INDIAN NATIONAL BIOLOGY OLYMPIAD – 2005*

THEORY PAPER **30th Jan, 2005**

Duration : 2 hrs

Maximum marks: 300

The question paper is divided into Part A and Part B.

Part A :

Part A consists of 31 questions carrying 3 marks each.

All 31 questions of Part A are of multiple choice type, with only one correct answer for each question.

Mark the correct answer with 'X' on the answer sheet, which is provided separately. (The correct way of marking a cross is shown below.) Use a dark pencil to mark your answer.

Q.No.	a	b	c	d
20		X		

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

Part B:

Part B has 23 questions carrying a total of 207 marks.

Answers to Part B should be written on the question paper and it should be submitted to the examiner stapled with the answer sheet of part A.

SCORING KEY

CORRECT NO. OF ANSWERS: X
INCORRECT NO. OF ANSWERS: Y
SCORE: PART A: 3X – Y

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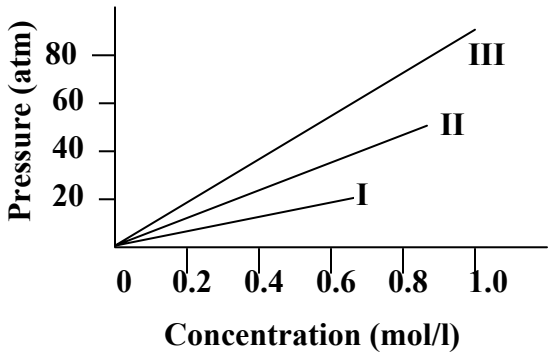
INDIAN NATIONAL BIOLOGY OLYMPIAD – 2005
PART A

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.**

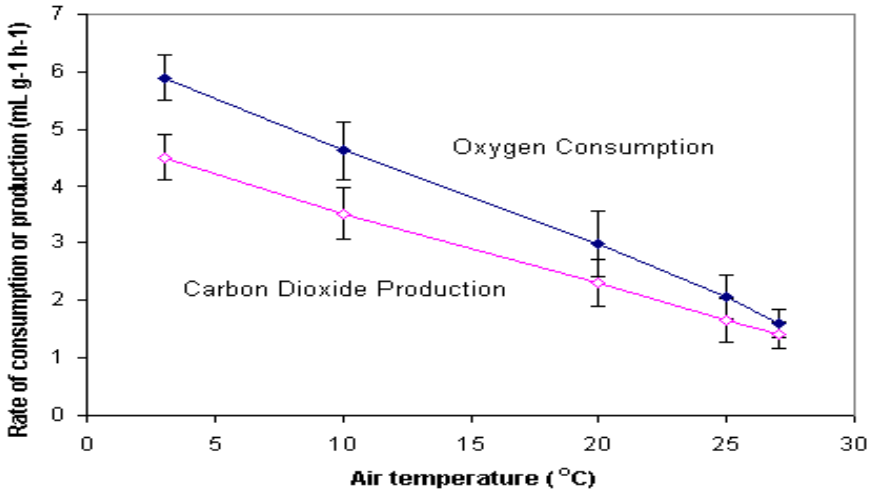
4. **Effect of pH on the osmotic pressure of haemoglobin in solution is tabulated.**

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:

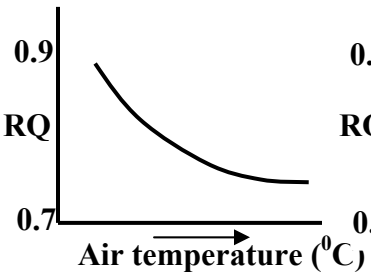
a. **protein folding**
b. **protein denaturation**
c. **haemoglobin oxygen interaction**
d. **all the above**

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.



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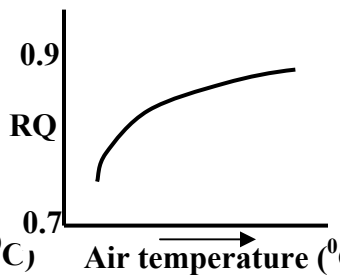
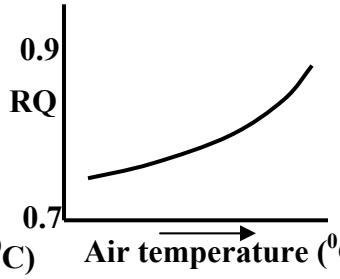
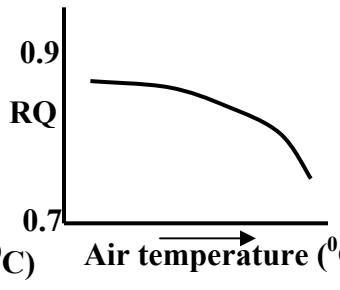


