ASSIGNMENT 1: GATE 2015
BT: BIOTECHNOLOGY ENGINEERING

AI25BTECH11025-R Nikhil

Q.1 Choose the most appropriate word to complete the sentence: *The principal presented the chief guest with a _____ as a token of appreciation.*

a) momento b) memento c) momentum d) moment

(GATE BT 2015)

Q.2 Choose the appropriate word/phrase out of the four options given below to complete the sentence: *Frogs _____.*

a) croak b) roar c) hiss d) patter

(GATE BT 2015)

Q.3 Choose the word most similar in meaning to the given word: **Educe**

a) Exert b) Educate c) Extract d) Extend

(GATE BT 2015)

Q.4 Operators $\square$, $\lozenge$ and $\rightarrow$ are defined by: $a\square b = \frac{a-b}{a+b}$, $a\lozenge b = \frac{a+b}{a-b}$, $a \rightarrow b = ab$ Find the value of $(66\square 6) \rightarrow (66\lozenge 6)$.

a) -2 b) -1 c) 1 d) 2

(GATE BT 2015)

Q.5 If $\log_x\left(\frac{5}{7}\right) = -\frac{1}{3}$, then the value of x is:

a) $\frac{343}{125}$

b) $\frac{125}{343}$

c) $-\frac{25}{49}$

d) $-\frac{49}{25}$

(GATE BT 2015)

Q.6 The following question presents a sentence, part of which is underlined. Beneath the sentence you find four ways of phrasing the underlined part. Following the requirements of the standard written English, select the answer that produces the most effective sentence.\$6pt]

Tuberculosis, together with its effects, ranks one of the leading causes of death in India.\$6pt]

a) ranks as one of the leading causes of death

b) rank as one of the leading causes of death

c) has the rank of one of the leading causes of death

d) are one of the leading causes of death

(GATE BT 2015)

Q.7 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 climate change may be suitable scientific innovations, while the other may be the Gandhian perspective on small-scale progress with focus on sustainability.

a) Human progress and security are positively associated with environmental security

b) Human progress is contradictory to environmental security

c) Human security is contradictory to environmental security

d) Human progress depends upon environmental security

(GATE BT 2015)

Q.8 Fill in the missing value

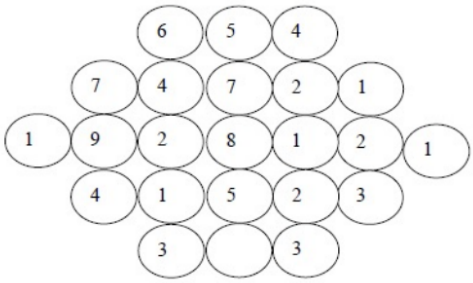

Fig. **Q.8**.

(GATE BT 2015)

Q.9 A cube of side 3 units is formed using 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.

a) 1 : 4 b) 1 : 3 c) 1 : 2 d) 2 : 3

(GATE BT 2015)

Q.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?

a) Humpty Dumpty always falls while having lunch

b) Humpty Dumpty does not fall sometimes while having lunch

c) Humpty Dumpty never falls during dinner

d) When Humpty Dumpty does not sit on the wall, the wall does not break

(GATE BT 2015)

Q.11 Which one of the following complement proteins is the initiator of the membrane attack complex?

a) C3a b) C3b c) C5a d) C5b

(GATE BT 2015)

Q.12 Levinthal's paradox is related to:

a) protein secretion

b) protein degradation

c) protein folding

d) protein trafficking

(GATE BT 2015)

Q.13 Which one of the following is a second generation genetically engineered crop?

a) Bt brinjal

b) Roundup soybean

c) Golden rice

d) Bt rice

(GATE BT 2015)

Q.14 Based on the heavy chain, which one of the following antibodies has multiple subtypes?

a) I_gM b) I_gD c) I_gE d) I_gG

(GATE BT 2015)

Q.15 The cytokinetic organelle in plant cells is:

a) centriole b) phragmoplast c) proplastid d) chromoplastid

(GATE BT 2015)

Q.16 Anergy refers to:

a) mitochondrial dysfunction

b) allergy to environmental antigens

c) unresponsiveness to antigens

d) a state of no energy

(GATE BT 2015)

Q.17 ABO blood group antigens in humans are differentiated from each other on the basis of:

a) sialic acid b) lipids c) spectrin d) glycoproteins

(GATE BT 2015)

Q.18 Which one of the following organisms is used for the determination of phenol coefficient of a disinfectant?

