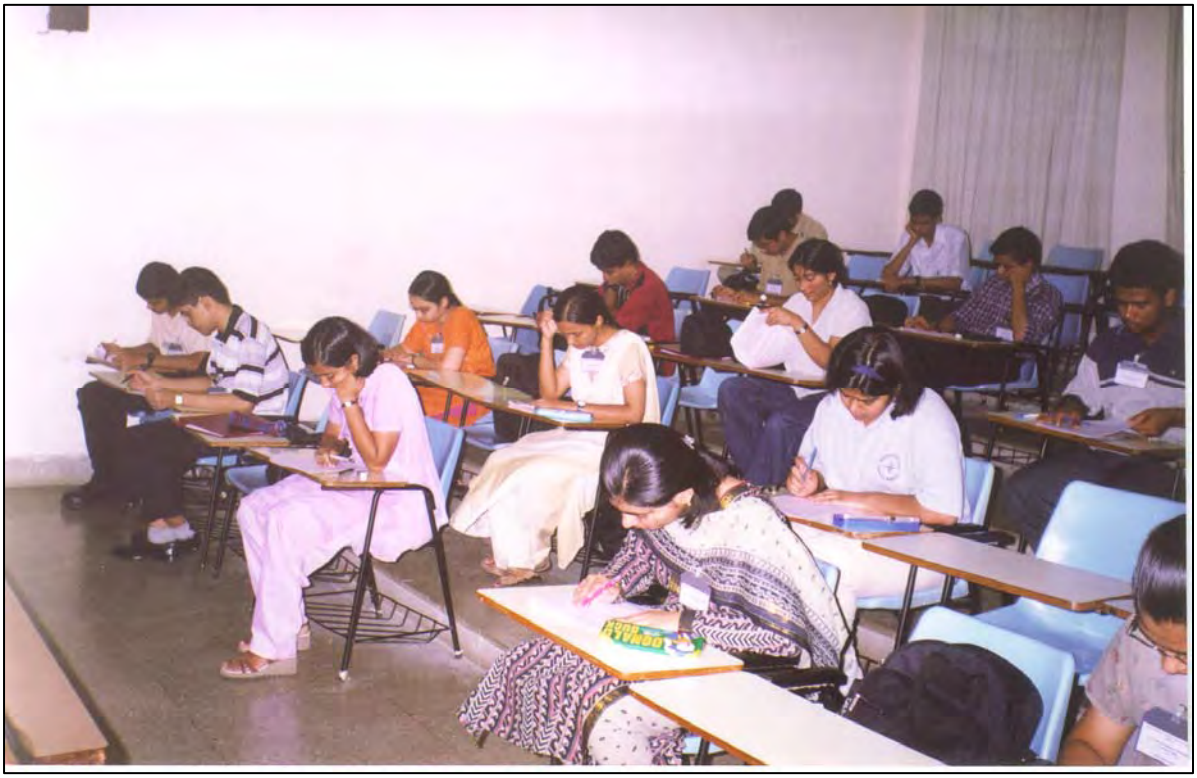
Indian National Biology Olympiad

THEORY PAPERS
2005 - 2007

Compiled by
Rekha Vartak
Anupama Ronad

INDIAN NATIONAL BIOLOGY OLYMPIAD

Theory Papers
(2005- 2007)



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Foreword

Competitive Examinations are not a new feature for the urban Indian household. In a career spanning high school to post graduation an average student takes over a dozen of these. Most of them are banal. However some like the Joint Entrance Examination conducted by the Indian Institutes of Technology (IITs) is considered by many to be an excellent test of competence in Physics, Chemistry and Mathematics at the higher secondary school level. The entrance examination conducted by the All India Institute of Medical Sciences (AIIMS) enjoys a similar status in Biology. Over the last decade however the Indian national Olympiad Examinations (INOs) in Physics (INPhO), Chemistry (INChO) and Biology (INBO) has in many opinion, emerged as the most comprehensive and the ultimate test for competency at this level.

The INOs are usually conducted in the last week of January every year. It is taken by about 250 to 300 of the brightest students in the nation. These students are selected after a wider nationwide examination called the National Standard Examinations in Physics (NSEP), Chemistry (NSEC) and biology (NSEB). The latter is taken by as many as 40000 students. It is conducted by the Indian Association of Physics Teachers (IAPT) and more recently the Indian Association of Chemistry Teachers (IACT) and the Indian Association of teachers in Biological Sciences (IATBS). The INOs are conducted by the Homi Bhabha Centre for Science Education (HBCSE) with the assistance of IAPT. Students who represent India in the International Olympiads in Physics, Chemistry and Biology are selected from the INOs and the subsequently held camps of the top 35 to 40 students of INOs. I may add that HBCSE is the nodal centre for science Olympiads and the effort has been financially supported by the Board of Research in Nuclear Sciences (Department of Atomic Energy). Department of Science and Technology and Ministry of Human Resource Development.

For some time now there has been a demand to bring out an official collection of the INO question papers. We have decided to meet this demand. It must be noted that this is not merely a collection of problems for higher secondary school students. I believe that it will motivate students and teachers at the undergraduate and graduate level. Indeed, even research scientists would find parts of it engaging.

The questions of INOs are designed by a small group of teachers and research scientists. I have been witness (and participant) to these paper-setting sessions – the lively and at times lonely nights and the endless debates. It may not be proper for me to make the names of the paper setters public but let me state that I cherish their memories and HBCSE is very grateful to them. They are the silent heroes of the present collection.

It is perhaps relevant to mention that the paper setting session is preceded by a weeklong intense workshop in which college teachers and research scientists

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from all over India come together to brainstorm and to design challenging problems and textual materials for students and teachers. These resource generation camps are held in the period of August – November.

Let me end with an anecdote. The Stokes theorem which is one of the cornerstones of vector calculus and modern differential geometry was proposed by Sir George G. Stokes as a problem for the Cambridge Smith prize examination in 1854. It is not known if any examinee was able to solve it. But James Clerk Maxwell was one of the examinees and the theorem made a deep impression on him. He went on to use it extensively and laid the foundations of modern electromagnetism. Perhaps many decades from now one of the problems form the current collection will be remembered and employed creatively by one of our readers.

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Preface

Biology Olympiad is a competition for pre-university students. Compared to other Olympiads of basic science subjects, namely physics, chemistry and maths, this has been the youngest Olympiads and was founded in 1990.

India started participating in the International Biology Olympiad (IBO) as a competitor since the year 2000. The main goal of this competition has been to bring together gifted students from all over the world and stimulate their interest in the subject by exposing them to challenging problems in various areas of biology. Thus the major emphasis of this competition is to test student's understanding of the concepts rather than testing the information acquired by the student. Especially the subject of 'Ethology' or 'Animal Behavior' which is not included in the undergraduate syllabus of our country is part of IBO syllabus and exposes students to new exciting frontiers of research.

This booklet is a compilation of theory papers of National Biology Olympiad examination conducted between 2005 -2007. HBCSE acknowledges the contributions of all the scientists and teachers who have contributed to these papers. I am sure that the students will find these questions challenging and their interest in the subject will be further stimulated.

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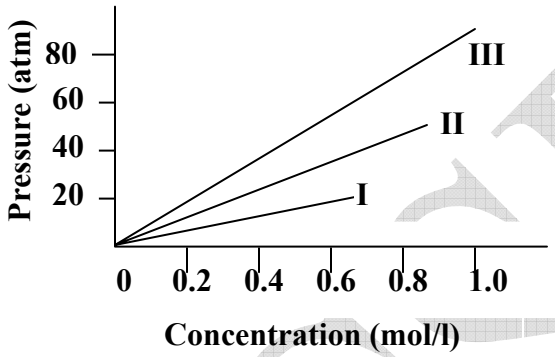
INDIAN NATIONAL BIOLOGY OLYMPIAD – 2005
PART A

CELL BIOLOGY

1. Osmotic pressure measurements of three solutes resulted in the following graph. The three solutes most likely are:



a. I: glucose II: KCl III: NaCl
b. I: NaOH II: NaCl III: HCl
c. I: $CaCl_2$ II: sucrose III: AgCl
d. I: glucose II: NaCl III: $Ca(NO_3)_2$

2. Many food materials are well preserved using high salt concentration. The protective effect provided by salts is most likely due to:
a. dehydration of food.
b. alteration of pH of food.
c. alteration of enzymes of micro organisms.
d. all the above

3. Unsaturated fatty acids predominate in the lower parts of legs of animals living in extreme cold regions while saturated ones predominate in the upper parts. Which of the following correlates with the above observation?
a. Unsaturated fatty acids are more fluid at lower temperatures.
b. Saturated fatty acids are more fluid at lower temperatures.
c. Unsaturation leads to more energy content, which helps maintain body temperature.
d. Saturated fatty acids offer protective effects at low temperatures.

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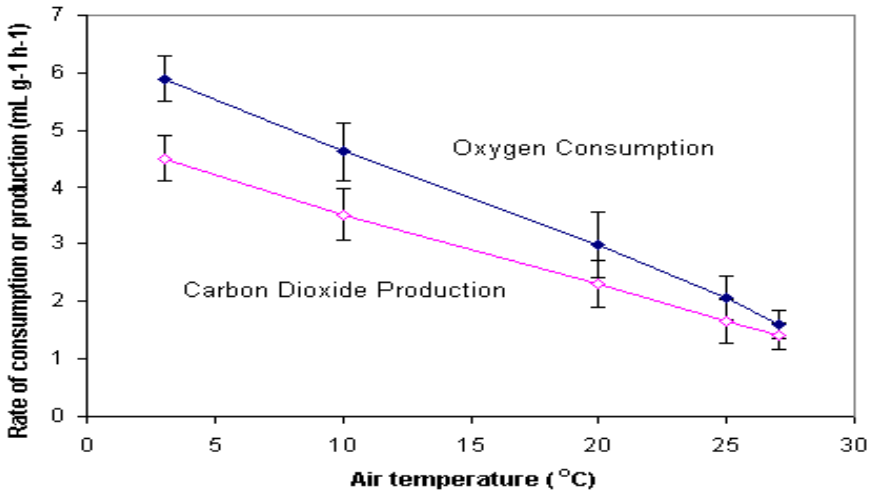
4. **Effect of pH on the osmotic pressure of haemoglobin in solution is tabulated.**

pH	Osmotic pressure (mmHg/gm protein/100ml)
5.0	21.5
7.2	5.0
9.6	15.6
10.2	21.4

The above effect is due to:

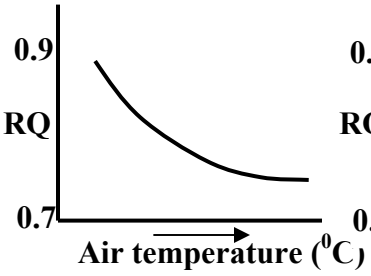
a. protein folding
b. protein denaturation
c. haemoglobin oxygen interaction
d. all the above

5. When changes in oxygen consumption and carbon dioxide production for the Siberian hamster approximately 1 hour after food access was measured, following graph was obtained.

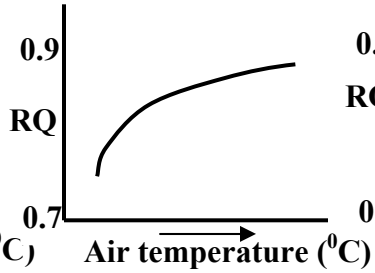


If the above data is converted into respiratory quotient (RQ) and plotted against the temperature, the graph that will be obtained is:

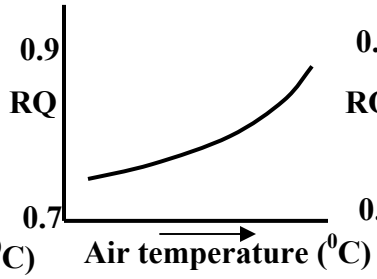
a.



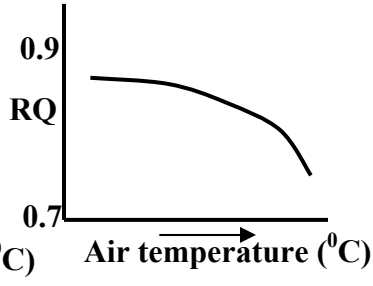
b.



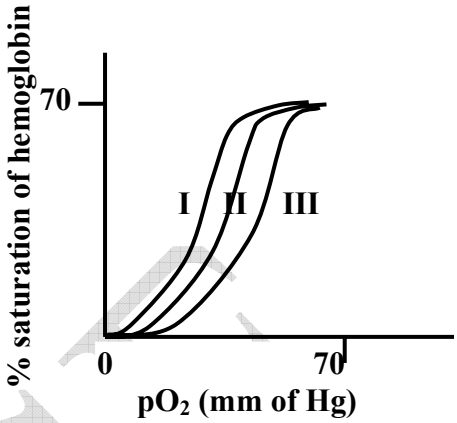
c.



d.



6. There are several factors that affect the binding of O_2 to Hemoglobin. In the following graph, the shift in the saturation curve of hemoglobin from I to III is a result of:



a. decrease in body temperature
b. increase in pCO_2 in the tissue
c. increase in blood pH
d. all the above

7. The manganese-containing superoxide dismutase (MnSOD) that catalyses conversion of superoxide ions is found in animal and plant mitochondria as well as in plant chloroplasts. Mark the appropriate statements.

i. It is likely to be activated under stress.
ii. It is most likely to be found in the bacterial cells.
iii. It is likely to be synthesized in obligate anaerobes.
iv. It is likely to have some role in respiration.

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

8. The pH of orange juice and distilled water were found to be 3.0 and 6.0 respectively. This means:
a. orange juice has a hydrogen ion concentration twice as that of distilled water.
b. the hydrogen ion concentration of orange juice is 10^3 moles/litre and that of distilled water is 10^6 moles/litre.
c. hydrogen ion concentration of orange juice is 1000 times greater than distilled water.
d. both b and c

PLANT SCIENCES

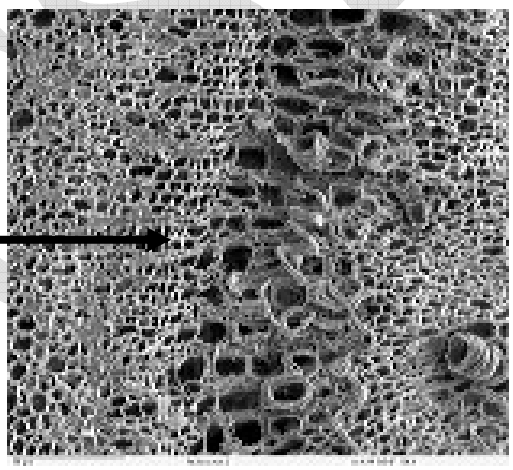
9. Some statements about phloem tissue are made.

i. Phloem is basically a parenchyma tissue.
ii. The pores of sieve plates are essentially well-developed plasmodesmata.
iii. The cytoplasm of sieve element is very simple, with no developed organelles.
iv. Transport of sugars and amino acids through phloem is bi-directional.

The correct statements are:

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

10. Observe the electron micrograph of a plant part below. Portion labeled A indicates:



a. parenchyma
b. cambium
c. phloem
d. mucilaginous cells

11. Young plant seedlings were subjected to two different growth conditions. Results at the end of 10 days are given in the table.

Experimental set-up		Average shoot length	Average root length	Total no. of leaves
1.	Sterile soil	2 mm	12 mm	3
2.	Sterile soil inoculated with fungal culture	8 mm	10 mm	13

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The relationship observed between fungus and plant is:

a. commensalism
b. mutualism
c. parasitism
d. neutral interaction

12. The structure that helps grasses to make excellent ground cover for preventing erosion is:

a. root cap
b. fibrous roots
c. sheathing leaf base
d. stolons

13. Find the odd set out.

a. stolons, rhizomes, corms
b. thorns, bracts, stipules
c. contractile roots, pneumatophores, haustoria
d. staminal corona, tapetum, microspore

14. Which of the following factors will adversely affect IAA-induced short-term cell elongation?

a. Increase in turgor pressure
b. Repression of enzymes breaking the bonds in the cellulose microfibrils
c. Increased plasticity of cell wall
d. Acidification of cell wall

15. From an anatomical view point, a reason why angiosperms dominate today's landscape is the presence of:

a. sclerenchymatous tissue
b. vessels
c. cork cambium
d. bordered pits

16. Mark the correct statement about photosynthesis.

a. The first intermediate of photosynthesis in C_3 plants is a 3-carbon sugar glycerate-3-phosphate.
b. Photosynthesis can be regarded as complete once the triose phosphate is converted to either sugars, amino acids or fats.
c. The major limiting factor for photosynthesis is the amount of RUBISCO in the stroma.

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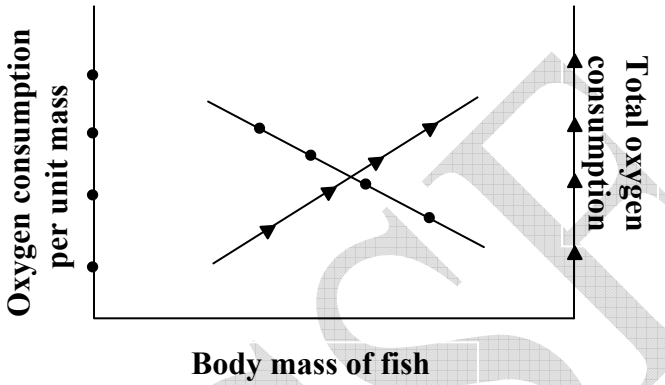
d. Part of the carbohydrate made during photosynthesis is utilized to regenerate ribulose bisphosphate.

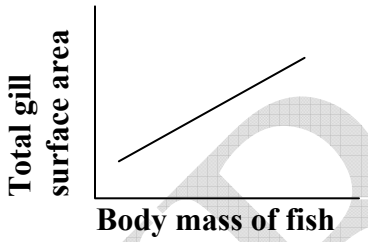
ANIMAL SCIENCES

17. The graph given below relates oxygen consumption with body mass of fish.



Which of the following graphs complies with the data in the above graph?

a.



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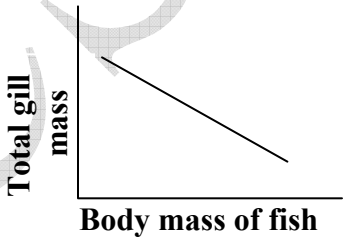

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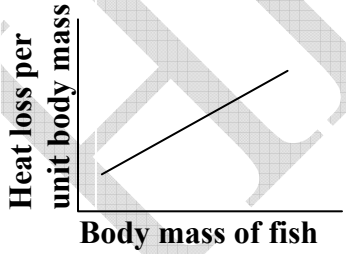

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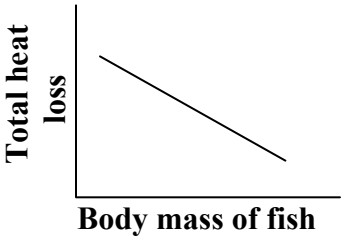

18. Fast-twitch muscle fibres can develop maximum tension more rapidly than slow-twitch fibres. Which of the following are examples of fast- twitch muscles?

i. white meat of chicken
ii. arm muscle of weight lifter
iii. leg muscle of long distance runner
iv. arm and leg muscles of sprinter

a. ii and iv

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

19. Mark the correct statement.
a. Dandruff is an example of discarded keratin protein.
b. Neurons and glial cells are two basic cells of nervous tissue that generate or conduct electrical impulse.
c. Intestine is a good example of organ composed of single type of tissue.
d. All the above statements are incorrect.

20. A digestive system comprising solely of the mouth, stomach, intestine and anus would most probably belong to:
a. cockroach
b. earthworm
c. snail
d. rabbit

21. Which of the following adaptations/strategies can help an animal to prevent dehydration?
a. Utilization of fat as a major energy source
b. Preference of a freshwater habitat over a marine
c. Increase in the blood osmolarity
d. All the above

22. If a taxon of animals is further classified on the basis of 'canal systems', the taxon has to be:
a. Phylum Echinodermata
b. Phylum Porifera
c. Class Osteichthyes
d. Class Insecta

GENETICS & EVOLUTION

23. An island showed a well spread population of:
(i) hawks,
(ii) squirrels and
(iii) a species of bird with long or short beaks
This island was split due to a major earthquake. Which of the following is most likely to occur as a result of this event?

