

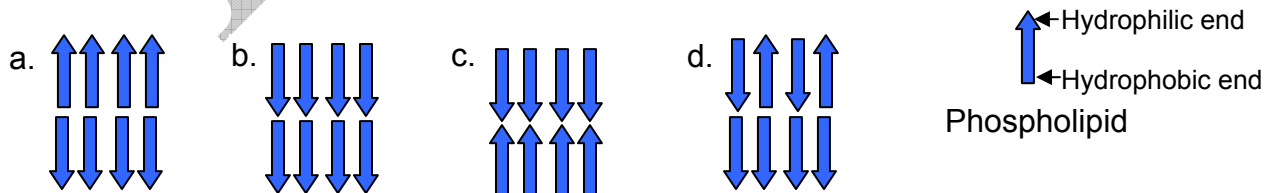
INDIAN NATIONAL BIOLOGY OLYMPIAD – 2009
SECTION A

CELL BIOLOGY (7)

1. (1 point) Which one of the following is made up of only one type of macromolecule?
 - a. Virus
 - b. Plasmid
 - c. Ribosome
 - d. Nucleosome

2. (1 point) A scientist introduced bacterial plasmids into bakers' yeast. However, the cells lost these plasmids over a period of time. Which of the following needs to be inserted into the bacterial plasmid to overcome this problem?
 - a. Centromere
 - b. Yeast origin of replication
 - c. Telomere
 - d. Bacterial origin of replication

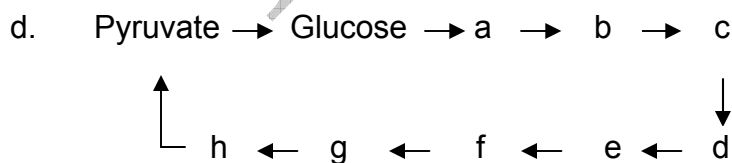
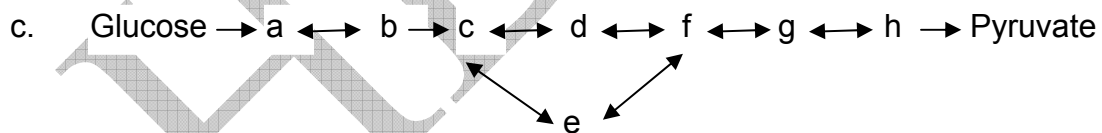
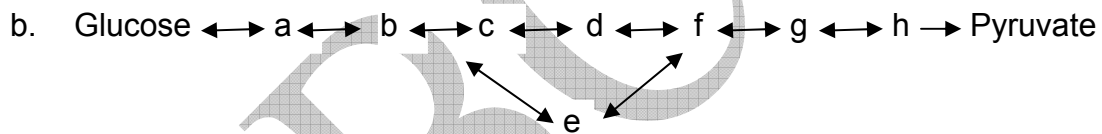
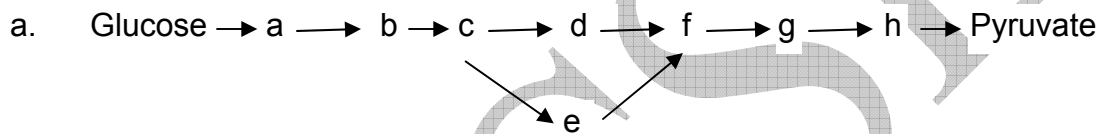
3. (1 point) A red blood corpuscle (RBC) was kept in a solution and treated so that it became inside - out. What will be the polarity of the phospholipid bilayer in this cell?



4. (1 point) Some vitamins need to be supplied regularly in our daily diets while others may be supplied intermittently. Examples of these two types, respectively, are:

- a. Vit C and Vit D
- b. Vit A and Vit B₆
- c. Vit D and Vit E
- d. Vit B₆ and Vit B₁₂

5. (1 point) Which of the following pathways depicts the generalized glycolytic scheme most accurately?



6. (1 point) Membrane compositions of three cell types are tabulated below.

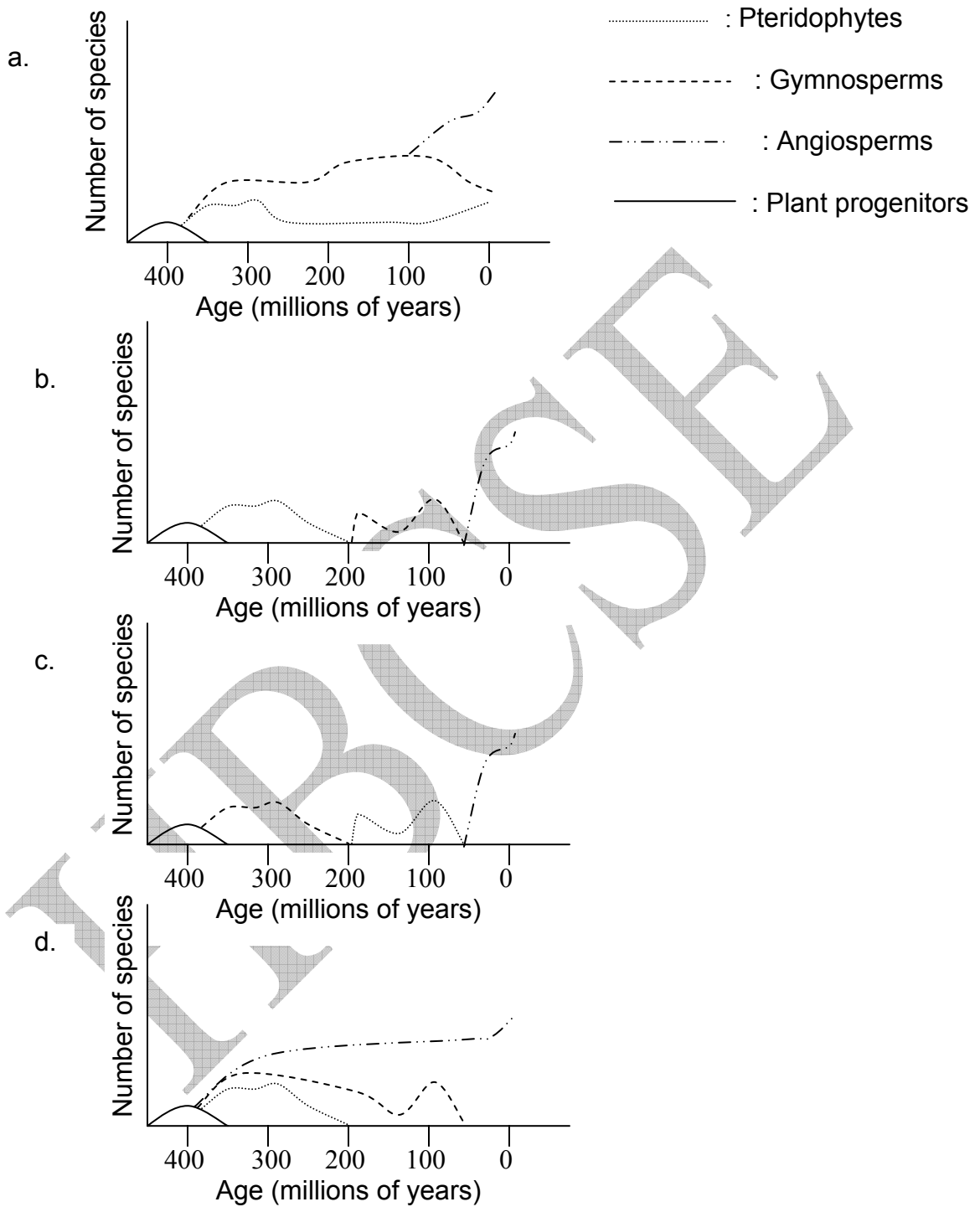
| Cell Type | Membrane Composition (%) | | |
|-----------------|--------------------------|--------------|--------|
| | Protein | Phospholipid | Sterol |
| Rat liver cell | 46 | 30 | 20 |
| Maize leaf cell | 40 | 35 | 8 |
| <i>E. coli</i> | 74 | 26 | 0 |

The % composition of inner mitochondrial membrane is likely to be:

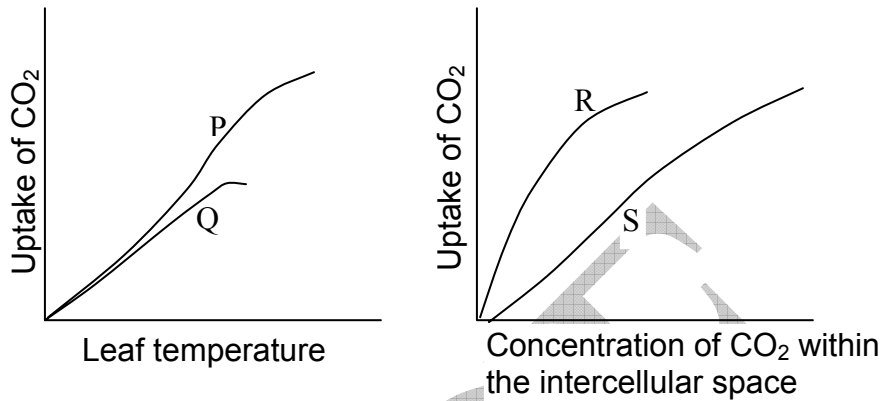
- a. 40:30:20
 - b. 42:33:9
 - c. 43:33:15
 - d. 76:24:0
7. (1 point) Which of the following facts supports the hypothesis that “viruses are not the fore-runners of cellular organisms but are derived from them”?
- a. Viruses use the same genetic code as the cellular organisms.
 - b. Viral proteins have the same basic amino acids as cellular organisms.
 - c. Viruses need the cellular machinery for replication.
 - d. Enzymes essential for viral replication are identical to those needed for cellular replication.