a) *Salmonella typhi*
b) *Escherichia coli*
c) *Candida albicans*
d) *Bacillus psychrophilus*

(GATE BT 2015)

Q.19 A single subunit enzyme converts 420 μmol of substrate to product in one minute. The activity of the enzyme is _____ $\times 10^{-6}$ Katal. (GATE BT 2015)

Q.20 Which one of the following amino acids has the highest probability to be found on the surface of a typical globular protein in aqueous environment?

a) Ala
b) Val
c) Arg
d) Ile

(GATE BT 2015)

Q.21 Which one of the following is **NOT** a product of denitrification in *Pseudomonas*?

a) N_2
b) N_2O
c) NO_2^-
d) NH_4^+

(GATE BT 2015)

Q.22 The determinant of the matrix $\begin{bmatrix} 3 & 0 & 0 \\ 2 & 5 & 0 \\ 6 & -8 & -4 \end{bmatrix}$ is _____. (GATE BT 2015)

Q.23 Which one of the following features is **NOT** required in a prokaryotic expression vector?

a) *oriC*
b) Selection marker
c) CMV promoter
d) Ribosome binding site

(GATE BT 2015)

Q.24 Production of monoclonal antibodies by hybridoma technology requires

a) splenocytes
b) osteocytes
c) hepatocytes
d) thymocytes

(GATE BT 2015)

Q.25 Which one of the following is **INCORRECT** about a typical apoptotic cell?

a) Phosphatidylserine is presented on the outer cell surface
b) Cytochrome c is released from mitochondria
c) Mitochondrial membrane potential does not change
d) Annexin-V binds to the cell surface

(GATE BT 2015)

Q.26 Identify the file format given below:

```
>P1; JMFD
Protein X -- Homo sapiens
MKALTARQQEVFLDRDHISRTLRQQGDWL
```

a) GDE b) FASTA c) NBRF d) GCG

(GATE BT 2015)

Q.27 Which one of the following relations holds true for the specific growth rate (μ) of a microorganism in the death phase?

a) $\mu = 0$
b) $\mu < 0$
c) $\mu = \mu_{max}$
d) $0 < \mu < \mu_{max}$

(GATE BT 2015)

Q.28 How many 3-tuples are possible for the following amino acid sequence?

`MADCMWDISEASE`

a) 4 b) 5 c) 11 d) 12

(GATE BT 2015)

Q.29 How many different protein sequences of 100 residues can be generated using 20 standard amino acids?

a) 100^{20} b) 100×20 c) 20^{100} d) $100! \times 20!$

(GATE BT 2015)

Q.30 In DNA sequencing reactions using the chain termination method, the ratio of ddNTPs to dNTPs should be

a) 0
b) < 1
c) 1
d) > 1

(GATE BT 2015)

Q.31 Which one of the following graphs represents uncompetitive inhibition?

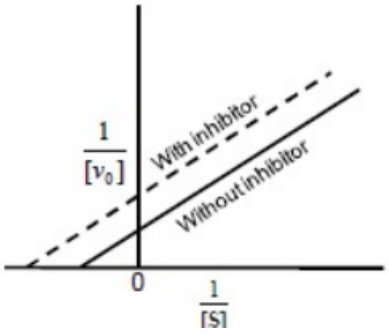

Fig. **Q.31**.

a)

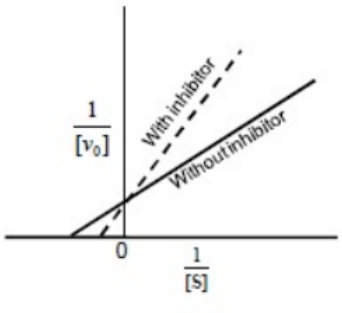

Fig. **Q.31**.

b)

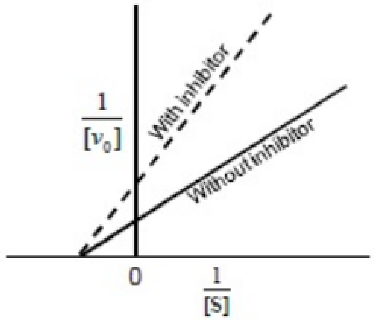

Fig. **Q.31**.

