M-56

Hall Ticket No. | | | | | | | | |

Entrance Examinations – 2016

Ph.D. Biochemistry

Time : 2 hours **Max. Marks : 75**

Please read the following instructions carefully before answering:

1. Enter Hall Ticket number in the space provided above and also on OMR sheet.
2. Paper contains two sections: Part A and Part B together with 60 questions for 75 marks. **Part A contains 45 questions, each question carries one mark. Part B contains 15 questions, each question carries two marks.**
3. **In Part A. there is negative marking. 0.33 marks will be deducted for each wrong answer. In Part B, there is negative marking. 0.66 marks will be deducted for each wrong answer.**
4. Answers have to be marked on the OMR sheet as per the instructions provided.
5. Apart from OMR sheet, the question paper contains 15 (fifteen) pages including the instructions.
6. **Please return the OMR answer sheet at the end of examination.**
7. No additional sheet will be provided.
8. Rough work can be carried out in the question paper itself in the space provided at the end of the booklet.
9. Non programmable calculators are allowed.

PART A

[Each question has only one right answer. Mark the right answer. Each question carries one mark. There is negative marking. 0.33 marks will be deducted for each wrong answer]

1. Which statement is INCORRECT about kinetic theory of gases?

a) Collisions are always inelastic
b) Heavier molecules transfer more momentum of the wall of the container
c) Only a small number of molecules have very high velocity
d) Between collisions, the molecules move in straight lines with constant velocities

2. The outermost electronic configuration of the most electronegative element is:

a) ns^2np^3 b) ns^2np^4 c) ns^2np^5 d) ns^2np^6

3. Which is the weakest among the following types of bonds?

a) Ionic bond b) Covalent bond c) Hydrogen bond d) Metallic bond

4. Sulphur has highest oxidation state in

a) H_2SO_4 b) SO_2 c) $Na_2S_2O_3$ d) $Na_2S_4O_6$

5. For the reaction $2NO_2$ (g) + O_2 (g) <=> N_2O_5 (g), the equilibrium constant is K_p. What would be the equilibrium constant for the following reaction?
$2N_2O_5$ (g) <=> $4NO_2$ (g) + $2O_2$ (g)

a) K_p^2 b) $2/K_p$ c) $1/K_p^2$ d) $1/\sqrt{K_p}$

6. In thermodynamics, a process is called reversible when:

a) Surroundings and system change into each other
b) There is no boundary between system and surroundings
c) The surroundings are always in equilibrium with the system
d) The system changes into the surroundings spontaneously

7. The following two arguments are made:
I) If two coins are tossed simultaneously there are three possible outcomes-two heads, two tails or one of each. Therefore, for each of these outcomes, the probability is 1/3
II) If a die is thrown, there are two possible outcomes-an odd number or an even number. Therefore, the probability of getting an odd number is ½
Which of the above arguments is (are) correct?

a) Only I b) Only II c) Both I and II d) Both are false

8. A 30-year-old man is a heterozygote for a disease that is prevalent in the population. If the population is in Hardy-Weinberg equilibrium, then $p^2 + 2pq + q^2 = 1$ and $p + q = 1$. Which of the following in this equation indicates the prevalence of heterozygotes?

a) p^2 b) q^2 c) 2pq d) $p^2 + q2$

9. Which of the following best describes a protein domain?

a) The α-helical portion of a protein
b) A discrete region of polypeptide chain that has folded into a self-contained three-dimensional structure

c) The β-pleated sheet portion of a protein
d) A feature that rarely occurs in globular proteins

10. Papain digestion of an antibody IgG molecule yields

a) Two separate heavy and light chain molecules
b) Digests the Fc fragment
c) Digests the light chain fragments of IgG
d) Two univalent Fab fragments and an Fc fragment

11. A linear DNA has 105 bp and the 5' and 3' ends are brought together twisting to the left one turn before the ends are sealed together. What would be the various parameters of this strained DNA viz., i) writhe (w), ii) no of base pairs /turn and iii), Linking number (Lk) if the DNA molecule to remain flat on the surface

a) W=1, 9.54bp/turn, Lk= 9
b) W=0, 10.5bp/turn, Lk= 10
c) W =0, 11.67 bp/turn, Lk=9
d) W=-1, 10.5 bp/turn, Lk= 9

