

# **GATE - 2016**

**(BIOTECHNOLOGY)**

**AIR 6**



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**Education for Life...**

**Pathfinder Academy**

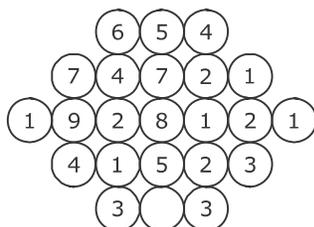


07. Read the following paragraph and choose the *correct* statement.

Climate change has reduced human security and threatened human well being. An ignored reality of human progress is that human security largely depends upon environmental security. But on the contrary, human progress seems contradictory to environmental security. To keep up both at the required level is a challenge to be addressed by one and all. One of the ways to curb the climate change may be suitable scientific innovations, while the other may be the Gandhian perspective on small scale progress with focus on sustainability.

- Human progress and security are positively associated with environmental security.
- Human progress is contradictory to environmental security.
- Human security is contradictory to environmental security.
- Human progress depends upon environmental security.

08. Fill in the missing value

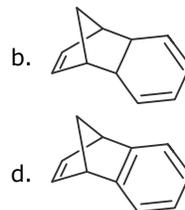
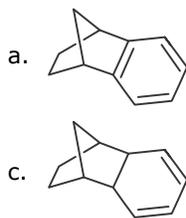


09. A cube of side 3 units is formed using a set of smaller cubes of side 1 unit. Find the proportion of the number of faces of the smaller cubes visible to those which are *not* visible.
- 1 : 4
  - 1 : 3
  - 1 : 2
  - 2 : 3
10. Humpty Dumpty sits on a wall every day while having lunch. The wall sometimes breaks. A person sitting on the wall falls if the wall breaks.
- Which one of the statements below is logically valid and can be inferred from the above sentences?
- Humpty Dumpty always falls while having lunch.
  - Humpty Dumpty does not fall sometimes while having lunch.
  - Humpty Dumpty never falls during dinner.
  - When Humpty Dumpty does not sit on the wall, the wall does not break.

## Chemistry

**Questions 11 to 15 carry one mark each.**

11. The molecule having net 'non-zero dipole moment' is
- $\text{CCl}_4$
  - $\text{NF}_3$
  - $\text{CO}_2$
  - $\text{BCl}_3$
12. The Diels-Alder adduct from the reaction between cyclopentadiene and benzyne is



13. The number of possible enantiomeric pair(s) in  $\text{HOOC}-\text{CH}(\text{OH})-\text{CH}(\text{OH})-\text{COOH}$  is \_\_\_\_\_.





29. Ribulose-5-phosphate epimerase is involved in which one of the following processes?  
 a. Glycolysis  
 b. TCA cycle  
 c. Glycosylation  
 d. Pentose phosphate pathway
30. Proteolytic enzymes are usually biosynthesized as large, inactive precursors known as  
 a. holoenzymes  
 b. ribozyme  
 c. zymogens  
 d. apoenzymes
31. The formation of a carbocation, also called an oxonium ion, occurs during the reaction catalyzed by  
 a. aldolase  
 b. lysozyme  
 c. ribonuclease A  
 d. carboxypeptidase
32. Which one of the following amino acid substitutions is likely to cause the largest change in protein conformation?  
 a. Phe → Ile  
 b. Ser → Thr  
 c. Gln → Tyr  
 d. Glu → Val
33. Which one of the following *does not* constitute the lipid moiety in lipid-linked membrane proteins?  
 a. Palmitic acid  
 b. Stearic acid  
 c. Farnesyl groups  
 d. Myristic acid
34. A closed circular B-DNA of 4000 base pairs is negatively supercoiled by introduction of 4 writhes. The super helical density of the resultant DNA molecule will be \_\_\_\_\_.
35. Which one of the following is *not* a receptor tyrosine kinase?  
 a. Platelet derived growth factor receptor  
 b. Insulin like growth factor -1 receptor  
 c. Macrophage colony stimulating factor receptor  
 d. Transforming growth factor  $\beta$ -receptor

