

INSTRUCTIONS

A. General :

1. This Booklet is your Question Paper. It contains **20** pages and has **100** questions.
2. The Question Booklet **Code** is printed on the right-hand top corner of this page.
3. The Question Booklet contains blank spaces for your rough work. No additional sheets will be provided for rough work.
4. **Non-Programmable Calculator is ALLOWED. But clip board, log tables, slide rule, cellular phone and other electronic gadgets are NOT ALLOWED.**
5. Write your **Name** and **Registration Number** in the space provided at the bottom.
6. All answers are to be marked only on the machine gradable Objective Response Sheet (**ORS**) provided along with this booklet, as per the instructions therein.
7. The Question Booklet along with the Objective Response Sheet (**ORS**) must be handed over to the Invigilator before leaving the examination hall.

B. Filling-in the ORS :

8. Write your Registration Number in the boxes provided on the **ORS** and darken the appropriate bubble under each digit of your Registration Number using a **black ink ball point pen**.
9. Ensure that the **code** on the **Question Booklet** and the **code** on the **ORS** are the same. If the codes do not match, report to the Invigilator immediately.
10. On the **ORS**, write your Name, Name of the Test Centre and put your signature in the appropriate box with ball-point pen. Do not write these anywhere else.

C. Marking of Answers on the ORS :

11. Each question has **4 choices** for its answer : (A), (B), (C) and (D). Only **ONE** of them is the correct answer.
12. On the left-hand-side of **ORS**, for each question number, darken **ONLY** one bubble corresponding to what you consider to be the most appropriate answer, from among the four choices.
13. There will be **negative marking** for wrong answers. Please see the Marking Scheme.

MARKING SCHEME :

- (a) For each correct answer, you will be awarded **1 (One)** mark.
- (b) For each wrong answer, you will be awarded **-1/3 (Negative 1/3)** mark.
- (c) Multiple answers to a question will be treated as a wrong answer.
- (d) For each un-attempted question, you will be awarded **0 (Zero)** mark.

Name							
Registration Number							

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- Q.1 Transposons are distributed throughout the human genome and constitute about 45% of the genome. Retrotransposons are
- (A) transposable elements that transpose from one site to another in the genome via reverse transcription through an RNA intermediate
 - (B) repetitive sequences in the genome
 - (C) DNA elements which move in the genome
 - (D) satellite DNA sequences
- Q.2 Several enzymes are involved in DNA repair pathways. Which one of the following enzymes is also referred to as a suicidal enzyme?
- (A) Ligase
 - (B) Polymerase
 - (C) Methyltransferase
 - (D) Excision repair enzyme
- Q.3 In the lactose operon, the *lac* repressor binds to the operator and does NOT allow RNA polymerase to bind to the promoter. Allolactose reduces the affinity of the repressor for the *lac* operator by binding and changing its conformation. Thus, addition of lactose or a synthetic inducer stimulates the transcription of the *lac* operon structural genes.
- Synthetic inducers are called gratuitous inducers because
- (A) they will be metabolized by beta-galactosidase to glucose and galactose
 - (B) they activate transcription but are NOT metabolized
 - (C) their removal does NOT lead to immediate inhibition of induced transcription
 - (D) RNA polymerase CANNOT bind to promoter in their presence
- Q.4 Group I lists certain plant fungal diseases. Group II lists the causative agents. Match the diseases with the corresponding causative agents.
- | Group I | Group II |
|---|------------------------------------|
| P. Damping off disease | 1. <i>Phytophthora infestans</i> |
| Q. Late blight or rot disease of potato | 2. <i>Pythium debaryanum</i> |
| R. Downy mildew | 3. <i>Peronospora parasitica</i> |
| S. Club root disease of broccoli | 4. <i>Plasmodiophora brassicae</i> |
| (A) P-2, Q-1, R-3, S-4 | (B) P-1, Q-2, R-4, S-3 |
| (C) P-3, Q-2, R-4, S-1 | (D) P-2, Q-3, R-1, S-4 |
- Q.5 Some mushrooms are poisonous and are popularly called “death caps” or “destroying angels”. Which one of the following is the deadliest mushroom?
- (A) *Amanita verna*
 - (B) *Volvarella volvacea*
 - (C) *Agaricus xanthodermus*
 - (D) *Pleurotus sajar-caju*