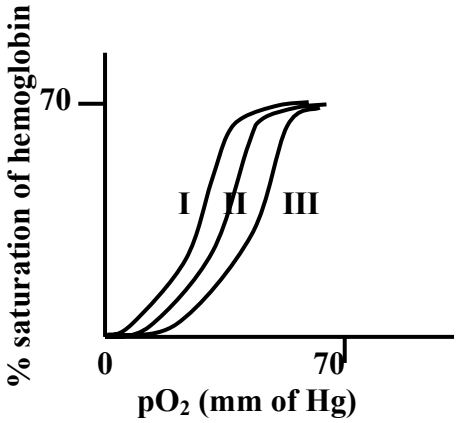
c.



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

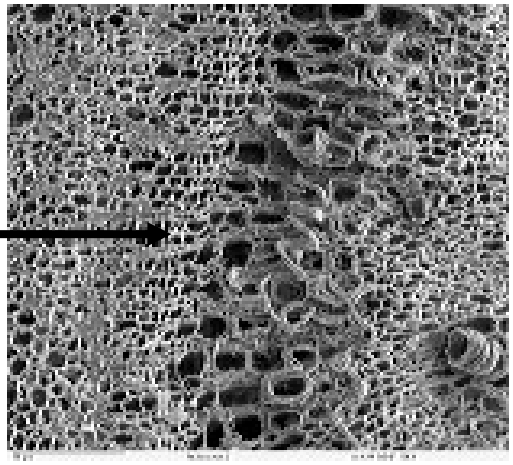
9. Some statements about phloem tissue are made.

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

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**

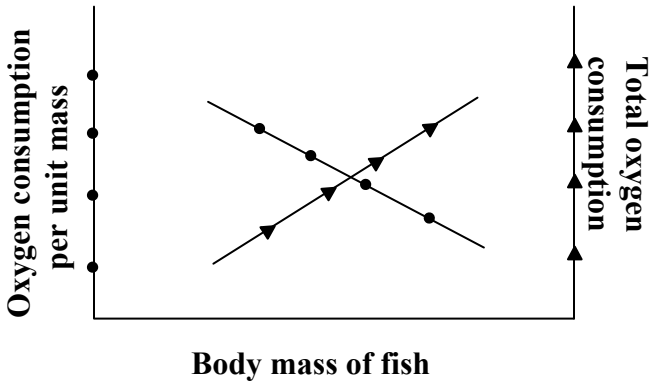
16. **Mark the correct statement about photosynthesis.**

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

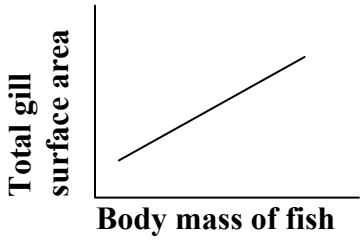
ANIMAL SCIENCES

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

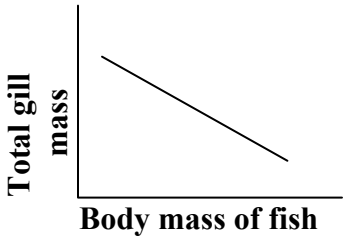


Which of the following graphs complies with the data in the above graph?

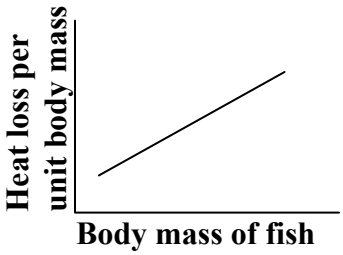
a.



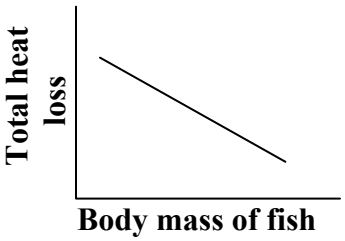
b.



c.



d.



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
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?

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

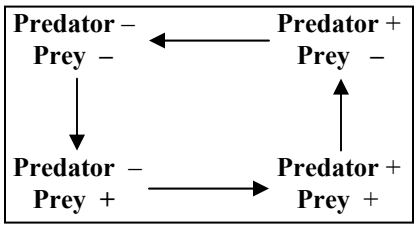
25. If two species of bird persist alongside each other as separate species, which of the following has to be true?