PLANT SCIENCES (8)

8. (1 point) Which of the following graphs correctly depicts the evolution of various vascular plant species in evolutionary time scale?



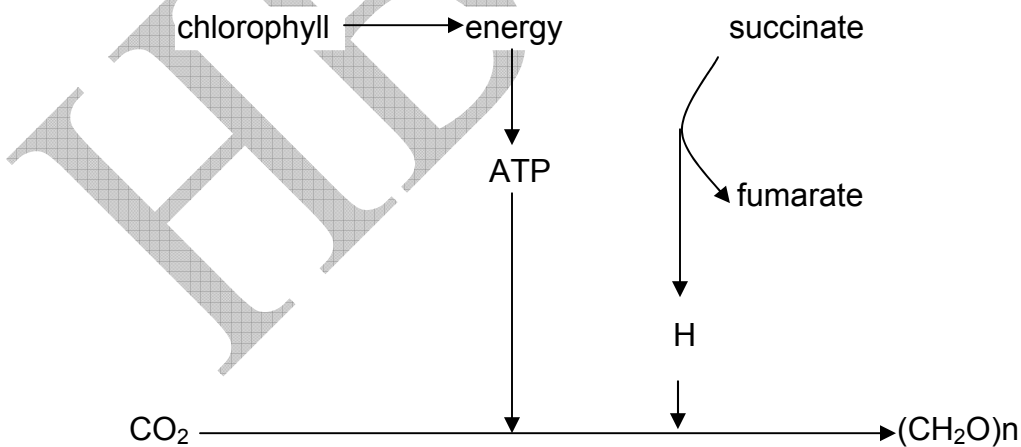
9. (1 point) Photosynthetic features of four plants P, Q, R and S are depicted in the graphs below.



These plant species belong to:

- | | | | |
|----------------------------|-------------------------|-------------------------|-------------------------|
| a. P: C ₃ plant | Q: C ₄ plant | R: CAM plant | S: shade plant |
| b. P: C ₄ plant | Q: C ₃ plant | R: C ₄ plant | S: C ₃ plant |
| c. P: C ₄ plant | Q: sun plant | R: C ₃ plant | S: CAM plant |
| d. P: C ₃ plant | Q: C ₄ plant | R: C ₃ plant | S: C ₄ plant |

10. (1 point) The nutritional pathway shown below represents:



- photo-litho-autotroph.
- photo-chemo-heterotroph.
- photo-organo-autotroph.
- chemo-organo-autotroph.

11. (1 point) On a warm summer's day, the transpiration pull is the main force that drives water from root parenchyma into the root xylem. The table shows values of ψ_p (pressure potential) and ψ_s (solute potential) in root xylem and root parenchyma, in kPa. In which of the alternatives a – d would transpiration pull cause water to move from root parenchyma into the root xylem?

| | Root parenchyma | | Root xylem | |
|---|-----------------|----------|------------|----------|
| | ψ_p | ψ_s | ψ_p | ψ_s |
| a | 200 | -190 | -200 | 5 |
| b | -200 | 220 | 65 | -5 |
| c | 200 | -220 | 65 | -5 |
| d | 200 | -220 | -65 | -5 |

12. (1 point) Calvin and colleagues determined the pathway of carbohydrate synthesis in plants by studying the incorporation of radioactive carbon dioxide into biological compounds. Suppose that photosynthesis is proceeding at a steady pace in a typical experiment with the lights on, and carbon dioxide is being combined with ribulose-bisphosphate (RuBP) to produce 3-phosphoglycerate (3PG). Then suddenly the source of carbon dioxide is eliminated. What changes in the concentrations of 3PG and RuBP would occur?

- 3PG levels rise, RuBP levels fall.
- 3PG levels fall, RuBP levels rise.
- 3PG levels rise, RuBP levels rise.
- 3PG levels rise, RuBP levels stay the same.

13. (1 point) Thermal imaging is a technique used to detect mutant varieties of plants that overproduce abscisic acid (ABA). Such plants are warmer than the surrounding plants. This can be explained as:

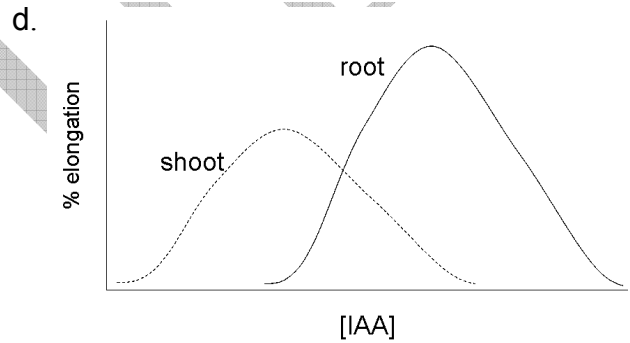
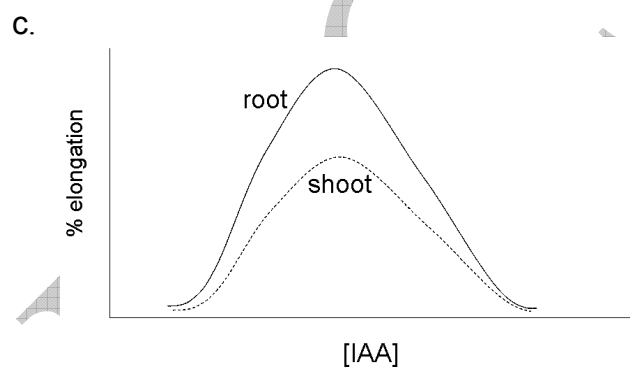
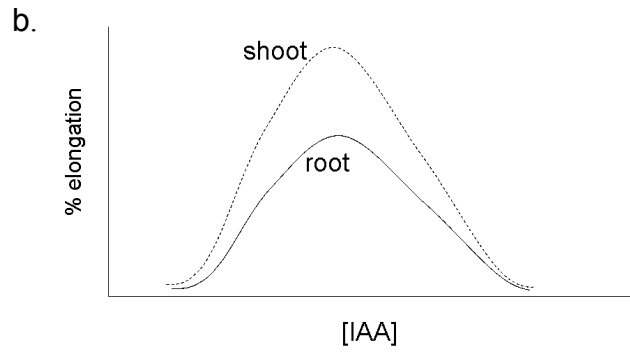
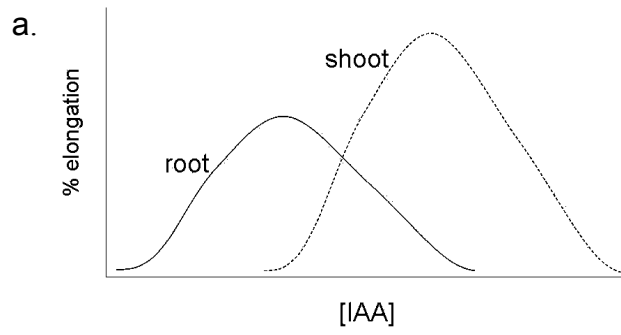
- an elevated level of ABA increases the rate of metabolism thereby producing more heat.

- b. overproduction of ABA is mostly observed in C4 plants which require high optimum temperatures for photosynthesis.
- c. increased levels of ABA in the cell sap will increase the rate of transpiration causing drying of the plant. This in turn will cause such a plant to be warmer than the surrounding plants.
- d. increased ABA will not allow the stomata to open completely and thereby reduce evaporative cooling of the plant.