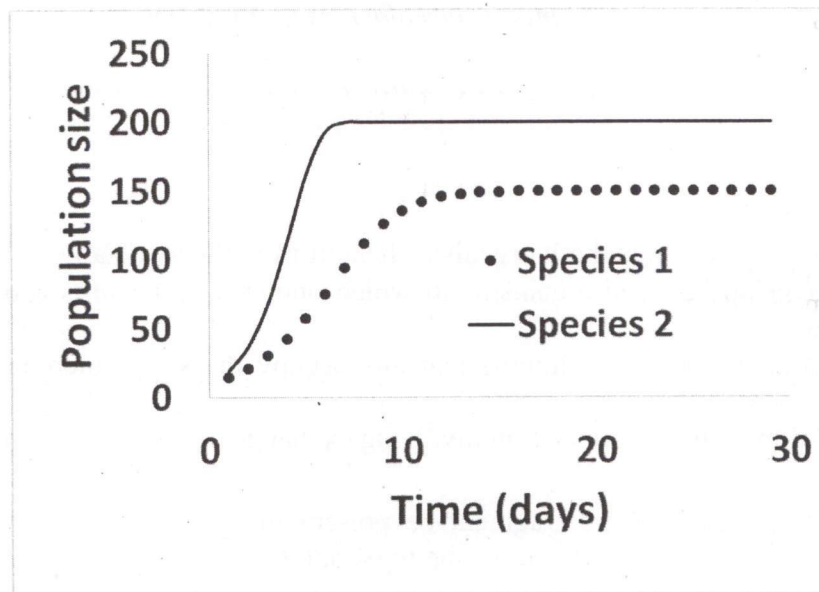
- Q.6 Flower is a modified shoot or a branch. Which one of the following **DOES NOT** provide evidence in support of the above statement?
- (A) Axis nature of the thalamus
(B) Leaf-like arrangement of the floral members
(C) Homology of floral and vegetative buds
(D) Occurrence of mitosis in the floral tissues
- Q.7 A few bacterial genera have cell walls composed of pseudomurein. These polymeric structures resemble eubacterial peptidoglycan but are very different in composition. Which one of the following possesses such structures in its cell wall?
- (A) *Salmonella* (B) *Methanobacterium*
(C) *Streptococcus* (D) *Mycobacterium*
- Q.8 Anoxygenic photosynthetic bacteria possess bacteriochlorophyll which absorbs light in the
- (A) visible range (B) infra-red region
(C) same range as plant chlorophylls (D) ultra-violet region
- Q.9 Which one of the following statements on 'cro repressor' and 'immunity repressor' of lambda phage is **NOT** correct?
- (A) Both bestow immunity to externally infecting phage
(B) Both inhibit phage gene expression and help in the integration into host genome
(C) The production and maintenance of the lysogenic state is due to the antagonism of two repressors
(D) Upon infection by lambda phage, *cro* gene is transcribed resulting in the synthesis of a protein repressor that inhibits the synthesis of immunity repressor
- Q.10 Following uncoating in the cytoplasm, parental (+)-strand RNA of poliovirus is used as template for the synthesis of the polymerase that catalyzes the formation of the (-)-strand RNA. This enzyme is called
- (A) reverse transcriptase (B) DNA-dependent RNA polymerase
(C) RNA-dependent RNA polymerase (D) RNA-dependent DNA polymerase
- Q.11 Virioids are agents of infectious diseases. Which one of the following statements is **NOT** correct?
- (A) Virioids usually do NOT possess a protein coat
(B) Virioids replicate autonomously in cells of susceptible plant species
(C) Virioids comprise of infectious molecules of RNA
(D) Virioids need helper viruses to infect host plant