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.

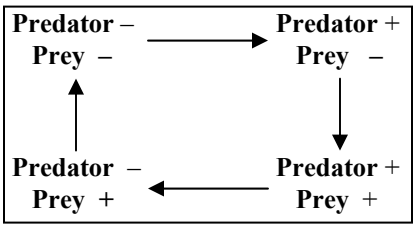
ECOLOGY

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

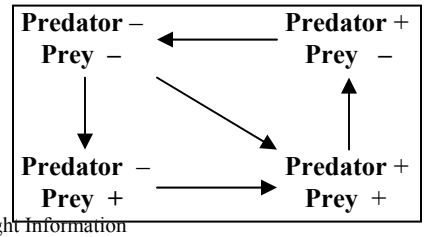
a.



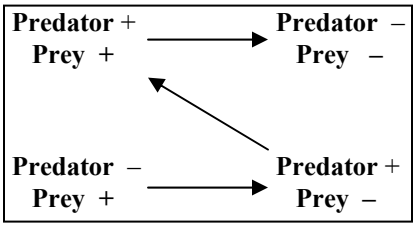
b.



c.



d.



27. A marine community produces an inverted pyramid of biomass yet it survives well because:

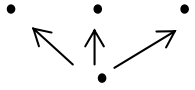
a. the producers have a rapid rate of cell division
b. the herbivores have a rapid turnover rate
c. detrivores immobilize most nutrients
d. all the above

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

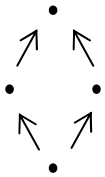
29. Observe the four food webs given below. The lowermost dot in each figure represents autotrophs. Among these, the most stable community will be:

a.



b.

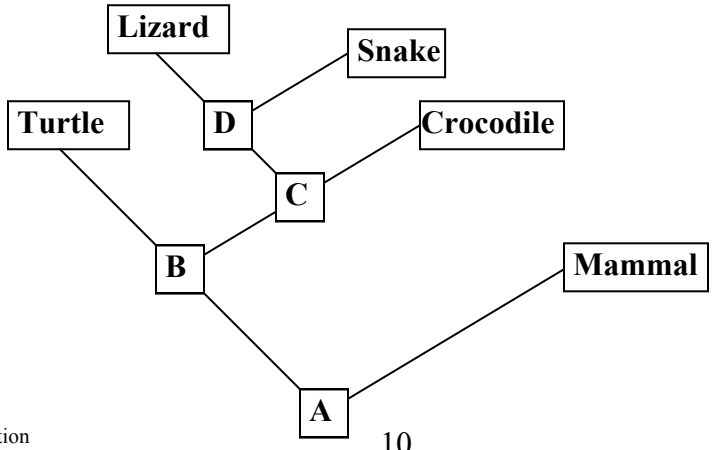
c.



d.