12. Psi (Ψ) bond in a polypeptide is between

a) The nitrogen and α-carbon
b) Nitrogen and carbonyl oxygen
c) α-carbon and carbonyl oxygen
d) α-carbon and hydrogen

13. Identify the right statement about biological polymers in the presence of water

a) They are kinetically and thermodynamically stable
b) Kinetically stable but thermodynamically unstable
c) Kinetically and thermodynamically unstable
d) Thermodynamically stable

14. Which of the following amino acid side chain will be the weakest nucleophile in enzyme catalysis?

a) Ser b) His c) Asn d) Lys

15. What activity is associated with maturation promoting factor (MPF)

a) Phosphotransferase activity
b) Caspase activity
c) Progesterone hormone activity
d) Transcription factor activity

16. The pK_1 (-COOH), pK_2 ($-NH_3^+$) and pK_3 (R: side chain) of Glutamic acid are 2.19, 9.67 and 4.25 and for Histidine 1.82, 9.17 and 6.00 respectively. Isoelectric point of Glu and His would be

a) 3.22 and 7.59 b) 6.96 and 3.91 c) 3.22 and 3.91 d) 6.96 and 7.59

17. Purification of kinase from 6 kg of muscles was done in several steps. In the 3rd step, a total of 120 mL carrying 200 mg of protein showed 60,000 units of activity. How many mg of this enzyme is required to consume substrate at the rate of 1.5×10^3 µmol/min? (1 unit = 1µmol/min)

a) 5 b) 3 c) 15 d) 40

18. Hybrid arrest translation system is useful

a) To determine the translation of chimerc/ hybrid mRNA using in vitro cell free translational systems.
b) Identify a cDNA of interest from a CDNA library by northern hybridization
c) To identify a micro RNA that inhibits translation of a messenger RNA to which it is complimentary.
d) Identify a CDNA of interest by its ability to inhibit the protein synthetic activity of a messenger RNA in test tube reactions

19. Signal recognition particle is

a) RNA-protein complex
b) Mitochondrial membrane-protein complex
c) SiRNA-miRNA complex
d) Ribosome-protein complex

20. The major electron transport chain complexes of mitochondria that are involved in the generation of Reactive oxygen species (ROS)

a) Complex I and Complex IV
b) Complex I and Complex III
c) Complex II and Complex IV
d) Complex III and Complex IV

21. What would be the efficiency of photosynthesis operating system in energy conservation when compared to the energy release during electron transport chain (ETC) mediated respiratory catabolism?

a) Photosynthesis and Respiration are equivalent in terms of efficiency
b) Photosynthesis operator is more energy efficient when compared to ETC.
c) ETC mediated catabolic process is more efficient than photosynthetic operating system.
d) Both are equivalent, however, photosynthesis is more rapid when compared to respiration.

22. Match the following inhibitors with corresponding electron transport chain complex and choose the correct answer from the options given below

1. Complex I	i. Azide
2. Complex II	ii. Malonate
3. Complex III	iii. Oligomycin
4. Complex IV	iv. Rotenone
5. Complex V	v. Myxothiozol

a) 1-iv; 2-v; 3-i; 4-ii; 5-iii
b) 1- v; 2-ii; 3-iv; 4-i; 5.iii
c) 1-iv; 2-v; 3-ii; 4-iii; 5-I
d) 1-iv; 2-ii; 3-v; 4-i; 5-iii

23. One example of a multiple sequence alignment tool is:

a) WebPRANK b) EMBOSS Needle c) EMBOSS Matcher d) None of the Above

24. Which of the following is a phylogenic tree building method for sequences that do not have recognizable similarity:

a) Neighbour joining
b) Maximum Likelihood
c) Maximum Parsimony
d) All of the above