- Q.12 Each of the four options given below contains the name of an antibiotic, an organism which produces an antibiotic and a possible mode of action. Which option contains the correct combination?
- (A) Erythromycin : *Streptomyces venezuelae* : binds to 30S subunit and prevents transpeptidation and translocation
 (B) Streptomycin : *Streptomyces griseus* : inhibits the interaction of mRNA with 50S subunit
 (C) Chlorotetracyclin : *Streptomyces aureofaciens* : inhibits the binding of amino acyl tRNA to 30S subunit
 (D) Chloramphenicol : *Streptomyces erythraeus* : binds to 50S subunit and inhibits protein synthesis
- Q.13 Commensalism refers to
- (A) a relationship in which both organisms benefit from the association
 (B) a relationship between organisms in which one species benefits and the other is NOT affected
 (C) two different species of microorganisms occupy the same microenvironment without affecting each other
 (D) a type of mutualistic association involving exchange of nutrients between two species
- Q.14 How many times can a 6 kb fragment be present in 3.9 micrograms of DNA containing 6 billion bases? Assume the MW of one bp to be 650 Da.
- (A) 1 (B) 100 (C) 600,000 (D) 100 million
- Q.15 Numerous bacteria are present in the human intestinal tract. Group I lists bacteria and Group II lists their usual location. Match the bacteria with their location.
- | Group I | Group II |
|------------------------------------|------------------------|
| P. Gram-positive cocci and bacilli | 1. Duodenum |
| Q. Enterococci, lactobacilli | 2. Jejunum |
| R. Enterobacteriaceae | 3. Ileum |
| S. <i>Escherichia coli</i> | 4. Colon |
| (A) P-4, Q-3, R-2, S-1 | (B) P-1, Q-2, R-3, S-4 |
| (C) P-3, Q-2, R-4, S-1 | (D) P-2, Q-3, R-1, S-4 |
- Q.16 Charles Darwin's theory about evolution by natural selection was influenced by the works of
- (A) Thomas Malthus (B) Gregor Mendel
 (C) Lynn Margulis (D) Mayr and Dobzhansky
- Q.17 Which one of the following sequence is logically **INCORRECT**?
- (A) Chordata, Hominidae, Man (B) Angiosperm, Poaceae, Rice
 (C) Insecta, Crustacea, Butterfly (D) Chordata, Reptilia, Dinosaur

Q.18 Biological nitrogen fixation by free-living and symbiotic microorganisms refers to the enzymatic conversion of

- (A) dinitrogen to ammonium (B) ammonium to nitrous acid
(C) nitrate to nitrite (D) nitrate to dinitrogen

Q.19 The following figure represents population growth in two species.



Which one of the following options is consistent with this graph?

- (A) Species 1 has higher carrying capacity
(B) Species 2 has higher growth rate, and lower carrying capacity
(C) Species 1 has higher growth rate, but lower carrying capacity
(D) Species 2 has higher growth rate, and higher carrying capacity

Q.20 Darwinian theory of evolution by natural selection can explain the

- (A) sudden arrival of a new trait or character in a population
(B) gradual increase in population size
(C) changes in frequency of different alleles in a population
(D) sudden changes in environmental conditions

Q.21 C_3 photosynthesis involves the conversion of atmospheric carbon dioxide to 3-carbon phosphoglycerate. Likewise, C_4 photosynthesis converts carbon dioxide to 4-carbon oxaloacetate. The C_4 pathway

- (A) reduces photorespiration and water-use efficiency
(B) increases photorespiration and water-use efficiency
(C) reduces photorespiration but increases water-use efficiency
(D) increases photorespiration but reduces water-use efficiency

Q.22 Consider the following anatomical features:

- P. Notochord
- Q. Dorsal nerve chord
- R. Rumen
- S. Four-chambered heart
- T. Binocular vision

All chordates are characterized by the presence of

- (A) only P
- (B) only P, Q and R
- (C) only P, Q, S and T
- (D) only P and Q

Q.23 In which of the following are the plant structures correctly matched with their edible parts?