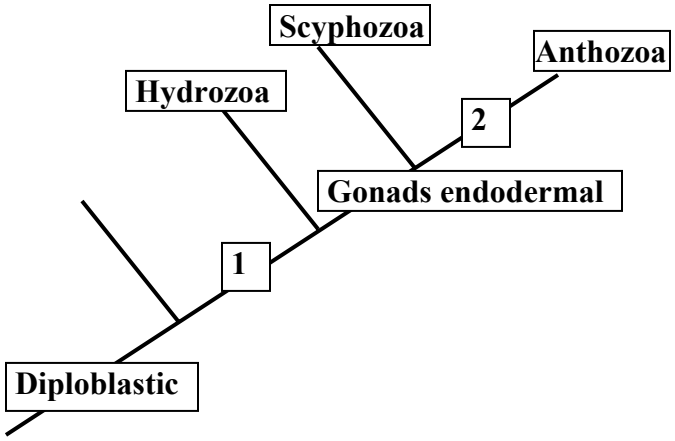
BIOSYSTEMATICS

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



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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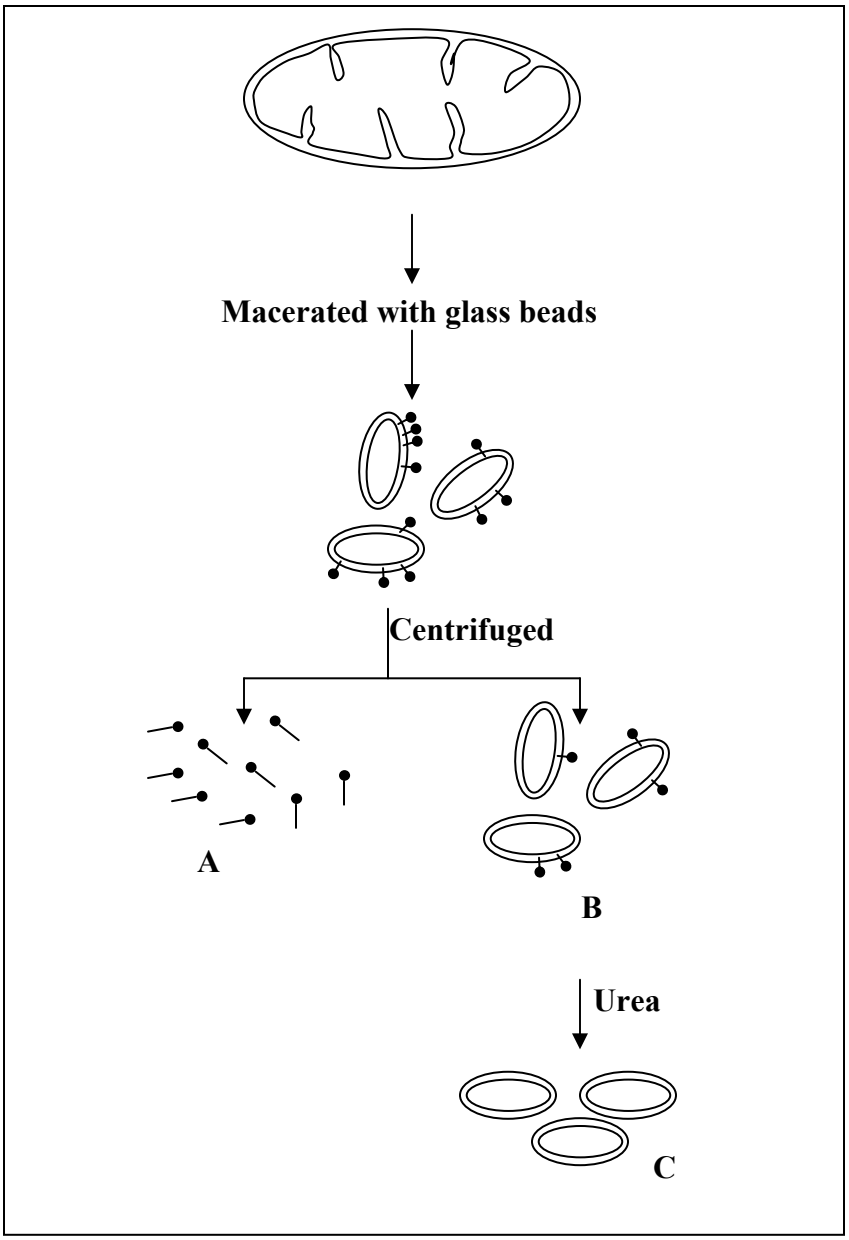
INDIAN NATIONAL BIOLOGY OLYMPIAD – 2005

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
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: _____

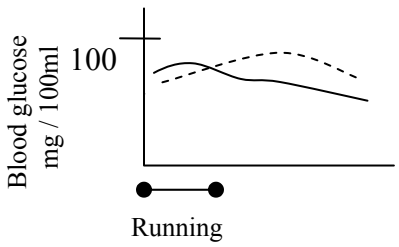
36. Graphs below indicate the blood profiles of a trained athlete and an untrained person during and after running for 1.5 hrs. Assign these graphs to the appropriate descriptions.

(i) Untrained subject is more prone to muscle cramps. Graph _____

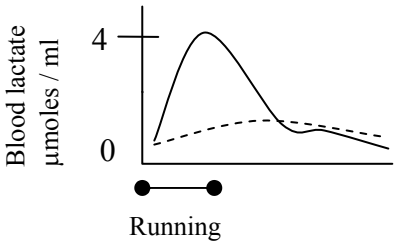
(ii) Glycogen was used as an important fuel. Graph _____

(iii) Athlete utilized fatty acid more efficiently. Graph _____

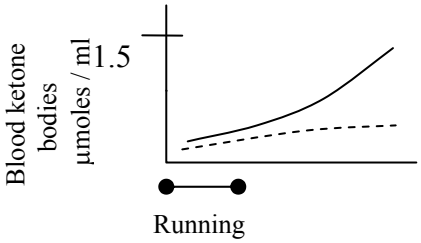
a.



b.



c.



