Date: 13/03/2022

Question Paper Code

23

Max. Marks : 120

Time : 75 Min.

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Questions & Answers

for

Indian Olympiad Qualifiers in Biology (IOQB) (Part I) 2021-22

INSTRUCTIONS TO CANDIDATES

(1) Question Paper has two parts such as **Part A1** and **Part A2**.

(2) There are 32 objective type questions. Out of 32 questions, 24 questions (Q. No. 1 to 24) in **Part A1** and 8 questions (Q. No. 25 to 32) in **Part A2**. All questions are compulsory.

(3) In **Part A1,** each question has four alternatives out of which **only one** is correct.

(4) In **Part A2,** each question has four alternatives out of which any number of alternative(s) (a, b, c or d) may be correct.

(5) For **Part A1**, each correct answer carries **3 marks** whereas 1 mark will be deducted for each wrong answer.

(6) For **Part A2**, each correct answer carries **6 marks** if all correct answers are marked and no incorrect. No negative marking for this part.

PART-A1

1. Type I diabetes, if untreated leads to a cascade of events culminating in to coma or death.

   Some of these events are listed below. Arrange them in the correct order.

   I. Circulatory failure

   II. Glucosuria

   III. Renal threshold for glucose exceeded

   IV. Blood volume and blood pressure drop

   V. Hperglycemia

   VI. Osmotic diuresis and polyuria

   The correct order is:

   (a) II → III → V → VI → IV → I

   (b) V → II → I → III → VI → IV

   (c) V → III → II → VI → IV → I

   (d) III → II → V → I → VI → IV

Answer (c)

2. Description of a few biomolecules is given below.

   I. When oxidised it can give as many as 544 ATP molecules by consuming 26 oxygen molecules.

   II. This is the only biomolecule that can generate energy aerobically as well as anaerobically.

   I and II respectively refer to:

   (a) Fatty acid and amino acid

   (b) Glycerol and glucose

   (c) Glycerol and fatty acid

   (d) Fatty acid and glucose

Answer (d)

3. Researchers were studying the effect of mineral Z on plant growth. They were also looking for its effect on seed germination. They grew barley plants for three generations in 0.0, 0.6 and 1.0 μM solutions of mineral Z. They harvested seeds from the third-generation plants of each group. After estimating the mineral concentration using a few seeds from every group, they remaining seeds were sown on 'mineral Z free' medium to check the germination success. Which of the following plots will help drawing appropriate conclusion?

   (a) X : Mineral Z concentration in nutrient solution, Y : Mineral Z concentration in seeds

   (b) X : Mineral Z concentration in seeds, Y : Percentage germination

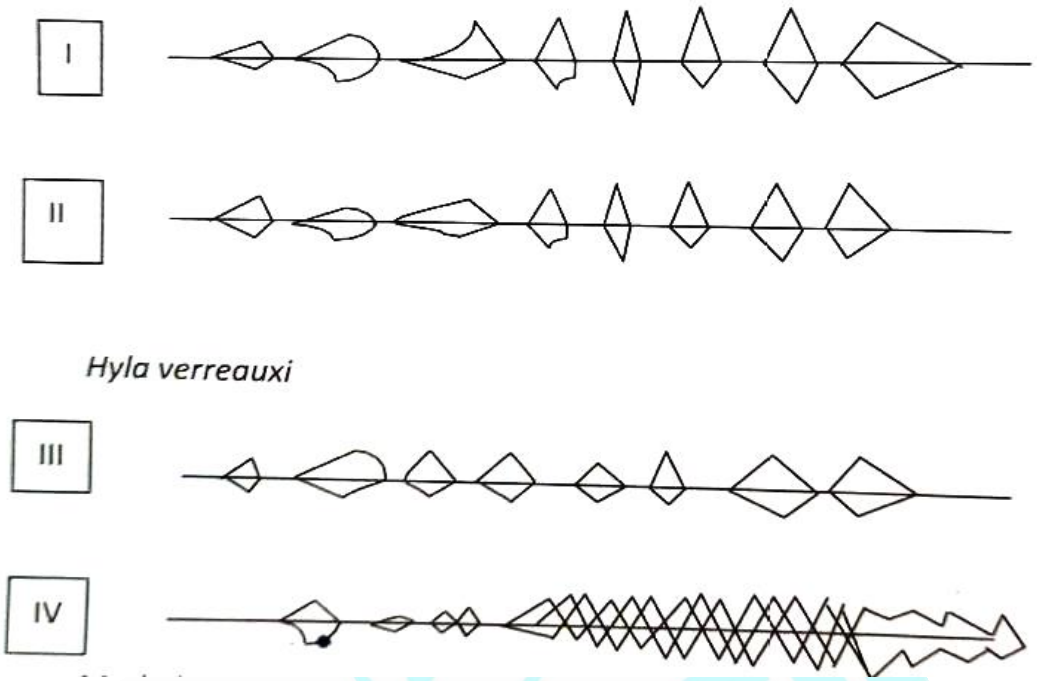
   (c) X : Mineral Z concentration in nutrient solution, Y : Length of coleoptile

   (d) X : Mineral Z concentration in seeds, Y : Rate of germination

Answer (d)

4. When two frog species *Hyla ewingi* and *Hyla verreauxi* were studied on three distant islands, following patterns of oscillograms (songs) were obtained.