25. Protein X was injected into a rabbit and anti-serum was collected. One portion of the anti-serum was treated with protein X in a tube to remove anti-X antibodies. Both the treated and the untreated anti-sera were then separated into constituent proteins by elecrophoresis. Which fraction would be reduced in the treated anti-serum as compared to the untreated anti-serum?

a) Albumin b) Alpha-globulins c) Beta-globulins d) Gamma-globulins

26. G-protein coupled epinephrine receptor has

a) No enzymatic activity
b) c-AMP dependent protein kinase activity
c) Tyrosine kinase activity
d) GTPase activity

27. Which of the lambda phage protein interacts with the *E. coli* protein prior to infection?

a) J protein b) Porin protein c) Integrase protein d) N protein

28. Bacteriphage lambda will follow lytic pathway during

a) Starvation
b) Increased cIII protein

c) Decreased cIII protein d) Degraded cII protein

29. A 50-year-old man undergoes genetic testing for hemochromatosis, an autosomal recessive disease characterized by abnormally elevated serum iron levels leading to organ toxicity. He is positive for a genetic mutation and is diagnosed with the disease. However, he never develops signs of elevated serum iron levels or organ toxicity. Which of the following terms best describes this patient's disease?

a) Low penetrance
b) Low expressivity
c) Low mosaicism
d) Low mendelian inheritance

30. Synthesis of GMP from IMP(Inosine Monophosphate) requires

a) One high energy bond supplied by ATP and Aspartic acid
b) Oxidation and amination reaction involving Gln and one high energy bond supplied by ATP.
c) Oxidation and amination reaction involving Gln and two high energy bond supplied by GTP
d) Oxidation and amination reaction involving Gln and two high energy bonds supplied by ATP.

31. Mark the correct statement. Vertical resolution at the Holliday junction always gives rise to:

a) Cross-over products with gene conversion.
b) Cross-over products with or without gene conversion
c) Non-cross-over products with gene conversion
d) Non-cross-over products with or without gene conversion

32. Haemophilia is an X linked trait and *H* (normal) is dominant over *h* (Haemophilic). A daughter of a haemophilic father and a son of another haemophilic father have several offsprings (assume that their mothers were normal not carriers). The percent of daughters and sons who will be haemophilic are respectively;

a) 25% each b) 0% and 100% c) 0% and 0% d) 0% and 50%

33. A wild-type fruit fly heterozygous for brown body color and normal wings was mated with a black fly with curly wings. The offspring had the following phenotypic distribution: wild type, 394; black-curly, 400; black-normal, 73; brown-curly, 81. What is the recombination frequency between these genes for body color and wing type?

a) 8% b) 16% c) 9% d) 0%

34. Which of the tetrahydrofolate derivatives are required in the conversion of dTMP from dUMP?

a) N^5 methyl tetrahydrofolate
b) N^5 N^{10} methylene tetrahydrofolate
c) N^5 N^{10} methenyl tetrahydrofolate
d) N^5 formimino tetrahydrofolate

35. Oxidation of unsaturated fatty acid requires:
a) isomerase and epimerase
b) only epimerase
c) only isomerase
d) a desaturase

36. Lysosomal enzymes carrying one of the following markers, mentioned below, are transported accurately from Golgi to lysosomes

a) Mannose 6-phosphate
b) Glucose 6-Phosphate
c) Galactose 6-phosphate
d) N-acetyl glucosamine

37. Proportion of polyribosomes will be higher in the total ribosomes from an eukaryotic cell compared to monosomes (80S) or their subunits (40S and 60S) in the presence of

a) Puromycin b) Cycloheximide c) Pactamycin d) Chloremphenicol

38. Fabry's disease is due to a

a) Deficiency in the enzyme alpha galactosidase
b) Deficiency in the enzyme beta-galactosidase
c) Deficiency of ceramidase enzyme
d) Deficiency of the enzyme glucocerebrosidase

39. Hormone that regulates body water

a) Histamine b) Somatomedins c) Vasopressin d) None of them mentioned in a, b & c

40. Endorphins are produced by

a) Adrenal cortex b) Pituitary c) Parathyroid d) Mast cells

41. Which of the following cycle is used in absorption of amino acids from the intestine?

a) Urea cycle b) Gamma glutamyl cycle c) Glyoxylate cycle d) Cori cycle

42. Which of the following techniques (mentioned in I- V below) can be used to inactivate a gene at the chromosomal locus?