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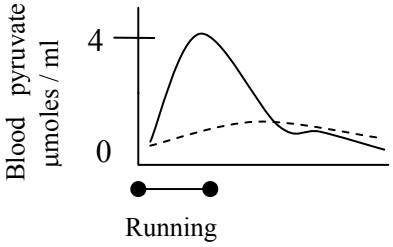
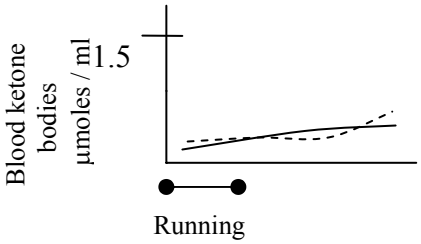


e.



PLANT SCIENCES

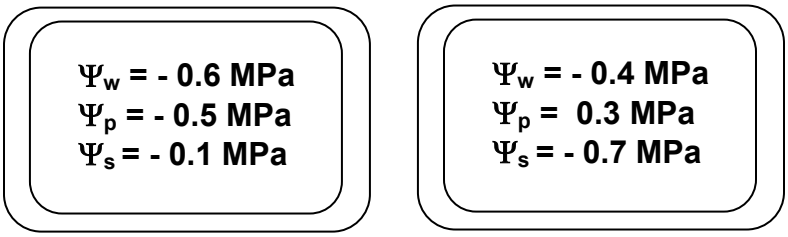
37. Stomatal frequency of 3 plants is given in the table. Match them with appropriate plant type. (Choose from the options given below)

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.



X **Y**

I. Mark the correct interpretation.

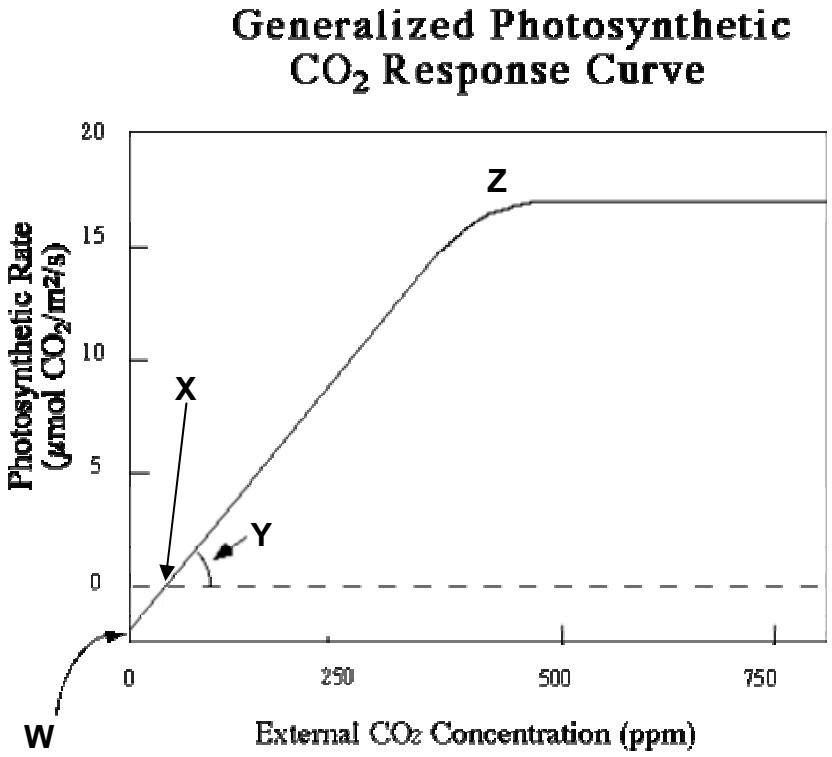
a X has higher solute and water content than Y.
b Y has greater solute potential and water potential than X.
c Y has greater turgor pressure and lower solute content than X.
d X has higher solute potential and water potential than Y.

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.