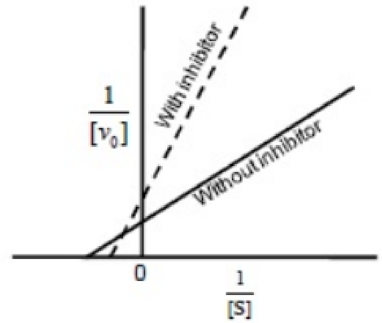

Fig. **Q.31**.

c) d)

(GATE BT 2015)

Q.32 Choose the appropriate pair of primers to amplify the following DNA fragment by the polymerase chain reaction (PCR):

$5' - GACCTGTGG - ATACGGGAT - 3'$

$3' - CTGGACACC - TATGCCCTA - 5'$

Primers:
P. $5' - GACCTGTGG - 3'$
Q. $5' - CCACAGGTC - 3'$
R. $5' - TAGGGGATA - 3'$
S. $5' - ATCCCGTAT - 3'$

a) P and R b) P and S c) Q and R d) Q and S

(GATE BT 2015)

Q.33 Consider the following infinite series:

$$1 + r + r^2 + r^3 + \ldots \infty$$

If $r = 0.3$, then the sum of this infinite series is ________.

Q.34 The system of linear equations in two variables shown below will have infinite solutions, if and only if, b is equal to _________.

$$2x_1 + x_2 = 3$$

$$5x_1 + bx_2 = 7.5$$

(GATE BT 2015)

Q.35 The interaction between an antigen (Ag) and a single-chain antibody (Ab) was studied using Scatchard analysis. The result is shown below.

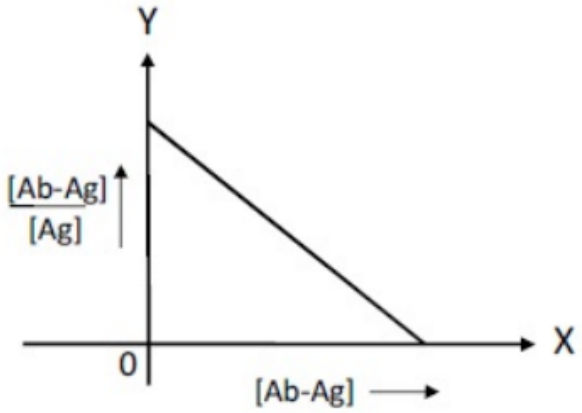

Fig. **Q.35**.

The affinity of interaction and the total concentration of antibody, respectively, can be determined from:

a) slope and Y-intercept
b) Y-intercept and slope
c) X-intercept and slope
d) slope and X-intercept

(GATE BT 2015)

Q.36 An isolated population on an island has the following genotypic frequencies:

Genotype	*AA*	*Aa*	*aa*
Frequency	0.3	0.4	0.3

Assuming that there are only two alleles (*A* and *a*) for the gene, the genotypic frequency of *AA* in the next generation will be _ _ _ _ _ _ _ _. (GATE BT 2015)

Q.37 How many rooted and unrooted phylogenetic trees, respectively, are possible with four different sequences?

a) 3 and 15
b) 15 and 3
c) 15 and 12
d) 12 and 3

(GATE BT 2015)

Q.38 Match the compounds in **Group I** with the correct entries in **Group II**.

Group I	**Group II**
P) Cyanide	1) K^+ ionophore
Q) Antimycin A	2) Electron transfer from cytochrome *b* to cytochrome c_1
R) Valinomycin	3) F_1 subunit of ATP synthase
S) Aurovertin	4) Cytochrome oxidase
	5) Adenine nucleotide translocase

(A) P-5, Q-2, R-3, S-1
(B) P-5, Q-2, R-1, S-3
(C) P-4, Q-2, R-1, S-3
(D) P-4, Q-5, R-3, S-1

(GATE BT 2015)

Q.39 What are the eigenvalues of the following matrix?

$$\begin{bmatrix} 1 & 1 \\ -2 & 4 \end{bmatrix}$$

a) 2 and 3 b) -2 and 3 c) 2 and -3 d) -2 and -3

(GATE BT 2015)

Q.40 For a discrete random variable X, $ran(X) = \{0, 1, 2, 3\}$ and the cumulative probability $F(X)$ is shown below:

X	0	1	2	3
$F(X)$	0.5	0.6	0.8	1.0

The mean value of X is _____. (GATE BT 2015)

Q.41 Match the drugs in **Group I** with their mechanism of action in **Group II**.