14. (1 point) While working on the root cap of *Rorippa amphibian*, some anatomists noticed presence of a few specialized cells with watery cytoplasm having freely movable starch grains. On further investigation, similar cells were found in the root cap of several other plants. The most likely function of these cells is:

- a. to give mechanical strength to the root cap.
- b. to provide ready source of energy required for rapid cell divisions at the root tip.
- c. to exert pressure along the physically lower side of the cell to ensure positive geotropism.
- d. to help replacing the worn out cells of the root cap.

15. (1 point) Auxin at an appropriate concentration can induce cell elongation in certain plant organs. However, tissues respond differently to different concentrations of auxin. Which graph best represents the IAA response of shoot and root?



ANIMAL SCIENCES (4)

16. (1 point) An enzyme arginase (that converts arginine to ornithine and urea) extracted from an amphibian kidney shows following biochemical parameters:

| | P | Q |
|-------------------|--------------------------------------|----------------------------------|
| V _{max} | 5.1×10^{-4} mM urea/ min | 8.3×10^{-4} mM urea/min |
| Specific Activity | 9.1×10^{-5} units | 1.3×10^{-4} units |

P and Q, respectively are:

- hydrated and desiccated environment of the animal.
- fresh water and saline environment.
- desiccated and deoxygenated environment.
- adult and tadpole stage.

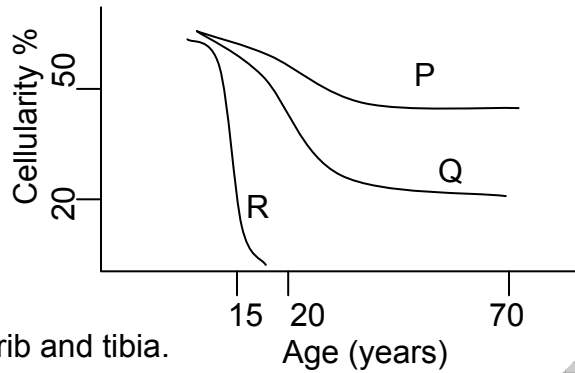
17. (1 point) Oxytocin shows following four consequences in the human body:

- Hypertension
- Uterine contraction
- Milk ejection
- Anti-diuresis

These results are due to effect on:

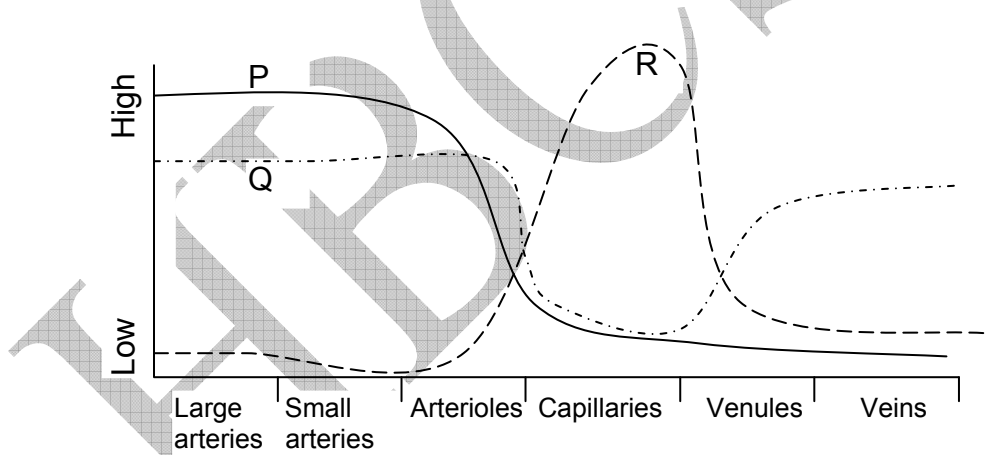
- smooth muscle and membrane permeability.
- striated muscle and membrane depolarization.
- smooth and striated muscles.
- voluntary and involuntary muscles.

18. (1 point) Relative rates of red blood cell production in the bone marrow of different bones at different ages are shown in the graph. P, Q and R are likely to be, respectively:



- a. vertebra, rib and tibia.
- b. femur, carpal and rib.
- c. tibia, fibula and femur.
- d. radius, sternum and carpal.

19. (1 point) Characteristic features of different blood vessels in the body are shown. P, Q and R represent:



- a. P: Total area Q: Velocity R: Blood pressure
- b. P: Blood pressure Q: Velocity R Total area
- c. P: Velocity Q: Total area R: Blood pressure
- d. P: Total area Q: Blood pressure R: Velocity

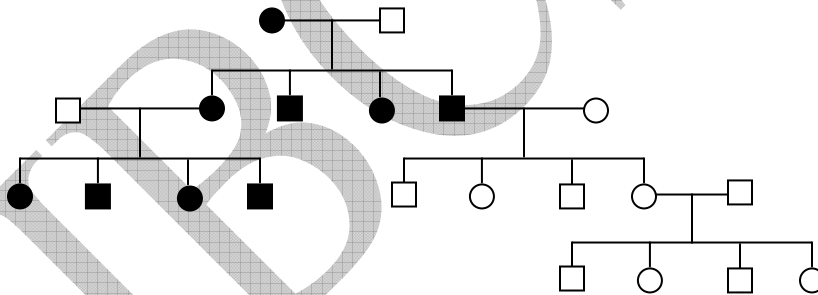
GENETICS & EVOLUTION (4)

20. (1 point) A recessive allele in homozygous condition causes dwarfism. In a mainland population, this condition is known to occur in 1 out of 1000 individuals. Among the tribal population of 12,000 individuals living on a nearby island, this condition is known to occur in 1 in 14 individuals. All these individuals are descendents of 30 people who migrated from the mainland to the island.

This is an example of:

- a. bottleneck effect.
- b. founder effect.
- c. non-random mating.
- d. natural Selection.

21. (1 point) Study the following pedigree. The transmission of the trait indicates:



- a. autosomal dominance.
- b. maternal imprinting.
- c. paternal imprinting.
- d. mitochondrial inheritance.

22. (1 point) Which of the following structures are 'homologous' from the evolutionary point of view?

- a. Petals of rose and the anther of an apple blossom.
- b. Wings of a bird and wings of a butterfly.
- c. Spines of a cactus and spines of a porcupine.

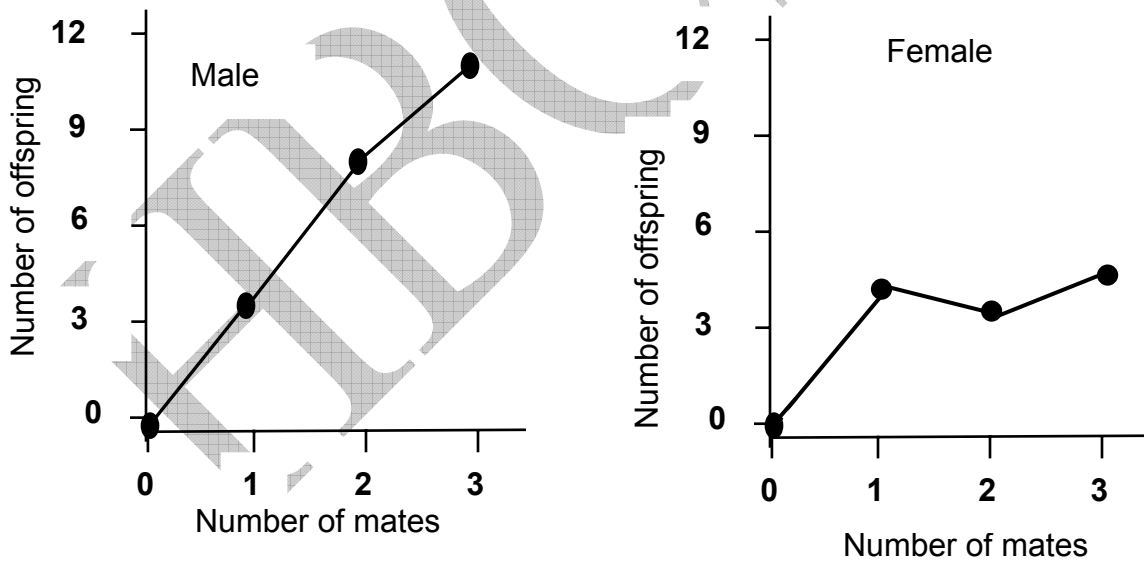
d. Flagellum of *Euglena* and the cilium of paramecium.