I) Homologous Recombination
II) CRISPR-Cas system
III) ZNFs (zinc finger nuclease) system
IV) TALENs (transcription activator-like effector nucleases) system
V) RNAi

a) Only I. b) Only I, II and III. c) Only I, II, III and IV. d) I, II, III, IV and V

43. Which of the following nucleases is used to identify split genes or to locate introns

a) Bal31 nuclease
b) S7 or micrococcal nuclease
c) Deoxyribonuclease 1
d) S1 nuclease

44. Which of the following marker (s) can be used for identifying pyroptosis

a) Procaspase- 3 to processed active caspase 3
b) Procaspase 1- to active caspase
c) DNA fragmentation
d) None of them mentioned in A to C

45. Translation of broken mRNAs is rescued by

a) Tm RNA
b) Guide RNA
c) Specific Micro RNA complimentary to broken mRNAs
d) EF-Tu-TS

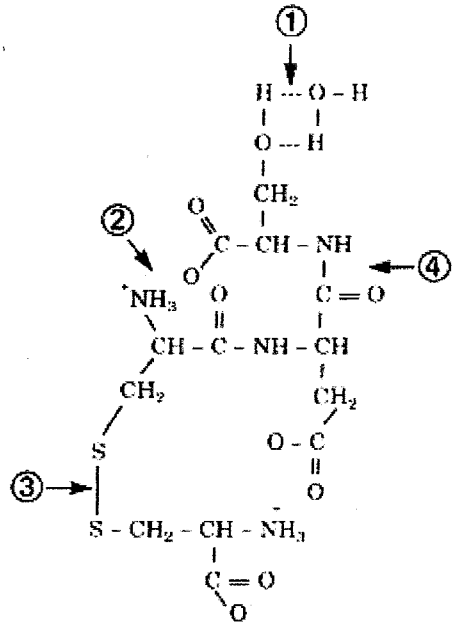
PART B

[Each question has only one right answer. Mark the right answer. Each question carries two marks. There is negative marking. 0.66 marks will be deducted for each wrong answer]

46. A solution of 8M urea is sometimes used in the isolation of protein molecules. When the solution is prepared by dissolving urea in water at room temperature, it becomes cold. Which of the following statements is correct about this reaction?

a) ΔH is negative, ΔG is negative and ΔS is positive
b) ΔH is negative, ΔG is negative and ΔS is negative
c) ΔH is positive, ΔG is negative and ΔS is positive
d) ΔH is positive, ΔG is positive and ΔS is negative

47. In the figure below, four bonds are indicated by numbers. Match the bonds with their correct description below.



a) (1) Electrostatic interaction; (2) hydrogenbond; (3) disulfide bond; (4) peptide bond
b) (1) Hydrogen bond; (2) peptide bond; (3) disulfide bond; (4) electrostatic interaction
c) (1) Hydrogen bond; (2) disulfide bond; (3) electrostatic interaction; (4) peptide bond
d) (1) Hydrogen bond; (2) electrostatic interaction;(3) disulfide bond; (4) peptide bond

48. How much water must be added to 300 mL of 0.2 M solution of acetic acid for the degree of dissociation of the acid to double? K_a for acetic acid is 1.8×10^{-5}.

a) 1000 mL
b) 900 mL
c) 500 mL
d) 300 mL

49. A 27-year-old firefighter is brought to the emergency room after being exposed to smoke during a training exercise. He looks ill and has labored breathing. He is clutching his head and exhibits an altered mental status. On examination, it was noted that he appeared red, and his pulse oximetry read 100%. You suspect carbon monoxide toxicity. What is true of the oxygen saturation curve during carbon monoxide toxicity?

a) The oxygen saturation curve is shifted to the left.
b) The oxygen saturation curve is shifted to the right.
c) The effect of carbon monoxide on hemoglobin is similar to that of having increased levels of 2,3 bisphosphoglycerate.
d) The effect of carbon monoxide on hemoglobin is similar to that of a low pH state.