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a. Emergence of new species of squirrels
b. Assortative mating of long-beaked birds and short-beaked birds
c. Emergence of a new hawk population
d. All the above.

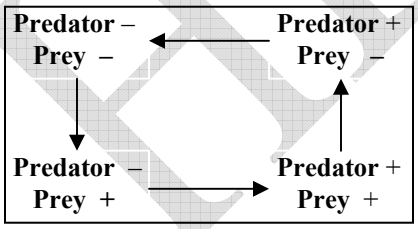
24. In an attempt to produce offspring by mating two different species of *Drosophila*, a scientist observed a defective set of genes for rRNA synthesis during early development as compared to normal intra-species offspring. This is an indication of:
a. pre-zygotic barrier with gametic isolation
b. post-zygotic barrier with reduced hybrid fertility
c. post-zygotic barrier with reduced hybrid viability
d. pre-zygotic barrier with temporal isolation

25. If two species of bird persist alongside each other as separate species, which of the following has to be true?
a. Both species should be very different in appearance.
b. Both the species must not interbreed.
c. Both the species should have same ecological niches.
d. One species must have evolved from the other.

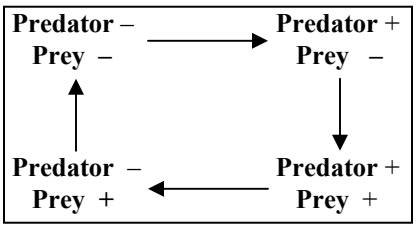
ECOLOGY

26. Which of the following figures correctly depicts predator-prey relationship observed in nature?

a.



b.



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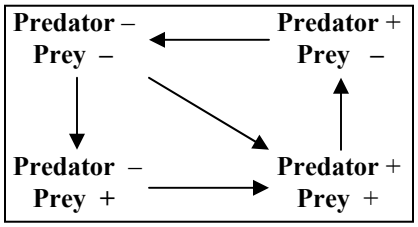

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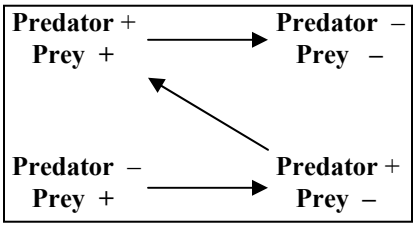

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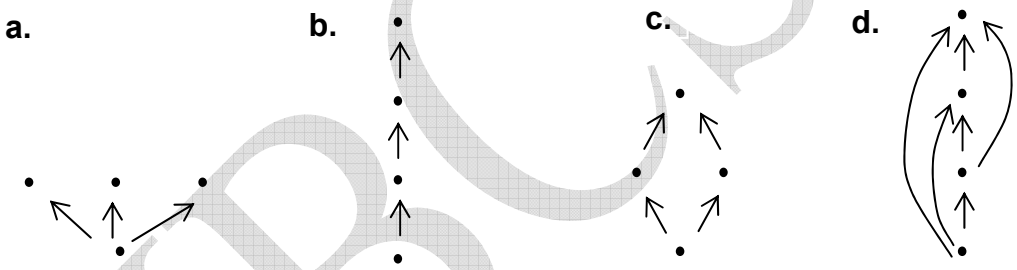
27. A marine community produces an inverted pyramid of biomass yet it survives well because:
a. the producers have a rapid rate of cell division
b. the herbivores have a rapid turnover rate
c. detrivores immobilize most nutrients
d. all the above

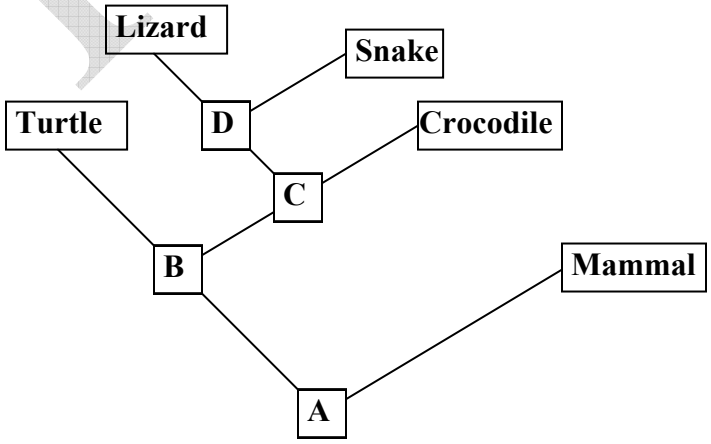
28. In any given ecosystem, it is generally observed that over time, the rate of arrival of new species deceases, rate of extinction increases and the total number of species reaches equilibrium. Which of the following island ecosystems will have the least number of species?
a. Large island far from mainland
b. Small island far from mainland
c. Large island close to mainland
d. Small island close to mainland

29. Observe the four food webs given below. The lowermost dot in each figure represents autotrophs. Among these, the most stable community will be:



BIOSYSTEMATICS

30. Phylogenetic tree for animal classification is shown. A, B, C and D are the ancestors. Mark the correct interpretation.



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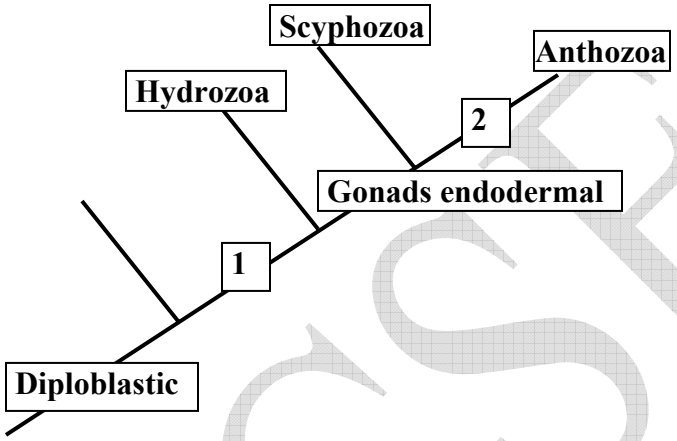
a. Turtle, lizard and snake form a monophyletic taxon.
b. Amniotic egg must have evolved at stage B or C.
c. The most recent common ancestor of lizard and turtle is B.
d. Both a and c.

31. The cladogram given below represents the evolution of Cnidaria.



1 and 2 would respectively be:

a. Polyp stage predominant and gastrovascular cavity septate
b. Planula larvae and rhopalium (sense organs) present
c. Polyps present and medusa stage suppressed
d. Gastrovascular cavity septate and polyps present

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INDIAN NATIONAL BIOLOGY OLYMPIAD – 2005

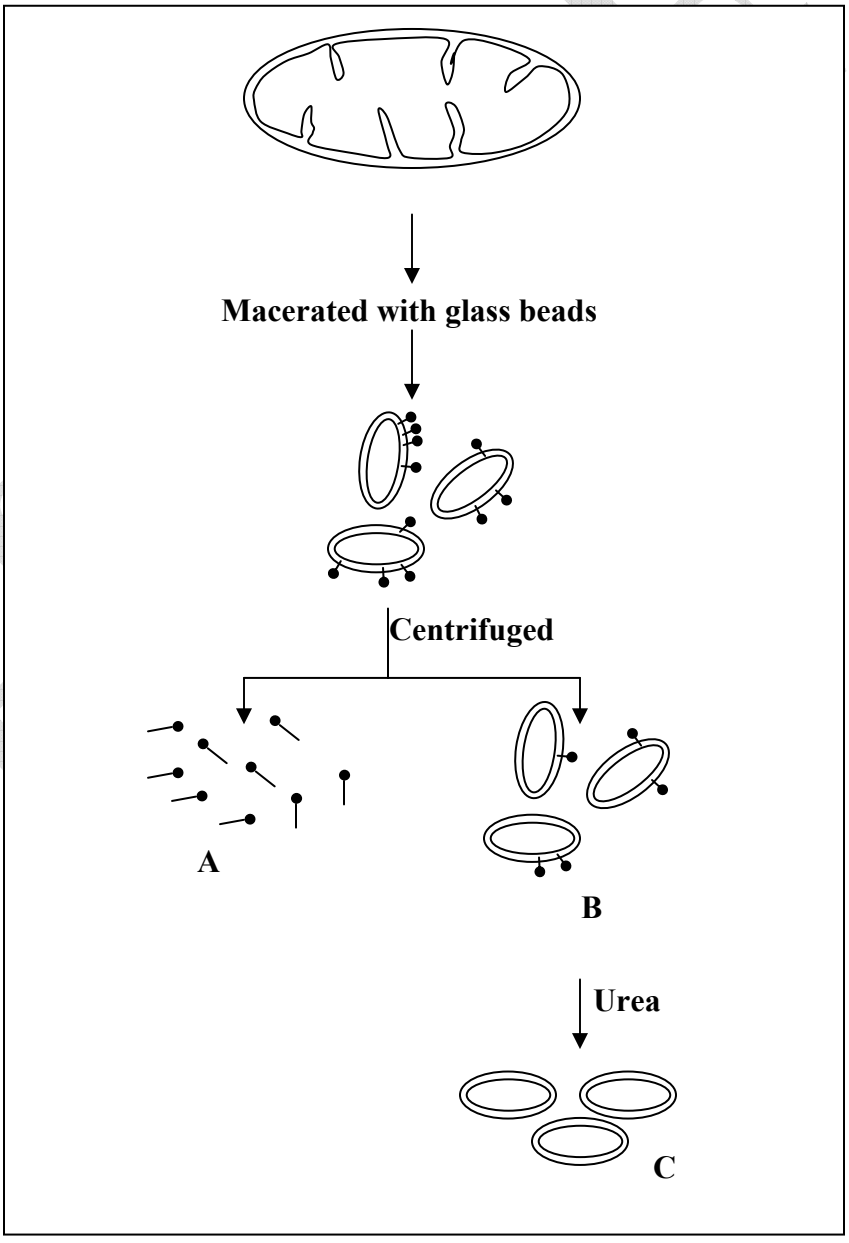
Name of the student:----------

Centre:----------

PART B

CELL BIOLOGY

32. Beef heart mitochondria were subjected to different treatments as shown in the protocol given below. The treatments resulted in fractions A, B and C.



Fill in the table with appropriate options given in the bracket.

Fraction	ATPase activity (low / high / absent)	Electron Transport System (present / absent)	Oxidative phosphorylation (low / high /absent)
A			
B			
C			

33. The nutrients used by organisms can be categorized as the source of energy, electrons and carbon. Fill in the table with the correct type of source that is used by the organisms.

Choose from the options given below.

Organism	Principle source of:		
	Energy	Electrons	Carbon
Aspergillus			
Cyanobacteria			
Nitrosomonas	Inorganic		

Options:

a. inorganic compounds
b. CO_2
c. organic compounds
d. light

34. (A) A student wants to separate the mitotic spindle protein from a dividing animal cell. She gathers the following information:

I. Mitotic spindles are proteins with many potential disulfide bonds.
II. Disulfide bonds resist solubilization of proteins by detergents.

With this information, the correct steps of separating the spindle proteins from the cell suspension will be:

a. addition of spindle formation inhibitor such as colchicine
b. addition of oxidizing agent such as hydrogen peroxide

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c. addition of reducing agent such as thioglycolic acid
d. addition of detergent such as Sodium lauryl sulphate
e. separation by centrifugation
f. separation by liquid chromatography
g. separation by density gradient centrifugation

(Choose only the correct options in the correct order)

ANS: ☐ → ☐ → pellet → ☐ → ☐ → ☐

(B). Once she has separated the spindle proteins, she wants to study its molecular size. The steps she will follow are:
(Choose from the same options given above).

ANS: ☐ → ☐

35. Three reactions that are used by living organisms for extracting energy are shown:

I. $NO_3 + 2e + 2H^+ \text{---------} > NO_2 + H_2O$

II. $SO_4^- + 8e^- + 8H^+ \text{-------} > S^{-2} + 4H_2O$

III. $S° + 1.5\ O_2 + H_2O \text{----------} > H_2SO_4$

Terminal electron acceptor for reaction I is: _____

Terminal electron acceptor for reaction II is: _____

The reaction in which energy is gained as result of net oxidation of substrate : _____

Examples of fermentation are reactions: _____

36. Graphs below indicate the blood profiles of a trained athlete and an untrained person during and after running for 1.5 hrs. Assign these graphs to the appropriate descriptions.

(i) Untrained subject is more prone to muscle cramps. Graph _____
(ii) Glycogen was used as an important fuel. Graph _____
(iii) Athlete utilized fatty acid more efficiently. Graph _____

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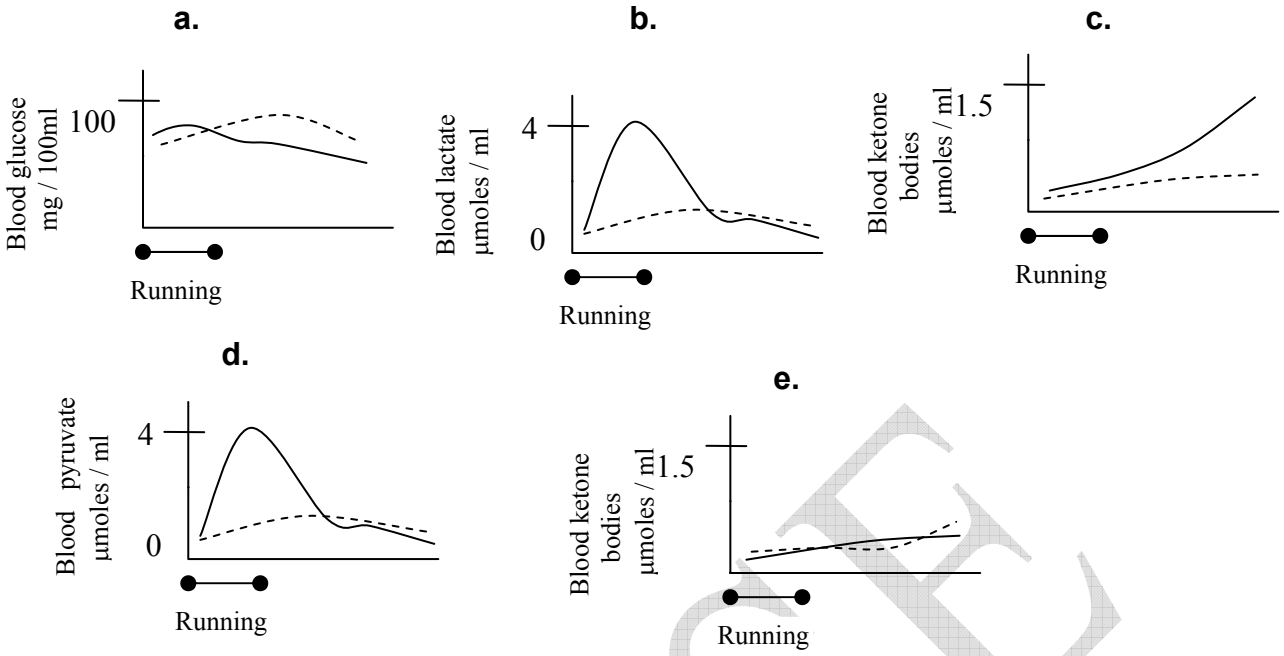


PLANT SCIENCES

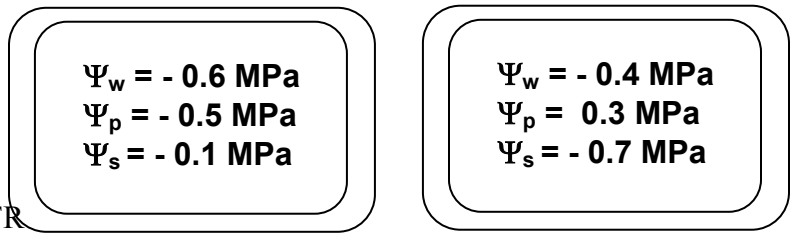
37. Stomatal frequency of 3 plants is given in the table. Match them with appropriate plant type. (Choose from the options given below)

Plant	Stomatal frequency (stomata / cm^2)	
	Upper epidermis	Lower epidermis
1	4000	24800
2	12000	12040
3	0	0

Plant 1: _____
Plant 2: _____
Plant 3: _____

Options:
(xerophytic monocot / mesophytic dicot / hydrophyte / mesophytic monocot)

38. Two plant cells with their characteristic water potentials (Ψ_w), solute potentials (Ψ_s) and hydrostatic pressure (Ψ_p) are represented.



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I. Mark the correct interpretation.

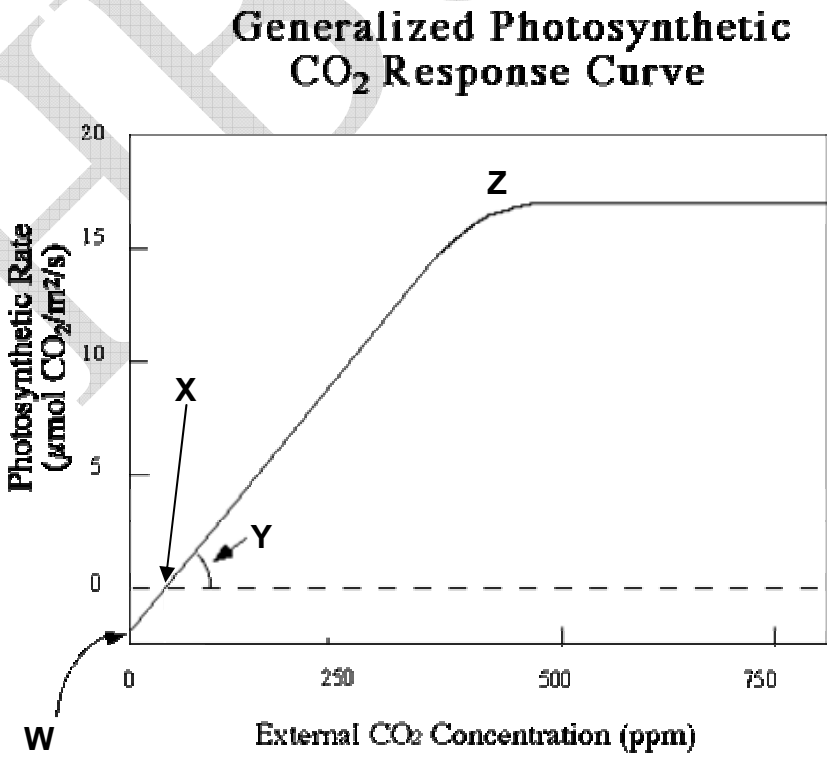
a X has higher solute and water content than Y.
b Y has greater solute potential and water potential than X.
c Y has greater turgor pressure and lower solute content than X.
d X has higher solute potential and water potential than Y.

II. If the two cells are adjacent to each other, the net flow of water will be:
a. from X to Y
b. from Y to X
c. zero

III. The two cells most likely are:

a.	X: cell from growing tip	Y: phloem
b.	X: companion cell	Y: xylem
c.	X: phloem	Y: xylem
d.	X: mature photosynthetic cell	Y: phloem

39. The photosynthetic response of a plant to varying CO_2 concentration is shown.



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I. What do W, X, Y and Z represent?

W:_____

X:_____

Y:_____

Z:_____

Options:
(carboxylation efficiency, photorespiration, CO_2 compensation point, light compensation point, CO_2 saturation point, dark reaction)

II. The plant represented in the graph is:
C_3 plant / C_4 plant / CAM plant

ANIMAL SCIENCES

40. Kangaroo rats live in deserts. The water balance (gain and loss per day) of the kangaroo rat versus man by various processes is tabulated.