- P. Leaf : Onion
- Q. Stem : Carrot
- R. Endosperm : Coconut
- S. Thalamus : Apple
- T. Root : Potato

- (A) P, Q and T only
- (B) Q, R and S only
- (C) P, R and S only
- (D) R, S and T only

Q.24 When different species interact, they may exert selective pressures on each other. Below, different types of species interactions are matched with expected evolutionary responses:

- P. Competition : NO selection on either competitor
- Q. Competition : selection towards decreased competitive effects
- R. Predation : selection towards enhanced prey defense
- S. Predation : selection on predator's traits that counter improved prey defense
- T. Commensalism : NO selection on either the commensal or the host

Which pairs are correctly matched?

- (A) Only P and R
- (B) Only Q, R and S
- (C) Only P and T
- (D) Only Q and S

Q.25 The term "biodiversity hotspot" refers to which of the following?

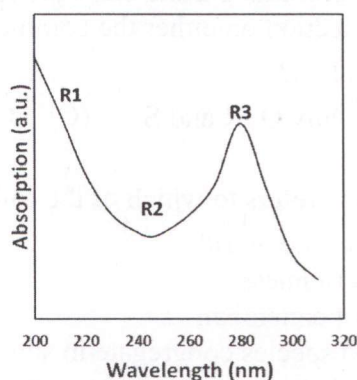
- P. Hot and humid regions of the world
- Q. Areas with high species richness
- R. Areas with high levels of endemism
- S. Areas where endangered species congregate in summers
- T. Areas where warm-blooded species are more common than cold-blooded species

- (A) Only P
- (B) Only Q and R
- (C) Only S and T
- (D) Only R and S

Q.26 In a population at Hardy-Weinberg equilibrium, the frequency of a recessive allele that causes a genetic disorder is 0.3. What percentage of the population is expected to suffer from this condition?

- (A) 9%
- (B) 0.3%
- (C) 0.09%
- (D) 30%

- Q.27 Chimpanzees have ABO blood group types similar to humans. In one year, a female chimpanzee mated with a B-type male and had an O-type baby. Next year, she mated with an A-type male and had an AB-type baby. What is the blood group genotype of this female chimpanzee?
 (A) $I^A I^B$ (B) $I^A I^A$ (C) $I^B i$ (D) ii
- Q.28 Double fertilization in angiosperms leads to the production of
 (A) diploid zygote and diploid endosperm
 (B) triploid zygote and diploid endosperm
 (C) diploid zygote and triploid endosperm
 (D) triploid zygote and triploid endosperm
- Q.29 Many disease-causing microbes are becoming resistant to drugs. This could be an example of
 (A) directional selection (B) stabilizing selection
 (C) disruptive selection (D) adaptive radiation
- Q.30 Deserts are arid ecosystems that occur near latitudes of 30 degrees North and South. Which one of the following can explain this geographic pattern?
 (A) High mountains in these regions create extensive rain shadows
 (B) Effect of global warming is stronger in these regions
 (C) These regions used to be lush forests, but have been converted to deserts due to extensive logging and subsequent degradation
 (D) Patterns in atmospheric circulation called Hadley cells that influence temperature and moisture content of air
- Q.31 Shown below is the schematic representation of the UV absorption spectrum of a protein:



Choose the option which correctly associates the regions marked in the schematic with the characteristic absorption maxima of different moieties found in proteins.