50. A biochemistry graduate student isolates all the enzymes of the TCA cycle and adds OAA and acetyl CoA, including the appropriate energy precursors, cofactors, and water in a test tube. Which of the following will not be a direct product of his experiment?

a) ATP
b) GTP
c) NADH
d) $FADH_2$

51. A 3-year-old boy presents to the emergency room after having a generalized tonic-clonic seizure. The child has a history of epilepsy, ataxia, and lactic acidosis. When questioned, the parents state that their child was born with a rare metabolic disease, pyruvate carboxylase deficiency. Which one of the following metabolites is this child unable to produce effectively?

a) Pyruvate
b) Alanine
c) Acetyl CoA
d) Oxaloacetate

52. MELAS is a mitochondrial disorder characterized by mitochondrial encephalopathy, lactic acidosis, and strokelike episodes. If a cell were to contain 100% nonfunctional mitochondria, what would be the net ATP yield that would be produced from 1 mole of glucose?

a) 1 mole
b) 2 moles
c) 4 moles
d) 0 moles

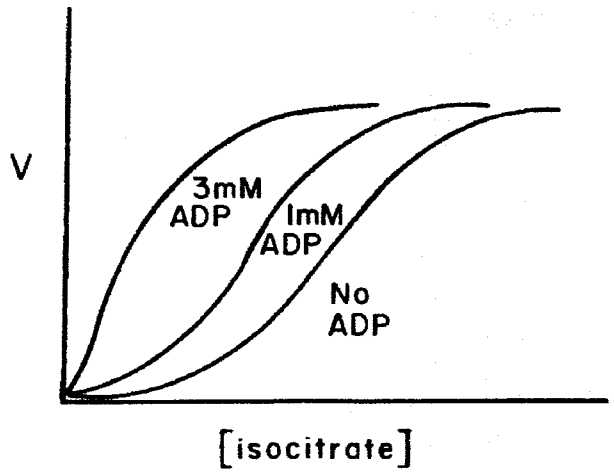
53. Recombinant plasmid pAMP (4539bp) is prepared by subcloning an EcoR1 fragment (6580bp) of a cloned gene. Recombinant plasmid is digested with EcoR1, BamH1 and EcoR1 + BamH1. Digested fragments were separated on agarose gel electrophoresis. EcoR1 digestion yields 8529bp and 4539 bp fragments. Bam H1 digestion of recombinant vector yields two fragments: 8529bp and 2860bp. Double digestion (EcoR1 and Bam H1) yields 4840bp 3419bp, 1740bp and 1120bp fragments. How many bp away the Bam H1" site is located from the EcoR1" site? (Hint: Two sites for EcoR1: EcoR1' and EcoR1"; Two sites for BamH1: BamH1' and BamH1").

a) BamH1" site is located 1740bp away from EcoR1" site
b) BamH1" site is located 1120 bp away from EcoR1" site
c) BamH1" site is located 3419 bp away from EcoR1" site
d) BamH1" site is located 4840 bp away from EcoR1" site

54. Isocitrate dehydrogenase catalyses the reaction:
Isocitrate + $NAD^+ \rightarrow$ *α-ketoglutarate* + *NADH* + CO_2 + H^+

The curves illustrated below are obtained when the initial velocity (v) of the reaction is plotted against isocitrate concentration in presence of various levels of ADP and exces NAD^+. Which of the following statements about this system is correct?

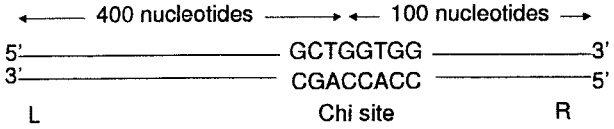
a) Isocitrate dehydrogenase exhibits simple Michaelis-Menten kinetics in the absence of ADP.
b) ADP increases the K_m of the enzyme for isocitrate.
c) ADP increases the V_{max} of the enzyme.
d) ADP activates the enzyme.