**Questions 36 to 45 carry two marks each.**

36. Match the entries in Column -1 with those in Column -2
- |                       |                           |
|-----------------------|---------------------------|
| Column-1              | Column-2                  |
| P. Vitamin B1         | 1. Thiamine pyrophosphate |
| Q. Carboxypeptidase   | 2. Aconitase              |
| R. TCA cycle          | 3. Sucrose                |
| S. Reducing sugar     | 4. $Zn^{2+}$              |
|                       | 5. Riboflavin             |
|                       | 6. Lactose                |
| a. P-1, Q-4, R-2, S-6 | b. P-5, Q-1, R-2, S-3     |
| c. P-1, Q-4, R-5, S-6 | d. P-5, Q-2, R-1, S-6     |
37. The following table provides information about four proteins.

Protein	Native mol. Wt. (Da)	pI	type
P	32000	6.4	monomer
Q	40000	8.5	homodimer
R	25000	4.9	monomer
S	45000	8.5	homotrimer

Which one of the following options *correctly* identifies the order of elution in size exclusion chromatography and the increasing order of mobility in SDS polyacrylamide gel?

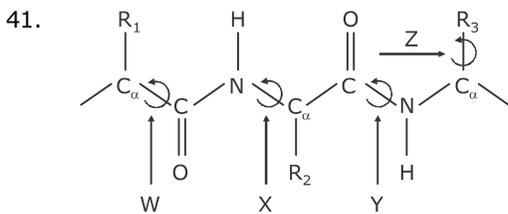
- Chromatography: SQPR; Electrophoresis: RPQS
- Chromatography: RPQS; Electrophoresis: SQPR
- Chromatography: PRQS; Electrophoresis: PRQS
- Chromatography: SQPR; Electrophoresis: PRQS

38. The predicted molar extinction coefficient at 280 nm for the peptide GEEFHISFLLIMFGAWSTHMYRTYWFHEMISTRY is \_\_\_\_\_  $M^{-1} cm^{-1}$ .  
[Molar extinction coefficient for phenylalanine, tryptophan and tyrosine at 280 nm are 200, 5600 and 1400  $M^{-1} cm^{-1}$ , respectively].

39. Match the contents of Column I with the most appropriate options in Column II.

Column I	Column II
P. Complement C1q	1. CD34
Q. L-Selectin	2. Complement C5b
R. Membrane Attack Complex	3. Fc region of antibody
S. T-Helper cells	4. Complement C5a
	5. CD40L
a. P-3, Q-5, R-4, S-1	b. P-1, Q-2, R-4, S-5
c. P-3, Q-1, R-2, S-5	d. P-4, Q-5, R-2, S-1

40. The value of  $\Delta G$  at 37°C for the movement of  $Ca^{2+}$  ions from the endoplasmic reticulum where  $[Ca^{2+}]$  is 1 mM to the cytosol where  $[Ca^{2+}]$  is 0.1  $\mu M$  at -50 mV membrane potential is \_\_\_\_\_  $kJ mol^{-1}$ .  
[ $R = 8.314 JK^{-1}mol^{-1}$  and 1 Faraday = 96500 Coulombs]



Column I	Column II
W	1. $\Psi$
X	2. $\chi$
Y	3. $\phi$
Z	4. $\omega$

Which of the following identifies the *correctly* matched pairs?

- W-3, X-1, Y-4, Z-2
- W-1, X-3, Y-4, Z-2
- W-1, X-3, Y-2, Z-4
- W-3, X-1, Y-2, Z-4

42. Which of the following statements is/are *incorrect* about hemoglobin (Hb)?

- Hb demonstrates higher oxygen carrying capacity compared to myoglobin.
  - There is covalent bonding between the four subunits of Hb.
  - During deoxygenation the loss of the first oxygen molecule from oxygenated Hb promotes the dissociation of oxygen from the other subunits.
- Q
  - Q and R
  - P and R
  - R

43. A 1.2 kb DNA fragment was used as a template for PCR amplification using primers P1, P2, P3 and P4 as shown in the scheme below. The annealing positions of primers on the template are indicated by numbers. Primers P2 and P3 contain single base mismatches as indicated by filled triangles.



