea (excretion of abnormal quantities of fat with the faeces).
(b) GLP-1 agonists can reduce post-prandial hyperglycemia.
(c) GLP-1 agonists can reduce VLDL in the plasma.
(d) GLP-1 antagonists can decrease fasting blood sugar.

Answer (b, c)

Sol. The correct answer is option (b) and (c) because glucagon-like peptide 1 (GLP-1) is an intestinal hormone that stimulates glucose – dependent insulin secretion so, it reduces post - prandial hyperglycaemia. GLP-1 agonists can reduce VLDL in the plasma. Option (a) is incorrect because GLP-1 antagonists will decrease steatorrhea. Option (d) is incorrect because GLP-1 antagonists will increase blood glucose level.

29. The tail suspension test (TST) is developed of study the effect to drugs or chemicals on the behaviour of rats. The test involves suspending mice above the ground by their tails for a period of 6 minutes. The time spend by the mouse to show any escape related activity is measured. It is subtracted from the total time to get immobilization time. It is based on the assumption that an animal will actively try to escape an aversive stimulus. If escape is impossible, the animal will eventually stop trying (“give up”). When rats fed with high fat diet (HFD) and those fed with lithium were tested using TST, the following results were obtained.



Which of the following statements are true?

- (a) High caloric value of HFD provided more energy to the mice.
(b) Li proves toxic to brain tissues and increases stress of mice.
(c) High fat content in the diet led to less agility and lesser efforts to escape the aversive situation.
(d) Li has improved the stress overcoming efforts of the mice.

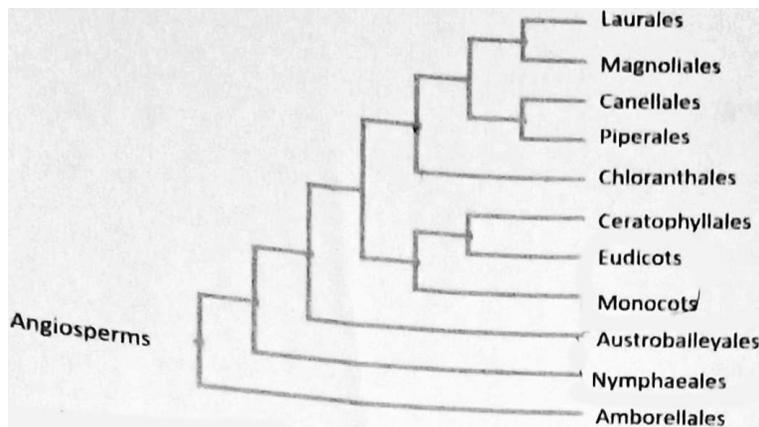
Answer (a, b)

Sol. Option a & bare both correct.

Rats fed with HFD – high fat diet spend longer time reaching the “give up” stage possibly due to more agility, more energy and make more efforts to escape the aversive situation.

Lithium proves toxic to brain tissues and increasing stress on mice as is suggested by decrease in immobilisation time in comparison to control.

30. Study the given cladogram and state which of the following statements is/are true.

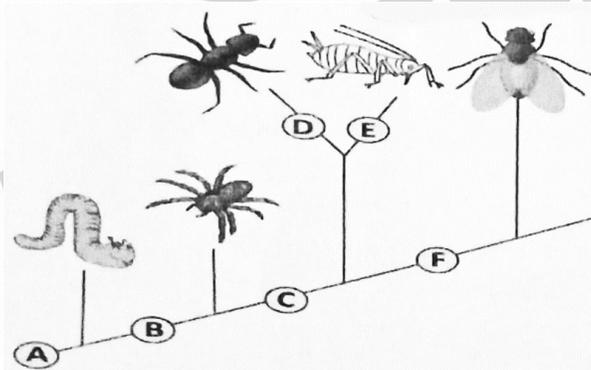


- (a) Laurales cannot be considered as an outgroup.
 (b) Austrobaileyales and Nymphaeales are polyphyletic groups.
 (c) Eudicots and Monocots are paraphyletic orders.
 (d) Chloranthales are more closely related to Piperales than to Canellales.

Answer (a, b, c)

Sol. Paraphyletic group includes common ancestor and some descendents of that ancestor. So monocot and eudicots are paraphyletic groups. Laurales is not a out-group as it share similarities with Magnoliales. Austrobaileyales and Nymphaeales are polyphyletic group because both do not have common ancestors. Piperales and Canellales are more close than chloranthales.

31. Based on the cladogram given below, match the following derived characteristics listed in the table with the alphabets A – D and choose the correct option/s.



Number	Characteristic
1	Legs
2	Cerci
3	Segmented Body
4	6 legs
5	Wings
6	Crushing Mouthparts

- (a) A: 6; C: 5; F: 2
 (b) B: 2; D: 4; E: 6
 (c) B: 1; E: 2; F: 5
 (d) A: 3; C: 4; D: 6

Answer (c, d)

Sol. Option c & d are correct.

A = Segmented body	(A : 3)	(Annelid)
B = Legs	(B : 1)	(Spider/Octapod)
C = 6 legs	(C : 4)	(Hexapoda)
D = Ant	D : 6	(Crushing mouth parts/mandibles)
E = Cerci	E : 2	
F = Wings	(F: 5)	

Legs are present since beginning of cladogram therefore F can't be 2.

D can't be (4) and 6 legs appear in the ancestor (C)

32. Which of the following are the possible agents of change in allele frequency?

- | | |
|--------------------|-------------------------|
| (a) Random mating. | (b) Gene flow. |
| (c) Genetic drift. | (d) Assortative mating. |

Answer (b, c, d)

Sol. Hardy-Weinberg equilibrium or the allele frequency of a large population is maintained by presence of random mating while presence of agents of change in allele frequency include:

- (b) Gene flow
- (c) Genetic drift
- (d) Assortative mating