	Water gain (% per day)			Water loss (% per day)		
Processes	A	B	C	M	N	O
Kangaroo rat	10	90	0	74	22.5	3.5
Man	30	10	60	36	60	4

The processes are:

A: _____

B: _____

C: _____

M: _____

N: _____

O: _____

Options:
(Urination, defecation, food ingestion, metabolism, liquid intake, evaporation)

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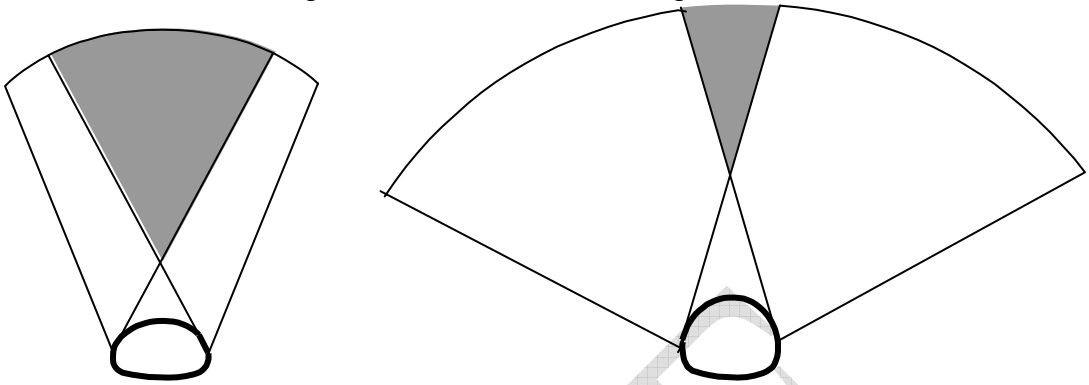
41. The breadth of visual fields perceived by two animals (I and II) is shown. Place the correct animal against each of the following statements.



Animal I **Animal II**

a. Eyes of animal positioned laterally: ____
b. Vision with greater depth perception: ____
c. Vision characteristic of a predator animal: ____
d. Lesser stereoscopic vision: ____

42. Match appropriate organ/s or tissue with each of the following statements. (Options: brain, liver, kidney, skeletal muscle, heart)

(i) Relative amount of oxygen consumed remains constant during rest as well as heavy work performed by the body.	_____
(ii) Whether body is at rest or doing heavy work, relative amount of oxygen consumed is always greater than any other organ/tissue.	_____
(iii) Greatest metabolic flexibility and an excretory function.	_____
(iv) Weight of reduces rapidly during fasting.	_____

HBCSE

GENETICS & EVOLUTION

43. What is the probability that a boy has inherited a complete set of chromosomes from his: (Choose from the options given below.)

    i. Maternal grandfather: _____

    ii. Paternal grandfather: _____

    III. Paternal grandmother: _____

    (Options: $(1/2)^{23}$, $(1/4)^{23}$, $(1/2)^{22}$, 0, 1, $(1/4)^{22}$)

44. In *Neurospora crassa*, haploid nuclei from both the parents fuse and then divide meiotically to produce four haploid spores. F^+ strain donates the nucleus and cytoplasm while F^- strain donates the nucleus.

    A scientist working on *Neurospora crassa* obtained two different slow growing phenotypes (Mutants I and II). The slow growth in both the mutants was due to the defects in the mitochondrial functioning.

    To characterize these mutations genetically, he crossed them with the wild type and with each other. The results obtained are tabulated below:

Cross	F^+ strain		F^- strain	Progeny	
				Fast growing phenotype	Slow growing phenotype
1	Mutant I	x	Wild	0	630
2	Wild	x	Mutant I	609	0
3	Mutant II	x	Wild	301	330
4	Wild	x	Mutant II	308	295
5	Mutant I	x	Mutant II	0	613
6	Mutant II	x	Mutant I	263	281
7	Wild	x	Wild	578	0
8	Mutant I	x	Mutant I	0	601
9	Mutant II	x	Mutant II	0	598

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Q. I. Among the above crosses, those that serve as control crosses are:_____

Q. II. Results that are not in accordance with Mendelian inheritance are: _____

Q. III. Mutation I is located in:
a. nuclear DNA
b. mitochondrial DNA
c. both a and b
d. none of the above

Q. IV. Mutation II is located in:
a. nuclear DNA
b. mitochondrial DNA
c. both a and b
d. none of the above

45. In social insects such as honeybees, all males are genetically haploid. If a queen that has mated once, dies and one of her daughters becomes the new queen, then the genetic relatedness of the offspring of this new queen with the workers (daughters) produced by the first queen will be:
a. 0.75
b. 0.375
c. 0.125
d. 0.25

46. Baldness in humans is a dominant sex influenced trait and the gene is carried on autosomes. A man who is BB or Bb is bald while a female Bb or bb is normal. If the two parents are heterozygous for this gene, what will be the probability of getting:
    i. Normal daughters: _____
    ii. Normal sons: _____

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ECOLOGY

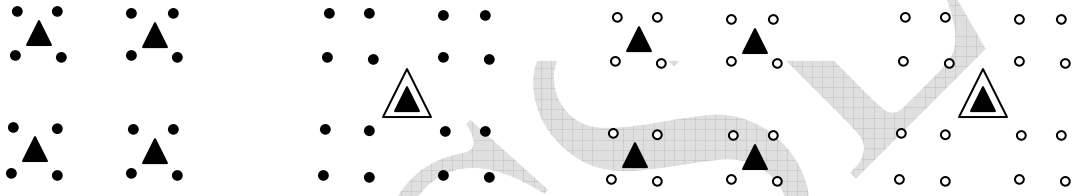
47. Four ecosystems are shown in the figures.

- **: (Solid circles): continuously available resources.**
- **: (open circles): resources variable in space / time.**

▲ **: Single nest.**

△ **: four nests together in a colony.**

D : mean distance traveled for food.



D = 1.42 **D = 2.94** **D = 3.96** **D = 2.94**

Mark the correct interpretation/s.

a. Colony nesting is the best strategy for reproductive success irrespective of the type of resources available.
b. Colony nesting gives more energy benefits to birds when food resources are continuously available as compared to variable resources.
c. Solitary nesting gives more energy benefits to birds when food resources are continuously available.
d. Solitary nesting is a unique strategy for avians to get maximum benefit to cost ratio for survival.
e. Coloniality provides special advantage over solitary nesting for reproduction in birds when the food resource is variable.
f. Nesting habit of birds dictates the resource distribution and availability in an ecosystem.
g. Solitary nesting is a preferred strategy when resources are variable as birds require to travel long distances. This increases their chances of finding a mate.

48. Reef-building corals are scattered throughout the tropical and sub-tropical Western Atlantic and Indo-Pacific oceans, generally within 30^0 N and 30^0 S latitudes.

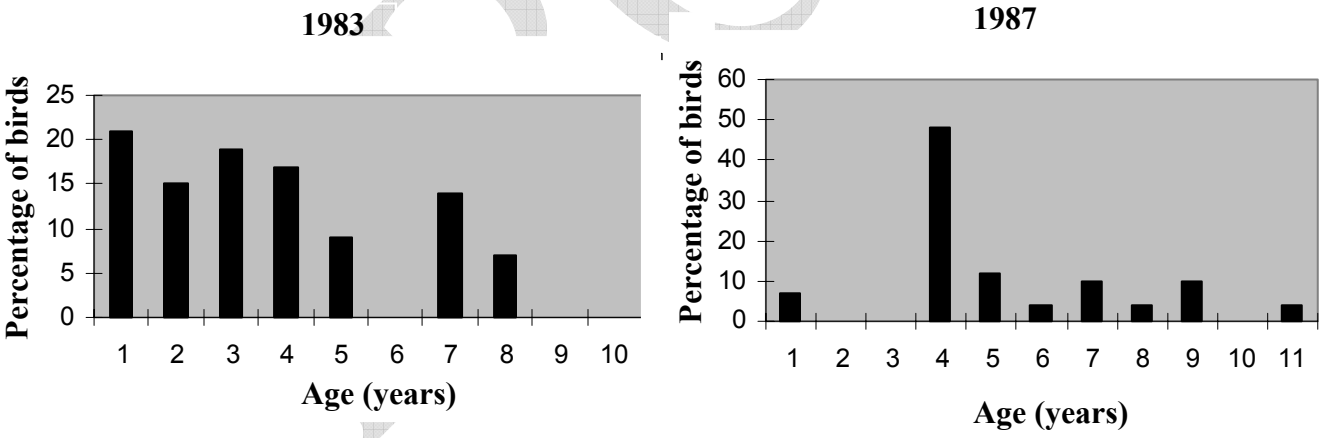
I. Which of the following environmental factors favour this distribution?

a. Shallow warm waters.
b. High salinity waters with strong wave action.
c. High CO_2 concentrations.
d. Clear waters that enhance photosynthesis.
e. Coexistence of diverse marine vertebrate and invertebrate species.
f. Cold waters with depths greater than 6000 meters.

II. Which of the following activities can harm an ecosystem of reef-building corals?

a. Fertilizer run off and untreated sewage entering sea waters
b. Deforestation
c. Fishing with dynamite
d. Water recreation activities like surfing

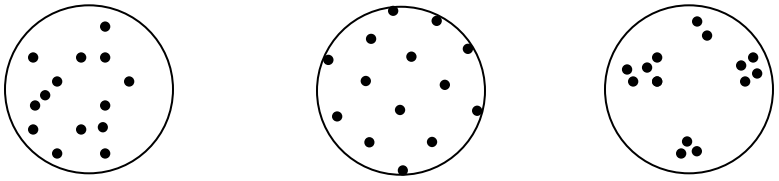
49. When the age distribution of finches in an ecosystem was studied for the years 1983 and 1987, the following graphs were obtained.



Indicate the following:

1. Year/s of most severe drought: _____
2. Year/s of maximum rains: _____
3. The years of high mortality among six year old finches in the study:_____

50. Distributions of individuals in the environment as a function of their interaction with each other and the environment are depicted. Match them with the correct statements.



I II III

1. Antagonistic interaction between individuals. _____
2. Neutral interaction between individuals and between individuals and the local environment. _____
3. Attraction between individuals or attraction of individuals to a common resource. _____
4. Local depletion of resources. _____

ETHOLOGY

51. Ants communicate with members of their own species using chemical scents known as pheromones. Study of their behavior shows that they follow some simple rules. Examine the five pictures given below. Match the behavior observed at different situations:

No.	Situation	Response
1.	Carrying food	
2.	Not carrying food, on pheromone trail	
3.	Reach food	
4.	Not carrying food, not on pheromone trail	
5.	Reach home without food on pheromone trail	

Responses:

I. Walk randomly, lay pheromone
II. Follow pheromone trail, lay more pheromone
III. Turn around and follow trail with higher pheromone
IV. Pick up food and turn around, follow trail in opposite direction
V. Deposit food turn around follow trail in opposite direction
VI. Follow the trail do not lay more pheromone
VII. Turn around walk randomly on new path

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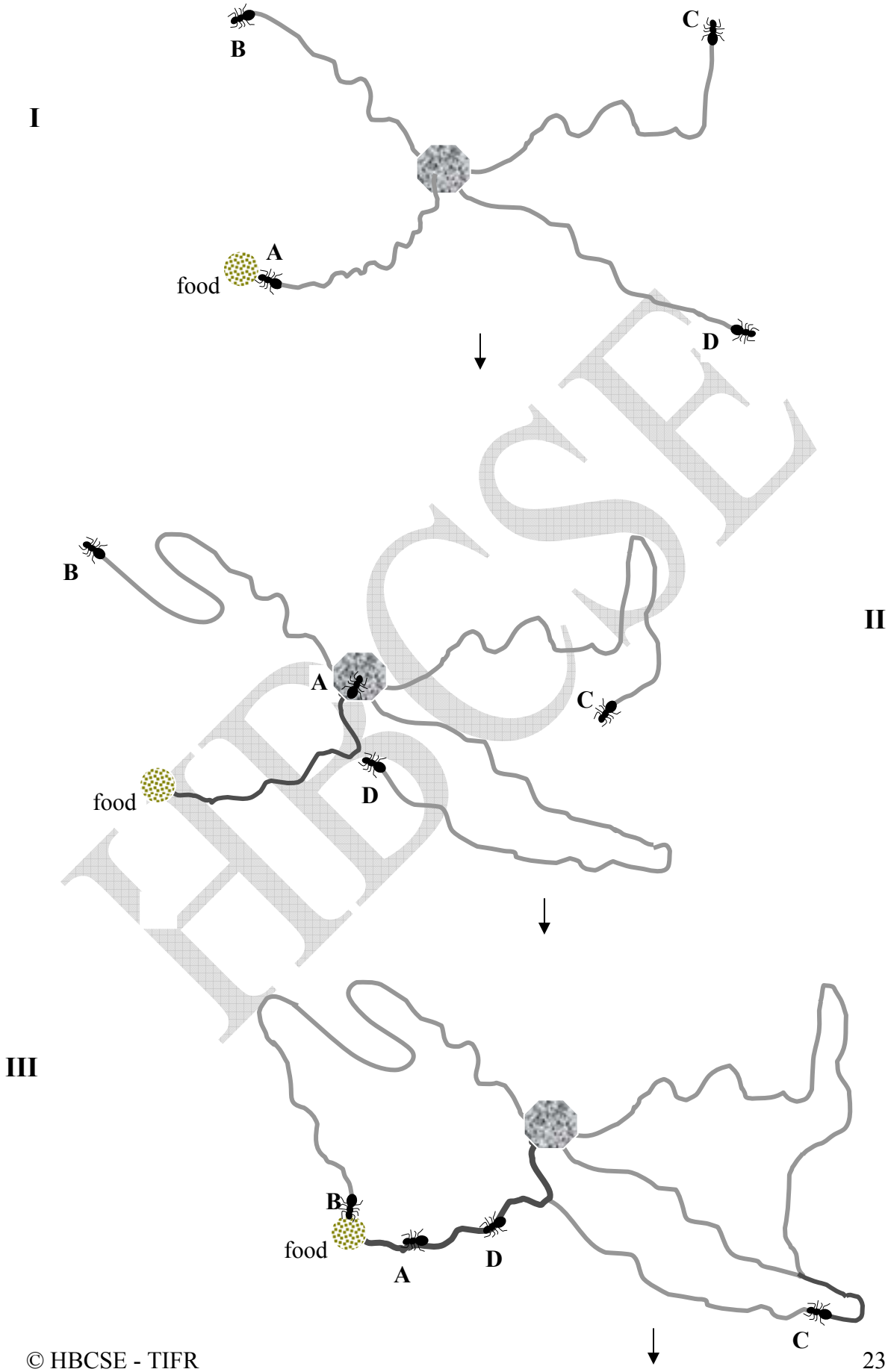

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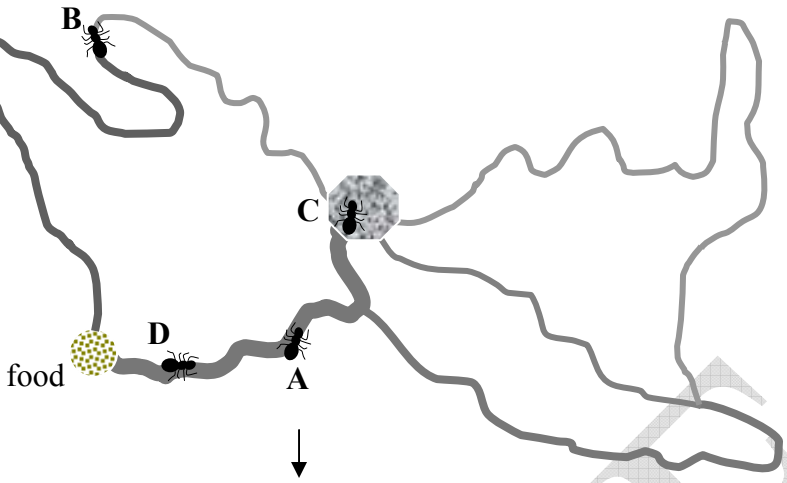
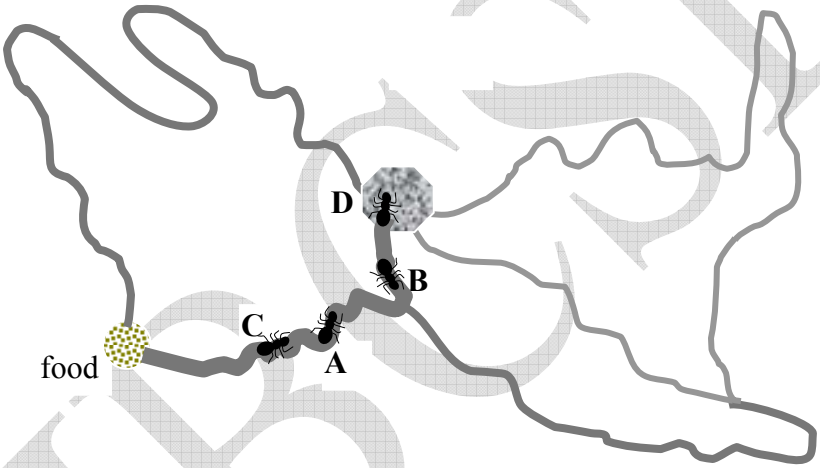
IV



V



52. Cooperative breeding is observed in some white-fronted bee-eater bird species in arid regions of Africa where individual/s, additional to the male-female pair assist in the rearing of young at the nest. The helper could be an offspring of one or both of the breeders. Evaluation of nests with/without a single mature male helper (which is an offspring of both the breeders) has shown the following results:

    i. pairs without helpers raise 1.62 young per nest.
    ii. pairs with 1 helper raise 1.94 young per nest.

Answer the following questions:

A. What is the reproductive success of the pair with a helper?

a. 1.00

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b. 1.94
c. 0.97
d. 1.78

B. What is the reproductive success of the helper?

a. 1.62
b. 0.32
c. 0.16
d. 0.00

C. Mark the most plausible evolutionary explanation for this behavior:

a. The helper belongs to the same species. By behaving altruistically, it helps better survival of other members of the species.
b. Remaining with other members of the species increases its chances of survival under adverse conditions.
c. Since the helper is closely related to the young ones, helping them would increase the chance of survival of its own genes.
d. Being with the breeding pair allows it to cannibalize the chicks if there is drought.

BIOSYSTEMATICS

53. I. Fill in the table below.

Features	Organisms			
	Echinoderm	Jelly fish	Arthopod	Flatworm
1. Symmetry (Radial/bilateral)				
2. Cephalisation (+ / -)				
3. Gut tube (+ / -)				
4. True coelom (+ / -)				
5. Segmentation (+ / -)				

II. Based on the above table, draw the most parsimonious cladogram in the space given below.

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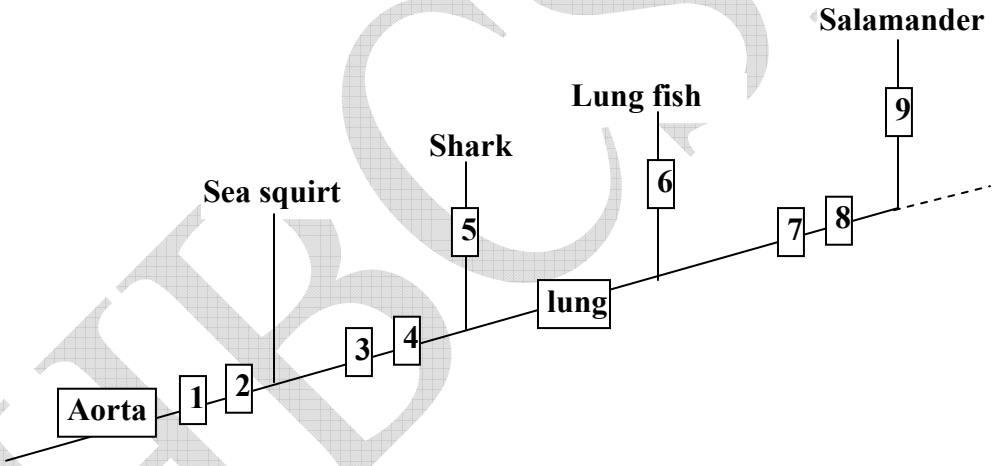
54. A cladistic classification of kingdom Animalia is shown. Assign the appropriate features (from the options given below) to the numbers 1- 9.