PCR was performed using primer pair P1 and P3 in one vial and P2 and P4 in another vial. The purified PCR products from the two vials were mixed and subjected to another round of PCR with primers P1 and P4. The final PCR product will correspond to a

- 1.2 kb wild type DNA
  - 1.2 kb DNA with two point mutations
  - 0.9 kb DNA with one point mutation
  - 0.5 kb DNA with one point mutation
44. A cell suspension was subjected to membrane disruption followed by differential centrifugation to fractionate the cellular components.

Match the centrifugal conditions in Column I to the appropriate subcellular components in Column II.

Column I

Column II

P. 1000 g, 10 min

1. Microsomes and small vesicles

Q. 20000 g, 30 min

2. Ribosomes

R. 80000 g, 1 hour

3. Nuclei

S. 150000 g, 3 hours

4. Lysosomes and peroxisomes

a. P-3, Q-4, R-1, S-2

b. P-1, Q-4, R-3, S-2

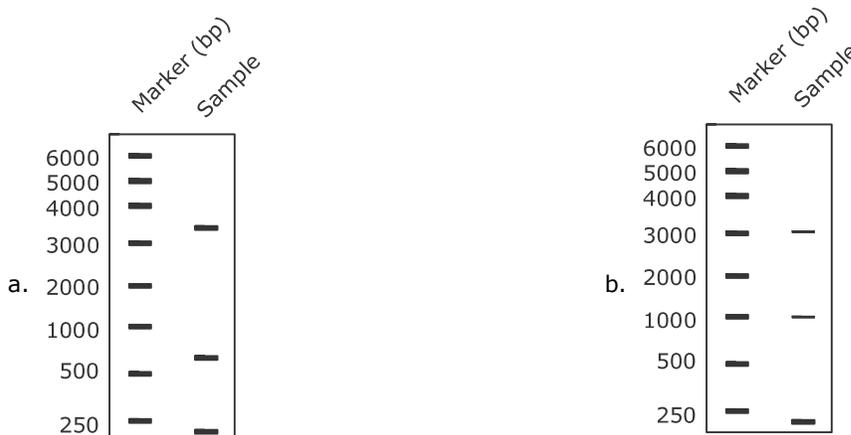
c. P-3, Q-4, R-2, S-1

d. P-2, Q-1, R-4, S-3

45. Given below are the maps of a 1200 base pairs (bp) long DNA insert and a 3000 bp expression vector. The *Bam*HI (B) and *Hind*III (H) restriction sites and DNA length between them are indicated in base pairs.



The insert is cloned into the vector at the *Bam*HI site and the desired orientation is shown by the arrow. After cloning, the orientation of the insert in the recombinant plasmid is tested by complete *Hind*III digestion followed by agarose gel electrophoresis. Which one of the following band patterns reveals the *correct* orientation of the insert in the construct?





54. Which one of the following is *not* a cryoprotectant for plant tissue?  
 a. Dimethyl sulfoxide  
 b. Glycerol  
 c. Ethylene glycol  
 d. Liquid nitrogen
55. Two similar holotypes are called  
 a. monotype  
 b. neotype  
 c. isotype  
 d. syntype