- (A) R1: amide bond, R2: none and R3: aromatic amino acids
 (B) R1: aromatic amino acids, R2: amide bond and R3: disulphide bond
 (C) R1: peptide bond, R2: disulphide bond and R3: aromatic amino acids
 (D) R1: none, R2: aromatic amino acids and R3: disulphide bond

Q.32 The following are some types of non-covalent interactions that stabilize biomolecules and their complexes:

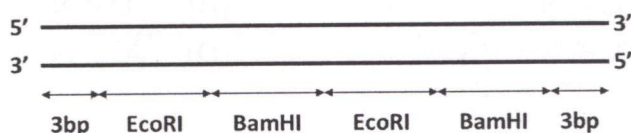
- (P) Hydrogen bond interactions
- (Q) Ionic interactions
- (R) London dispersion interactions
- (S) C–H ... pi interactions

Which of the above interactions are possible between the side chains of valine and tyrosine?

- (A) Only P, Q and R
- (B) Only P, R and S
- (C) Only R and S
- (D) Only Q and S

Q.33 The complexity of DNA can be less than or equal to its molecular mass. It depends on the degree of repetitiveness of the sequence.

Shown below is the schematic of a double stranded 30-mer oligonucleotide wherein the 3 bp at the two termini are of different sequences:



Assuming that the molecular mass of a bp is M Da, what is the complexity (in Da) of the oligonucleotide sequence given above?

- (A) $30 \times M$
- (B) $24 \times M$
- (C) $18 \times M$
- (D) $12 \times M$

Q.34 Proteins are intrinsically dynamic and retain some flexibility even in the crystalline state.

Determine the correctness or otherwise of the **Assertion [a]** and **Reason [r]** given below with respect to the above statement.

Assertion: Even when X-ray diffraction data are collected at cryo temperatures, disorder due to flexibility is **NOT** completely frozen.

Reason: Cryo temperatures freeze only dynamic disorder but **NOT** static disorder.

- (A) Both [a] and [r] are true and [r] is the correct reason for [a]
- (B) [a] is false but [r] is true
- (C) Both [a] and [r] are true but [r] is **NOT** the correct reason for [a]
- (D) Both [a] and [r] are false

Q.35 A globular protein containing approximately 200 amino acid residues was crystallised. X-ray diffraction data were collected using this crystal and the 3-dimensional structure was determined successfully.

Which one of the following statements is consistent with the information given above?

- (A) The crystal is completely devoid of solvent molecules
- (B) The positions of the hydrogen atoms have been determined
- (C) The crystal contains around 80 to 100 molecules of the protein
- (D) Even though the crystal is tightly packed, small molecules (MW 80-100 Da) can diffuse through it

Q.36 Two molecules of a protein associate to form a homodimer. Let S be the combined translational and rotational entropies of one monomer.

The combined translational and rotational entropies of the homodimer will be

- (A) $2 \times S$ (B) S
 (C) Marginally more than $2 \times S$ (D) Marginally more than S

Q.37 The effect of isotopic substitution on reaction rates can be used to characterize transition states. The rate of breakage of a C–N bond varies depending upon the isotopes of C and N present in the bond.

Which one of the following gives the correct order of the rates for C–N bond breakage?

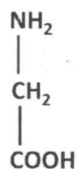
- (A) $^{13}\text{C}-^{14}\text{N} < ^{12}\text{C}-^{14}\text{N} < ^{13}\text{C}-^{15}\text{N}$ (B) $^{13}\text{C}-^{15}\text{N} < ^{12}\text{C}-^{14}\text{N} < ^{13}\text{C}-^{14}\text{N}$
 (C) $^{12}\text{C}-^{14}\text{N} < ^{13}\text{C}-^{14}\text{N} < ^{13}\text{C}-^{15}\text{N}$ (D) $^{13}\text{C}-^{15}\text{N} < ^{13}\text{C}-^{14}\text{N} < ^{12}\text{C}-^{14}\text{N}$

Q.38 A protein **P** can exist in either the native form **N** or the denatured form **D**. A ligand **L** binds to **N** but not to **D**. Thermal denaturation of **P** was monitored both in presence and in absence of **L**.