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1. Cephalization
2. _____
3. Hinged jaw
4. _____
5. _____
6. _____
7. Limbs
8. _____
9. _____

Options:

Swim bladder
Limbs
Three chambered heart
Hinged jaw
Vertebrae
Internal development of egg
Long sticky tongue
Cephalization
Gill slits
Amniotic egg
Fibrous protein skeleton
Bony fin
Muscular lobed fins

****

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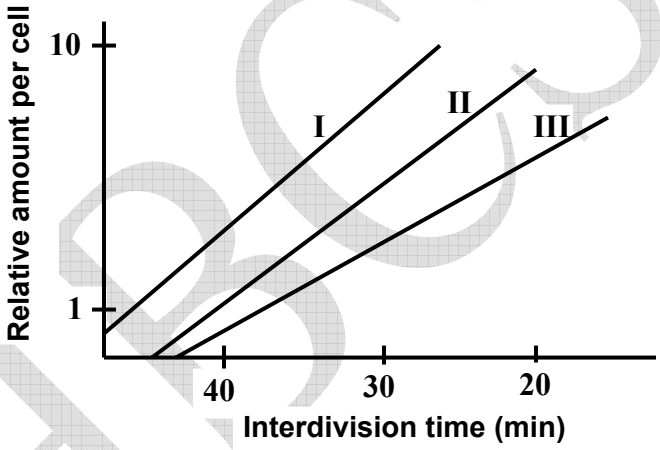
INDIAN NATIONAL BIOLOGY OLYMPIAD – 2006
PART A

CELL BIOLOGY

1. A purple bacterium whose reaction center is P720 was illuminated with blue light (experiment A) and with red light (experiment B). The bacterium:

a. gets more energy in experiment A than in experiment B.
b. gets more energy in experiment B than in experiment A.
c. gets same amount of energy in both the experiments.
d. can not utilize either blue or red light.

2. The growth of bacterial cells in a culture medium is depicted in the graph. Lines I, II and III respectively represent:



a.	I: DNA	II: RNA	III: Cell number
b.	I: RNA	II: Protein	III: DNA
c.	I: DNA	II: RNA	III: Protein
d.	I: DNA & RNA	II: Protein	III: Cell number

3. ATP hydrolysis reaction in humans:

a. is at equilibrium under all conditions.
b. is far away from equilibrium under all conditions.
c. is far away from equilibrium under conditions such as during exercise.
d. is at equilibrium only during rest.

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4. Compared to lipids found in tropical fish, lipids in arctic fish are more likely to have:

a. longer and saturated hydrocarbon tails.
b. shorter and saturated hydrocarbon tails.
c. longer and unsaturated hydrocarbon tails.
d. shorter and unsaturated hydrocarbon tails.

5. To amplify the following gene by PCR we need the following primers:

5'-AGTCTTACG_____CTGCAATCC-3'
3'-TCAGAATGC_____GACGTTAGG-5'

a. 5'-AGTCTTACG-3' and 5'-GACGTTAGG-3'
b. 5'-GCATTCTGA-3'and 5'-GGATTGCAG -3'
c. 5'-AGTCTTACG-3' and 5'-GGATTGCAG-3'
d. 5' – AGTCTTACG – 3'alone

6. When an eukaryotic cell is starved, one of the organelles is found to increase in copy number. This organelle must be:

a. mitochondria
b. peroxisome
c. autophagosome
d. microbodies

7. The nucleotide composition of the genome of a newly isolated virus is as follows:
adenine: 20 %, guanine: 20%, cytosine: 30%, thymine: 30%
The virus genome is:

a. ss DNA
b. ds DNA
c. ss RNA
d. ds RNA

8. Which of the following is functionally equivalent to mitochondrial intermembrane space?

a. Stroma
b. Thylakoid lumen
c. Chloroplast intermembrane space
d. Cytosol of bacteria

9. A facultative anaerobe is grown on glycerol- 3- phosphate as the sole source of energy and carbon. Glycerol- 3-phosphate is utilized as follows:

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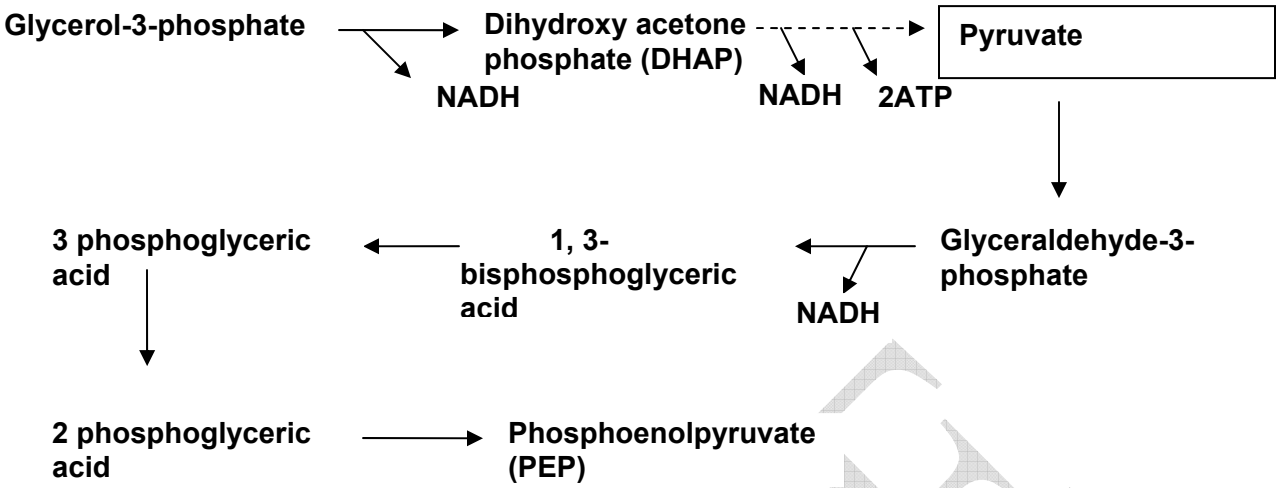
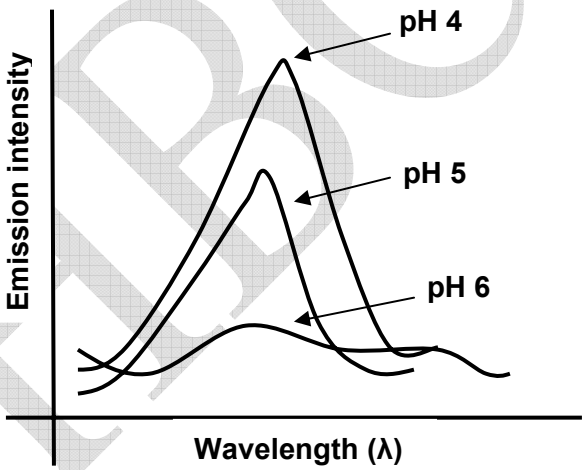


Which of the following statements is correct?

a. It grows only under anaerobic conditions.
b. It grows only under aerobic conditions.
c. It can grow under either aerobic or anaerobic conditions.
d. Glycerol 3-phosphate can not be a carbon and energy source.

10. The fluorescence spectrum of a fluorophore is as follows:



This fluorophore shows fluorescence when it is present:

a. in lysosome but not in vacuole or cytosol.
b. in lysosome or in vacuole but not in cytosol.
c. in vacuole but not in cytosol or lysosome.
d. in vacuole, lysosome or cytosol.

11. Which of the curves A, B, C and D represents enzyme activity in the presence of a competitive inhibitor?

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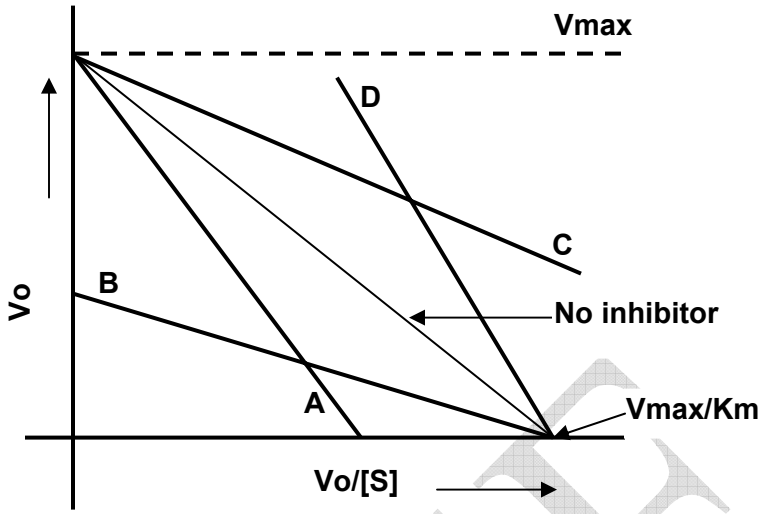

a. A
b. B
c. C
d. D

PLANT SCIENCES

12. The female flowers of a dioecious plants will produce seeds that will give rise to:

a. all female plants.
b. all male plants.
c. all monoecious plants.
d. male and female plants.

13. Which of the following plants have the largest surface area per single leaf?

a. Teak
b. Mango
c. Coconut
d. Tamarind

14. On the basis of fruit types, find the odd series out:

a. coconut, olive, amla
b. guava, capsicum, strawberry
c. lady's finger, drumstick, cotton
d. fig, pineapple, jackfruit

15. Some features of plant families are given below:

(ii) herbs or climbers, rarely shrubs or trees
(iii) stem always erect

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(iv) tap root system
(v) leaves radical or cauline, simple
(vi) flowers on a scape, trimerous, hypogynous, bracteate
(vii) perianth present
(viii) epiphyllous stamens
(ix) basal placentation

The feature/s belonging to family Liliaceae is/are:
a. All the above.
b. All except (ii), (iii), (viii).
c. All except (iii).
d. Only (v).

16. Photosynthesis is an important mode of autotrophic nutrition. During photosynthesis:
a. light and dark reactions occur simultaneously.
b. light reactions occur during daylight, dark reactions occur during night.
c. light reactions occur during daylight, dark reactions can occur at any time depending on cellular needs.
d. co-occurrence of light/dark reactions depends on whether it is a plant or microbe.

17. Which of the following does <u>not</u> indicate reproductive advancement of plant over fungi?
a. Specialised sex organs in plants as opposed to drastic life cycle changes in fungi.
b. Sexual reproduction in plants involves morphologically different and specialised sex cells.
c. Asexual reproduction is less prevalent in plants as opposed to fungi.
d. Meiosis is followed by mitosis in plants for production of spores.

18. Auxin moves down in response to gravitational stimulus in tipped over plants, both in roots and shoots, but shoots move negatively geotropic while roots are positively geotropic. Which of the following can explain the difference?
a. At both root and shoot same auxin concentration leads to growth in the respective sides.
b. At both root and shoot same auxin concentration leads to inhibition of growth in the respective sides.
c. Same high concentration of auxin is inhibitory to root growth while it is stimulatory to shoot growth.
d. Same high concentration of auxin is stimulatory to root growth while it is inhibitory to shoot growth.

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ANIMAL SCIENCES

19. Invertebrates use equilibrium organs called Statocysts that use hair cells to signal the position of the animal with respect to the gravity.
In the centre of the statocyst there is a dense statolith. In one experiment, the statolith in a lobster was replaced by Iron filings. What will happen when a magnet is placed above the lobster?

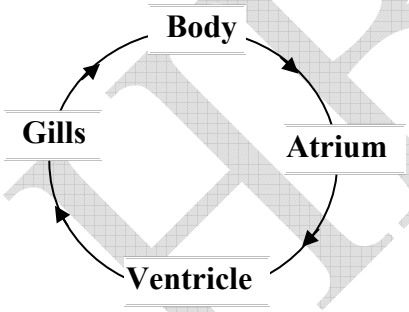
a. It will swim in the normal position as visual clues are stronger than others regarding position of the animal.
b. It will swim upside down.
c. It will adopt varying postures during swimming.
d. It will swim along its side.

20. In an amphibian, blood entering the right atrium shows higher levels of oxygenation than that in the left atrium when:

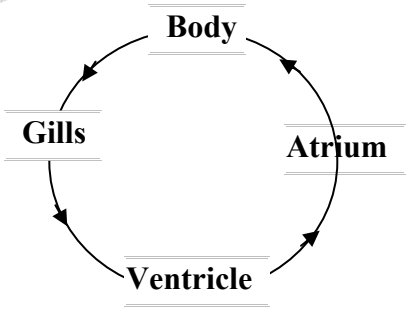
a. it is hyperactivated.
b. it is hibernating.
c. it is submerged.
d. it is in the terrestrial habitat.

21. Mark the option that correctly depicts the blood circulation in fish.

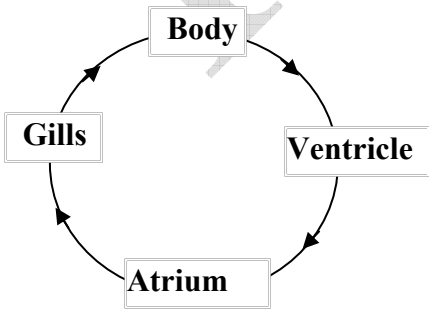
a.



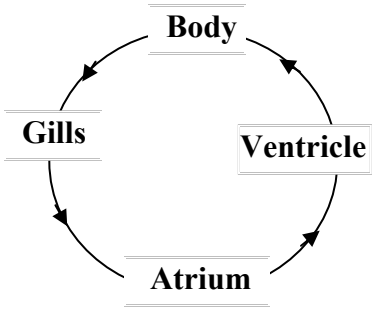
b.



c.



d.



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22. Which of the following cells do not belong to connective tissue?
a. Fibroblasts
b. Macrophages
c. Epithelial cells
d. Adipose cells

23. Of the amount of energy consumed by a cell to sustain Basal metabolic rate (BMR) of the body, about 60% is utilized for:
a. protein synthesis.
b. DNA replication.
c. cytoplasmic streaming.
d. sodium – potassium co-transport.

24. How does the vertebrate immune system differ from that of invertebrates?
a. Presence of phagocytic cells.
b. Formation of memory cells.
c. Antigen presentation.
d. Presence of non specific defenses.

GENETICS & EVOLUTION

25. In terms of the algebraic symbols used to represent the Hardy-Weinberg equilibrium (*p* and *q*), the most likely effect of assortative mating on the frequencies of alleles and genotypes for a gene locus would be:
a. a trend toward zero for both p^2 and q^2.
b. convergence of p^2 and q^2 toward equal values.
c. a decrease in the frequency of either *p* or *q* relative to the other.
d. a decrease in *2pq* below the expected value.

26. You have recently discovered a small population of monkeys – the Arunachal macaque – in the high altitudes of the Himalayas. Most of the variation that you see in coat coloration and facial features of individual monkeys is probably due to:
a. new mutations that occurred in the preceding generation.
b. sexual recombination of alleles.
c. genetic drift due to the small size of the population.
d. environmental effects, particularly low temperature regimes in that area.

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27. As humans diverged from other primates, which of the following most likely appeared first?
a. Toolmaking
b. Language
c. An erect stance
d. An enlarged brain

28. The "biological species" concept cannot be applied to two putative species that are:
a. sympatric, and occur within the same area.
b. indistinguishable in morphology.
c. capable of forming viable hybrids.
d. exclusively asexual.

29. Which of the following is/are the consequence/s of the evolution of photosystem II?
    i. Enrichment of the atmosphere with oxygen gas.
    ii. Development of eukaryotic algal forms.
    iii. Enhanced ability of plants to colonise land.
    iv. Ability to use simple molecules like water to manufacture food.

    Choose the correct option.
a. i, ii and iv
b. i, iii and iv
c. i and iv
d. i, ii, iii and iv

30. Which of the following traits can be said to have influenced the evolution of complexity in Kingdom Animalia?
a. Multicellularity
b. Three layered tissue structures
c. Development of a coelom
d. All the above

31. Which of the following is <u>not</u> a reason why rRNA is particularly useful in evolutionary studies of living organisms?
a. rRNA is evolutionarily ancient and no living organism lacks it.
b. It is easier to extract, purify and analyse rRNA than tRNA and mRNA.
c. rRNA plays the same role in translation in all organisms.
d. rRNA has evolved slowly so that sequence similarities between groups of organisms are easily found.

HBCSE

ETHOLOGY

32. A definite pecking order exists among a certain species of mice. Which of the following is least likely to raise the hierarchy of a lower order mouse?
a. Injecting it with testosterone.
b. Isolating it and giving it unlimited food without competition to increase the vigor.
c. Putting them in another group which it dominates and thus gains "self confidence" and then reintroducing it in its original group.
d. Bright coloration given to the mouse.

33. In an insect society, such as the honeybee society:
a. all adult members share labour equally.
b. division of labour is based on biologically determined castes.
c. reproduction is altered seasonally among the adults.
d. the organisation of the society is flexible and adaptable.

ECOLOGY

34. There is a population of 20 insects – 10 male and 10 female – in which each female can produce two offspring in her lifetime. The females in this population, however, are of two types. Five females reproduce asexually, giving birth only to more females. The other five reproduce sexually and give birth to males and females in equal proportions. After five generations, how many females of each type will be in the population?
a. 160 asexually-reproducing and 160 sexually-reproducing females.
b. 160 asexually-reproducing and 80 sexually-reproducing females.
c. 160 asexually-reproducing and 40 sexually-reproducing females.
d. 160 asexually-reproducing and 5 sexually-reproducing females.

35. All the following are reasonable hypotheses to explain the high biodiversity of tropical rainforests except*:*
a. habitat heterogeneity.
b. energy availability and the elevated photosynthetic rate.
c. climatic variability.
d. population interactions and co-evolution.

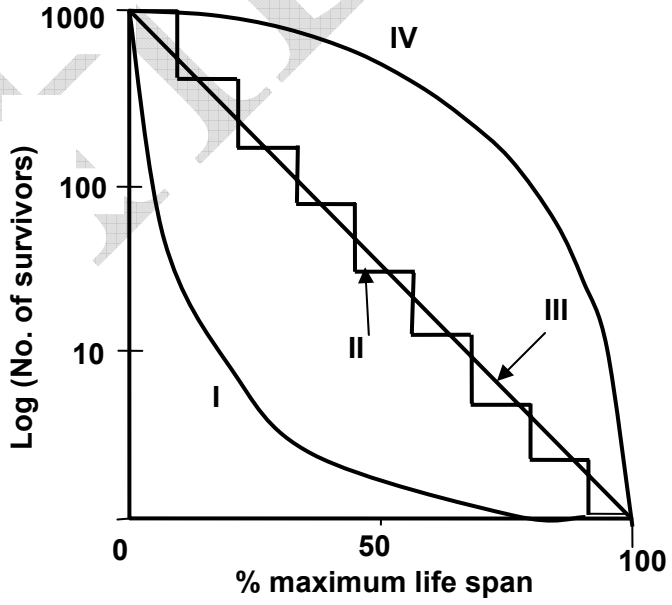
HBCSE

36. The concept of competitive exclusion suggests that:
a. extinction or emigration are the only possible results of competitive interactions.
b. intraspecific competition results in the success of the best-adapted individuals.
c. two species cannot share the same realized niche within a habitat.
d. resource partitioning will allow a species to utilize all the resources available in its niche.

37. A population of strictly monogamous sarus cranes in Ettawah district of Uttar Pradesh consists of 40 males and 10 females. The effective population size (N_e), or the number of individuals contributing to the next generation, is:
a. 10
b. 20
c. 40
d. 50

38. Consider four human populations that differ demographically only in their age structures. The population that will grow the most in the next 10 years is the one with the greatest fraction of people in the age group of:
a. 10–20 years
b. 20–30 years
c. 30–40 years
d. 40–60 years

39. The four curves shown in the graph illustrate idealized patterns of survivorship in different kinds of organisms.



HBCSE

Choose the correct option.

a. I: marine fish, II: desert lizard, III: freshwater crab, IV: large forest mammal
b. I: large forest mammal, II: desert lizard, III: freshwater crab, IV: marine fish
c. I: large forest mammal, II: freshwater crab, III:, desert lizard, IV: marine fish
d. I: marine fish, II: freshwater crab, III:, desert lizard, IV: large forest mammal

40. A uniform dispersion pattern for a population may indicate that:

a. the population is spreading out and increasing its range.
b. resources are heterogeneously distributed.
c. individuals of the population are competing for certain resources.
d. there are no strong attractions or repulsions between individuals.

41. White clover (*Trifolium repens)* is distributed in Europe. Some individuals produce cyanide as a protection against grazing herbivores. However under freezing temperatures membrane damage releases cyanide and causes damage to its own tissues.
Considering these evolutionary forces, predict the distribution of cyanide producing individuals.

a. Frequency of cyanide producing individuals will increase from north to south and even heavily grazed areas in north will lack cyanide producers.
b. Frequency will increase from north to south but heavily grazed areas in north will have greater frequency of cyanide producing individuals.
c. Frequency will increase from south to north as membrane damage in colder areas releases cyanide and makes it more harmful to herbivores.
d. Since in north the population of grazing herbivores is less the frequency distribution will be random but in the south the cyanide producing population will be high.