**Questions 56 to 65 carry two marks each.**

56. A cross was made between AABBCCDDEE and aabbccdde. The resultants  $F_1$  were selfed. Applying Mendelian principle, *predict* the proportion of phenotype showing all the recessive characters in  $F_2$  generation  
 a. 1/64  
 b. 1/256  
 c. 1/512  
 d. 1/1024
57. Identify the *correct* statements with respect to functioning of ecosystem.  
 P. A food chain is a series of organisms, each one feeding on the organism succeeding it.  
 Q. Food web presents a complete picture of the feeding relationships in any given ecosystem.  
 R. In ecosystem, energy flows in unidirectional way, whereas nutrients flow in cyclic fashion.  
 S. In biogeochemical cycles, nutrients do not alternate between organisms and environment.  
 a. P, Q  
 b. P, R  
 c. R, S  
 d. Q, R
58. Match the name of the diseases with their causal organisms.
- | Disease                       | Causal Organism                    |
|-------------------------------|------------------------------------|
| P. Loose smut of wheat        | 1. <i>Cercospora personata</i>     |
| Q. Wart disease of potato     | 2. <i>Alternaria solani</i>        |
| R. Panama disease of banana   | 3. <i>Synchytrium endobioticum</i> |
| S. Tikka disease of groundnut | 4. <i>Ustilago tritici</i>         |
|                               | 5. <i>Fusarium oxysporum</i>       |
|                               | 6. <i>Erwinia amylovora</i>        |
- a. P-6, Q-4, R-3, S-2  
 b. P-4, Q-6, R-1, S-3  
 c. P-4, Q-3, R-5, S-1  
 d. P-2, Q-3, R-2, S-6
59. Match the plant products with their sources and the plant parts from which they are obtained.
- | Product     | Source                     | Plant part |
|-------------|----------------------------|------------|
| P. Annatto  | 1. <i>Acacia catechu</i>   | i. seed    |
| Q. Cutch    | 2. <i>Rubia tinctorum</i>  | ii. Leaf   |
| R. Henna    | 3. <i>Bixa orellana</i>    | iii. Root  |
| S. Alizarin | 4. <i>Lawsonia inermis</i> | iv. Stem   |
- a. P-3-ii, Q-4-i, R-2-iii, S-1-iv  
 b. P-3-i, Q-1-iv, R-4-ii, S-2-iii  
 c. P-2-ii, Q-1-iii, R-4-iv, S-3-i  
 d. P-4-ii, Q-3-iv, R-1-iii, S-2-i
60. Match the floral structures with the families and representative plant species.
- | Floral structure   | Family            | Plant                          |
|--------------------|-------------------|--------------------------------|
| P. Gynostegium     | 1. Orchidaceae    | i. <i>Ocimum sanctum</i>       |
| Q. Gynostemium     | 2. Lamiaceae      | ii. <i>Cleome gynandra</i>     |
| R. Gynobasic style | 3. Capparidaceae  | iii. <i>Calotropis procera</i> |
| S. Gynophore       | 4. Asclepiadaceae | iv. <i>Vanilla planifolia</i>  |