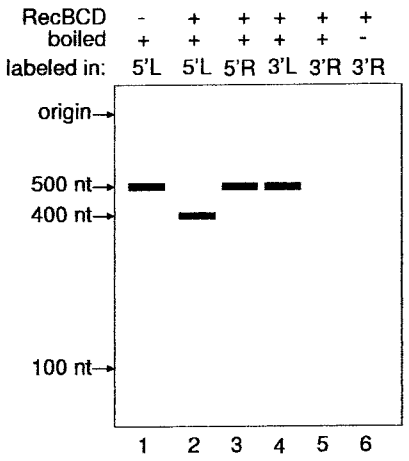


55. You carryout a series of incubations to compare the properties of *E. coli* DNA polymerase I and III. After incubating a DNA template prepared from bacteriophage T7 with one or the other polymerase for 20 minutes, you add a large amount of a second template, bacteriophage T3 DNA, and permit the reaction to continue for another 40 minutes. You then determine how much of the DNA synthesized is T3 and how much is T7 DNA. Considering that enzymes are limiting, which of the following will be the correct observation?

a) You find most of the DNA in both polymerase I and polymerase III incubations are T3 DNA.
b) You find most of the DNA in both polymerase I and polymerase III incubations are T7 DNA.
c) You find most of the DNA in polymerase I incubation is T3 DNA, but almost the entire DNA in the polymerase III incubation is T7 DNA.
d) You find most of the DNA in polymerase I incubation T7 DNA, but almost the entire DNA in the polymerase III incubation is T3 DNA.

56. In order to study the initiation step during homologous recombination, you have purified RecBCD enzymes and incubated with the following linear, double stranded DNA fragment containing a Chi site:





Different samples of this linear DNA was labeled specifically at the 5' end on the left (5'L); at the 5' end on the right (5'R); at the 3' end on the left (3'L), and the 3' end on the right (3'R). Each sample was then incubated in a reaction buffer containing RecBCD. As a control a separate aliquot of labeled DNA was incubated in reaction buffer without RecBCD. After 1 hour of reaction the DNA was denatured by boiling, and the resulting single strands were separated by electrophoresis through a polyacrylamid gel. The pattern of radioactively labeled DNA fragments is shown below. As a further control, a sample of the 3'R that has been incubated with RecBCD was run on the gel without first denaturing it.

The following inferences have been drawn from the above experiments:

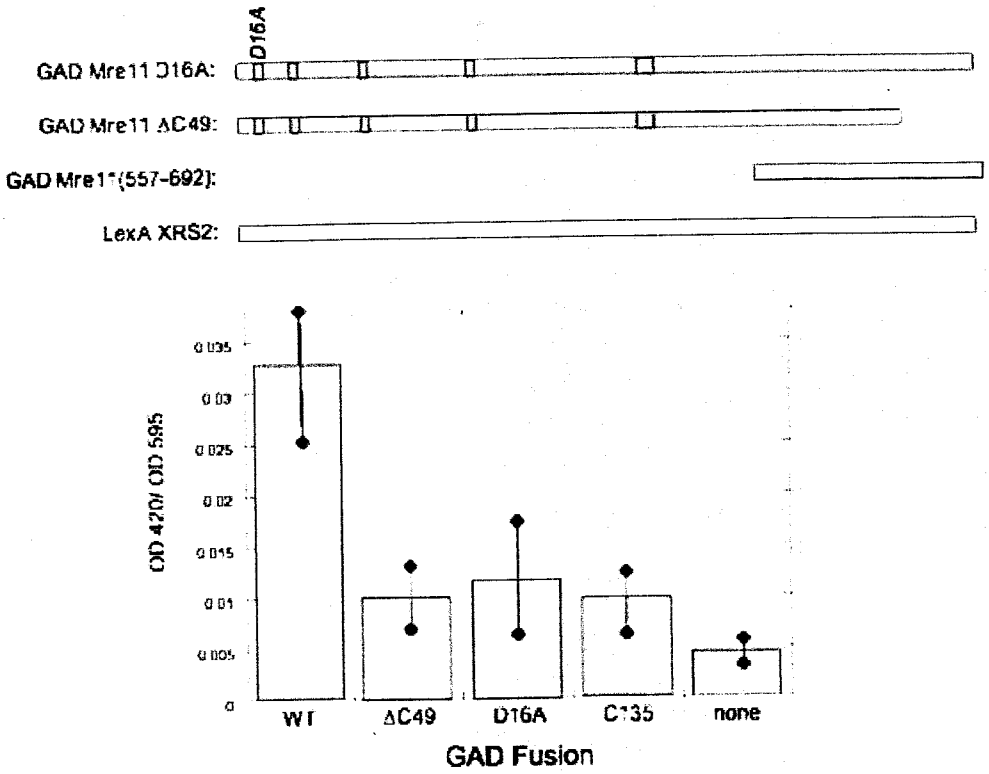
I) RecBCD cuts at the Chi sequence.
II) RecBCD is a single strand specific endo-nuclease.
III) RecBCD is a double strand specific endo-nuclease.
IV) RecBCD is a single stranded DNA specific exo-nuclease.
V) RecBCD can unwind DNA.