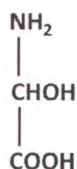
Which one of the following statements holds true for these denaturation experiments?

- (A) T_m is higher in the absence of **L**
 (B) At a given temperature, amount of **D** is more in presence of **L**
 (C) At a given temperature, amounts of **D** and **N** are same whether or not **L** is present
 (D) T_m is lower in the absence of **L**

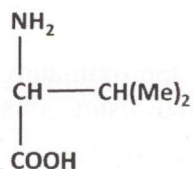
Q.39 Which one of the following will have the highest number of stereoisomers?



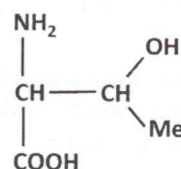
P



Q



R



S

- (A) **P** (B) **Q** (C) **R** (D) **S**

Q.40 The following **Assertion [a]** and **Reason [r]** are in relation to the way water molecules interact with different types of solutes.

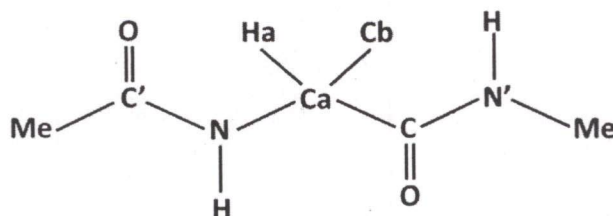
Assertion: Heat capacity at constant pressure of an aqueous solution of a polar amino acid is higher than that of an apolar amino acid.

Reason: The water molecules that surround polar molecules form a hydrogen bonded clathrate-like cage structure

- (A) Both [a] and [r] are true and [r] is the correct reason for [a]
- (B) [a] is false but [r] is true
- (C) Both [a] and [r] are true but [r] is NOT the correct reason for [a]
- (D) Both [a] and [r] are false

Q.41 A Ramachandran map depicts the regions that are sterically allowed for various combinations of phi and psi. The allowed region is related to the geometry (i.e., bond lengths and bond angles) of the molecule.

Shown below is the schematic of an end-protected alanine:



For this molecule, the allowed region

- (A) increases when the bond angle N–Ca–C decreases
- (B) decreases when N–Ca and Ca–C bond lengths increase
- (C) decreases when the bond angle N–Ca–Cb increases
- (D) increases when N–Ca bond length increases

Q.42 The concept of a folding funnel is widely used to understand various aspects of protein folding.

Which one of the following statements related to folding funnel is **FALSE**?

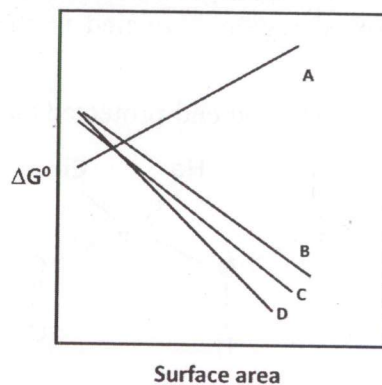
- (A) The large circumference of the upper rim is indicative of the large number of conformations possible for the unfolded state.
- (B) The number and location of local and global minima will be identical irrespective of the conditions.
- (C) The global minimum corresponds to the native state only under certain conditions.
- (D) Conformational entropy decreases as one moves from the rim of the funnel to the tip.

Q.43 Reduced glutathione is gamma-glutamyl-cysteinyl-glycine. At pH 9.0, the net charge on reduced glutathione is

- (A) 0
- (B) -1
- (C) -2
- (D) -3

- Q.44 An enzyme follows Michaelis-Menten kinetics for the conversion of a substrate to a product. Under certain conditions of assay, there is no net conversion of the substrate after 30 min of incubation. The product can be reliably detected from 2 min after the incubation begins. In order to calculate K_m , the assay should be carried out for
 (A) 2 min. (B) 5 min. (C) 30 min. (D) 60 min.