23. (1 point) Which of the following ways is most likely to decrease the genetic diversity in a population?

- a. Gene mutation
- b. Genetic recombination
- c. Stabilizing natural selection
- d. Immigration of individuals

ETHOLOGY (2)

24. (1 point) The average reproductive success of an adult male *Drosophila melanogaster* kept with a varying number of females and of an adult female kept with a varying number of males is shown in the figure below.

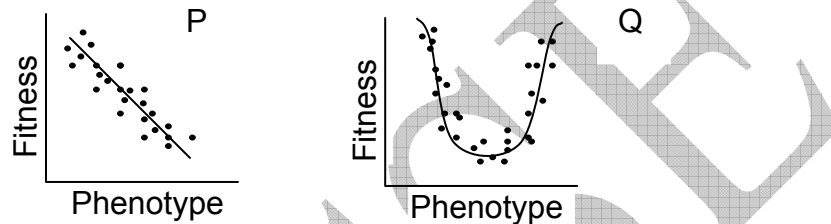


Which of the following statements is true?

- a. The reproductive success of both the sexes is limited by the number of mates available.
- b. The reproductive success of both the sexes is uninfluenced by the number of mates available.

- c. The reproductive success of males is limited by the number of available females.
- d. The reproductive success of females is limited by the number of available males.

25. (1 point) The fitness of individuals with different phenotypes of the same trait differs in two different situations P and Q. P and Q respectively indicate:



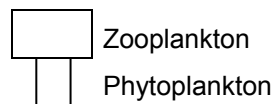
- a. disruptive and directional selection.
- b. directional and stabilizing selection.
- c. directional and disruptive selection.
- d. stabilizing and disruptive selection.

ECOLOGY (2)

26. (1 point) Which one of the following includes all the other?

- a. Osmotroph
- b. Parasite
- c. Sanguivore
- d. Heterotroph

27. (1 point) The pyramid shows the relative biomass of zooplankton and phytoplankton in a marine ecosystem.



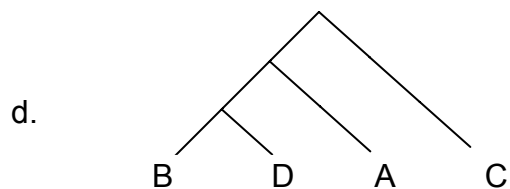
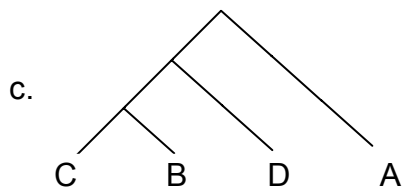
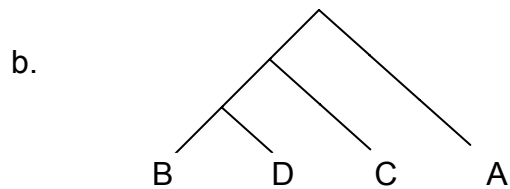
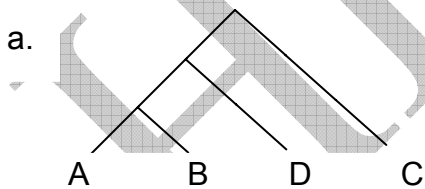
The biomass of the zooplanktons is higher than that of the phytoplanktons because:

- the zooplanktons convert energy more efficiently.
- the zooplanktons have a shorter life cycle than the phytoplanktons.
- the phytoplanktons are individually much smaller than the zooplanktons.
- the phytoplanktons have an extremely high turnover rate.

BIOSYSTEMATICS (1)

28. (1 point) Following table shows data on amino acid substitution in the α chain of hemoglobin in four different mammalian species A, B, C and D. On the basis of the data shown in the table, choose the most appropriate evolutionary tree from those given below.

| Comparison of species | Number of amino acid substitution. |
|-----------------------|------------------------------------|
| A and B | 19 |
| B and C | 26 |
| A and C | 27 |
| D and C | 27 |
| A and D | 20 |
| D and B | 1 |



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SECTION B

CELL BIOLOGY (28)

29. (6 points) Following radioactive precursors were used to label different macromolecules in the cells. These precursors are incorporated during active synthesis of the macromolecules.

| Precursors | Macromolecules |
|-------------------------------|----------------|
| [³ H] Thymidine | DNA |
| [¹⁴ C] Uridine | RNA |
| [³⁵ S] Methionine | Protein |

(A) In which of the following mammalian cell types would these precursors be incorporated? Indicate by using (+) for incorporation and (-) for no incorporation. Fill your answers in **table 29.A in the answer sheet.**

Table 29.A

| Cell types | [³ H] Thymidine | [¹⁴ C] Uridine | [³⁵ S] Methionine |
|--------------------------|-----------------------------|----------------------------|-------------------------------|
| Intestinal mucosal cells | | | |
| Reticulocytes | | | |
| Neurons | | | |
| RBC | | | |

(B) If the above cell types are exposed briefly to ionizing radiations, what would be the pattern of incorporation of these precursors? Indicate by using (+) for incorporation and (-) for no incorporation. Fill your answers in **table 29.B in the answer sheet.**

Table 29.B

| Cell types | [³ H] Thymidine | [¹⁴ C] Uridine | [³⁵ S] Methionine |
|--------------------------|-----------------------------|----------------------------|-------------------------------|
| Intestinal mucosal cells | | | |
| Reticulocytes | | | |
| Neurons | | | |
| RBC | | | |

30. (3 points) Read the following observations and some interpretations.

Observations:

1. To preserve the sweet taste of a freshly picked corn, it is immersed in boiling water for a few minutes.
2. The sweetness of honey decreases if it is heated.
3. Commercial fructose cannot be used as a sweetener for hot drinks.

Interpretations:

- I. The properties of sugar vary with temperature.
- II. Enzyme that converts starch to glucose is activated due to rise in temperature.
- III. Some sugars are thermostable hence their properties do not change with change in temperature.
- IV. Enzyme that converts glucose to starch is destroyed due to rise in temperature.

Mark the correct interpretation against each observation. **Fill in your answers in the answer sheet.**

1. _____
2. _____
3. _____

31. (2 points) Malarial parasite, *Plasmodium falciparum*, is extremely sensitive to any oxidative stress in the cell. The antimalarial drug Primaquine is known to induce formation of H_2O_2 and other reactive oxygen species. Fava beans are also known to contain a chemical which is responsible for raising the concentration of reactive oxygen species. Glucose-6-phosphate-dehydrogenase (G6PD) is an enzyme that helps cells produce a reductant NADPH which protects cells from oxidative damage caused by H_2O_2 and other reactive species.

Indicate whether the following statements are true or false by putting a tick mark (\checkmark) in the appropriate boxes **in the table in the answer sheet.**

- A. G6PD deficient individual is unlikely to develop *P. falciparum* infection.
- B. Primaquine treatment in G6PD normal person is more harmful to the individual than that in G6PD-deficient person.
- C. Eating Fava beans would be more beneficial for a malaria patient who is G6PD deficient than one who has normal G6PD.
- D. In areas where malaria is endemic, natural selection would eliminate individuals with G6PD deficiency.

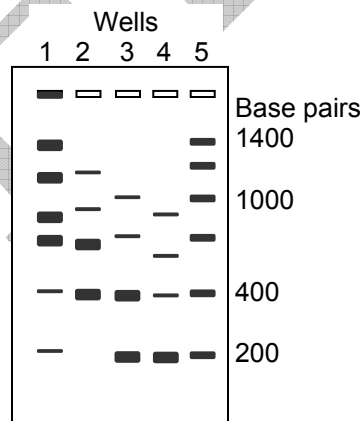
| Statement | True | False |
|-----------|------|-------|
| A | | |
| B | | |
| C | | |
| D | | |

32. (3 points) Dinitrophenol is a chemical that inhibits the F_0F_1 ATP synthase molecule, located in the inner wall of mitochondrion. What would be the effects of accidental consumption of this chemical? Put tick marks (\checkmark) in the appropriate boxes **in the table in the answer sheet.**

| No. | Effects | True | False |
|-----|---|------|-------|
| 1. | Increased glycogen and fat biosynthesis | | |
| 2. | Decreased rate of metabolism | | |
| 3. | Increased sweating | | |
| 4. | Decreased mean body temperature | | |
| 5. | Increase in heat production | | |
| 6. | Decreased cardiac output | | |

33. (2 points) Rat cell nuclei were isolated and mixed with nuclease. The DNA was then extracted and run on agarose gel. The results obtained are shown in the diagram below. The wells 1- 4 represent four such DNA samples while lane 5 indicates the molecular weight markers. Mark the correct interpretation of the results **by putting a tick mark (✓) in the appropriate box in the answer sheet**. Select from the options given below:

- DNA from four different tissues of rat.
- DNA mixed with nuclease for the different periods of time.
- DNA at different stages of cell cycle.
- Varying content of single and double stranded DNA in the cells.



| | |
|----|--|
| a. | |
| b. | |
| c. | |
| d. | |

34. (3 points) Following is the list of biomolecules that can diffuse through a synthetic lipid bilayer to a varying extent. Arrange them in the decreasing order of this ability and fill your **answers in the answer sheet**.