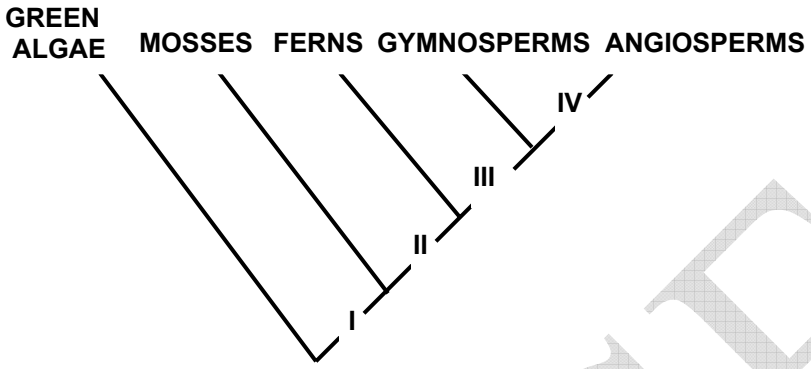
42. In a mark-recapture study of the Gangetic dolphin in the Hooghly river, 40 individuals were captured, marked and released. In a second capture, 45 dolphins were captured; 9 of these were found to be marked. What is the estimated number of individuals in the Gangetic dolphin population?

a. 200
b. 360
c. 405
d. 800

HBCSE

BIOSYSTEMATICS

43. A cladogram within the plant kingdom is shown below.



Match the derived characters given below with the correct branch points in the above cladogram.

double fertilisation
embryos
seeds
vascular tissue

a. I: vascular tissue II: double fertilization III: embryos IV: seeds
b. I: embryos II: vascular tissue III: seeds IV: double fertilization
c. I: vascular tissue II: seeds III: double fertilization IV: embryos
d. I: embryos II: vascular tissue III: double fertilization IV: seeds

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HBCSE

INDIAN NATIONAL BIOLOGY OLYMPIAD – 2006

Name of the student:----------

Centre:----------

PART B

CELL BIOLOGY

44. When a plasmid of size 2.6 kb was digested with various restriction enzymes, the following fragments were obtained:

Enzymes	Size of fragments (kb)
1) *Eco*RI, *Pst*I	0.46, 2.14
2) *Eco*RI, *Bam*HI	0.2, 2.4
3) *Eco*RI, *Hin*dIII	0.05, 2.55
4) *Eco*RI, *Bam*HI, *Pst*I	0.2, 0.46, 1.94
5) *Bam*HI, *Hin*dIII	0.15, 2.45

The correct order of occurrence of the restriction sites on the plasmid is:

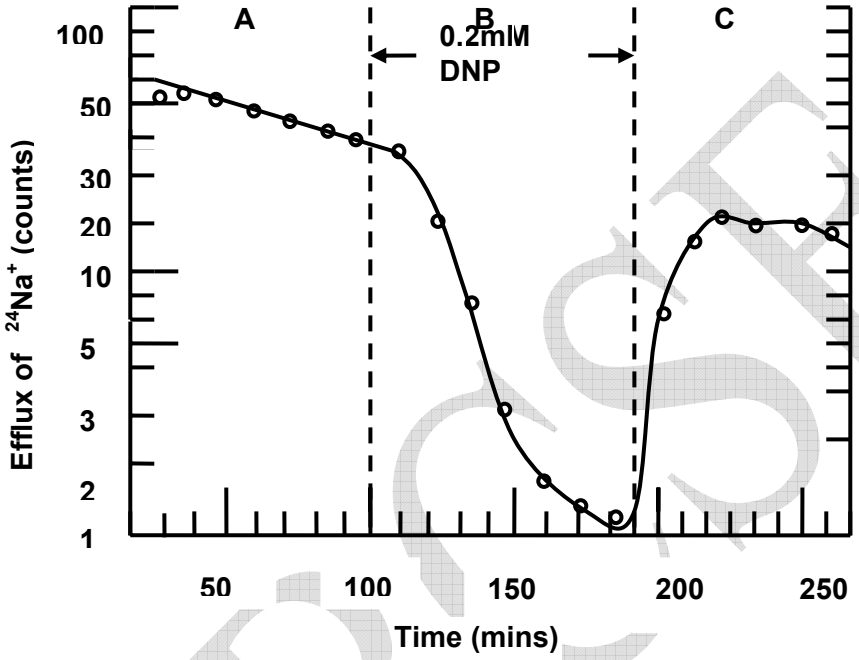
a. *Bam*HI*, Hind*III*, Eco*RI*, Pst*I
b. *Bam*HI*, Eco*RI*, Pst*I*, Hind*III
c. *Pst*I*, Hind*III*, Eco*R*I, Bam*HI
d. *Hind*III, PstI*, Eco*R*I, Bam*HI

45. Endosomes and lysosomes are organelles found in eukaryotic cells. They show many structural and functional similarities. The major difference between them is:

a. Lysosome formation is an active process while endosome formation is not.
b. Digestion by endosomes is mainly intracellular while that of lysosome is extracellular.
c. Lysosomes contain hydrolytic enzymes while endosomes do not.
d. Endosomes digest non-self components whereas lysosomes digest both self and non-self components.

HBCSE

46. A nerve sample is incubated in $^{24}Na^{+}$ solution for some time and then mounted in a non radioactive bathing solution. The graph shows the rate of efflux of radioactive Na^{+} ion from a nerve sample.
Samples from the bathing solution were collected at 10 minute intervals. The difference in two successive counts indicates the efflux of radioactive sodium ions.



A) What is the cause of a steep decline in the efflux in phase B after adding 0.2 mM DNP(dinitrophenol) – a proton ionophore?

a. DNP blocks Ca^{++} binding site of $Na^{+}K^{+}$ATPase.
b. DNP increases the membrane permeability for sodium ions.
c. DNP blocks ATP synthesis.
d. DNP complexes sodium ions and hence makes it unavailable to its respective carrier.

B) What is the cause of slow linear decrease in radioactive sodium efflux in phase A?

a. inactivation of Na^{+} transport channels due to continued Na^{+} exposure.
b. Decrease in ATP available for active pumping out by $Na^{+}K^{+}$ATPase.
c. Decrease in intracellular sodium ion due to continued efflux.
d. Gradual dilution of intracellular $^{24}Na+$ as it is continuously replaced by normal ions from outside.

HBCSE

47. Consider the following statements about the serial endosymbiosis theory.

i. Chloroplasts and mitochondria are self replicating structures.
ii. Chloroplasts and mitochondria require some proteins coded by the nuclear DNA.
iii. Chloroplasts and mitochondria are double membrane structures.
iv. In aerobic prokaryotes plasma membrane incorporates electron transport chain.
v. Chloroplasts are equally distributed during the cell division.

Which of these statements support the theory?

a. i, iii and iv
b. i, ii and v
c. I, ii and iv
d. ii and iii

48. From the given options, choose the appropriate wavelengths for the following:

Food preservation: _____
Demonstration of bacterial flagella: _____
Studying 3D structure of protein; _____
Observing fluorescence of chlorophyll: _____

(Options: 0.1A^o/ 1.5 A^o/ 3000A^o/ 5000A^o)

49. A cellular enzyme extract was subjected to different purification procedures. The results are tabulated below:

Procedure	Total protein (mg)	Activity (units)
Crude extract	20,000	4,000,000
Salt precipitation	5,000	3,000,000
pH precipitation	4,000	1,000,000
Ion exchange chromatography	200	800,000
Affinity chromatography	50	750,000
Gel filtration	45	675,000

The most effective purification step is: _____

HBCSE

PLANT SCIENCES

50. In the Calvin Benson cycle, the following parameters were varied to study their effect on the concentration of intermediates:
I: Cutting off light supply
II: Cutting off CO_2 supply
The most likely effects would be:

a. I : 3 Phosphoglycerate increases II : 1,5 RUBP increases

b. I : 3 Phosphoglyceraldehyde depleted II : 3 Phosphoglycerate depleted

c. I : 1,5 RUBP depleted II : 3 Phosphoglycerate increases

d. Both a and b

51. Which of the following structures is/are not found associated with chloroplasts?
I) Membrane bound ribosomes
II) Multiple copies of circular DNA
III) Polysomes
IV) Lipids
V) 80S ribosomes

Options:
a. I, II and V
b. IV and V
c. III and IV
d. Only V

52. A few statements about chlorophyll pigment are made. Mark the correct statement.
a. Chlorophyll shows characteristic absorption spectrum in red and blue region owing to its porphyrin ring.
b. A long hydrophobic tail of chlorophyll acts as an antenna to receive light energy in the form of photons
c. Chlorophyll a is considered as a primary pigment for photosynthesis because its absorption spectrum almost overlaps with the action spectrum of photosynthesis.
d. None of the above.

HBCSE

53. To study the limiting factors for photosynthesis, three plants of the same C3 species were kept in three different conditions as follows:

I: Cool environment (15^0C) in shade
II: Cool environment (15^0C) in greenhouse
III: Warm environment (25^0C) in bright light

The rate of photosynthesis will be:

a. III > II > I
b. I > II > III
c. (II = III) > I
d. III > I > II

54. Plants grown under increased CO_2 concentration show various physiological effects. Some of these effects are listed below. Select the underlying reasons for each effect from the options given.

	Physiological effect	Reason
1.	Greater abundance of mycorrhizal fungi	
2.	Ability to withstand air pollutants	
3.	Reduced loss of water	
4.	Increased tolerance to soil salinity	

Options:

a. increase in biomass
b. stomatal closure
c. decrease in rate of respiration
d. root nodule formation
e. stomatal opening

ANIMAL SCIENCES

55. Some body characteristics observed in Kingdom Animalia are given below. Match the terms with the correct descriptions.

(i) Flexible rod like structure that runs from the middle of the brain to the tip of the tail and provides internal support: _____
(ii) Fluid filled chamber in which gut and other organs are cushioned and protected: _____
(iii) Pair of openings through the pharynx where food is filtered: _____
(iv) Stinging capsules embedded with the epidermis: _____

(Nematocysts, coelom, nerve cord, notochord, lungs, gill slits, mesoglea, radula)

HBCSE

56. Features of various animals are tabulated below. Mark them (√) against the appropriate taxon.

		Taxa					
	Features	Fish	Amphibian	Reptile	Bird	Mammal	All vertebrates
1	Countercurrent gas exchange						
2	RBCs with haemoglobin						
3	Lungs in the form of simple sacs						
4	Digestive system with storage function						
5	Flexible joints of skull bones that can separate during feeding						
6	Eggs developed within female reproductive tract and nourished by female						

57. A) Which of the following enzyme is responsible for high mutation rates of HIV virus?

a. Reverse transcriptase
b. Integrase
c. Protease
d. Endonuclease

B) Which of the following is <u>not</u> a strategy to fight the HIV virus?

a. Prevention of binding of the virus to the cell surface receptors.
b. Inhibition of reverse transcription.
c. Use of protease inhibitors that block the production of mature viral proteins.
d. Development of monoclonal antibodies against the virus.

HBCSE

GENETICS & EVOLUTION

58. Tasmanian hen is a polyandrous bird. The female can copulate with two males: One dominant and another subordinate. It was observed that a dominant male alone can produce 5.5 chicks per season with the female. Along with the subordinate male, 7.5 chicks per season are produced, but only half of them are his own because both are equal partners in reproduction.

    The behaviour 'the dominant male allowing the subordinate male to copulate with the female' will evolve only if; according to Hamilton's rule the gain of an individual in the latter situation is greater than that in the former situation. (Gain of an individual can be determined by multiplying the number of offspring with the relatedness to them.)

    Using the above information, determine under which conditions the behavior can evolve.

a. Such behaviour can evolve with any unrelated subordinate male (relatedness = 0).
b. It can evolve only when the subordinate male is a brother (relatedness = 0.5).
c. It can evolve even when the subordinate male is a half brother of the dominant male (relatedness = 0.25).
d. The cost involved is so great that it can not evolve in any case.

59. In chimapanzees, long hair is governed by recessive allele (l) and short hair by dominant allele (L). Black hair is controlled by dominant allele (B) and brown by recessive allele (b).

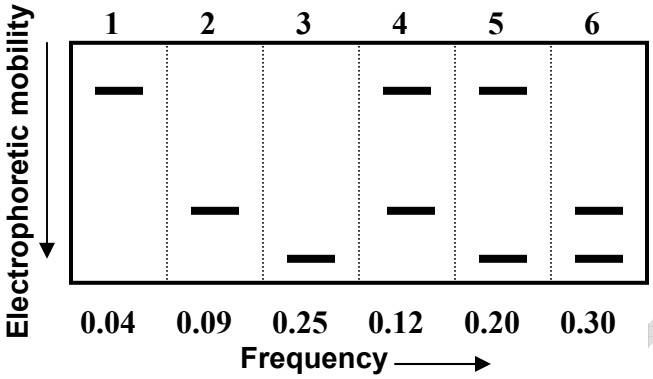
    Assuming that the genes are on separate chromosomes and a heterozygous short brown female is crossed with a heterozygous short black male, determine the following:

    Ratio of progeny with short hair: long hair _____

    Ratio of progeny with black hair: brown hair _____

60. A large population of pigs was studied for presence of isozymes of a particular enzyme. Electrophoretic separation of these enzyme preparations gave the following pattern.

HBCSE



A. The principle of separation used in the above technique is:
a. charge density
b. molecular weight
c. polarity of molecules
d. solubility

B. The total number of alleles in the population are: _____

C. Total frequency of homozygous individuals in the population is: ___

D. Is the population in Hardy Weinberg equilibrium? Yes / No

61. A) Which of the following mutations in *E. coli* will make the *lac* operon noninducible by lactose?

I. In the permease gene resulting in reduced transport of lactose.
II. In the operator region resulting in increased affinity for the repressor.
III. In the repressor gene resulting in decreased affinity for the inducer.
IV. In the transacetylase gene resulting in nonfunctional protein.

Mark the correct option.
a. Only I
b. II and III
c. I, II and III
d. I, II, III and IV

B) Which of the following mutations will make the *lac* operon constitutively expressed?
a. In the DNA-binding domain of the repressor.
b. In the β-galactosidase gene.
c. In the trans-acetylase gene.

HBCSE

d. All of the above.

62. Patterns of inheritance can be studied using pedigree analysis. Mark the appropriate trait/s (by putting √) for each of the three situations.

Situations	Trait				
	Autosomal dominant	Autosomal recessive	X linked recessive	X linked dominant	Y linked
1. Both parents can be unaffected, yet the offspring is affected					
2. If father is affected, only daughters are affected					
3. If father is affected, son can be affected					

ETHOLOGY

63. In a study on Belding's ground squirrels, Sherman observed the following:

Category of squirrel	Number exposed to predator	Squirrels giving alarm calls	Squirrels expected to call if alarms are random
Males	67	12	30
Females with living relatives	190	105	85
Females without living relatives	168	60	75

A). Are the following statements true or false?

a. In general, females are more likely to give alarm calls than are males. _____

b. Females with relatives living nearby are as likely to give alarm calls as are females without relatives as neighbours. _____

HBCSE

c. Both males and females emit alarm calls at levels comparable to what they would if they were calling at random. _____

d. Females, in particular, give calls in response to a predator significantly less than what would be expected by chance alone. _____

B). If you wanted to analyse the supplied data to verify whether alarm calls are emitted at higher levels than would be expected by chance alone, a suitable statistical test is the:

a. Student t test
b. Analysis of Variance
c. Chi-square test

ECOLOGY

64. In a pasture, the energy budget was observed as follows:

Incident solar energy	1×10^6 cal/ m^2/yr
Solar energy absorbed by plants	0.4×10^6 cal/ m^2/yr
Energy lost by re-radiation from plants	0.24×10^6 cal/ m^2/yr
Energy loss by respiration of plants	0.1×10^6 cal/ m^2/yr
Grazing by cattle	0.02×10^6 cal/ m^2/yr

A. The efficiency of the system in fixing energy is:

a. 12%
b. 16%
c. 24%
d. 40%

B. Biomass accumulation over a span of ten years:

a. 4×10^6 cal/m^2
b. 3×10^6 cal/m^2
c. 0.4×10^6 cal/m^2
d. 0.3×10^6 cal/m^2

HBCSE

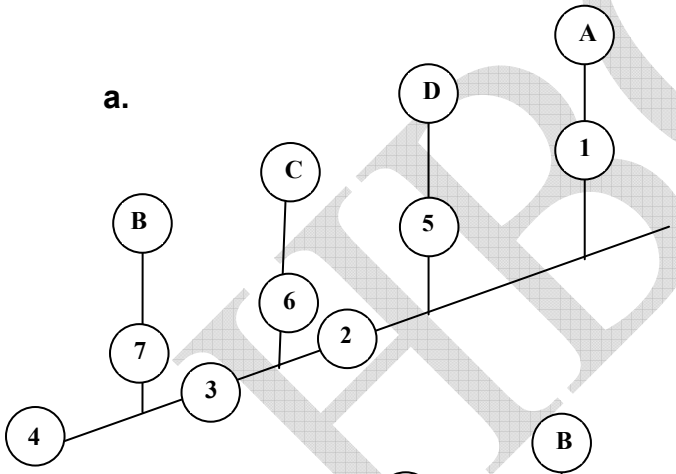
BIOSYSTEMATICS

65. Morphological characters of some animals are listed in the table.

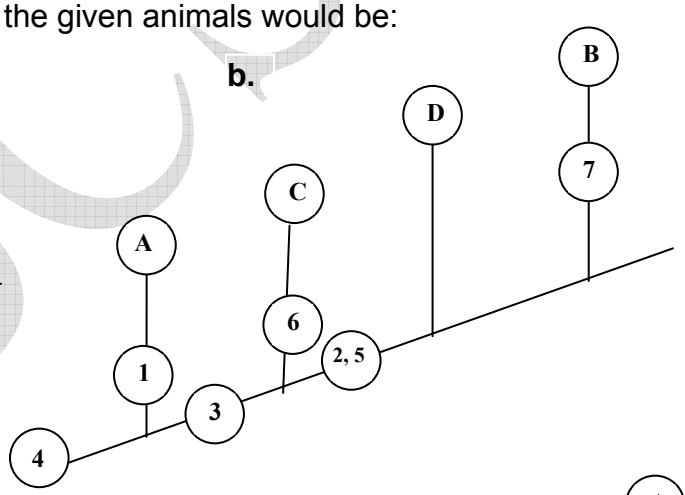
Animal	1. CaCO3 endoskeleton	2. Notochord	3. Pharyngeal slits	4. Deuterostomy	5. Post natal tail	6. Feeding tentacles	7. Dorsal and ventral aortae
A. Sea Urchin	+	-	-	+	-	-	-
B. Lancelet	-	+	+	+	+	-	+
C. Acorn worm	-	-	+	+	-	+	-
D. Tunicate	-	+	+	+	+	-	-

The most parsimonious cladogram for the given animals would be:

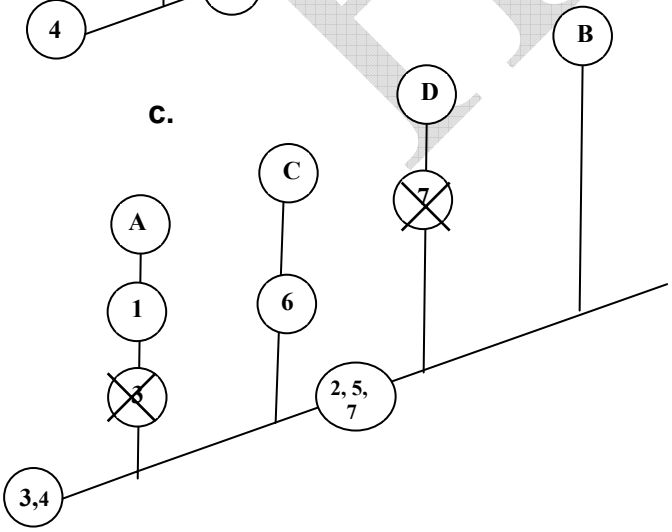
a.