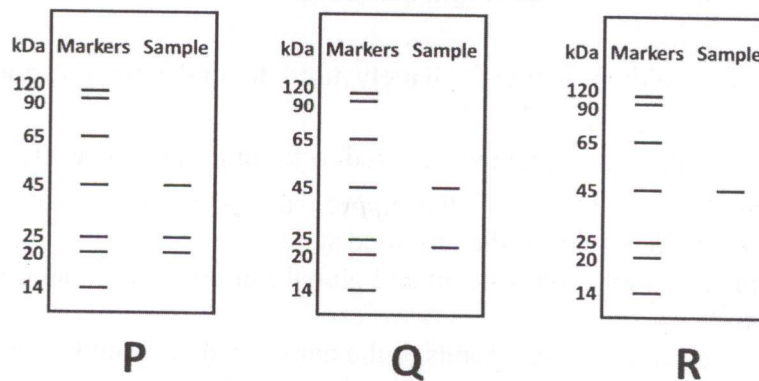
- Q.45 Standard free energies (ΔG°) for the transfer of a series of alkanes to different solvents were measured. The series of solutes considered were methane, ethane, propane, n-butane and n-pentane. The solvents were water, benzene, DMSO and methanol. The plots of free energy versus surface areas of the solutes are shown below. The four lines marked A, B, C and D correspond each to one solvent.



The line marked A corresponds to

- (A) benzene (B) DMSO (C) methanol (D) water

- Q.46 Shown below are the schematics of three SDS-PAGE gels:



A mixture of proteins was subjected to gel filtration. Fractions corresponding to 45 kDa MW were pooled and subjected to SDS-PAGE. Which of the above three gels can possibly be obtained in this experiment?

- (A) Only P and R (B) Only P and Q (C) Only R (D) P, Q and R

Q.47 ATP is a cellular energy currency. Free energy available upon ATP hydrolysis is used by cells to perform work.

Which one of the following statements about the free energy of ATP hydrolysis is correct?

- (A) It is same in all compartments of the cell
- (B) It varies with the metabolic state in a sub-cellular compartment
- (C) It is same within mitochondrial matrix and cytosol
- (D) It is same whether it is intracellular or extracellular

Q.48 Bacteriorhodopsin is a light-harvesting proton pump. Its prosthetic group undergoes a conformational change during the proton pumping cycle.

A derivative of which one of the following also undergoes a similar conformational change as part of its function in human beings?

- (A) Vitamin A
- (B) Vitamin C
- (C) Vitamin D
- (D) Vitamin K

Q.49 Under identical conditions of assay, an enzyme from *E. coli* converts 45% of a substrate to product whereas the same enzyme from yeast converts 66% of the substrate.

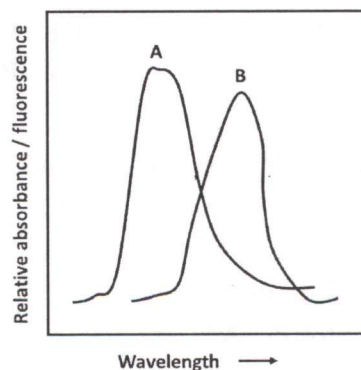
The following explanations were put forward as possible reasons to explain this difference:

- P. The equilibrium constants are different.
- Q. The rates of the reactions are different.
- S. The temperatures for optimal activity are different.

Which of the above three are likely to be true?

- (A) Only P and Q
- (B) Only P and S
- (C) Only Q and S
- (D) P, Q and S

Q.50 Shown below is the absorbance / emission spectra of certain chromophores:



Under which one of the following conditions can FRET be observed?

- (A) Donor: spectrum A; acceptor: spectrum B; donor...acceptor distance > 1.5 nm
- (B) Donor: spectrum A; acceptor: spectrum B; donor...acceptor distance < 1.0 nm
- (C) Donor: spectrum B; acceptor: spectrum A; donor...acceptor distance > 1.5 nm
- (D) Donor: spectrum B; acceptor: spectrum A; donor...acceptor distance < 1.0 nm