- a. P-2-i, Q-3-iii, R-4-ii, S-1-iv  
 b. P-3-ii, Q-4-i, R-2-iii, S-1-iv  
 c. P-4-iii, Q-1-iv, R-2-i, S-3-ii  
 d. P-4-ii, Q-2-iii, R-1-iv, S-3-i
61. Identify the *incorrect* statements with respect to plastid transformation.  
 P. Antibiotic used for selection of transplastomic plant is spectinomycin.  
 Q. Chances of gene escape from transplastomic plants are high.  
 R. Microprojectile bombardment is the method of DNA delivery.  
 S. Levels of transgene expression are low.  
 a. P, R  
 b. P, Q  
 c. Q, S  
 d. R, S
62. Which of the following statements are *true* with regard to the similarities between Crassulacean Acid Metabolism (CAM) and C<sub>4</sub> cycle?  
 P. Stomata open during night and remain closed during the day.  
 Q. PEPcase is the carboxylating enzyme to form C<sub>4</sub> acid.  
 R. C<sub>4</sub> acid is decarboxylated to provide CO<sub>2</sub> for C<sub>3</sub> cycle.  
 S. Kranz anatomy is predominant in both CAM and C<sub>4</sub> plants.  
 a. P, S  
 b. Q, R  
 c. P, Q  
 d. R, S
63. With respect to germination of seeds, the *correct* sequence of events is  
 P. Seed imbibes water.  
 Q. Mobilization of starch reserve to embryo.  
 R. Diffusion of gibberellin from embryo to aleurone layer.  
 S. Synthesis of  $\alpha$ -amylase in the aleurone layer.  
 a. P, Q, S, R  
 b. P, R, S, Q  
 c. R, P, Q, S  
 d. R, Q, P, S
64. Identify the *correct* statements with regard to the function of plant hormones.  
 P. ABA is synthesized from chorismate and promotes viviparous germination.  
 Q. Auxin induces acidification of cell wall followed by turgor-induced cell expansion.  
 R. Gibberellin-responsive genes become activated by the repression of DELLA protein.  
 S. Cytokinin regulates the G<sub>2</sub> to M transition in the cell cycle.  
 a. P, Q  
 b. Q, R  
 c. Q, S  
 d. P, R
65. Statements given below are either *true* (T) or *false* (F). Find the *correct* combination.  
 P. Somatic embryo is unipolar in nature.  
 Q. Heterokaryon can be selected using a fluorescence activated cell sorter (FACS).  
 R. The term somaclonal variation is coined by Larkin and Scowcroft.  
 S. Differentiation of shoot buds during *in vitro* culture is known as somatic embryogenesis.  
 a. P-T, Q-F, R-T, S-F  
 b. P-F, Q-T, R-F, S-T  
 c. P-T, Q-F, R-F, S-T  
 d. P-F, Q-T, R-T, S-F

## Microbiology

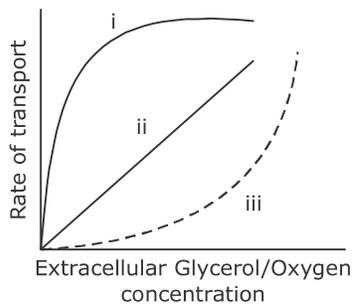
**Questions 66 to 75 carry one mark each.**

66. Lophotrichous bacteria have
- one flagellum
  - a cluster of flagella at one or both ends
  - flagella that are spread evenly over the whole surface
  - a single flagellum at each pole
67. In aerobic respiration, the final electron acceptor is
- hydrogen
  - nitrogen
  - sulfur
  - oxygen
68. A process in which fatty acids are shortened by two carbons at a time resulting in release of acetyl-CoA is known as
- photophosphorylation
  - carboxylation
  - $\beta$ -oxidation
  - oxidative phosphorylation
69. Limulus Amoebocyte Lysate (LAL) assay is used to identify the presence of
- endotoxin
  - exotoxin
  - anthrax toxin
  - tetanus toxin
70. Match scientists in Group I with terms related to their major scientific contributions in Group II.
- | Group I               | Group II                      |
|-----------------------|-------------------------------|
| P. Sanger             | 1. DNA double helix structure |
| Q. Watson and Crick   | 2. DNA sequencing             |
| R. Waksman            | 3. Complement                 |
| S. Bordet             | 4. Streptomycin               |
|                       | 5. Immune tolerance           |
| a. P-3, Q-4, R-2, S-1 | b. P-2, Q-3, R-4, S-5         |
| c. P-4, Q-1, R-2, S-5 | d. P-2, Q-1, R-4, S-3         |
71. Base-pair substitutions caused by the chemical mutagen ethyl methane sulfonate are a result of
- hydroxylation
  - alkylation
  - deamination
  - intercalation
72. The classical way of representing taxonomic hierarchy of living organisms in *ascending order* is
- genus, species, class, order, family
  - species, genus, order, family, class
  - species, genus, family, order, class
  - genus, species, order, class, family
73. Of the following, the most effective method to kill bacterial endospores is
- moist heat sterilization
  - UV irradiation
  - filtration
  - pasteurization
74. The class of enzymes, which catalyze addition of groups to double bonds and non-hydrolytic removal of chemical groups, is
- oxidoreductase
  - transferase
  - hydrolase
  - lyase