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: _____

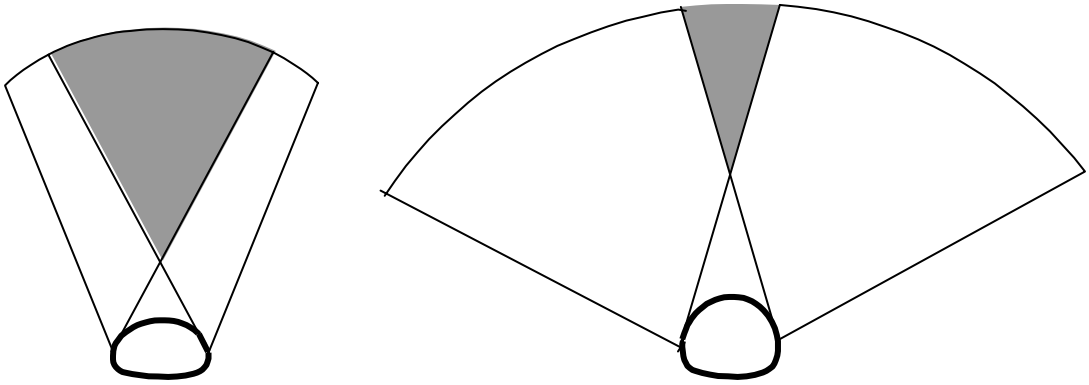
M: _____

N: _____

O: _____

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

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.	_____

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

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

Q. II. Results that are <u>not</u> 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:

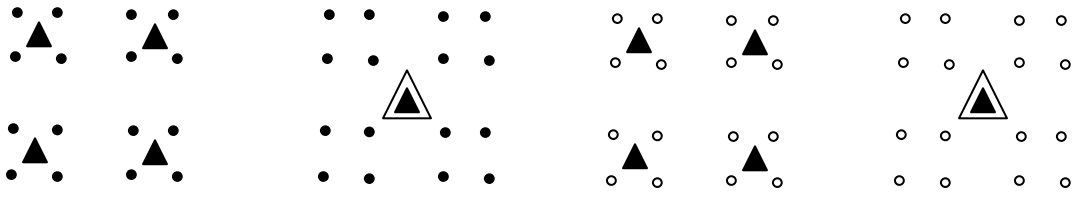
i. Normal daughters: _____
ii. Normal sons: _____

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.

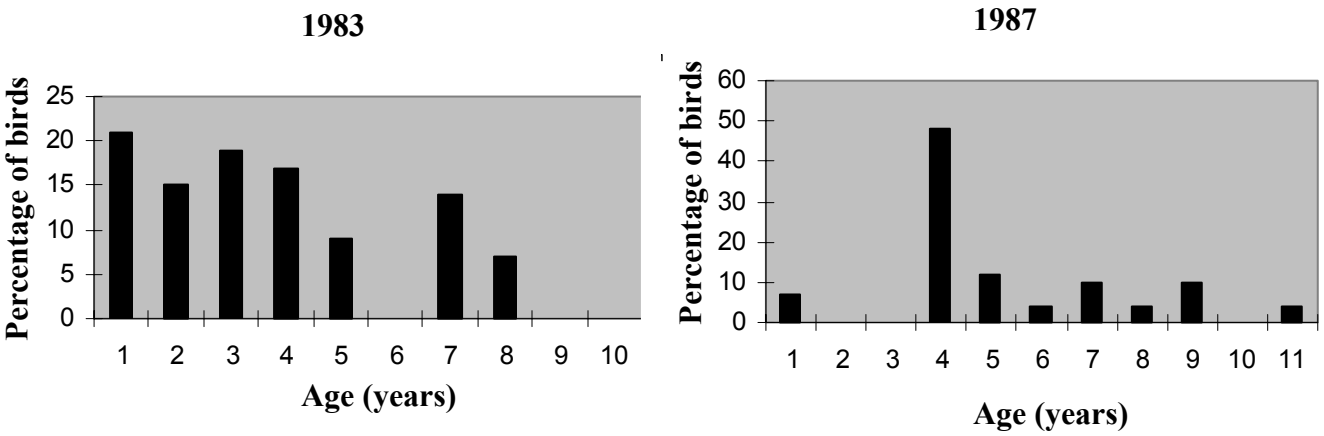
I. Which of the following environmental factors favour this distribution?

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

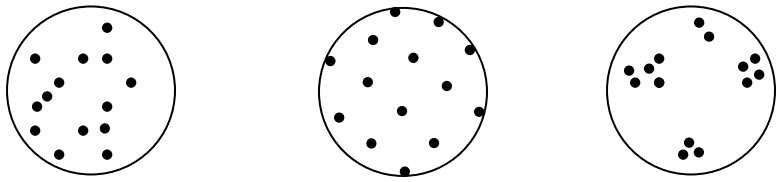
49. When the age distribution of finches in an ecosystem was studied for the years 1983 and 1987, the following graphs were obtained.