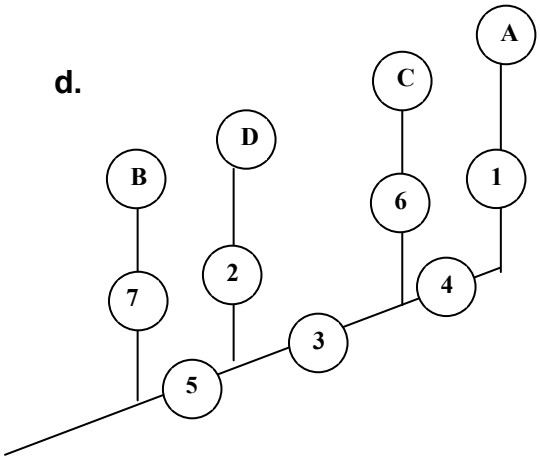
b.



c.

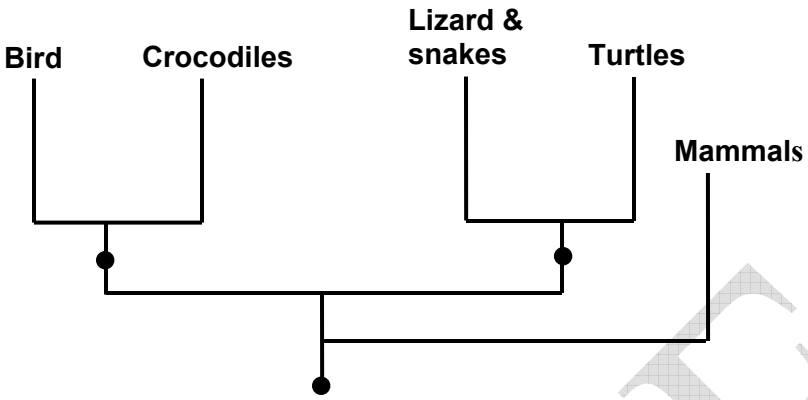


d.



HBCSE

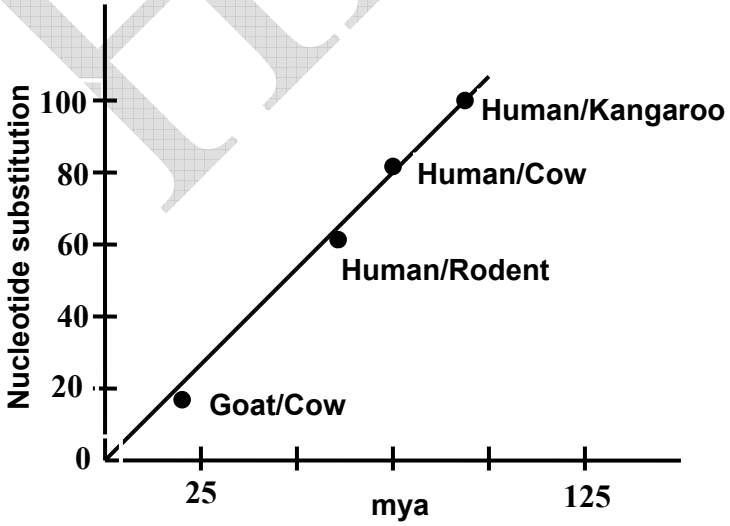
66. Classification of some animals is shown below.



Mark the correct interpretation.

e. Classification shown above does not imply correct evolutionary trend because crocodilians which belong to class Reptilia are outgrouped with aves.
f. Cladogram reveals that birds and crocodilians share a common ancestor however, birds have evolved rapidly than crocodilians to show distinct morphological traits.
g. Bird should be placed in a separate class because they show traits very different from crocodilians and hence the cladogram is incorrect.
h. Cladistics tree shown is incorrect because it shows that mammals evolved earlier than aves.

67. Scientists compared various pairs of animals for cytochrome C gene. When they counted the number of nucleotides in the gene that were not the same, they obtained the following graph.

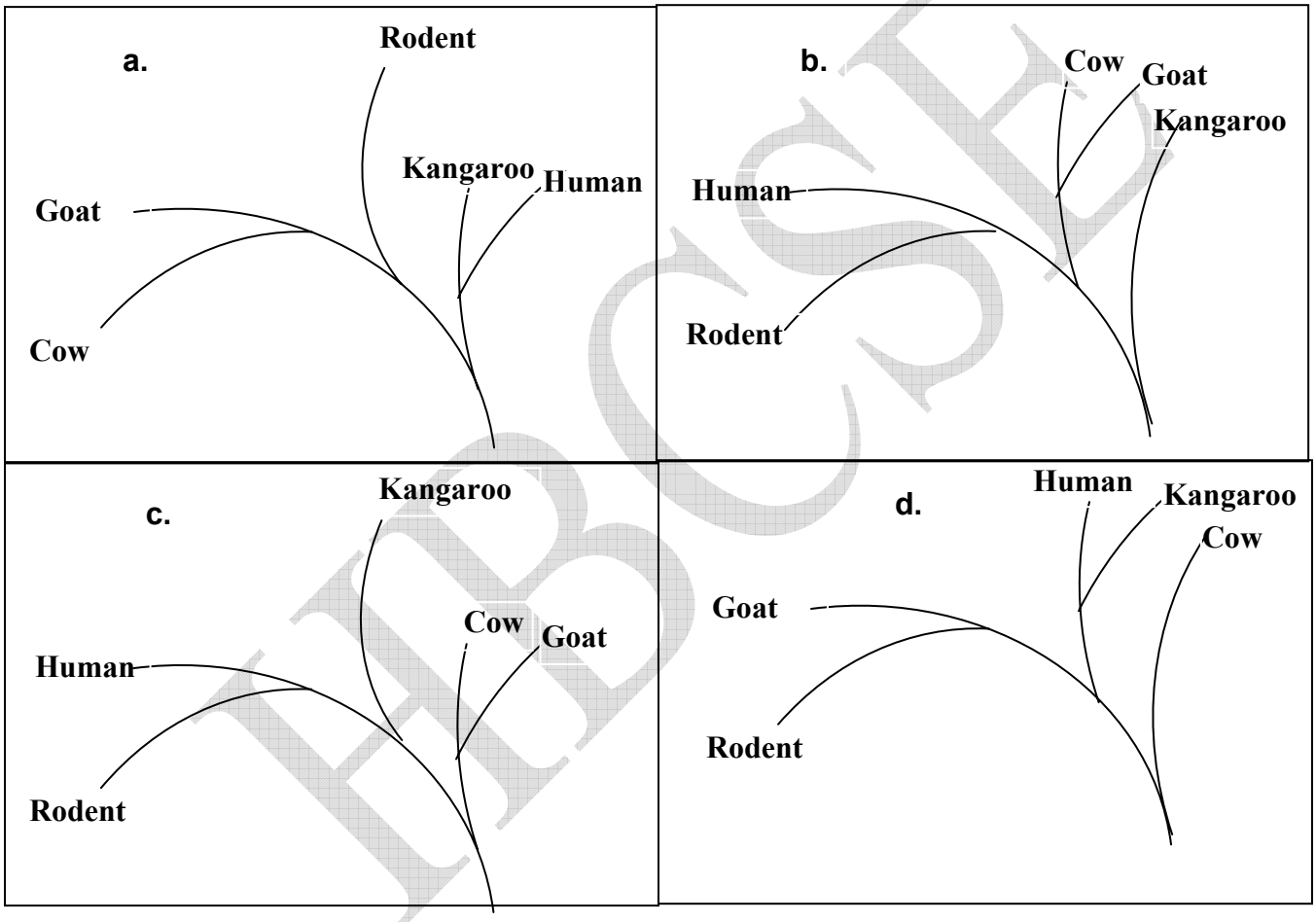


HBCSE

A. The cytochrome C gene was used in this study because:

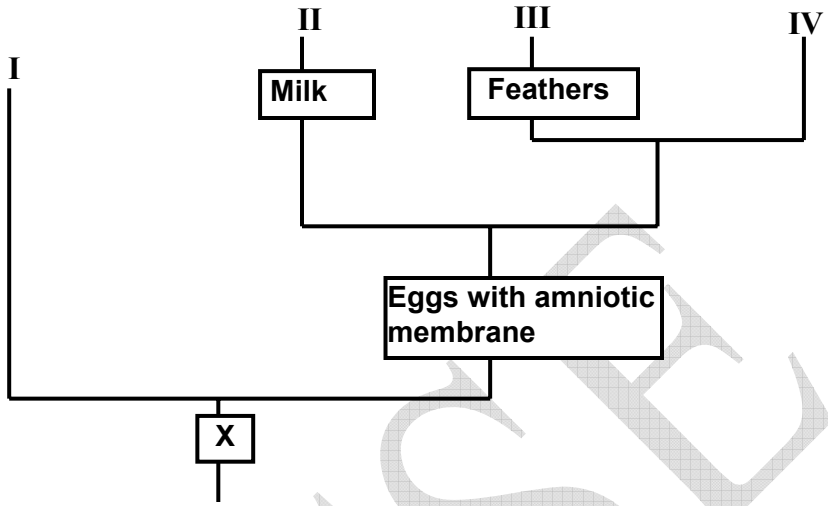
a. The gene does not mutate over time.
b. The gene evolves at a constant rate.
c. Oxidation is the basic life process of all organisms and cytochrome C plays an important role in this process.
d. This gene has a sufficiently large number of nucleotides so that it can accommodate a large number of changes in the sequence.

B. Based on the data in the graph, the correct evolutionary tree is:



HBCSE

68. A cladogram depicting the evolution of animal kingdom is shown. Mark the correct option.



A) I, II, III and IV represent:

a.	I: reptile	II: mammal	III: bird	IV: amphibian
b.	I: jawless fish	II: mammal	III: bird	IV: tunicates
c.	I: amphibian	II: mammal	III: bird	IV: reptile
d.	I: arthropod	II: mammal	III: bird	IV: amphibian

B) The trait (X) that evolved very close to amniotic membrane would be:

a. vertebrae
b. lungs
c. limbs
d. jointed appendages

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HBCSE

INDIAN NATIONAL BIOLOGY OLYMPIAD – 2007
PART A

CELL BIOLOGY

1. Which of the following processes will lead to expansion of plasma membrane of a cell?

a. Exocytosis
b. Endocytosis
c. Pinocytosis
d. ATP driven co-transport

2. Inhibition of hexose monophosphate pathway will have a direct effect on:
   I) Reductive biosynthesis
   II) DNA and RNA synthesis
   III) Electron transport through ETC.

a. I and II
b. I, II, III
c. I alone
d. II alone

3. The gecko is a reptile with remarkable ability to climb on smooth surfaces. The interaction of gecko limbs with smooth surfaces involves:

a. van der waal interactions
b. hydrogen bonds
c. covalent bonds
d. ionic interactions

4. The eukaryotic cell cycle is divided into four phases – G1, S, G2 and M. DNA synthesis occurs during S phase and chromosome segregation during M phase while G1 and G2 are the phases preceding S and M phases respectively. The drug hydroxyurea inhibits the enzyme ribonucleotide reductase. Cells treated with hydroxyurea will arrest the cell cycle in:

a. M phase
b. G1 phase
c. G2 phase
d. S phase

HBCSE

5. Which of the following molecules will pass freely through plasma membrane?
   I) CO_2
   II) O_2
   III) H_2O
   IV) protein of very small molecular weight

a. All the four
b. All except IV
c. I and II
d. Only II

6. Two linear double stranded DNA fragments A and B have the same number of base pairs (120 Kb) but A contains 80% A-T pairs while B contains 80% G-C pairs. When run on agarose gel:

a. A will run 1.5 times faster than B
b. B will run 1.5 times faster than A
c. A and B will run at the same speed
d. the separation pattern will depend on the pH of buffer used.

7. A dialysis bag of cut-off MW 10 kD contains 1 mmoles solution of a succinate binding protein (MW 20 kD; binding stoichiometry is 1 : 1). 5 mmoles succinate is added to the solution containing the dialysis bag and succinate is allowed to reach equilibrium. Total amount of succinate inside the dialysis bag will be :

a. 5 mmoles
b. 3 mmoles
c. 2.5 mmoles
d. 2 mmoles

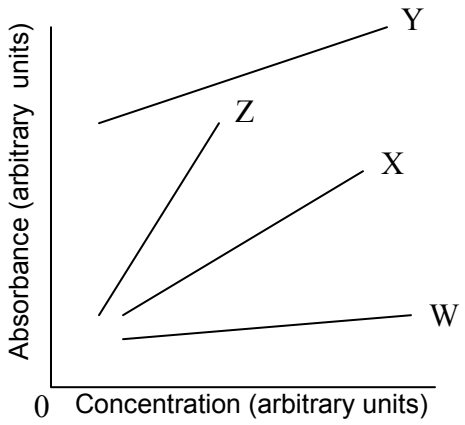
8. W, X, Y, and Z are such that:

$$W \xrightarrow{\text{Peroxidase, } H_2O_2} X$$

$$Y \xrightarrow{\text{Peroxidase, } H_2O_2} Z$$

Absorbance properties of these compounds are shown in the graph.

HBCSE



The most sensitive method of assaying peroxidase will involve monitoring:

a. increase in absorbace of X
b. decrease in absorbance of W
c. increase in absorbance of Z
d. decrease in absorbance of Y

9. During protein purification, which of the following techniques will yield the most purified protein fraction?

a. Salt precipitation
b. Charge separation
c. Separation by molecular weight
d. Affinity purification

10. Which of the following statement/s is/are true?

I. $FADH_2$ is a carrier of higher-energy electrons than NADH.
II. NADP+, not FAD+, is involved in oxidation of iso-citrate in Krebs cycle.
III. Metabolism of proteins, fatty acids and carbohydrates are interlinked mainly at the stage of pyruvate.
IV Per molecule of glucose, energy yield of oxidative respiration is 24 times greater than that of glycolysis alone.

a. II
b. IV
c. I and III
d. None of the above

PLANT SCIENCES

11. If the entire evolutionary time scale of 4.5 billion years were condensed into a 24 hour clock, the invasion of land by plants must have occurred:

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a. by noon
b. by evening
c. by night
d. just prior to midnight

12. If a plant cell wall is compared to a reinforced concrete, then the steel rods and the concrete would respectively represent:

a. pectin and cellulose
b. cellulose and pectin
c. hemicellulose and cellulose
d. cellulose and sucrose

13. A cell having a flagellum, single large chloroplast and a cell wall, is most likely:

a. prokaryotic mixotroph
b. eukaryotic autotroph
c. eukaryotic heterotroph
d. prokaryotic autotroph

14. Which of the following plant organelles exhibit least surface to volume ratio?

a. Mitochondria
b. Chloroplasts
c. Vacuoles
d. Nucleus

15. The sour taste of the citrus fruit is due to a:

a. highly acidic cytoplasm
b. highly acidic vacuolar sap
c. high concentration of H^+ in cell wall
d. high concentration of H^+ in periplasmic space

16. In which of the following conditions will water from soil enter the roots? (Ψ indicates water potential)

a. Ψsoil = -0.3MPa, Ψroot xylem = -0.2 MPa
b. Ψtrunk xylem = -0.6MPa, Ψroot xylem = -0.3 MPa
c. Ψtrunk xylem = -0.3MPa, Ψleaf = 0.7 MPa
d. Ψoutside air = -10.3MPa, Ψleaf = -12 MPa

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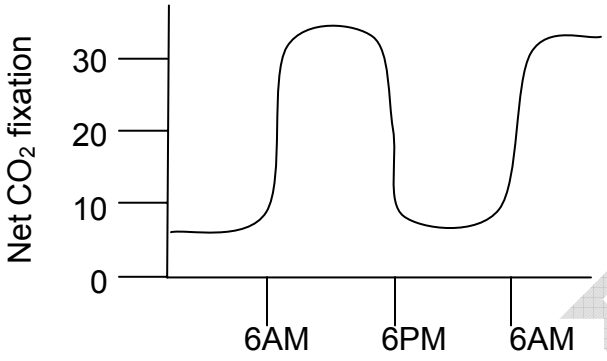
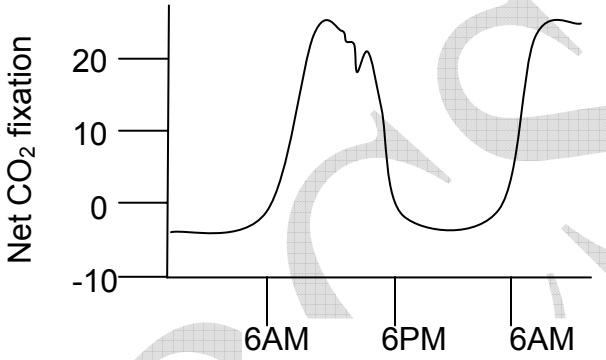
17. Which of the following graphs correctly depicts the photosynthetic activity of a sun plant during summer?

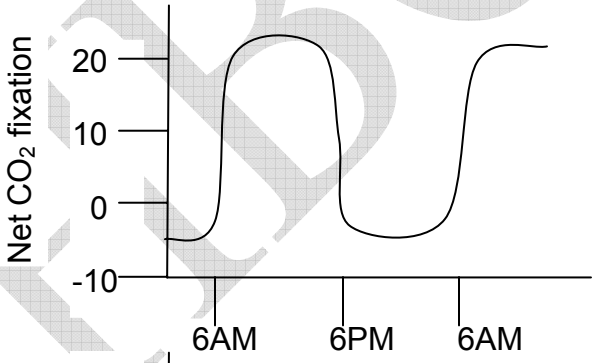
a.



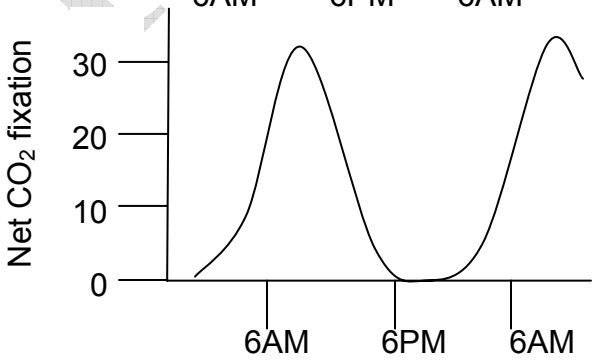
b.



c.



d.



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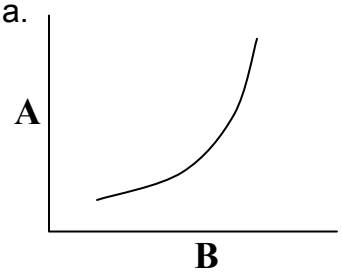
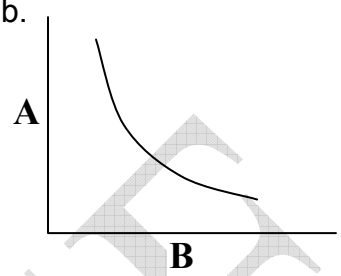
ANIMAL SCIENCES

18. Metabolic rate per unit body mass (A) is plotted against the total body mass of mammals(B). This relationship is correctly shown in graph:

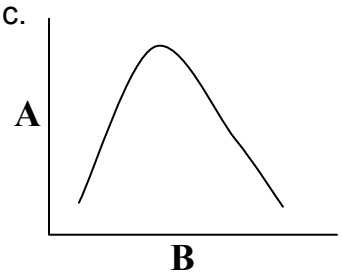
a.



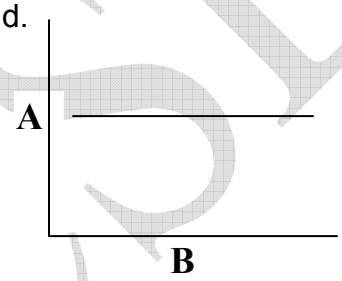
b.



c.



d.



19. The organ for which the respiratory quotient will always be 1 is:

a. liver
b. brain
c. kidney
d. heart

20. The only way to bring closer the weight-specific metabolic rates of a large and a very small sized mammal is:

a. by feeding the smaller animal with high fat diet.
b. by providing oxygen-rich atmosphere to larger animal.
c. by providing extra thick insulation to smaller animal.
d. by placing the larger animal in a warmer chamber.