Hyla ewingi



Mark the **correct** statement

(a) *H. ewingi* with song pattern I and *H. verreauxi* with song pattern III are likely to co-exist on the same island.

(b) *H. ewingi* with song pattern II and *H. verreauxi* with song pattern IV are likely to be staying on the same island.

(c) *H. ewingi* with song pattern I and *H. verreauxi* with song pattern III are likely to be freely interbreeding on one of the islands.

(d) Species *H. verreauxi* shows greater genetic variability that *H. ewingi.*

Answer (b)

5. A vast country has a time difference of 3 hrs between the east and west coasts. Regular football matches are played between the East Coast Team (ECT) and West Coast Team (WCT) of this country. The venue is always a West Coast or East Coast. Considering the effect of day-night cycle on athletic performance, which of the following statements about the outcome of the matches?

(a) Night matches will always be advantageous for West Coast players as their training time and match time overlap.

(b) Matches played during day hours in summer will yield better performance of East Coast players.

(c) The outcome of the matches will depend on which team has to travel to the venue.

(d) Variation in the day-night temperature can affect the overall performance of athletes, thus favoring one team over the other.

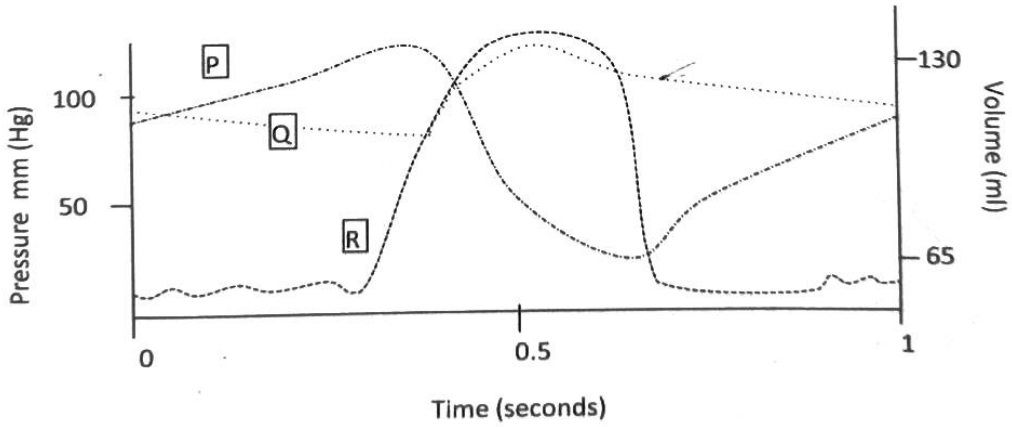
Answer (c)

6. A group of scientists was working on the effect of different wavelengths of light on seed germination. They placed hundred *Vigna unguiculata* (Cowpea) seeds in different Petridishes containing sand soaked with nutrient solution. Each Petridish was exposed to a different wavelength of light up to 96 hrs. If we arrange the plates in descending order of the percentage germination found at different wavelength of light, the most accurate sequence will be:

(a) Green > Yellow > Blue > Red
(b) Blue > Red > Green > Yellow
(c) Yellow > Green > Red > Blue
(d) Red > Blue > Yellow > Green

Answer (d)

7. The rhythmic contraction (systole) and relaxation (diastole) of the ventricles constitute the cardiac cycle. The graphical representation below shows the pressure and volume changes during the cardiac cycle (for the left ventricle).

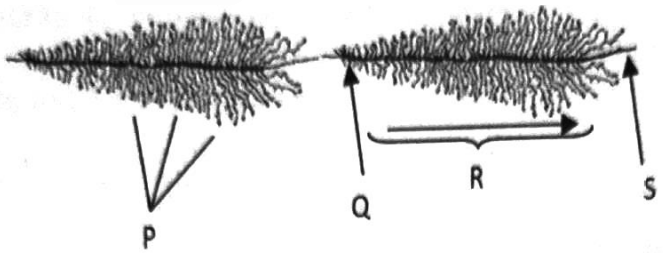


P, Q and R in the graph respectively represent:

(a) Pressure in left ventricle; pressure in aorta and volume in left ventricle
(b) Volume in left ventricle; pressure in left ventricle and pressure in aorta
(c) Pressure in left ventricle; volume in left ventricle and pressure in aorta
(d) Volume in left ventricle; pressure in aorta and pressure in left ventricle

Answer (d)

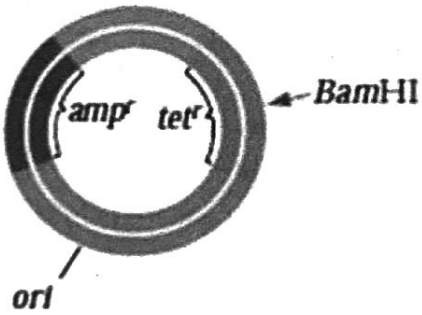
8. Transcription of multiple genes of rRNA is represented below. P, Q, R and S in the figure respectively indicate.