75. Anammox organisms carry out
- anaerobic reduction of  $\text{NO}_3^-$
  - anaerobic oxidation of  $\text{NH}_4^+$
  - aerobic oxidation of  $\text{NH}_4^+$
  - aerobic oxidation of  $\text{NO}_2^-$

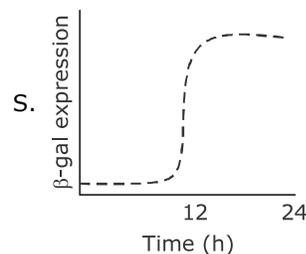
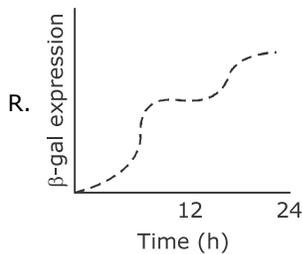
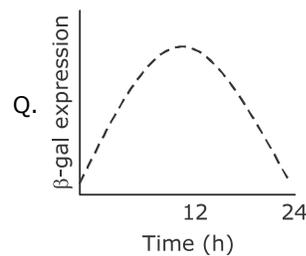
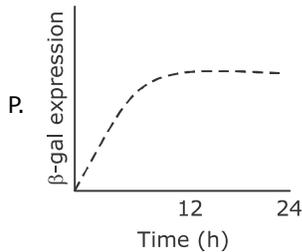
**Questions 76 to 85 carry two marks each.**

76. Which combination of the following statements about specialized transduction is *true*?
- P. Specialized transducing phages can transport only certain genes between bacteria.  
 Q. Specialized transducing phages can transport any gene between bacteria.  
 R. Phage P22 is a specialized transducing phage.  
 S. Phage lambda ( $\lambda$ ) is a specialized transducing phage.
- P and S only
  - Q and R only
  - P and R only
  - Q and S only
77. Which combination of profiles in the following figure accurately represents the transport rate of glycerol and oxygen into *E. coli* cells as a function of their extracellular concentration?



- glycerol-(ii) and oxygen-(iii)
  - glycerol-(ii) and oxygen-(i)
  - glycerol-(iii) and oxygen-(i)
  - glycerol-(i) and oxygen-(ii)
78. Which one of the following about the standard free energy change ( $\Delta G^\circ$ ) and the equilibrium constant ( $K_{eq}$ ) of an exergonic reaction, at pH 7.0, is *true*?
- $\Delta G^\circ$  is positive and  $K_{eq}$  is less than one.
  - $\Delta G^\circ$  is negative and  $K_{eq}$  is less than one.
  - $\Delta G^\circ$  is negative and  $K_{eq}$  is greater than one.
  - $\Delta G^\circ$  is positive and  $K_{eq}$  is greater than one.
79. An oil immersion objective of a light microscope has a numerical aperture of 1.25. Using the Abbe equation the maximum theoretical resolving power (in nm) of the microscope with this objective and blue light (wavelength = 450 nm) is \_\_\_\_\_.
80. The working volume (in liter) of a chemostat with  $0.1 \text{ h}^{-1}$  dilution rate and 100 ml/h feed flow rate is \_\_\_\_\_.
81. If the decimal reduction time for spores of a certain bacterium at  $121^\circ\text{C}$  is 12 seconds, the time required (in minutes) to reduce  $10^{10}$  spores to one spore by heating at  $121^\circ\text{C}$  is \_\_\_\_\_.
82. The doubling time (in minutes) of a bacterium with a specific growth rate of  $2.3 \text{ h}^{-1}$  in 500 ml of growth medium is \_\_\_\_\_.
83. A bacterial culture is grown using 2.0 mg/ml fructose as the sole source of carbon and energy. The bacterial biomass concentrations immediately after inoculation and at the end of the growth phase are 0.1 mg/ml and 0.9 mg/ml, respectively. Assuming complete utilization of the substrate, the bacterial growth yield ( $Y$ ) on fructose is \_\_\_\_\_.