Group I	**Group II**
P) Paclitaxel	1) Inhibits protein translation
Q) Colchicine	2) Inhibits microtubule depolymerization
R) Etoposide	3) Inhibits DNA replication
S) Methotrexate	4) Alkylates DNA
	5) Inhibits dihydrofolate reductase
	6) Inhibits microtubule polymerization

a) P-1, Q-6, R-3, S-4 c) P-1, Q-3, R-6, S-5

b) P-2, Q-6, R-3, S-5 d) P-2, Q-3, R-6, S-4

(GATE BT 2015)

Q.42 The limit of the function $\left(1 + \frac{x}{n}\right)^n$ as $n \to \infty$ is

a) $\ln x$ c) e^x

b) $\ln \frac{1}{x}$ d) e^x

(GATE BT 2015)

Q.43 Match the cells in **Group I** with their corresponding entries in **Group II**.

Group I	**Group II**
P) Mast cells	1) Activation of the complement pathway
Q) Natural killer cells	2) Expression of CD56
R) Neutrophils	3) Contains azurophilic granules
S) Dendritic cells	4) Defense against helminthic infection
	5) Production of antibodies specific to bacteria
	6) Contains long membranous projections

a) P-4, Q-2, R-3, S-5 c) P-3, Q-1, R-2, S-5

b) P-4, Q-2, R-3, S-6 d) P-3, Q-1, R-2, S-6

(GATE BT 2015)

Q.44 Oxygen transfer was measured in a stirred tank bioreactor using dynamic method. The dissolved oxygen tension was found to be 80% air saturation under steady state conditions. The measured oxygen tensions at 7 s and 17 s were 55% and 68% air saturation, respectively. The volumetric mass transfer coefficient k_La is _____ s^{-1}.

Q.45 Match the microorganisms in **Group I** with their fermentation products in **Group II**.

Group I	**Group II**
P) *Leuconostoc mesenteroides*	1) Cobalamin
Q) *Rhizopus oryzae*	2) Sorbose
R) *Gluconobacter suboxydans*	3) Dextran
S) *Streptomyces olivaceus*	4) Lactic acid
	5) Butanol

a) P-5, Q-4, R-2, S-1

b) P-5, Q-3, R-2, S-4

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

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

(GATE BT 2015)

Q.46 Plasmid DNA (0.5 μg) containing an ampicillin resistance marker was added to 200 μl of competent cells. The transformed competent cells were diluted 10,000 times, out of which 50 μl was plated on agar plates containing ampicillin. A total of 35 colonies were obtained. The transformation efficiency is _____ $\times 10^6$ cfu $\cdot \mu g^{-1}$. (GATE BT 2015)

Q.47 Match the reagents in **Group I** with their preferred cleavage sites in **Group II**.

Group I	**Group II**
P) Cyanogen bromide	1) Carboxyl side of methionine
Q) o-Iodosobenzoate	2) Amino side of methionine
R) Hydroxylamine	3) Carboxyl side of tryptophan
S) 2-Nitro-5-thiocyanobenzoate	4) Amino side of cysteine
	5) Asparagine-glycine bonds

a) P-1, Q-3, R-5, S-4

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

c) P-1, Q-2, R-5, S-4

d) P-4, Q-2, R-5, S-3

(GATE BT 2015)

Q.48 *Saccharomyces cerevisiae* produces ethanol by fermentation. The theoretical yield of ethanol from 2.5 g of glucose is _____ g. (GATE BT 2015)

Q.49 Choose the **CORRECT** sequence of steps involved in cytoplast production:

a) Digestion of cell wall → protoplast viability → cybrid formation → osmotic stabilizer

b) Osmotic stabilizer → digestion of cell wall → protoplast viability → cybrid formation

c) Protoplast viability → osmotic stabilizer → digestion of cell wall → cybrid formation

d) Osmotic stabilizer → digestion of cell wall → cybrid formation → protoplast viability

(GATE BT 2015)

Q.50 Match the antibiotics in **Group I** with their modes of action in **Group II**.

Group I	Group II
P) Chloramphenicol	1) Inhibits protein synthesis by acting on 30S ribosomal subunit
Q) Rifampicin	2) Interferes with DNA replication by inhibiting DNA gyrase
R) Tetracycline	3) Inhibits protein synthesis by acting on 50S ribosomal subunit
S) Quinolone	4) Interferes with RNA polymerase activity
	5) Inhibits β-lactamase activity

a) P-1, Q-2, R-3, S-5

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

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

d)] P-1, Q-4, R-3, S-2

(GATE BT 2015)

Q.51 The diameters of a large and a small vessel are $1.62\,m$ and $16.2\,cm$, respectively. The vessels are geometrically similar and operated under similar volumetric agitated power input. The mixing time in the small vessel was found to be $15\,s$. Determine the mixing time (in seconds) in the large vessel.