1. Ethanol
2. Water
3. O₂
4. K⁺
5. DNA
6. Glucose

— > — > — > — > —

35. (2 points) Lysosomes are cell organelles filled with hydrolytic enzymes. These enzymes are delivered to lysosomes through ER and golgi apparatus. 'M6P' is a unique marker group attached to these enzymes that is recognized by the lysosomal receptors. Two enzymes namely, PT and PG convert mannose to M6P as follows:

PT PG

Mannose → Intermediate → M6P

Patients with “I-cell disease” produce perfectly healthy hydrolases but instead of being delivered to lysosomes, in these patients, they are delivered outside

the cell. Three such cell lines (I, II and III) having this defect have been identified.

In order to detect the exact cause of the defect, following experiments were done:

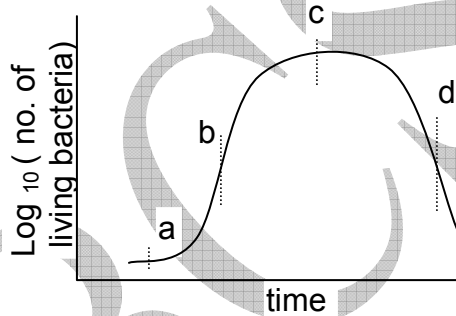
| No. | Experiment | Result |
|-----|-----------------------------------|-----------------------|
| 1. | Supernatant from I added to II. | Defect corrected. |
| 2. | Supernatant from II added to III. | Defect corrected. |
| 3. | Supernatant from II added to I. | Defect not corrected. |
| 4. | Supernatant from I added to III. | Defect corrected. |
| 5. | Supernatant from III added to I. | Defect not corrected. |
| 6. | Supernatant from III added to II. | Defect corrected. |

Which are the most likely causes of the defect? Put a tick mark (✓) in the appropriate box in the answer sheet.

- I: Deficiency of enzyme PT and PG, II: Deficiency of enzyme PT, III: Deficiency of enzyme PG
- I: Deficiency of enzyme PT, II: receptor deficiency, II: Deficiency of enzyme PG
- I: Deficiency of enzyme PG, II: receptor deficiency, II: Deficiency of enzyme PT
- I: receptor deficiency, II: Deficiency of enzyme PT or PG, III: Deficiency of enzyme PG or PT

| | |
|----|--|
| a. | |
| b. | |
| c. | |
| d. | |

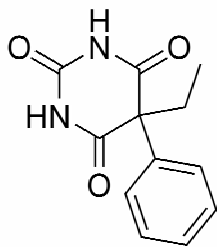
36. (2 points) A typical growth curve of a bacterial population is shown. Four stages in the growth curve are marked as a, b, c and d. Match them against the correct population (P, Q, R, S). Fill in your answers in the **table given in the answer sheet**.



| Population | No. of cells in millions | |
|------------|--------------------------|-------|
| | Living | Total |
| P | 10 | 11 |
| Q | 400 | 450 |
| R | 225 | 950 |
| S | 550 | 950 |

| Population | Stage |
|------------|-------|
| P | |
| Q | |
| R | |
| S | |

37. (5 points) Phenobarbital is a compound that is highly effective as an anti-convulsant agent. It has a pKa of 7.41.



Using Henderson Hasselbach equation, $\text{pH} = \text{pKa} + \log \left[\frac{[\text{A}^-]}{[\text{HA}]} \right]$, calculate the ratio of drug ionized to un-ionised in:

(Fill your answers in the answer sheet.)

- A. stomach (pH2). _____
- B. duodenum (pH 6.0) _____
- C. jejunum (pH 7.4) _____
- D. Which of the above pH values, is the most appropriate for the drug absorption? _____
- E. A person has accidentally consumed the drug in higher amounts. In order to increase the excretion of the drug from renal tubules, which of the following measures will help the most? **Put a tick mark (✓) in the appropriate box in the answer sheet.**
- Administering urinary acidifiers.
 - Administering urinary alkalinizers.
 - Ingestion of excess water.
 - Administering anti-diuretic drugs.

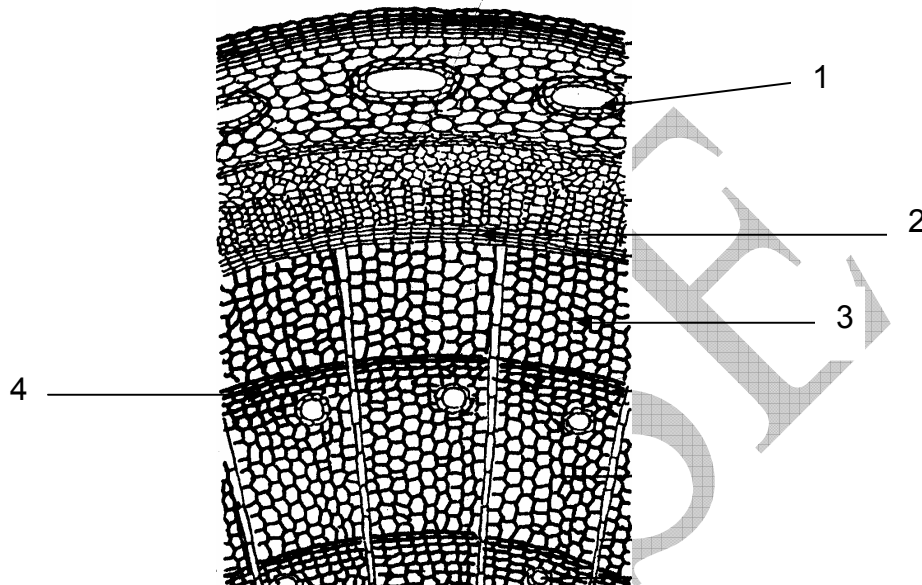
| | |
|----|--|
| a. | |
| b. | |
| c. | |
| d. | |

PLANT SCIENCES (6)

38. (2 points) A few characteristics of C₃ and C₄ plants are compared in the following table. Place > or < or = or X (cannot be determined) **in the empty places in the table given in the answer sheet.**

| Characteristic | Type of plant | >/</=/X | Type of plant |
|--|-----------------------|---------|-----------------------|
| Light compensation point | C ₃ plants | | C ₄ plants |
| Photorespiration rate | C ₃ plants | | C ₄ plants |
| Optimum temperature for photosynthesis | C ₃ plants | | C ₄ plants |
| Productivity | C ₃ plants | | C ₄ plants |

39. (2 points) The figure shows a transverse section of a *Pinus* tree. Correlate the structures with the numbers. Choose from the options given below and **fill in your answers in the answer sheet.**



Options:

Cambium, spring wood, autumn wood, aerenchyma, mucilage duct, cuticle, phloem, primary ray, pith, periderm

1: _____

2: _____

3: _____

4: _____

40. (2 points) Some orders under pteridophyta are characterized by homosporous i.e. production of only one type of spores that grow into independent, bisexual gametophyte while others are known to exhibit heterosporous i.e. production of male/microspores and female/megaspores developing into male and female gametophytes respectively, often dependent on sporophyte.

Indicate whether the following statements are true or false by putting a tick mark (✓) in the appropriate boxes **in the table given in the answer sheet.**

- I. Homospory is an advanced feature involving development of an independent bisexual gametophyte.
- II. Heterospory is a primitive feature since a greater amount of energy is spent for reproduction.
- III. Heterospory is a transitional evolutionary stage in the evolution of spermatophytes since it involves retention of spores and gametophytes in the sporangia.
- IV. Homospory is a primitive feature since it involves development of an independent gametophyte that has to complete vegetative growth before taking up reproduction.

| Statements | True | False |
|------------|------|-------|
| I. | | |
| II. | | |
| III. | | |
| IV. | | |

ANIMAL SCIENCES (10)

41. (2 points) Which of the following activities will increase the partial pressure of CO₂ in the lungs? Fill your answers by putting tick marks (√) in the appropriate boxes in the table given in the answer sheet.