Which of the above statements are correct?

a) Statements I, II and V are correct.
b) Statements I, III and V are correct.
c) Statements I, IV and V are correct.
d) Only statements I and V are correct.

57. In order to map the interacting domain of Mre11 and Xrs2 yeast-two-hybrid experiments were performed. *XRS2* gene was cloned in the bait vector so as to produce fusion protein with LexA DNA binding domain. Wild-type (WT) or various mutants of *MRE11* gene was cloned in the prey vector to produce GAD fusion proteins..The relevant pGAD fusion proteins are

shown in the top panel and denoted below the graph in the bottom panel. The reporter gene activity (*LacZ*) was measured in the presence of a chromogenic substrate at 420 nm. The OD 420 was normalized for protein levels by measuring the O.D. 595 after conducting the Bio Rad protein assay. The normalized ratio is expressed as OD420/OD595 on the y-axis of the graph for each of the pGAD-fusion proteins tested. Bars indicate the standard error of the means of values in the four trials carried out for each fusion protein.



Based on the results depicted in the graph mention which of the statements is correct?

a) Mre11 does not directly interact with Xrs2.
b) The C-terminal domain of Mre11 is necessary and sufficient for its interaction with Xrs2.
c) C-terminal 135 amino acid sequence of Mre11 is sufficient for Mre11-Xrs2 stable interaction.
d) Both the N-terminal and C-terminal domain of Mre11 are required for its interaction with Xrs2.

58. While studying the upstream regulatory sequence of gene *VIG* (very interesting gene) you found that it contains DNA sequence of *ERE* elements (Estrogen responsive element). In order to know whether the expression of this gene is regulated by estrogen you have divided your cultured cells in two parts and treated one part with estrogen and the other part remained untreated. You have performed real-time RT-PCR analysis on mRNA isolated from each treatment. The following C_T values were obtained for gene *VIG* and gene *ACTIN* (a gene

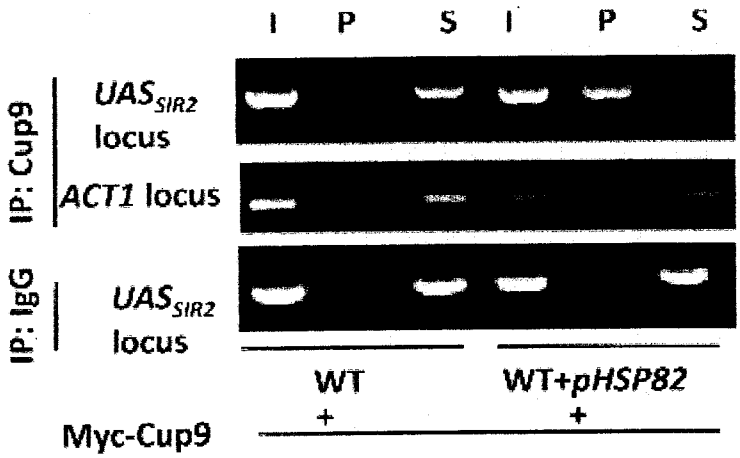
whose transcription is known to be unaffected upon estrogen treatment and thus used as a normalization control).