(a) DNA; start of transcription; RNA elongation and rRNA strands
(b) mRNA strands; RNA elongation; start of transcription and DNA
(c) rRNA stands; start of transcription; RNA elongation and DNA
(d) Start of transcription; RNA elongation; rRNA and DNA strands

Answer (c)

9. Reporter genes on plasmids are used in gene cloning experiments to determine the success of foreign DNA insertion. In an experiment, pBR322 plasmid, as shown below, was used as a vector and *Bam*HI was used as the restriction enzyme to carry out the DNA insertion and cloning. Amp^r and tet^r genes which confer resistance to ampicillin and tetracycline respectively were used as reporter genes.



Which of the following indicates the successful insertion of the foreign DNA?

(a) Cells will grow on medium containing ampicillin and tetracycline

(b) Cells will grow on media with tetracycline but not with ampicillin

(c) Cells will only grow on media without any antibiotic

(d) Cells will show resistance to ampicillin but not to tetracycline

Answer (d)

10. As part of cloning Dolly, the sheep, biologist Ian Wilmut took differentiated cells from an ewe's udder and starved them of nutrients for a week. One of these cells was then fused with an enucleated egg from a different breed of ewe and nutrients for the further development of egg were provided. Starvation of the differentiated cells halts the cells in which phase of the cell cycle?

(a) M

(b) G1

(c) S

(d) G2

Answer (b)

11. During the development of sea urchin embryos, the position of the polar body establishes the animal (upper) pole and the vegetal (lower) pole. After fertilization and cell division upto the 8-cell stage, a developmental biologist used a glass needle to bisect the embryos horizontally (Set 1) and vertically (Set 2). The results of the treatments were as follows:

Set 1: Cells of upper half remained embryonic while cells of lower half developed into small abnormal larvae.

Set 2: Normal but small larvae developed.

Which of the following can be concluded from this experiment?

(a) The right and left half of the embryo differ in their developmental potential.

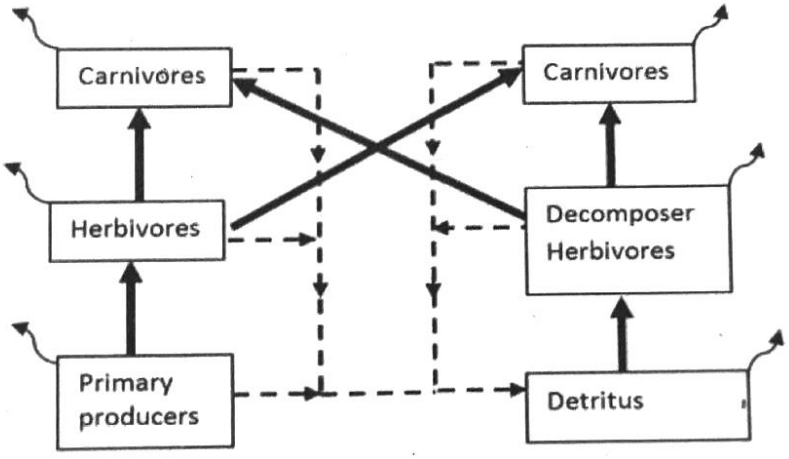
(b) There is no asymmetry in the early embryos.

(c) The animal and vegetal halves of the embryos differ in the composition of cytoplasmic determinants.

(d) Segregation of nuclear components alone play a role in determining the developmental fate of cells.

Answer (c)

12. The figure below depicts two parts of an ecosystem namely the grazing food chain and the detrital food chain. The solid arrows, curved arrows and dashed arrows respectively represent:



(a) Energy flow; dead organic matter; respiration

(b) Energy flow; respiration; dead organic matter & waste products

(c) Total biomass; unconsumed biomass; faeces & urine

(d) Unconsumed biomass; waste products; energy flow

Answer (b)

13. The loading of photosynthates from mesophyll cells into sieve tubes is sensitive to oxygen shortage and metabolic inhibitors suggesting that the process is:

(a) Concentration dependent

(b) Spontaneous

(c) Facilitated diffusion

(d) Active-ATP dependent

Answer (d)

14. Photoconversion of phytochrome Pr to Pfr leads to regulation of gene expressions related to which of the following?

I. Opening and greening of cotyledons

II. Shade avoidance

III. Etiolation

IV. Geotropism

V. Flowering

(a) I, II, III & VI

(b) II, IV, V & VI

(c) Only I, II & VI

(d) Only II, IV & V

Answer (c)

15. A statement and two assumptions, I and II are provided below. Choose the correct option from the options given below-

Statement- Tropical plants develop adaptations to maintain the rate of photosynthesis to overcome the limitation of CO_2 concentration.