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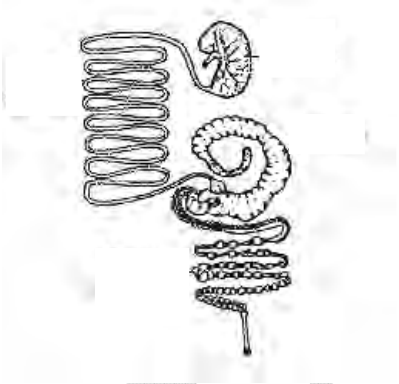
21. The digestive system in the diagram represents:

a. carnivore
b. ruminant herbivore
c. fructivore
d. non-ruminant herbivore



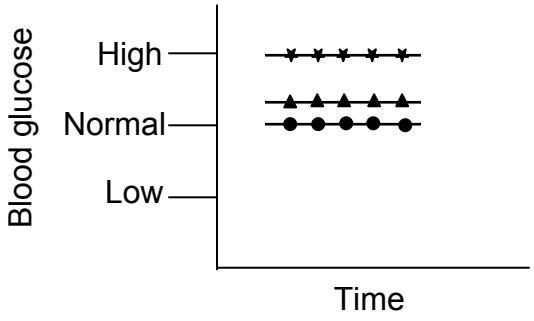
22. In a patient suffering from diarrhoea, the best way to get glucose into his/her body via the gastro-intestinal tract is by:

a. giving diluted glucose solution
b. giving glucose solution with Na^{+}
c. giving glucose solution with Ca^{2+}
d. giving glucose solution with fibre and protein rich diet.

23. Which of the following statements about body temperature regulation of animals is <u>false</u>?

a. Cold blooded animals often maintain their body temperature lower than their surroundings.
b. Endotherms are able to remain active at night even if temperature is low.
c. Endotherms are able to live at higher elevations and at farther northern and southern latitudes as compared to ectotherms.
d. A cold blooded animal can subsist on about one-tenth of the food required by a similar sized endotherm.

24. The blood sugar levels in a normal healthy person just after meals are shown in the graph.



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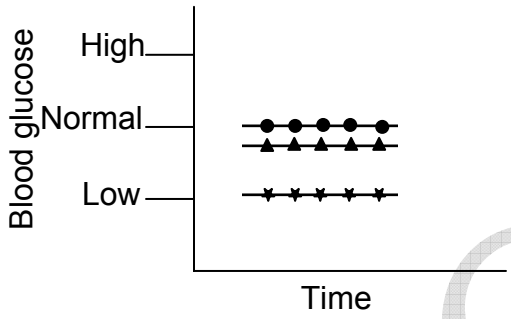
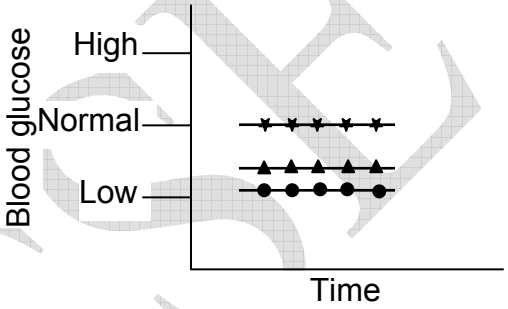
Blood entering liver
Blood leaving liver
Blood supplied to other body parts

With this reference, the blood sugar levels after exercise will be:

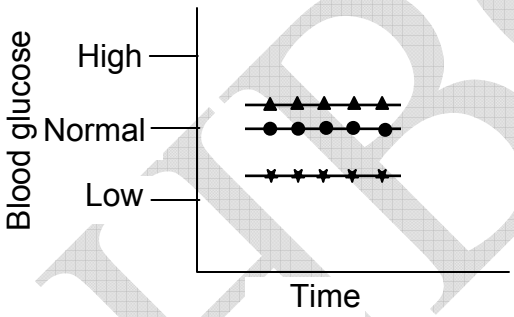
a.



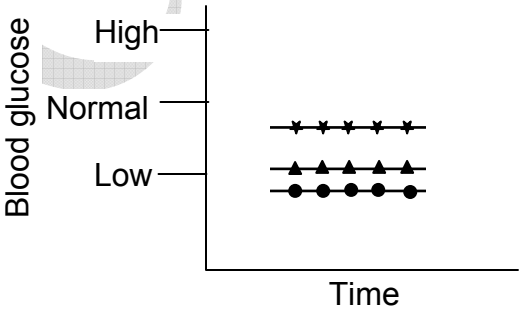
b.



c.



d.



GENETICS & EVOLUTION

25. Dwarfing is a X-linked dominant condition. In a population, if 60 % of men showed a dominant X-linked trait, what percentage of women would be expected to show this trait? (Assume Hardy Weinberg Law.)

a. 40%
b. 48%
c. 16%
d. 84%

HBCSE

26. An investigator finds that a group of people meets the conditions of the Hardy Weinberg Law. She tells you that there are twice as many persons of genotype B/B as there are heterozygotes. What will be the frequency of allele B?

a. 0.2
b. 0.6
c. 0.7
d. 0.8

27. For a gene existing as two alleles, what are the allele frequencies when the heterozygote frequency is at its maximum value?

a. p: 0.9, q:0.1
b. p: 0.1, q: 0.9
c. p: 0.5, q:0.5
d. p: 0.75, q: 0.25

28. Aphids can reproduce either sexually or asexually. When a species of an aphid is on a suitable plant shoot, it starts reproducing and increases in number (Situation I). When conditions start becoming adverse, it undergoes a surge of reproduction now producing winged offspring. These offspring go out and reproduce (Situation II).Which evolutionary strategy will prove advantageous to the aphid species?

a. Sexual reproduction in Situation I and asexual reproduction in Situation II.
b. Asexual reproduction in both the Situations.
c. Asexual reproduction in Situation I and sexual reproduction in Situation II.
d. Sexual reproduction in both the Situations.

29. In a hermaphrodite animal species, frequency of heterozygotes for a trait is found to be 0.5. If these individuals are bred in isolation from each other, what is likely to be the frequency of heterozygotes in the next generation?

a. 0.25
b. 0.75
c. 0.50
d. 1.00

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ETHOLOGY

30. Niko Tinbergen, a Nobel laureate in ethology, observed that ground nesting gulls meticulously remove broken egg shells and other debris from their nests, whereas cliff nesting birds do not. He found the following correlation between distance of eggs from egg shells and percentage survival of the chicks in ground nesting gulls:

Distance between eggs and egg shells (cm)	% survival of the chicks
5	35
15	58
100	68
200	79
No egg shells	78

Which of the following hypothesis can be supported by his observation?

a. Damaged eggs would be a source of disease that could infect the newly hatched young.
b. The jagged edges of broken shells can endanger the chicks.
c. Unrelieved white of the exposed interior and broken shells might nullify camouflage provided by olive-drab exterior.
d. By clearing the surrounding, the birds can lay more eggs; as a result the survival chances of the chick increase.

31. A large population of guppies was divided into two parts and reared in two different pond ecosystems. After many generations, the male guppies isolated from them showed some morphological dissimilarity.

Males from pond I showed brighter colouration and larger tails.
Males from pond II showed smaller tails and dull colouration.

What can be the most probable explanation for this?

a. Guppies from pond II had more predator pressure than those from pond I.
b. Difference in morphology was merely a chance that led to variation.
c. Guppies from pond I had female mate choice while those in pond II did not show such choice.
d. Founder population of pond I must have been guppies with large tails and bright colouration and that of pond II must have been those with small tails and dull colouration.

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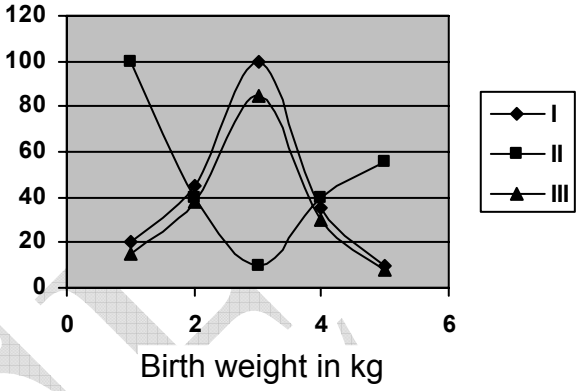
ECOLOGY

32. Study the graphs and assign each one the respective parameter (B is % of births in a particular weight category, M is % mortality at birth, A is % infants alive after one year)

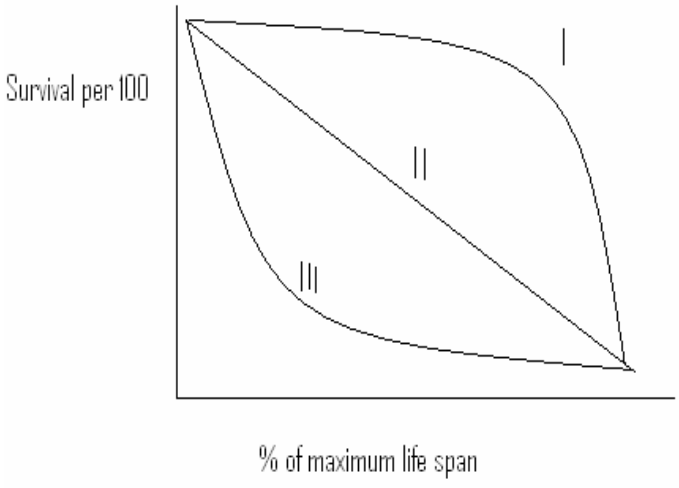


a. I:B II:M III:A
b. I:M II:B III:A
c. I:A II:B III:M
d. I:A II:M III:B

33. It has generally been observed that small young individuals of a fish population occur in shallow waters whereas large old individuals occur in deeper waters. This differential distribution of fish can be explained as:

a. Hydrostatic pressure of deep waters is better tolerated by large sized fish than the small young fishes.
b. Larger fish have lower oxygen requirement, show less relative gill surface area to body volume and move to cooler water.
c. Larger fish with relatively large surface area of gills to body volume can compensate for reduced O_2 availability in deeper waters.
d. Smaller fish have greater surface area to body volume ratio and need to be in warmer shallow waters to raise body temperature.

34. The figure shows survivorship curves of 3 different species. Assign each one to the appropriate species.



	I	II	III
a.	Oyster	Human	Hydra
b.	Human	Oyster	Hydra
c.	Human	Hydra	Oyster
d.	Hydra	Human	Oyster

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BIOSYSTEMATICS

35. Which of the following species are evolutionarily more closely related to each other?

a. Two species with very similar morphology but moderately different DNA sequences.
b. Two species with highly contrasting/different morphology but nearly identical gene sequences.
c. Two species with moderately matching morphology and genetic make up.
d. Two species with very similar morphology and moderately divergent gene sequences.

36. If the ratio of C^{14} to C^{12} found in the upper atmosphere is X, then this ratio in plants actively photosynthesizing today and a human body buried 500 years ago will respectively be:

a. >x and <x
b. <x and >x
c. =x and >x
d. =x and <x

37. A feature that applies to all the three phyla namely Echinodermata, Hemichordata and Chordata is:

a. presence of segmentation.
b. bilateral symmetry.
c. closed circulatory system.
d. complete digestive tract with anus from blastopore.

****

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INDIAN NATIONAL BIOLOGY OLYMPIAD – 2007

Name of the student:----------

Centre:----------

PART B

CELL BIOLOGY

38. Ultraviolet (UV) light induces the formation of thymidine dimers in DNA leading to an inhibition of DNA replication. A stretch of DNA containing the dimers is excised and the gap generated is filled in by DNA polymerase I. Mutant versions of the enzymes required for the repair of thymidine dimers are unable to correct these defects resulting often in the inheritance of mutations. Individuals carrying mutations in these enzymes will show:
    (i) High rates of genetic variation
    (ii) Lower mutagenic frequencies
    (iii) An increased incidence of genetic disorders such as cancer
    (iv) An increased resistance to UV light

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

39. Description of three methanogenic archaebacteria are given. Based on the information provided about them, place them into appropriate category: (Choose from the options given)

Type I : These methanogens solely grow on carbon dioxide and hydrogen and produce methane using electrons from hydrogen as follows:

$4H_2 + CO_2 \rightarrow CH_4 + 2H_2O$ _____

Type II: These methanogens can grow solely on CH_3OH and CO_2 and use methanol as a substrate for methanogenesis.

$4CH_3OH \rightarrow 3CH_4 + CO_2 + 2H_2O$ _____

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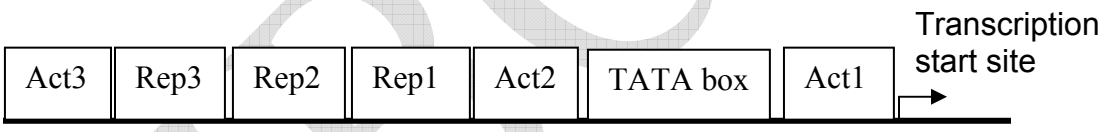
Type III: These methanogens produce both methane and carbon dioxide when grown solely on acetate.

$CH_3COO^- + H^+ \rightarrow CH_4 + CO_2$ _____

Options:
a. Chemo-litho-autotroph
b. Photo-litho-autotroph
c. Chemo-organo-heterotroph
d. Chemo-litho-heterotroph
e. Photo-litho-heterotroph
f. Chemo-organo-autotroph.

40. Rate of transcription at eukaryotic promoter depends on the combined activity of different activator and repressor proteins that bind to different DNA sequences in the promoter. Consider the eukaryotic promoter diagrammed below with binding sites for three activator proteins (Act1, Act2 and Act3) and three repressor proteins (Rep1, Rep2 and Rep3). All the activator and repressor proteins are of equal strength, i.e. they activate or repress expression to the same degree. The TATA box is where RNA polymerase and its associated proteins bind and they initiate transcription at the transcription start site.



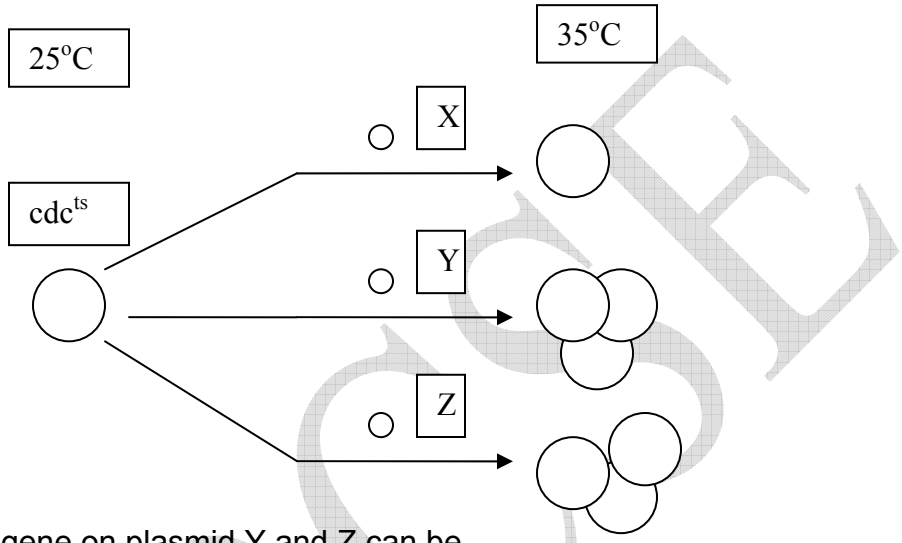
Which of the following statements is incorrect?

a. Binding of the respective proteins at all the sites in the promoter will lead to basal level of transcription.
b. If only repressor proteins are bound to DNA it will result in complete repression of transcription.
c. The presence of Act1 and Act2 at the promoter will lead to high levels of transcription even if Rep1, Rep2 and Rep3 are bound to DNA.
d. If Act3 and Rep3 are both bound to the promoter the level of transcription will be close to that observed when all the proteins are bound to DNA.

41. Conditional mutants are those mutants whose phenotypic expression depends either on environmental conditions or on presence of other mutations. Temperature sensitive mutants are one such example. Temperature sensitive (ts) mutants of cdc genes cannot divide at higher

temperatures (35°C), while cold sensitive (cs) mutants cannot divide at low temperature (25°C).

In one experiment, cdc^{ts} cells were grown at 25°C, then transformed using a plasmid from a gene library and then grown at 35°C. The results of the treatment are shown below.



The gene on plasmid Y and Z can be----

I) a wild type cdc allele
II) a cdc^{ts} allele
III) a cdc^{cs} allele

a. I only
b. II only
c. I, III
d. I, II, III

42. A bacterial cell culture was grown in a nutrient medium for Y minutes. The culture was known to have an approximate lag phase of 120 minutes and a doubling time of 20 minutes. At the end of Y minutes the culture was centrifuged and the mass of the cells alone was measured, found to be M grams. If the inoculum of the culture contained 100 cells, the approximate weight of each cell will be:

a. $(10^2) \times 2^Y \times M$
b. $(10^{-2}) \times 2^{(120-Y)/20} \times M$
c. $(10^2) \times 2^{(Y-120)/20} \times M$

HBCSE

d. $(10^{-2}) \times 2^{Y} \times M$

43. Antigenic determinants or **epitopes** are surfaces of a protein that are specifically recognized by immunoglobulin molecules. They can be classified as:

I) Linear: This is a continuous sequence of a few amino acid residues.
II) Conformational: This occurs as a result of the higher order of the protein structure.
III) Neo-antigenic: It is the epitope which is not antigenic in the native protein.

Consider the following data of antigen antibody interaction:

	Antibody		
Antigen	1	2	3
A	+	-	-
A*	-	-	-
B	-	+	-
B*	-	+	-
C	-	-	-
C*	-	-	+

NOTE: 1) * denotes antigen after heating at 80^{0}C for 20 minutes.
2) + indicates presence of detectable antigen-antibody reaction

Based on the above data, we can deduce the type of antigenic determinant in A, B and C to respectively be:

a) II,III,I
b) II,I,III
c) I,III,II
d) III,I,II

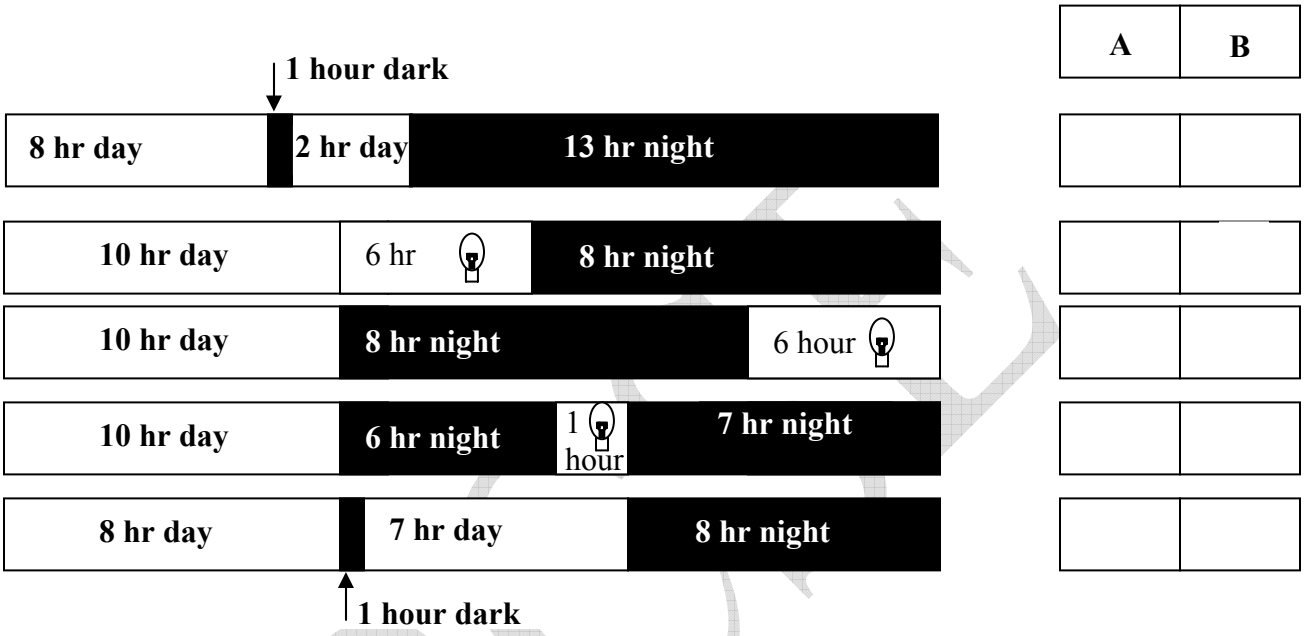
PLANT SCIENCES

44. Horticulturists manipulate the light and dark periods to which plants are exposed in order to trigger photoperiodic plants to flower during any season of the year.