84. The volume (in ml) of a 1.0 mg/ml stock solution of ampicillin to be added to 0.1 liter of growth medium for achieving a final ampicillin concentration of 50  $\mu\text{g/ml}$  is \_\_\_\_\_.
85. An *E. coli* strain is grown initially on glucose as the sole carbon source. Upon complete consumption of glucose following 12 h of growth, lactose is added as the sole carbon source and the strain is further grown for 12 h. Assuming that the *E. coli* strain has a functional wild type *lac* operon, which one of the following profiles is the most accurate representation of  $\beta$ -galactosidase ( $\beta$ -gal) expression (in arbitrary units)?



- a. P  
b. R  
c. Q  
d. S

## Zoology

**Questions 86 to 95 carry one mark each.**

86. The term "paedomorphosis" refers to
- accelerated reproductive development as compared to somatic development.
  - a transient stage in the developmental event.
  - two independent structures resembling each other, yet performing different functions.
  - a form of mimicry.
87. Which one of the following statements is *true* when determining the age of a fossil using carbon dating?
- Carbon dating is based on carbon-13 to carbon-12 ratio in fossils.
  - Carbon dating is useful for determining the age of only fossils older than 100,000 years.
  - Older the fossil, lesser the carbon-14 to carbon-12 ratio.
  - Older the fossil, lesser the carbon-12 to carbon-14 ratio.
88. Constitutive enzymes are
- induced by effector molecules
  - repressed by repressors
  - encoded by sequences that occur as part of an operon
  - always produced in the cell