	Un-treated		Treated	
	VIG	*ACTIN*	*VIG*	*ACTIN*
C_T value	18	20	17	21

Based on the above data, choose the correct conclusion.

a) Expression of *VIG* is down-regulated 2 times in the presence of estrogen.
b) Expression of *VIG* is up-regulated 2 times in the presence of estrogen.
c) Expression of *VIG* is up-regulated 4 times in the presence of estrogen.
d) Expression of *VIG* remains un-changed in the presence of estrogen.

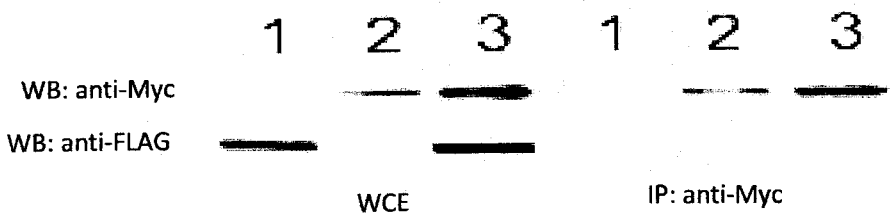
59. In yeast it is observed that heat shock leads to over-expression of HSP82, up-regulation of *CUP9* (transcription factor) and down-regulation of *SIR2*. ChIP (chromatin immunoprecipitation) assays were performed to understand whether Cup9 is recruited at SIR2 promoter-proximal region ($SIR2_{UAS}$). *CUP9 MYC*-tagged cells were used in the absence or presence of *HSP82* over-expression plasmid. Anti-Myc antibodies or control IgG (immunoglobulin G) were used for precipitation. Input DNA (I), immunoprecipitated DNA (P), and DNA from supernatant (S) were amplified by semi-quantitative PCR with primers that covered $SIR2_{UAS}$ *locus* or *ACT1* locus.



On the basis of given description and experimental results answer which of following statement are correct.
I) Heat shock or *HSP82* over-expression induces transcriptional down-regulation of *SIR2*.
II) Heat shock leads to up-regulation *CUP9*.
III) Over-expression of *HSP82* leads to up-regulation and recruitment of Cup9 at $SIR2_{UAS}$.
IV) Over-expression of *HSP82* leads to down-regulation of *CUP9*.

a) Only I, III, IV
b) Only I, III
c) Only I, II, III
d) Only I, II, IV

60. To examine the interaction between protein R and protein J, two plasmids were constructed. Plasmid 1 harbors Myc-tagged Protein R and plasmid 2 harbors FLAG-tagged Protein J. Cells were co-transfected with both the plasmids (lane 3). As controls to this experiment cells were also co-transfected with plasmid 1 and empty plasmid 2 (lane 2); or with plasmid 2 and empty plasmid 1 (lane 1). Immuno-precipitation experiments were performed with cell lysate with anti-Myc antibody (right panel). Whole cell extract WCE (before immuno-precipitation) as well as immuno-percipitated samples (IP) were analyzed on Western blot (WB) using anti-Myc or anti-FLAG antibodies as marked on the figure.



Lane 1: Empty plasmid 1(Myc) + plasmid 2 (FLAG-protein J)

Lane 2: Plasmid 1(Myc-protein R) + empty plasmid 2 (FLAG)

On the basis of the above description and figure which of the following statement will explain Protein R and Protein J pool down accurately?

a) Protein J was co-immunoprecipitated with Protein R using anti-Myc antibody. Protein J was detected on Western blot with anti-FLAG antibody.
b) Protein J was co-immunoprecipitated with Protein R using anti-FLAG antibody. Protein J was detected on Western blot with anti-Myc antibody.
c) Protein R was co-immunoprecipitated with Protein J using anti-Myc antibody. Protein R was detected on Western blot with anti-FLAG antibody.
d) Protein R was co-immunoprecipitated with Protein J using anti-FLAG antibody. Protein R was detected on Western blot with anti-Myc antibody.