Following are two plant species:

A: short day plant with a critical photoperiod of 13 hours
B: long day plant with a critical photoperiod of 15 hours.

Indicate by symbol √ where flowering will occur and X where flowering will not occur.



45. Characteristics of a few organelles observed in a succulent plant cell are described below.

Organelle	Membrane bound	Comparative size	No. found per cell
P	Single	P>Q, P> R	1
Q	Single	Q<P	1
R	Double	R>S, R<P	1
S	Double	S<R	> 1

The four organelles most likely are:

P: _____

Q: _____

R: _____

S: _____

(Options: chloroplast, vacuole, oil body, endoplasmic reticulum, peroxisome, nucleus, mitochondrion)

46. Stomatal movement is controlled by physiological as well as environmental factors. What will be the effect of following factors on stomata? (Use √ symbol)

Factor	Stomata will		
	open	close	No effect
1. Decrease in vapor pressure deficit of the surrounding			
2. Increase in wind velocity			
3. Low internal CO_2 concentration			
4. High water stress			

47. In a plant physiology experiment, red beetroot was cut into pieces of uniform size (1 x 2 x 3 cm). Each piece was washed thoroughly with distilled water and then subjected to following treatments:

I: Immersed in water at 5^0C for 1 hour

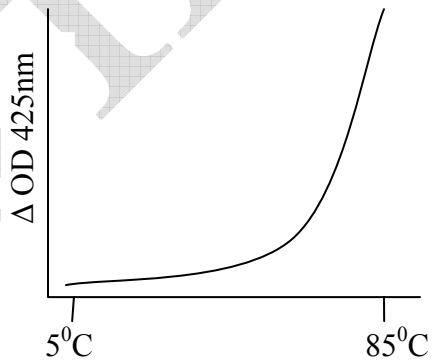
II: Immersed in water at 25^0C for 1 hour

III: Immersed in water at 45^0C for 1 minute and then in water at 25^0C for 1 hour

IV: Immersed in water at 65^0C for 1 minute and then in water at 25^0C for 1 hour

V: Immersed in water at 85^0C for 1 minute and then in water at 25^0C for 1 hour

Following graph was obtained when absorbance of water samples in all the sets was measured at 425nm.



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

a. Temperature hastened the respiration of the cells which resulted in rapid export of pigments to the exterior.

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b. Temperature led to physical damage of the membrane leading to leakage of pigments.
c. Rise in temperature led to increased rate of pigment synthesis as indicated by higher values of absorbance.
d. Rate of diffusion is directly proportional to temperature. Hence higher temperature led to higher extracellular concentration of pigments.

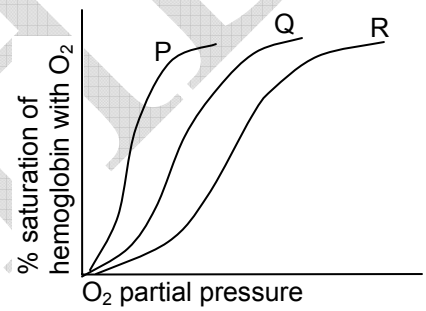
ANIMAL SCIENCES

48. Which of the following points regarding the differences between a person A acclimatized to hot environments and a person B acclimatized to cold environments are true?

I. A starts to sweat at a lower temperature than B.
II. B starts sweating at a lower temperature than A.
III. A has less sweating capacity compared to B, to conserve water.
IV. B has less sweating capacity compared to A, though A has a need to conserve water.
V. Distribution of sweat glands is more uniform on the body of A.

a. I, III, V
b. I, IV, V
c. II, IV only
d. II, III only

49. Dissociation curves of the hemoglobin molecules of three mammals are shown in the figure. Match them with the metabolic rate provided in the table.



Mammal	Metabolic rate (mm^3 O_2/g body wt/h)
I	870
II	500
III	100

a. Match the curves with appropriate mammal:

P:_____

Q:_____

R:_____

b. Mammal I, II and III are:

i) elephant, rabbit, mouse
ii) shrew, cat, human
iii) rat, horse, bat
iv) whale, human, rabbit

50. In order to understand human physiology, scientists performed many experiments on dogs. When they surgically removed the pancreas of a dog, they noticed that the dog's urine was attracting an unusual number of ants. In order to find a remedy to this physiological state (which was later named as diabetes), they performed the following three sets of experiments.

Expt I: They ground the removed pancreatic tissue to prepare an extract and introduced it in the diabetic dog's circulation---diabetes was not controlled.

Expt II: They tied off the pancreatic ducts of another dog. After a few days, they collected the pancreatic tissue, macerated it and an extract was made and introduced in the diabetic dog's circulation---diabetes was controlled.

Expt III: Extracts were prepared from pancreas of embryonic dogs and introduced in the diabetic dog's circulation---diabetes was controlled.

Which of the following explanations correlate with each of the above observations?

a. Extract must be predominated by acinar cells with exocrine activity
b. Extract must be predominated by inactive pro-insulin molecules
c. Proteolytic enzymes must have destroyed insulin molecules
d. Majority of the acinar cells must be destroyed
e. Majority of the islet cells must be destroyed
f. Endocrine cell development precedes exocrine cell development
g. Procedure used for extraction caused protein denaturation

Expt. I:_____

Expt. II:_____

HBCSE

Expt. III:_____

GENETICS & EVOLUTION

51. A bacterial cell requires enzyme products of three genes, namely, *proA*, *proB* and *proC* for the synthesis of an amino acid proline. Some genotypes are listed below. Indicate the correct phenotype i.e., Pro^+, Pro^- or Uncertain, for each one of them.

a. $proA^+proB^+proC^+$: _____

b. $proA^+proB^-proC^+/\ pro^+$:_____

c. $proA^+proB^-proC^+/\ proA^+proB^-proC^-$: _____

52. During the process of evolution, three types of natural selections have been identified:

A. Directional selection: It eliminates one extreme from an array of phenotypes.
B. Stabilizing selection: It eliminates both extreme phenotypes.
C. Disruptive selection: It eliminates the intermediate phenotypes.

Which of these are active in the following situations?

I. In a population of butterflies, 3 distinct colour patterns of poisonous butterflies are seen. The non-poisonous butterflies show colour pattern of either of these types._____

II. In chicken and duck, the eggs of medium weight showed increased survival rate._____

III. When flies with a strong tendency to fly towards light were inbred, the next generation showed greater tendency to fly towards light._____

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53. Agents of evolutionary change are listed below. Match them against the correct description.

I. The ultimate source of genetic variation:_____

II. Frequency of alleles changes by chance alone:_____

III. It does not alter allele frequency:_____

IV. The only factor/agent that produces adaptive evolutionary change:_____

Options:

(A) Genetic drift
(B) Migration
(C) Mutation
(D) Non-random mating
(E) Selection

54. (A) A series of litters of two black rabbits was found to have 17 black and 7 white rabbits. What assumption does a student require to make to conclude that the progeny is in the ratio of 3:1?

a. at least one parent is heterozygous for the trait
b. both parents are heterozygous for the trait
c. one parent is homozygous for the trait
d. white phenotype is homozygous and recessive
e. black phenotype is homozygous and recessive

(B)On further investigation, the student finds that the dominant homozygous individuals die long before birth. What will be the implication of this finding?

a. The absolute number of homozygous recessive rabbits will increase.
b. the expected percentage of heterozygous rabbits will decrease.
c. the expected percentage of homozygous recessive rabbits will increase
d. the expected ratio of heterozygous to homozygous rabbits will increase.

55. It is a well known fact that carriers of sickle cell trait (heterozygotes) have an advantage in survival over those who lack it in malaria-prevalent regions. How will the gene frequency for sickle cell trait be affected in the following situations? (Match the appropriate option/s against each statement)

a. A population of individuals with a low sickle cell frequency enters a malaria-prone region: _____

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b. A population with high sickle cell frequency enters the malaria-prone region:_____

c. A population with high sickle cell frequency enters non-malaria region: _____

Options:

(1) The frequency for sickle cell trait will initially show some fluctuations but ultimately will remain unaffected.

(2) The frequency for sickle cell trait will increase and then stabilize at equilibrium frequency of that region.

(3) Frequency will decrease initially and then reach equilibrium.

(4) Frequency will override the existing frequency and will increase with every next generation.

(5) Frequency will decrease to a low value.

ETHOLOGY

56. The nature and evolution of male-female relationships- especially the mating systems are influenced by many factors such as availability of resources, nature of parental care required etc. There are different kinds of mating strategies observed in animals such as monogamy and polygamy. In each of the following situations, state which kind of mating strategy can give maximum advantage to the individuals?
(options: monogamy/polygyny/polyandry/promiscuity)

a. Male has no role to play in feeding and protection of the young._____
b. Male and female contribute equally in rearing the young._____
c. Territories held by different males who also rear the young._____
d. Males are bigger in size than females and compete for control over sexual access to females._____

ECOLOGY

57. Stomata and venation of leaves of *Phaseolus vulgaris* grown in different conditions are shown. If P and Q represent normal conditions, then R and S will be:

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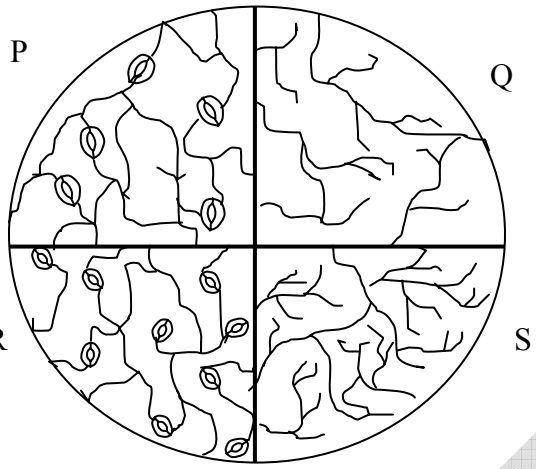


R: _____

S: _____

Options:

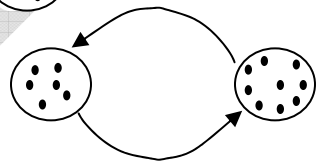
a. limiting soil moisture
b. unrestricted water supply
c. environment with limiting CO_2 concentration
d. limiting soil micronutrients

58. Amount of chlorophyll observed per unit area of a photosynthetic surface in random samples of different communities is shown diagrammatically.

Community I:  _____

Community II:  _____

Community III:  _____

Community IV:  _____

Match the four numbers with the type of ecosystem:

a. forest ecosystem
b. cave communities
c. phytoplankton
d. algal matter on rocks

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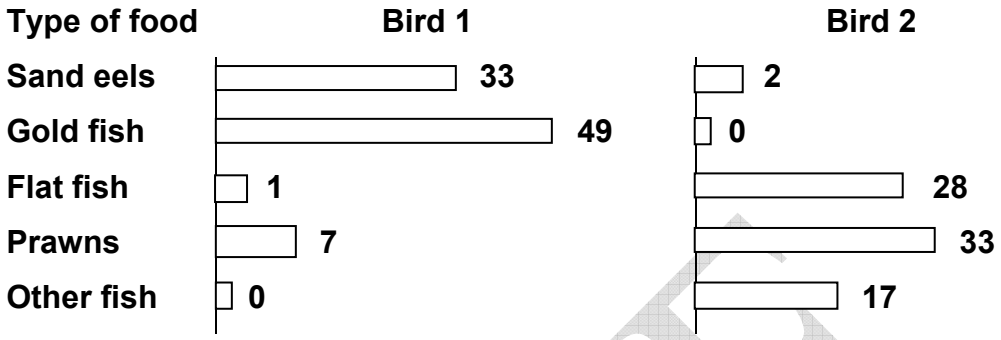
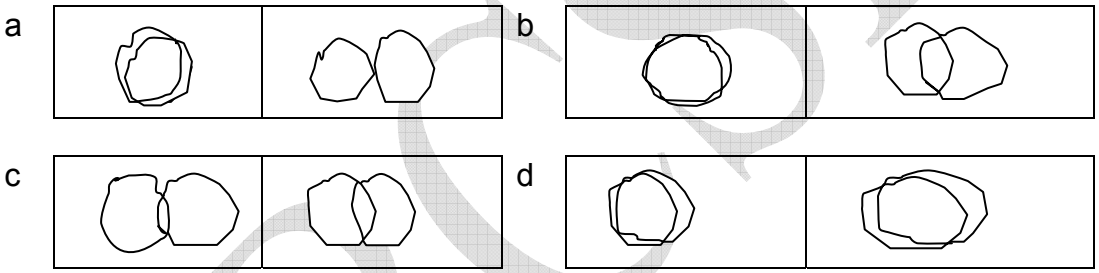
59. Two species of birds (1 and 2) that commonly feed in same waters and nest on the same cliff show following food habits.



The correct representation of their habitat and niche respectively is:



BIOSYSTEMATICS

60. Molecular systematics has revealed that archaebacteria are more closely related to eukaryotes than to eubacteria. Which of the following facts about archaebacteria contribute to it?

a. Absence of peptidoglycan in the cell wall
b. Presence of histone proteins associated with DNA
c. Absence of nuclear envelope
d. Presence of circular chromosome
e. Streptomycin resistance
f. Ability to grow at high temperatures
g. Presence of only one kind of polymerase enzyme
h. Presence of introns

61. To learn the relationships of organisms, scientists study the structure of specific genes across species. This is called as molecular phylogeny.

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(A) Which properties of a gene make it suitable for such studies?

a. The gene must be involved in a universal cellular function.
b. The gene should be very small in size ie. not exceeding 50-80 bases.
c. The gene sequence should be conserved almost entirely.
d. Maximum portion of the gene sequence should be open for change without affecting its function.
e. The genes should not show natural lateral transfer (transfer of genes between species).

(B) Among the following RNA molecules, which is most suitable for comparative phylogenetics?_____

	Molecule	Size (nucleotide bases)
a	5S rRNA	120
b	16S rRNA	1500
c	30S rRNA	6500
d	tRNA	75

(C) In a molecular phylogeny experiment, a group of organisms was found to contain the following sequences in a rRNA molecule:

A scientist desires to synthesize a probe (radio-labeled DNA sequence) that can be used as a signature sequence for this group. Which region of this sequence should he/she must use?

CAA-AGGAAG CACCGGCTAA CTCCGTGCCA GCAGCCGCGG TAATAAAAACGGAG
CAA-AGGAAG CACCGGCTAA CTCCGTGCCA GCAGCCGCGG TAATAAAAAGGGAG
CAATAGGAAG CACCGGCTAA CTCCGTGCCA GCAGCCGCGG TAATAAAAACGGAG
TAG- AGGAAG CACCGGCTAA CTCCGTGCCA GCAGCCGCGG TAATAAAAACGGAG
CAA-AGGAAC CACCGGCTAA CTCCGTGCCA GCAGCCGCGG TAATAAAAACGGGG
CGA-AGGAAG CACCGGCTAA CTCCGTGCCA GCAGCCGCGG TAGTAAAAACGGCG
YRR- AGGAAS CACCGGCTAA CTCCGTGCCA GCAGCCGCGG TARTAAAAASGGRG
10 20 30 40 50

Ans: From nucleotide _____to _____

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THE STAGES OF THE INDIAN OLYMPIAD PROGRAMME

The Olympiad programme is a 5-stage process for each subject separately. Stage I for each subject is organized by the Indian Association of Physics Teachers (IAPT) with the assistance of Indian Association of Chemistry Teachers (IACT) and the Association of Teachers in Biological Sciences (ATBS). All the subsequent stages are organized by the Homi Bhabha Centre for Science Education (HBCSE).

Stage I: National Standard Examination in Biology (NSEB) NSEB is usually conducted in the last week of November a about 1000 centres all over India. About 10,000 students enroll for the NSEB.

Stage II: Indian National Biology Olympiad (INBO) Around 300 meritorious students from the NSEB are selected to appear for the INBO examination. This exam is usually conducted either in the last week of January or in the first week of February at about 15 centres in the country.

Stage III: Orientation Cum Selection Camp (OCSC) Based on the performance in the INBO exam, about 35 students are chosen to attend this camp. The selected students are invited to the OCSC held during the first week of June. At the end of the camp, the top four students are selected to represent India at the International Biology Olympiad (IBO).

Stage IV: Pre-Departure Training Camp (PDTC) The four students undergo a two-week training camp before departing for the International Biology Olympiad.

Stage V: Participation at the International Biology Olympiad (IBO) The selected students and 2 to 3 teacher leaders and scientific observers constitute the delegation to represent India at the International Biology Olympiad (IBO) normally held in July.

Information regarding Stage I is available on
IAPT website – http://www.iapt.org.in

Information regarding Stages II to V and details of eligibility for various stages is available on
HBCSE website – http://olympiads.hbcse.tifr.res.in

TEAM PERFORMANCE AT THE INTERNATIONAL BIOLOGY OLYMPIADS (2000 – 2010)

Year 2000: Antalya, Turkey — **1 Silver & 3 Bronze medals**

Sahajal Dhooria	Silver
Pallavi Torka	Bronze
Ashok Sekar	Bronze
Swati Pandey	Bronze

Year 2001: Brussels, Belgium — **1 Gold & 3 Silver medals**

Preetpaul Singh Ahluwalia	Gold
Namrata Vijayvergia	Silver
Nilesh Chandra	Silver
Shikhar Agarwal	Silver

Year 2002: Riga, Latvia — **3 Silver & 1 Bronze medals**

Hrishikesh Bhattacharya	Silver
Siddharth Sarkar	Silver
Ashish Aggarwal	Silver
Sruti Srivatsan	Bronze

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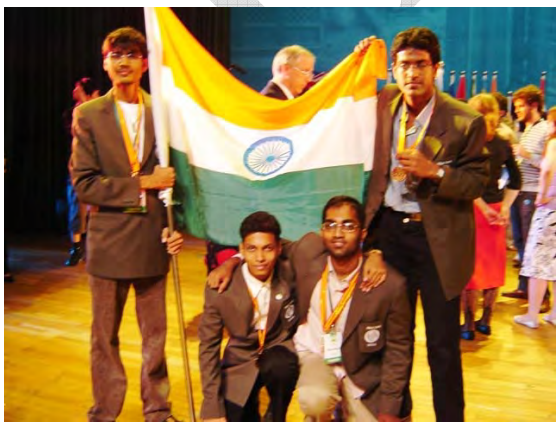
Year 2003: Minsk, Belarus **1 Gold, 2 Silver & 1 Bronze medals**

Ankur Mahindroo	Gold
Praveg Goyal	Silver
Kovid Trivedi	Silver
Srivats Madhavan	Bronze

Year 2004: Brisbane, Australia **3 Silver & 1 Bronze medals**

Niranjan Khaire	Silver
Raghav Bansal	Silver
S. Mahavir Agarwal	Silver
Suman Saurabh	Bronze

Year 2005: Beijing, PR of China **1 Gold & 3 Bronze medals**



Anand Venkatraman	Gold
Saurabh Mahajan	Bronze
Parijat Sen	Bronze
Shanoob Azad	Bronze

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Year 2006: Cordoba, Argentina

3 Silver & 1 Bronze medals

Rohan Khera	Silver
Divam Narula	Silver
Smita Parakh	Silver
S. Ajay Subramanian	Bronze

Year 2007: Saskatoon, Canada

1 Gold & 3 Silver medals

Kalyani	Gold
Anurag Chahal	Silver
Devanshu Bansal	Silver
Anurag Shahi	Silver

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Year 2008: Mumbai, India **1 Gold, 2 Silver and 1 Bronze medals**

Subrashish Guha Niyogi	Gold
Siddharth Iyengar	Silver
P. G. Nandan	Silver
Sachit Daniel	Silver

Year 2009: Tsukuba, Japan **1 Gold, 2 Silver and 1 Bronze medals**

Vidhi Hathi	Gold
Chetan S.	Silver
Usnish Adhikari	Silver
Amit Gupta	Bronze

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Year 2010: Chagwon, Korea **1 Gold & 3 Silver medals**

Sahal Kaushik	Gold
Syed Mustafa Hashmi	Silver
Preet Hathi	Silver
Apoorv Singh Yadav	Silver

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Image on front cover
Specimens of univalve and bivalve molluscan shells

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