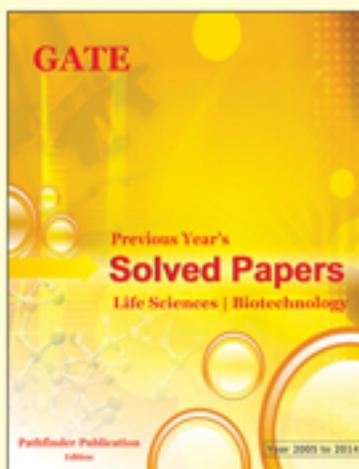
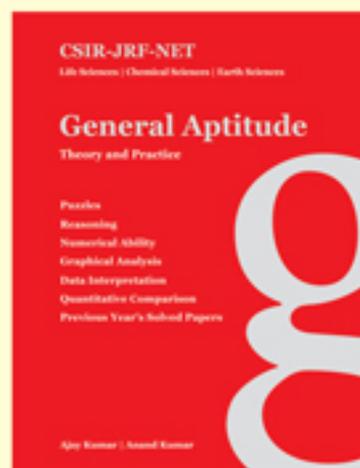
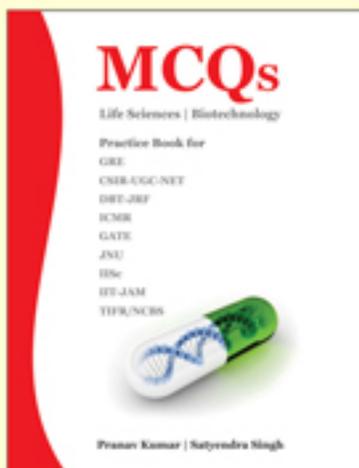
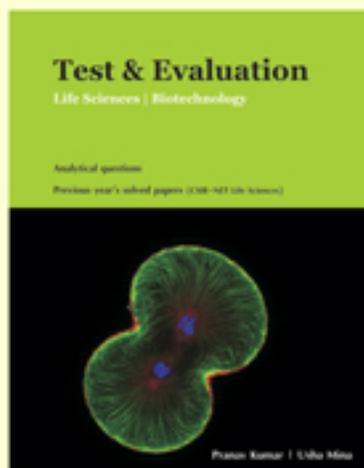
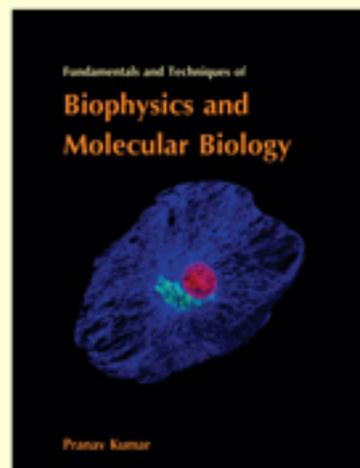
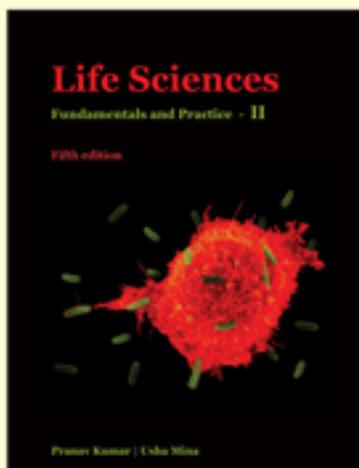
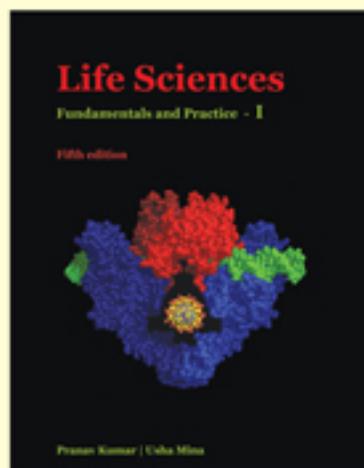
89. Which one of the following is a function of intermediate filaments?
- Chromosome movement during the cell division
  - Cytoplasmic streaming
  - Formation of tight junctions
  - Anchorage of the nucleus
90. Which one of the following statements is *false* with respect to phospholipids?
- Phospholipids have amphipathic character.
  - Phospholipids form the lipid bilayer of the cell membrane.
  - Phospholipids form micelles in living systems.
  - Some phospholipid molecules may contain a double bond in hydrophobic tails.
91. Which one of the following organs is *incorrectly* paired with its function?
- Intestinal villi – absorption
  - Epiglottis – closure of larynx
  - Gall bladder – carbohydrate digestion
  - Parietal cells – hydrochloric acid
92. Where do B lymphocytes acquire immune competence?
- Thymus
  - Bone Marrow
  - Lymph nodes
  - Spleen
93. Which one of the following life cycle stages of *Plasmodium falciparum* is infectious?
- Sporozoite
  - Cryptozoite
  - Merozoite
  - Trophozoite
94. What is the role of the notochord during organogenesis in a vertebrate embryo?
- Signaling the development of placenta.
  - Induction of neural plate formation.
  - Stimulation of the umbilical chord formation.
  - Suppression of the development of extra-embryonic membranes.
95. The behavior of young ducks following their mother is known as
- Imprinting
  - Innate behavior
  - Habituation
  - Mimicry

**Questions 96 to 105 carry two marks each.**

96. Match the species names with class names.
- |                                  |                   |
|----------------------------------|-------------------|
| P. <i>Calotes versicolor</i>     | 1. Insecta        |
| Q. <i>Periplaneta americana</i>  | 2. Reptilia       |
| R. <i>Glyphidrilus birmancus</i> | 3. Actinopterygii |
| S. <i>Clarias batrachus</i>      | 4. Clitellata     |
- P-2, Q-1, R-4, S-3
  - P-1, Q-2, R-3, S-4
  - P-2, Q-1, R-3, S-4
  - P-3, Q-1, R-2, S-4
97. A population of spotted deer found in a national forest is in Hardy-Weinberg equilibrium. For a particular genetic locus in this deer species, only two alleles A and a are possible. If the frequency of the A allele in this population is 0.6, and the frequency of the a allele is 0.4, what will be the frequency of the genotype Aa?
- 0.24
  - 0.48
  - 0.96
  - 1.6



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