- A. Rapid deep breathing
- B. Holding breath
- C. Slow muscular exercise
- D. Breathing in a paper bag

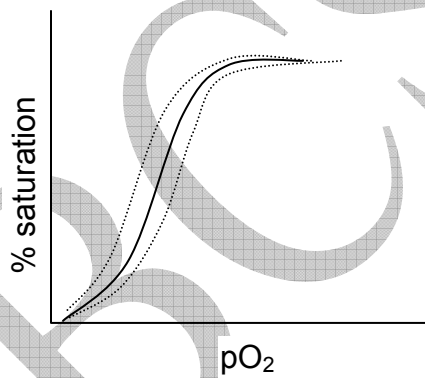
| Activity | Will increase | Will not increase |
|----------|---------------|-------------------|
| A. | | |
| B. | | |
| C. | | |
| D. | | |

42. (2 points) An athlete runs a 100 m sprint. At the end of this event, she breathes rapidly for sometime and then slowly her breathing rate comes to normal in the next 30 minutes. Which of the following processes is predominantly going on in her body during this recovery period? Put a tick mark in the appropriate box in the answer sheet.

- a. Uniform distribution of inhaled oxygen to all the tissues of the body.
- b. Generation of ATP to convert lactate to glucose
- c. Excess breakdown of glycogen to maintain blood glucose level.
- d. Formation of depleted muscle glycogen from the glucose available from the blood.

| | |
|----|--|
| a. | |
| b. | |
| c. | |
| d. | |

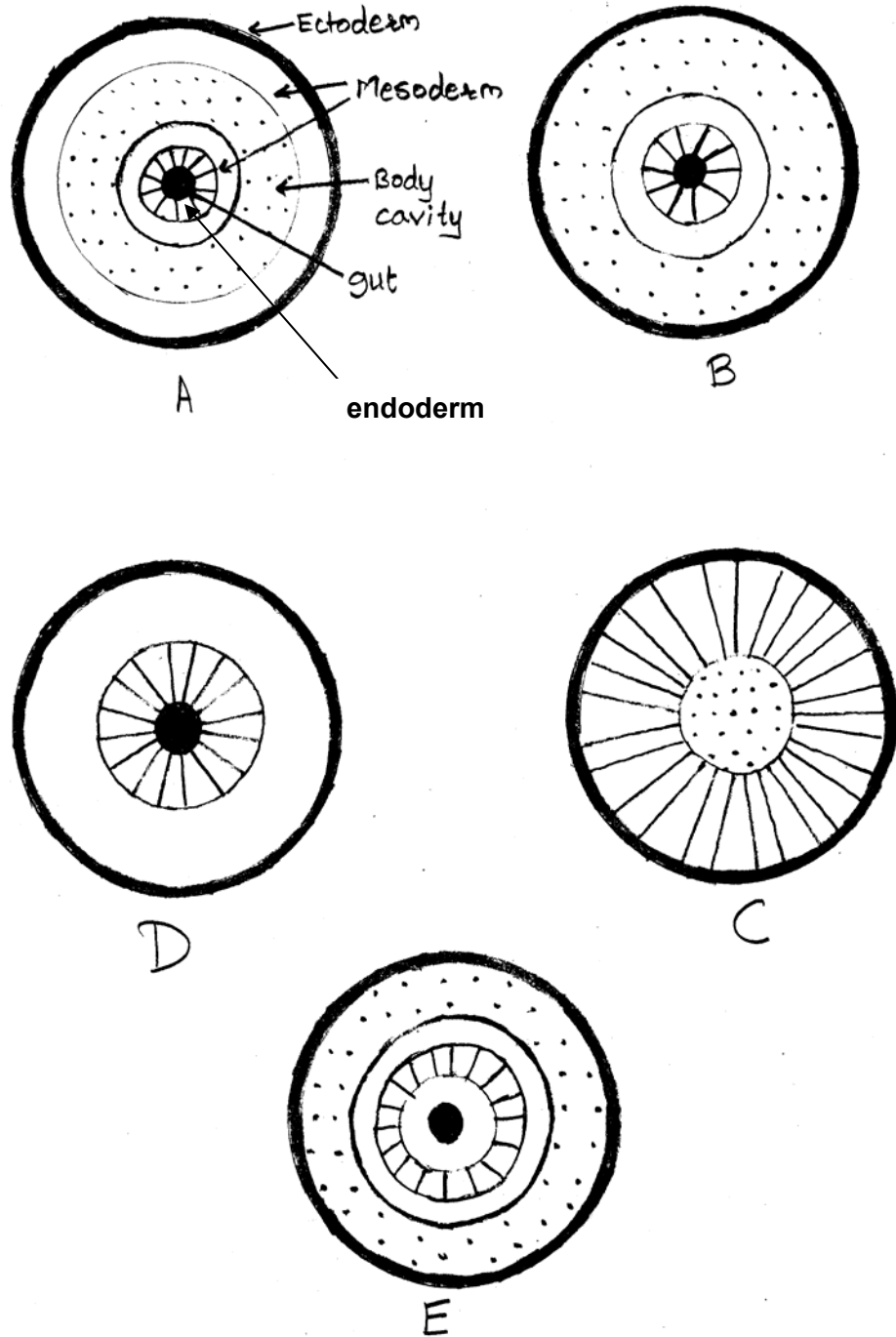
43. (2 points) Normal hemoglobin saturation curve in the resting stage is shown in the graph as a solid line. However, it may shift to left or right (shown as dotted lines) depending on the need of the cell. Indicate whether the following statements are true or false by putting tick marks (\checkmark) in the appropriate boxes in the table given in the answer sheet.



- A. During exercise, the curve is likely to shift to the right in the muscle.
- B. After exercise, the curve is likely to shift to the left in the alveoli.
- C. During exercise, the curve is likely to shift to the left in the liver.
- D. After exercise, the curve is likely to shift to the left in the muscle.

| Statements | True | False |
|------------|------|-------|
| A. | | |
| B. | | |
| C. | | |
| D. | | |

44. (4 points) Different types of 'tube-within-tube' body pattern of multicellular animals have been depicted as A, B, C, D and E.



Diameters of circles not to the scale.

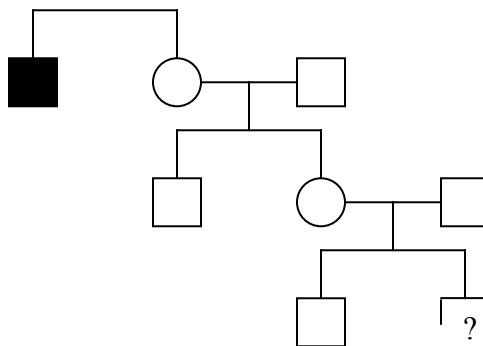
Determine the body pattern for each of the animal/animal groups listed below.

(Fill your answers **in the table given in the answer sheet.**)

| Animal group | Body pattern (A/B/C/D/E) |
|--------------|-----------------------------|
| Sea urchin | |
| Sea anemone | |
| Nematodes | |
| Star fish | |
| Corals | |
| Snakes | |
| Rotifers | |
| Tape worm | |

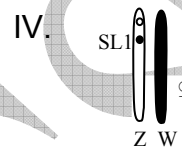
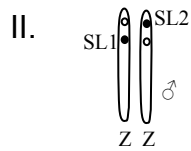
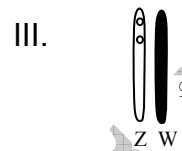
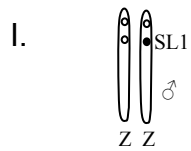
GENETICS & EVOLUTION (9.5)

45. (1.5 points) In the following pedigree, the black square indicates the male affected with Hemophilia which is a X-linked recessive trait. What is the probability that the proposed child, which is a male (indicated as ?), will carry the disease? Fill your answer **in the answer sheet.**



Answer: _____

46. (1 point) Males of silkworm *Bombyx mori* are known to produce more silk per unit quantity of leaf consumed. Hence, they are preferably bred in sericulture industry. Which of the following genotypes should be crossed in order to get maximum fraction of male insects? Fill your answer **in the answer sheet**.



SL1 and SL2 are two sex linked recessive lethal mutations.