Assumption I- Intense light and high temperature induce partial to total closure of stomata.

Assumption II- In C_3 plants RBPCase behaves as oxidase while in C_4 plants PEPCase fixes CO_2 at low concentrations.

(a) If only assumption I is implicit.
(b) If only assumption II is implicit.
(c) If neither I nor II is implicit.
(d) If both I and II are implicit.

Answer (b)

16. Evaluate following statements and choose the correct option;

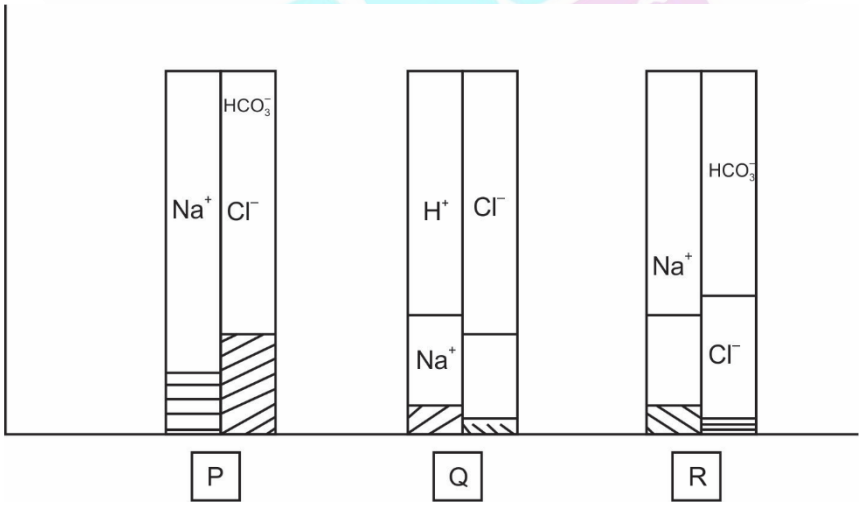
I. Statement: In a person having hyperthyroidism, there are high chances of infection of *Helicobacter pylori.*

II. Reason: One of the symptoms of the infection by *H. pylori* is bloody/ black vomit.

(a) Both I and II are correct but II cannot explain I
(b) Both I and II are correct and II explains I
(c) Only I is true and II false
(d) Both I and II are false

Answer (a)

17. Relative compositions of major electrolytes in three body secretions in humans are depicted. Shaded regions represent other constituents.



The three secretions P, Q and R most likely represent (respectively)

(a) Blood plasma, gastric juice and gastric mucus.
(b) Blood plasma, gastric juice and pancreatic juice.
(c) Jejunal secretions, gastric mucus and bile.
(d) Gastric juice, hepatic duct secretion and pancreatic juice.

Answer (b)

18. *Salvia* has commercial value for its bright beautiful inflorescence. Consider a situation where this short day plant is cultivated under controlled environment of greenhouse. It is subjected to only 9 hours of light condition every day to get the best yield. One day the worker accidentally flashed *Far red* light night over a new batch of plants which were yet to bear flowers. What should be done to make the plant flower normally?

(a) A flash of red light need to be given during the same night.

(b) The whole batch should be kept in 24 hr darkness for the next day.

(c) The day time needs to be interrupted by momentary dark period.

(d) There is no need to do anything as it will not affect flowering.

Answer (d)

19. Meena bought new bird feeder. She filled it with bird food and hung it over a window near her study table. After a few days, sparrows started approaching the feeder but they continued to fly away as soon as they felt Meena's presence. Meena's mother advised her to avoid approaching the window when sparrows were picking food. She also told her to ignore them and not to show any sudden movements when they were nearby. In a couple of weeks, the sparrows started visiting the feeder even when Meena was sitting at her table near the window. This is an example of:

(a) Associative learning

(b) Habituation

(c) Imprinting

(d) Altruism

Answer (b)

20. A team of researchers in an agricultural research institute was working on two varieties of commercially important crop having genotypes PpQQRr and PPQqrr respectively. They were trying to get PpQqRr hybrid by crossing the above two types. What is the probability of getting the expected genotype?

(a) 1/6 (b) 1/8

(c) 1/2 (d) 1/4

Answer (b)

21. The following table indicates the different effects imposed by two species P and Q on each other. The '+' sign indicates growth of the population while '–' is for decrease in the same. The '0' sign is given for 'no effect'.