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

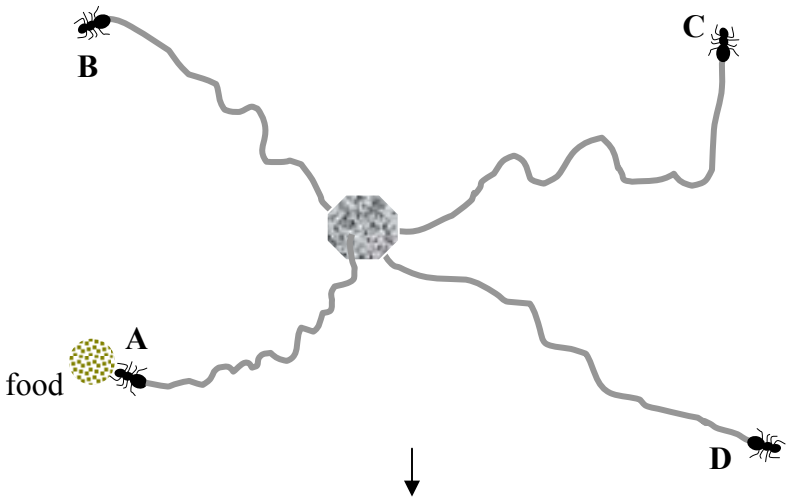
51. Ants communicate with members of their own species using chemical scents known as pheromones. Study of their behavior shows that they follow some simple rules. Examine the five pictures given below. Match the behavior observed at different situations:

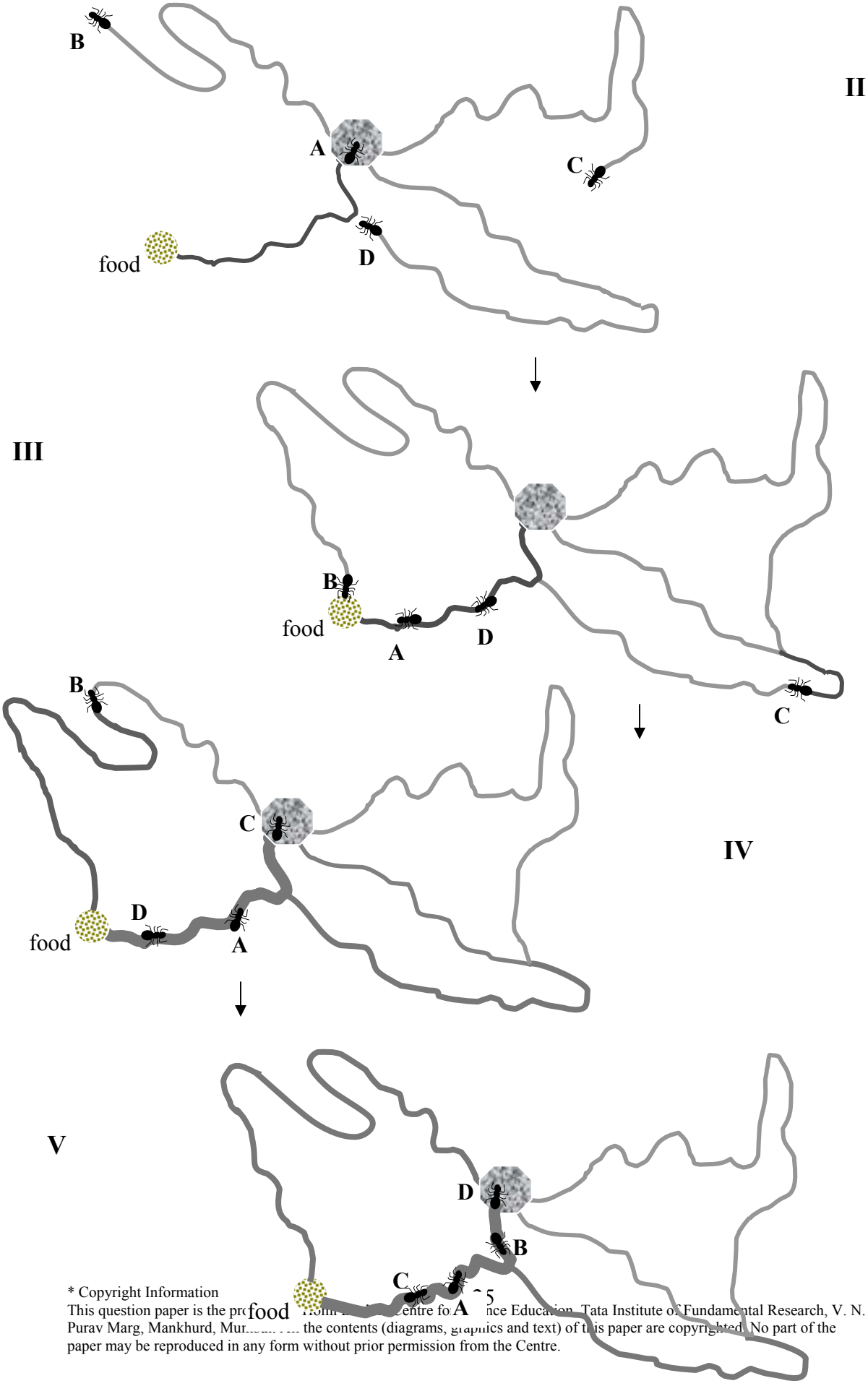
No.	Situation	Response
1.	Carrying food	
2.	Not carrying food, on pheromone trail	
3.	Reach food	
4.	Not carrying food, not on pheromone trail	
5.	Reach home without food on pheromone trail	