Answer: _____

47. (2.5 points) Read the following statements and determine whether they suggest pre-zygotic or post-zygotic barriers. Put tick marks (✓) in the appropriate boxes **in the table given in the answer sheet**.
- Male Jackals only mate with domestic dogs if the Jackal pups are raised by a domestic dog.
 - Lions and Tigers must overcome behavioural (courtship) barriers, but produce fertile female offspring and sterile male offspring.
 - Flowers of genus *Aquilegia* have long floral nectarines. Flowers of *Aquilegia pubiscens* are upright in position and pollinated by hawkmoths, while flowers of *A. formosa* are angling type and pollinated by hummingbird. The hybrids of these plants, although fertile, are rarely found in nature.

D. In *Heliconius* butterflies, fertile hybrids are common which can breed with other hybrids, or with either parent species. However, pure-bred *Heliconius* butterflies have warning colouration to ward off predators while hybrids have intermediate patterns which are not recognized.

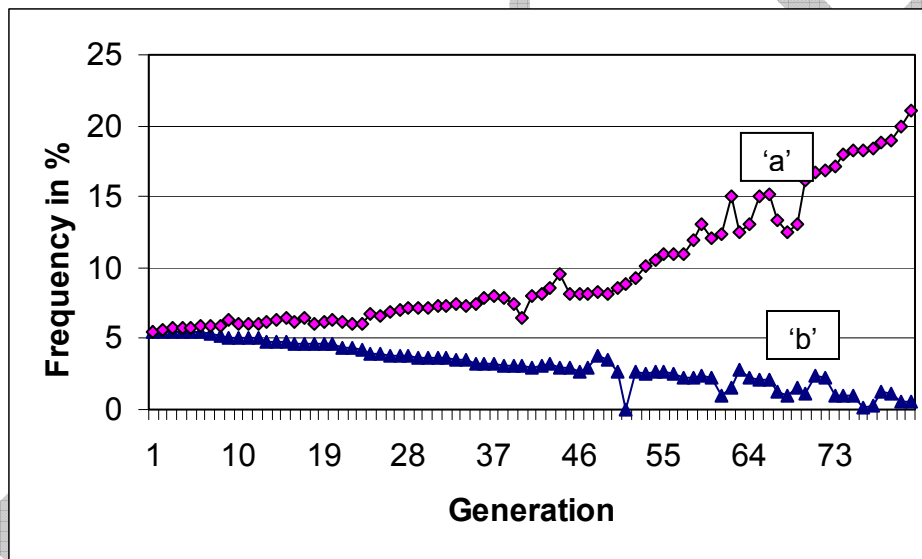
| Description | Whether description suggests | |
|-------------|------------------------------|----------------------|
| | Pre-zygotic barrier | Post-zygotic barrier |
| A. | | |
| B. | | |
| C. | | |
| D. | | |

48. (2.5 points) Bathypelagic fish (those which live at around 1000-2000 meters of depth in ocean) show varying adaptations as compared to mesopelagic fish (that live at around 200-700 meters of depth). Which of the statements correctly generalize body features in these two groups? Indicate whether each statement is true or false by putting tick marks (✓) **in the appropriate boxes in the table given in the answer sheet.**

- A. Bathypelagic fishes are mostly black in colour as against variedly coloured mesopelagic fishes.
- B. Bathypelagic fish have relatively long jaws as compared to mesopelagic fish.
- C. Mesopelagic fish have fairly large eyes in as compared to bathypelagic fishes.
- D. Mesopelagic fish have retina predominantly containing rod cells as compared to retina with more cone cells in bathypelagic fishes.
- E. Well developed gill system in mesopelagic fishes as compared to bathypelagic fishes.

| Statements | True | False |
|------------|------|-------|
| A. | | |
| B. | | |
| C. | | |
| D. | | |
| E. | | |

49. (2 points) In a long term experiment on a population of *Drosophila melanogaster*, the frequency of two alleles 'a' and 'b' of a multi-allelic locus X over time has been shown in the following graph.



6 students were asked to evaluate the observed patterns and their inferences are given below:

- Student # 1 : Environment is not uniformly selective.
- Student # 2 : Population may be under artificial selection.
- Student # 3 : Genetic variability is progressively increased.
- Student # 4 : Genetic variability is progressively reduced.
- Student # 5 : Mechanism such as genetic drift is operating from time to time.
- Student # 6: Selection is favouring a particular genotype through directional selection.

The appropriate conclusions were drawn by:

(Put a tick mark (√) in the **appropriate box in the answer sheet.**)

- a. Students # 2, ,5 and 6
- b. Students # 1, 3 and 5
- c. Students # 2, 4 and 6
- d. Students # 1, 3 and 6

| | |
|----|--|
| a. | |
| b. | |
| c. | |
| d. | |

ETHOLOGY (5)

50. (3 points) A number of social factors influence the reproductive physiology and behaviour of house mice. Some social conditions and responses have been enlisted in the table below. Match each social condition with the corresponding response and **fill in the response number in the table in the answer sheet.**

Social condition

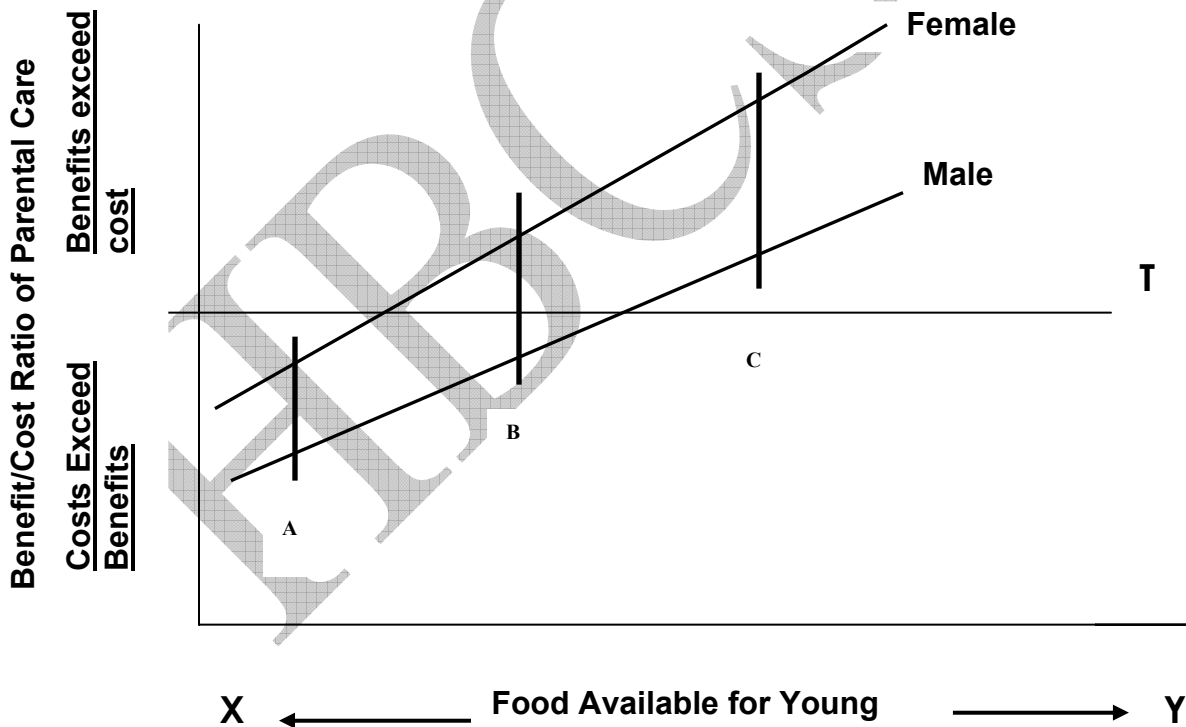
- A. Juvenile females held with a dominant male
- B. Adult females held in a group without a male
- C. A dominant male added to a group containing only adult females
- D. Pregnant females exposed to the urine of a strange male
- E. An adult male exposed to a strange female
- F. An adult male exposed to the urine of pregnant or lactating mates

Response

- 1. Females begin estrous cycling
- 2. Females resorb embryos or abort spontaneously
- 3. The male's sexual activity falls
- 4. The sexual maturation of females occurs rapidly
- 5. Females stop estrous cycling
- 6. The male's testosterone levels and sexual activity rise

| Social condition | Response |
|------------------|----------|
| A. | |
| B. | |
| C. | |
| D. | |
| E. | |
| F. | |

51. (2 points) Parental care in animals may be promoted by certain ecological factors. The possibility of parental care by the two sexes of a certain species in response to food availability is shown in the following figure.



A. The availability of food for the young is related to parental care under the following conditions:

(Put a tick mark (✓) in the appropriate box in the answer sheet.)