Types of interaction	Effect on growth and survival of Population P and Q			
	When not interacting		When Interacting	
	P	Q	P	Q
i	0	0	–	0
ii	–	0	+	0
iii	0	0	+	+
iv	–	–	+	+

The types of interaction i, ii, iii and iv respectively are:

(a) Ammensalism, Parasitism, Mutualism, Neutralism

(b) Ammensalism, Commensalism, Protocooperation, Mutualism

(c) Commensalism, Competition, Neutralism, Protocooperation

(d) Commensalism, Neutralism, Parasitism, Competition

Answer (b)

22. Carbon dating is a process where age of certain fossils or old artifacts is determined with the help of its C^{14} content. All the living organisms have C^{12} and C^{14} in a certain proportion as it is continuously maintained in equilibrium with the surrounding environment. As the organism dies, C^{14} being unstable, starts decreasing in amount. Its half life is around 5700 years.

One such fossil sample obtained by archaeologists had 0.185 mg of C^{14} content. If the C^{14} was 0.26 mg at the time of death of the organism. How old is the fossil?

(a) 1000-1500 years

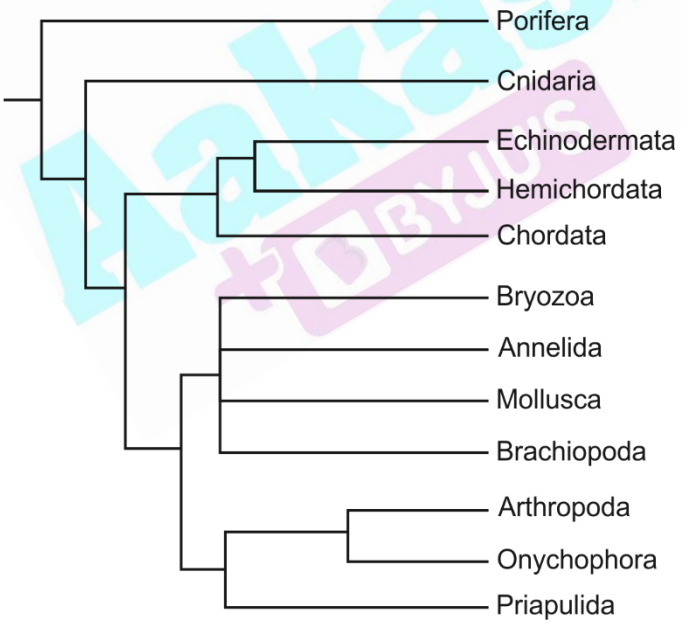
(b) Around 3000 years

(c) 6000 years approximately

(d) 10,000-12,000 years old

Answer (b)

23. Observe the following cladogram and determine which one is the ***false*** statement from the given options:



(a) Bryozoa, Annelida, Mollusca and Brachiopoda are monophyletic taxa

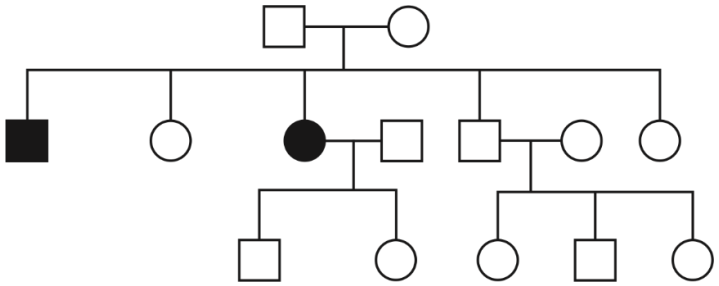
(b) Chordata is as distantly related to Echinodermata as Hemichordata

(c) Cnidaria is the earliest evolved class after Porifera

(d) Arthropoda, Onychophora and Priapulida form paraphyletic group

Answer (d)

24. The inheritance in the following pedigree chart is of:



(a) Autosomal Dominant
(b) Autosomal Recessive
(c) X-lined Dominant
(d) X-linked Recessive

Answer (b)

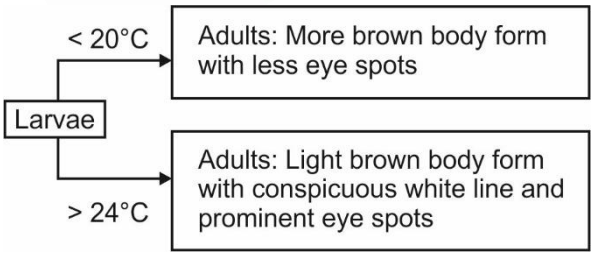
PART-A2

25. Consider two populations each with 200 diploid individuals. The genotypic distribution of people for a gene with dominant allele 'A' and recessive allele 'a' for population I is 90AA, 40Aa and 70aa while for population II the distribution is 45AA, 130Aa and 25aa. Which of the following statements are true?

(a) Population I is in Hardy Weinberg equilibrium while population II is not.
(b) Both the populations have the same allele frequencies for 'A' and 'a'.
(c) Genetic variation of the two populations is the same.
(d) Allele frequency of the recessive allele for population II is 0.55.