a) 15 b) 30 c) 61 d) 122

(GATE BT 2015)

Q.52 If $A = \begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}$, then $A^2 + 3A$ will be

a) $\begin{bmatrix} 30 & 20 \\ 10 & 20 \end{bmatrix}$

b) $\begin{bmatrix} 28 & 10 \\ 4 & 18 \end{bmatrix}$

c) $\begin{bmatrix} 31 & 13 \\ 7 & 21 \end{bmatrix}$

d) $\begin{bmatrix} 20 & 10 \\ 5 & 15 \end{bmatrix}$

(GATE BT 2015)

Q.53 Consider the following multiple sequence alignment of four DNA sequences:

$$\begin{matrix} A & C & T & A \\ A & C & T & G \\ A & G & T & C \\ A & G & C & T \end{matrix}$$

Shannon's entropy of the above alignment is _____. (GATE BT 2015)

Q.54 The K_i of a novel competitive inhibitor designed against an enzyme is $2.5\,\mu M$. The enzyme was assayed in the absence or presence of the inhibitor ($5\,\mu M$) under identical conditions. The K_m in the presence of the inhibitor was found to be $30\,\mu M$. The K_m in the absence of the inhibitor is _____ μM. (GATE BT 2015)

Q.55 A heterozygous tall plant (Tt) was crossed with a homozygous dwarf plant (tt). The resultant seeds were collected. If five seeds are chosen at random, then the probability (in %) that exactly two of these seeds will yield dwarf plants is _____. (GATE BT 2015)

Q.56 Assuming random distribution of nucleotides, the average number of fragments generated upon digestion of a circular DNA of size 4.3×10^5 bp with $A_{lu}I$ (5′-AG↓CT-3′) is _____ $\times 10^3$. (GATE BT 2015)

Q.57 A synchronous culture containing 1.8×10^5 monkey kidney cells was seeded into three identical flasks. The doubling time of these cells is 24 *h*. After 24 *h*, the cells from all the three flasks were pooled and dispensed equally into each well of three 6-well plates. The number of cells in each well will be _____ $\times 10^4$. (GATE BT 2015)

Q.58 An *in vitro* translation system can synthesize peptides in all three reading frames of the RNA template. When 5′-UCUCUCUC—$(UC)_n$—UCUCUCUC-3′ was used as the template in this *in vitro* translation system, the synthesized peptides contained 50% each of serine and leucine. When 5′-CCUCCUCCU—$(CCU)_n$—CCUCCU-3′ was used as the template, the synthesized peptides contained 33.3% each of serine, leucine, and proline. Deduce the codon for proline.

a) UCU b) CUC c) CCU d) UCC

(GATE BT 2015)

Q.59 Three distinct antigens X, Y and Z were used to raise antibodies. Antigen Z was injected in a mouse on day zero followed by the administration of antigens X and Y on day 28. A second injection of antigen X was administered on day 70. The antibody titers were monitored in the serum every day and the results are shown below:

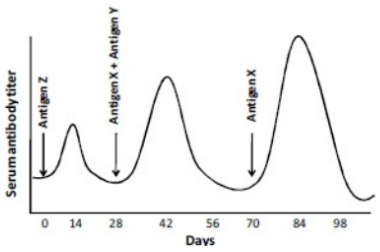

Fig. **Q.59**.

Which one of the following statements regarding the antibody titers in the serum is **INCORRECT**?

a) Z-specific IgG will be high on day 14

b) X-specific antibody titer will be high on day 84

c) X-specific IgG will be high on day 42

d) Y-specific IgG will be high on day 84

(GATE BT 2015)

Q.60 The standard free energy change ($\Delta G^{\circ\prime}$) for ATP hydrolysis is $-30\,\text{kJ mol}^{-1}$. The *in vivo* concentrations of ATP, ADP and P_i in *E. coli* are 7.90, 1.04 and 7.90 mM, respectively. When *E. coli* cells are cultured at 37°C, the free energy change (ΔG) for ATP hydrolysis *in vivo* is _____ kJ mol^{-1}. (GATE BT 2015)

Q.61 In a fed-batch culture, 200 g L^{-1} glucose solution is added at a flow rate of 50 L h^{-1}. The initial culture volume (at quasi steady state) and the initial cell concentration are 600 L and 20 g L^{-1}, respectively. The yield coefficient ($Y_{x/s}$) is 0.5 g cell mass g substrate^{-1}. The cell concentration (g L^{-1}) at quasi steady state at $t = 8$ h is

a) 40 b) 52 c) 60 d) 68

(GATE BT 2015)