- a. X: Low, Y: Abundant.
- b. X: Abundant, Y: Low.
- c. X and Y both low.
- d. X and Y both abundant.

| | |
|----|--|
| a. | |
| b. | |
| c. | |
| d. | |

B. The line labeled T is the threshold above which:

(Put a tick mark (√) in the **appropriate box in the answer sheet.**)

- a. parental care will evolve.
- b. parental care will be abolished.

| | |
|----|--|
| a. | |
| b. | |

C. At the point marked A:

(Put a tick mark (√) in the **appropriate box in the answer sheet.**)

- a. only females will exhibit parental care.
- b. only males will exhibit parental care.
- c. neither of the sexes will exhibit parental care.
- d. both the sexes will exhibit parental care.

| | |
|----|--|
| a. | |
| b. | |
| c. | |
| d. | |

D. At the point marked B:

(Put a tick mark (√) in the **appropriate box in the answer sheet.**)

- a. males gain by being parental but females do not.
- b. females gain by being parental but males do not.
- c. both sexes gain by being parental.

| | |
|----|--|
| a. | |
| b. | |
| c. | |

ECOLOGY (11.5)

52. (2.5 points) Bottom dwelling invertebrates that produce young ones may do so by one of the following ways:

- I. They may produce large number of very small eggs which quickly hatch into larvae. These larvae are free-swimming and feed on phytoplankton present in water column.
- II. They may lay fewer eggs with yolk. When hatched, these larvae do not feed on plankton and spend less time in water column before settling.
- III. They may produce very few eggs that undergo entire development in the eggs and emerge out as juveniles on the sea beds.

For each of the following conditions, select a mode that will be favoured.

Fill your answers **in the table given in the answer sheet.**

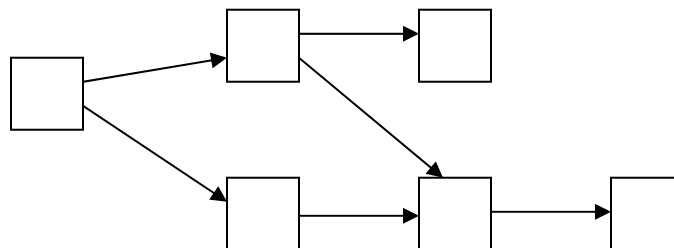
- A. Environment where dispersal is a prime concern over survival.
- B. Environment where planktonic mortality is high.
- C. Environment with few predators and unpredictable plankton food.
- D. Environment where developmental time is short.
- E. Environment where survival is of prime concern.

| Condition | Mode |
|-----------|------|
| A. | |
| B. | |
| C. | |
| D. | |
| E. | |

53. (3 points) Members of a macroscopic food chain of a marine ecosystem are enlisted below. Numbers in front of them indicate the carbon assimilated in gms/m²/year.

- 1. Filter feeders 500
- 2. Surf zooplankton 400
- 3. Surf diatoms 350
- 4. Fishes 140
- 5. Benthic carnivores 40
- 6. Piscivorous fishes 8

Place them in the appropriate boxes in the following food chain. (Each member should be used only once.) Fill your answers **in the answer sheet**.



54. (4 points) (A) During ecology practical exercise, a student studied some types of soil millipedes and presented the data as follows:

| Millipede species | Average body weight (mg) | Daily food consumed as % of body weight | Food consumed by animal in 5 days (mg of air-dried matter) |
|-------------------|--------------------------|---|--|
| 1. | 51.2 | 70 | 60 |
| 2. | 116.4 | 46 | 88.5 |
| 3. | 186.5 | 43 | 133.2 |

Study the table and mark the correct statement from those given below. Fill your answer by putting a tick mark (✓) in the **appropriate box in the answer sheet.**

- a. There is an error in the data as total food consumed by millipede species 1 is less than the daily food intake.
- b. Data is incorrect as the daily food intake should be highest for the largest animal ie. Species no. 3.
- c. The data is correct and indicates that the rate of metabolism is highest for the smallest animal species.
- d. The data is incorrect as it indicates that species 1, though smallest in size, has the largest total body surface area and hence consumes more food daily.

| | |
|----|--|
| a. | |
| b. | |
| c. | |
| d. | |

(B) To obtain the total surface area of each of these species, following formula was used:

$$\text{Surface area} = k \times g^{2/3}$$

where g is the weight of the animal. Finally, the surface area to total body weight was calculated, following data was obtained:

Species 1: 4.3: 1

Species 2: 3.7: 1

Species 3: 3.1: 1

The above data indicates that:

(Fill your answer by putting a tick mark (\checkmark) in the **appropriate box in the answer sheet.**)

- a. rate of metabolism is directly proportional to body weight.
- b. rate of metabolism is directly proportional to body weight/surface area.
- c. rate of metabolism is directly proportional to total surface area.
- d. rate of metabolism is directly proportional to surface area/body weight.

| | |
|----|--|
| a. | |
| b. | |
| c. | |
| d. | |

55. (2 points) Below are listed some anatomical/physiological adaptations of brown alga *Fucus vasiculosus*. Match each one with one survival advantage by writing the correct alphabet (a-g) **in the table in the answer sheet.** Choose from the options given below.

| Adaptation | Advantage |
|--|-----------|
| Dichotomous branching of thallus | |
| Presence of fucoxanthin | |
| Mucilaginous secretions | |
| Lower solute potential than the surroundings | |

Options:

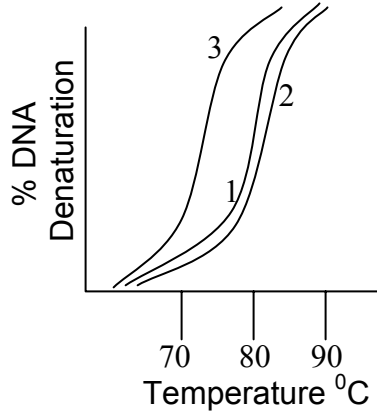
- a. Optimum absorption of red light
- b. Strength against pounding waves and stones
- c. Protection against desiccation at low tides
- d. Prevention of water loss by osmosis
- e. Optimum buoyancy at high tides
- f. Effective movement of motile gametes
- g. Optimal absorption of blue light.

BIOSYSTEMATICS (2)

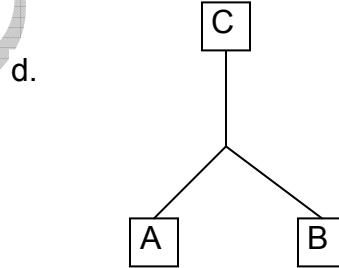
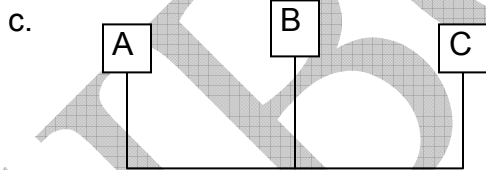
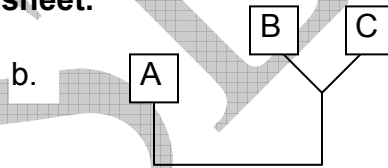
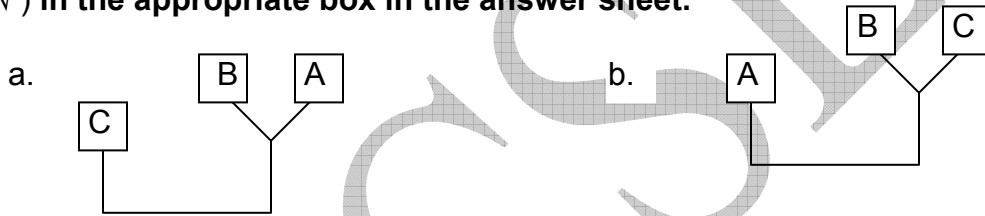
56. (2 points) The technique of DNA-DNA hybridization provides a way of comparing the total genome of the species. Following procedure was used to assess the evolutionary relationship of species A, B and C:

1. The total DNA was extracted from the cells of each species and purified.
2. Each of the three samples was denatured by heating.
3. The resulting single strands were then mixed as follows:
 - Test tube 1: Strands from sp. A
 - Test tube 2: Strands from sp. A and B
 - Test tube 3: Strands from sp. A and C.
4. All the samples were cooled.

5. DNA melting curve for all the three samples was studied. The result is shown in the graph:



Select the cladogram that matches with the data obtained. Put a tick mark (✓) in the appropriate box in the answer sheet.



| | |
|----|--------------------------|
| a. | <input type="checkbox"/> |
| b. | <input type="checkbox"/> |
| c. | <input type="checkbox"/> |
| d. | <input type="checkbox"/> |