Answer (b, c)

26. The West African butterfly *Bicyclus anynana* has two colour forms. During the dry season most butterflies rest on the dry forest floor much of the time while the wet-season form is the more active form. The distal-less gene in this organism is responsible for the eye-spot formation which helps the butterflies to adapt to different season. Larvae that develop at temperatures < 20°C give rise to adult butterflies that have a more brown body form with less eye spots while the larvae developing at > 24°C give rise to adults with lighter body form with conspicuous white line and prominent eye spots.



Which of the following statement/s is/are correct?

(a) Pupae developing under temperatures <20°C produce the dry season form.
(b) During pupal development, the area over which distal-less is expressed decreases with rise in temperature.
(c) The wet-season form possesses more prominent eye sports that helps in escaping predation by birds.
(d) The expression of distal-less gene is subdued in the wet-season form.

Answer (a, c)

27. Woodlice show the following behavioural patterns:

I. They show negative phototactic response during the day and positive response to humidity.

II. During night, they show negative phototaxis and less pronounced positive response to humidity.

III. Under extreme low humidity, they show weakly positive phototactic response.

Which of the following statements are true?

(a) The possibility of woodlice moving through dry places is higher at night

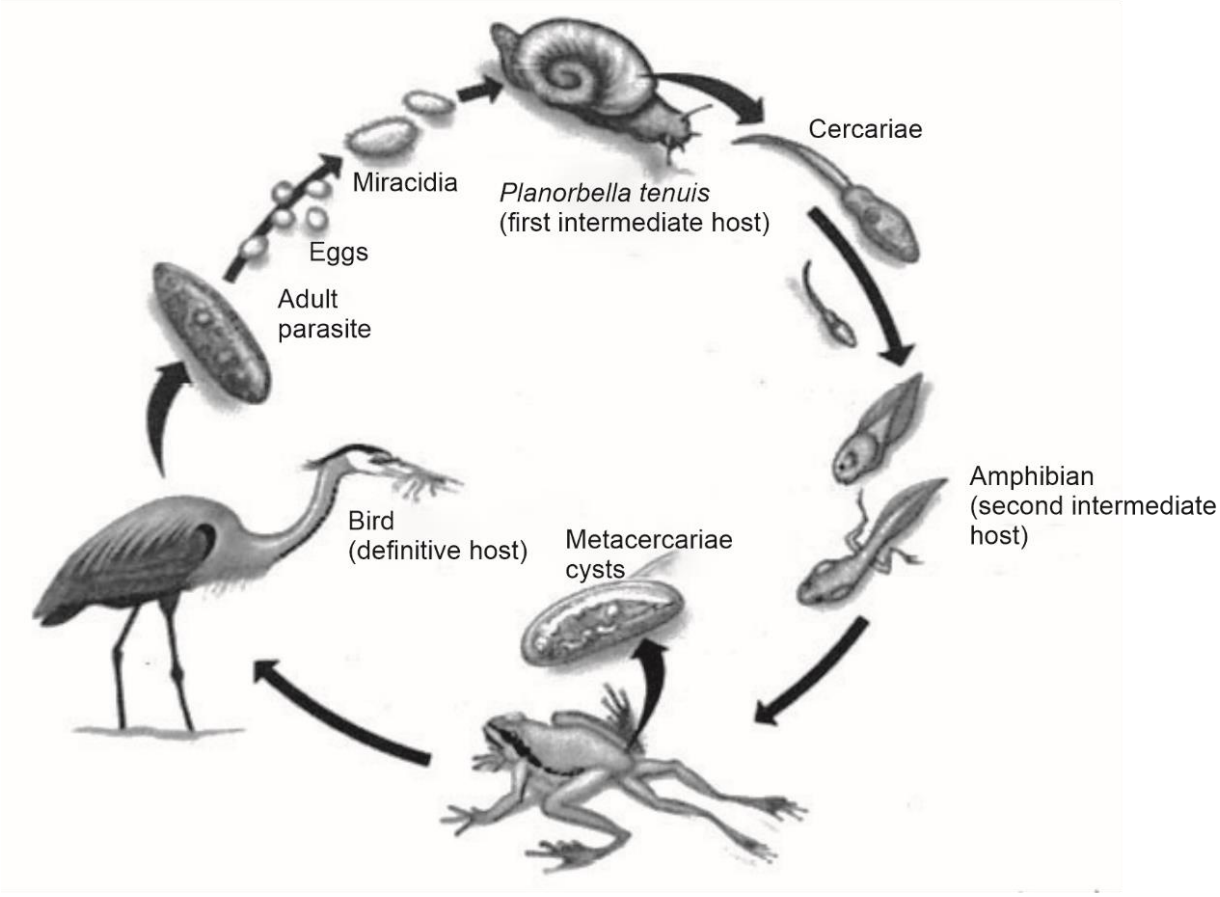
(b) Light is always a stronger cue for woodlice as compared to humidity

(c) The behavioural traits show that photoperiod has a direct influence on its survival

(d) All the three behavioural traits have adaptive significance

Answer (a, c, d)