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

I





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
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:

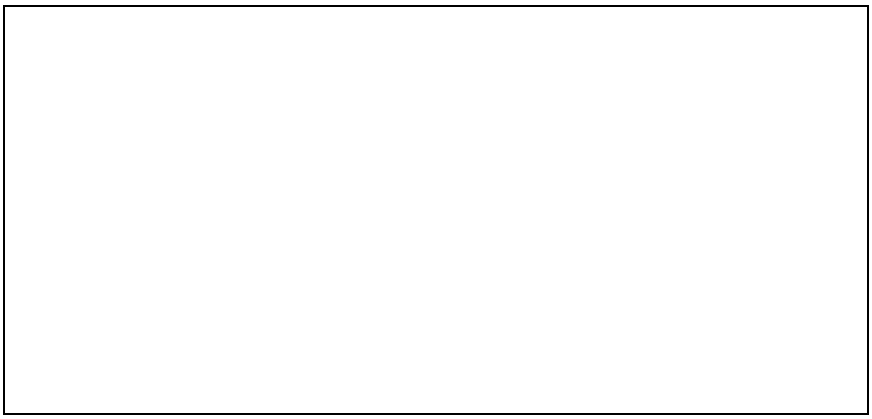
a. The helper belongs to the same species. By behaving altruistically, it helps better survival of other members of the species.
b. Remaining with other members of the species increases its chances of survival under adverse conditions.
c. Since the helper is closely related to the young ones, helping 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

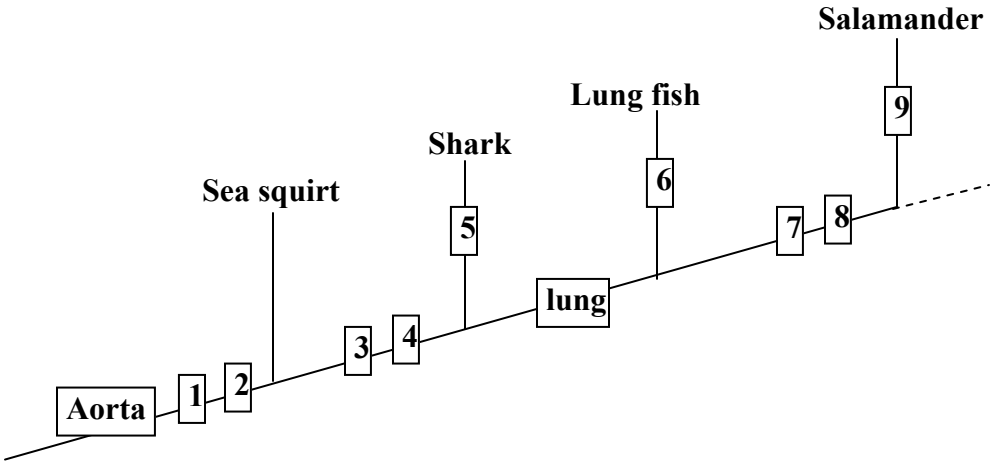
53. I. Fill in the table below.

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.



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



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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