Q.62 Cytoplasmic extract from the wild type strain of a bacterium has the ability to convert a colorless substrate (S) to a colored product (P) via three colorless intermediates X, Y and Z, in that order. Each step of the pathway involves a specific enzyme coded by a distinct gene. Four mutant strains (a^-, b^-, c^-, d^-) were isolated, whose extracts are incapable of producing the colored product in the presence of S. In a series of experiments, extracts from the individual mutants were incubated with X, Y, or Z and scored for color development. The data are summarized in the table below. (Yes: color developed, No: no color developed)

Mutants \ Compounds	X	Y	Z
a^-	No	No	No
b^-	No	Yes	Yes
c^-	Yes	Yes	Yes
d^-	No	No	Yes

Fig. **Q.62**.

Based on the data, which one of the following is the correct order of enzymes involved in the pathway?

a) $S \xrightarrow{a} X \xrightarrow{c} Y \xrightarrow{b} Z \xrightarrow{d} P$

b) $S \xrightarrow{a} X \xrightarrow{d} Y \xrightarrow{b} Z \xrightarrow{c} P$

c) $S \xrightarrow{X} Y \xrightarrow{c} Z \xrightarrow{d} P$

d) $S \xrightarrow{c} X \xrightarrow{b} Y \xrightarrow{d} Z \xrightarrow{a} P$

(GATE BT 2015)

Q.63 Samples of bacterial culture taken at 5 PM and then the next day at 5 AM were found to have 10^4 and 10^7 cells mL^{-1}, respectively. Assuming that both the samples were taken during the log phase of cell growth, the generation time of this bacterium will be _____ h. (GATE BT 2015)

Q.64 Biomass is being produced in a continuous stirred tank bioreactor of 750 L capacity. The sterile feed containing 8 g L^{-1} glucose as substrate was fed at a flow rate of 150 L h^{-1}. The microbial system follows Monod's model with $\mu_m = 0.4\,h^{-1}$, $K_s = 1.5$ g L^{-1} and $Y_{x/s} = 0.5$ g cell mass g^{-1} substrate. Determine the cell productivity (g $L^{-1}h^{-1}$) at steady state.

a) 0.85 b) 0.65 c) 0.45 d) 0.25

(GATE BT 2015)

Q.65 A linear double stranded DNA of length 8 kbp has three restriction sites. Each of these can either be a *BamHI* or a *HaeIII* site. The DNA was digested completely with both enzymes. The products were purified and subjected to an end-filling reaction using the Klenow fragment and [α-^{32}P]-dCTP. The products of the end-filling reaction were purified, resolved by electrophoresis, stained with ethidium bromide (EtBr) and then subjected to autoradiography. The corresponding images are shown below.

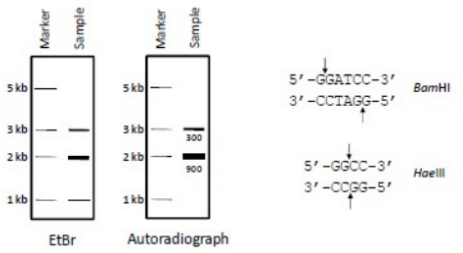

Fig. **Q.65**.

The numbers below each band in the sample lane in the autoradiograph represent their mean signal intensity in arbitrary units. Which one of the following options is the correct restriction map of the DNA?

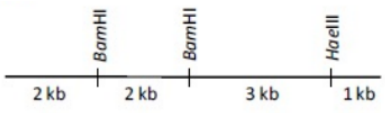

Fig. **Q.65**.

a)

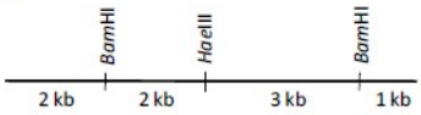

Fig. **Q.65**.

b)

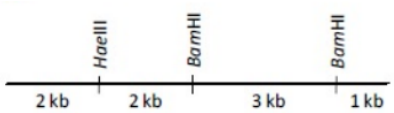

Fig. **Q.65**.

c)

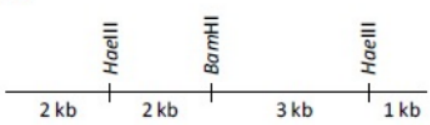

Fig. **Q.65**.

d)

(GATE BT 2015)