28. Trematode lifecycle is shown alongside. What could be the explanation for the lifecycle? (Choose the correct answers)



(a) The final host of the parasite in snail and uses the bird dropping to gain access to soil

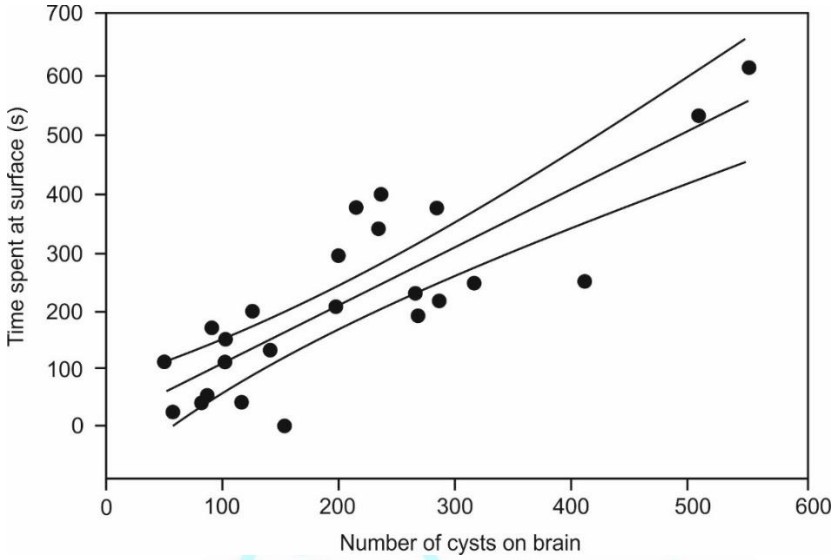
(b) The parasitic infection causes supernumerary limbs to develop in tadpoles

(c) The final host of parasite is bird, so by ensuring food, the parasite gains entry into the final host

(d) The parasite enters the tadpoles of frogs and accelerates their metamorphosis into frogs

Answer (b, c, d)

29. Longnose killifish, *Fundulus similis*, are found in estuarian habitats of South Texas. They are naturally infected with metacercariae of the trematode, *Euhaplorchis sp*. Relationship between the number of cysts of *Euhaplorchis sp*. in the brain of *Fundulus similis*, and the time spent in the top 5 cm of the water column in an experimental tank during 15 min of observations is depicted in the figure below;



Which of the following statements are correct?

(a) Changes in the surfacing behavior could make the infected fish survive longer in the murky estuarine water by gulping air.

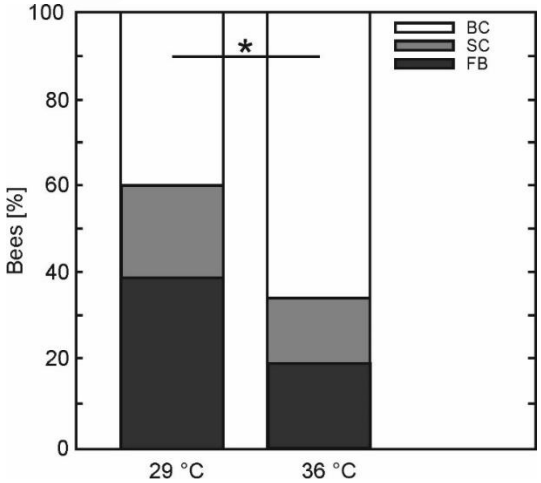
(b) It is possible that larger and, hence heavily infected fish are removed from the population by predation.

(c) The infection of trematode parasite and its effect on the behavior of killifish host, provides an adaptive advantage to the host in the estuarine ecosystem.

(d) Time spent in the top 5 cm of the tank is significantly and positively related to the number of metacercariae on the brain of the killifish.

Answer (b, d)

30. In an experiment, a cluster of bees was exposed to uniform temperature. The figure alongside, shows the percentage of bees not in clusters (free bees, FB), bees in small clusters (2–3 bees, SC) and the bees in big clusters (>3 bees, BC) at 29 ±1°C compared to the free bees, bees in small clusters and bees in big clusters at 36 ±1°C. (* indicates significant difference.)



(a) Bees form more smaller clusters at 29°C, where the waiting time is short and form bigger clusters at 36°C.

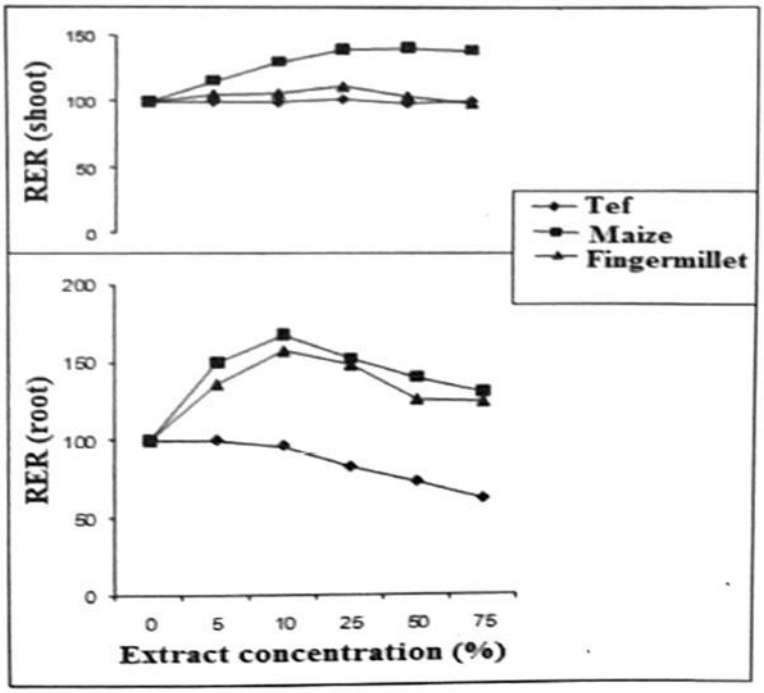
(b) Clustering of the bees in the optimal temperatures spot is an occasional event and with homogeneous temperatures in a given area, the bees tend to form several small clusters scattered across the area.

(c) The bees forming several big clusters in an area of homogeneous temperature in a hive, has the advantage to bees of wandering from one small cluster to the other, increasing the probability of reaching all cells that require cleaning.

(d) Bigger clusters form slowly than smaller ones, but in smaller clusters a higher percentage of bees may be at sub-optimum temperature due to crowding effects.

Answer (a, d)

31. *Lantana camara* leaf extracts were prepared in different concentrations. Germinating seeds of maize (*Zea mays*), finger millet (*Eleusine coracana*) and tef grass (*Eragrostis tef* were exposed to soil treated with various concentrations of the leaf extract. The relative elongation ratio (RER) was estimated for the root and shoot lengths. The observations as compared to control plants treated with water are shown in the figure alongside.



Which of the following statements are correct?

(a) The leaf extract has differential allelopathic effect on the germination and growth of different seeds used in the experiment

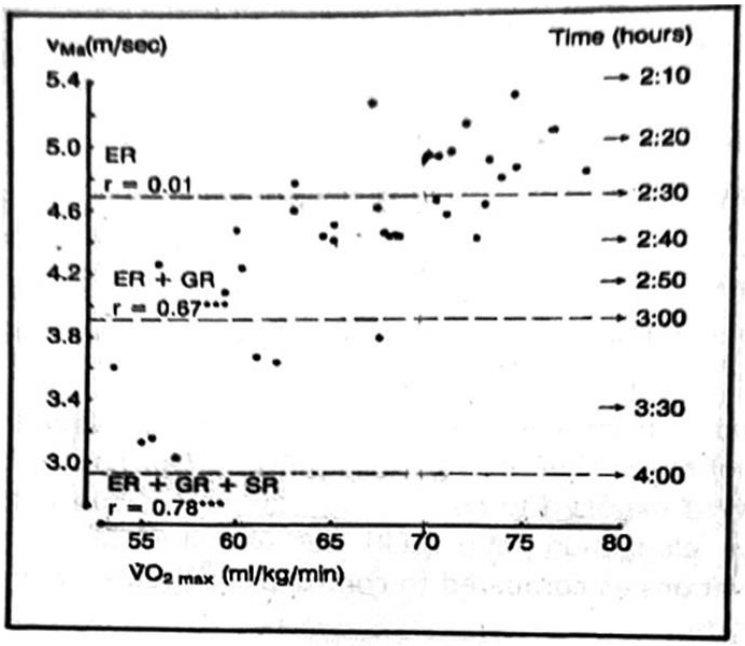
(b) Shoot growth is less affected by the leaf extract treatment than root growth

(c) The results indicate the possibility to cultivate maize and finger millet in agricultural lands invaded by *Lantana* after its removal

(d) Growing tef grass may be promising in areas where *Lantana* invasion occurs due to positive allelopathic interference

Answer (a, b)

32. maximal oxygen output (VO_{2max}) is high in endurance event athletes like marathon runners. Mean Marathon velocity (V_{Ma}) and the VO_{2max} in different groups of Elite marathon runners (ER) are shown in the figure with their different styles of running i.e. Good runners (GR) and slow runners (SR). "r" is the correlation coefficient.



Which of the following statements are correct?

(a) There is a large variation in performance between runners of equal VO_{2max} and vice versa

(b) Marathon runners with a good performance timing (< 2h 30min) have VO_{2max} above 70 ml/Kg/min

(c) Elite Marathon runners with personal best of less than 2h 30min show a VO_{2max} more than 65 ml/Kg/min

(d) From the figure, it is evident that, when a subgroup of marathon runners is studied, there is a high correlation between marathon performance and VO_{2max}

Answer (a, c, d)

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