Entrance Examinations – 2018

Ph.D. Biochemistry

Hall Ticket No. [   ]

Time :   2 hours   Max. Marks : 80

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 70 questions for 80 marks. **Part A contains 30 questions on research methodology. Questions 1 to 20 carries one mark each and questions 21 to 30 carries two marks each. Part B contains 40 questions on biology. Question number 31 to 70 carries one mark each.**
3. **There is no negative marking in any of the parts.**
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

[Total 40 marks. Questions 1-20 carries 1 mark each and question 21 to 30 carries 2 marks each. There is no negative marking.]

1. If 'BINARY' is coded as 'DHPZTX' the how will 'KIDNAP' is coded?
A. MKFPCQ
B. MHFPZQ
C. IKFMYO
D. MHFMCO

2. December 9, 2001 is Sunday, what was the day on December 9, 1971?
A. Thursday
B. Wednesday
C. Saturday
D. Sunday

3. At a railway station a 24-hour watch loses 3 minutes in 4 hours, if it is set correctly on Sunday noon when will the watch show the correct time?
A. 6 PM after 40 days

B. 12 noon after 75 days

C. 12 PM after 100 days

D. 12 noon after 80 days
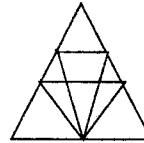
4. Find the missing number in the following figure.

1	1/2	3/2
2	2/3	8/3
3	?	19/5

A. 1/2

B. 2/3

C. 3/4

D. 4/5

5. A number of friends decided to go for a picnic and planned to spend Rs. 96 on eatables. Four of them, however, did not turn up. As a consequence, the remaining ones had to contribute Rs. 4 each extra. The number of those who attended the picnic was

A. 8

B. 12

C. 16

D. 24

6. Find the numbers of triangles in the given figure.

A. 12

B. 18

C. 22

D. 26

7. The difference between interest received by A and B is Rs. 18 on Rs. 1500 for 3 years. What is the difference in the rate of interest?

A. 1%

B. 2.5%

C. 0.5%

D. 0.4%

8. The ratio of the age of the father and the daughter at present is 3:1. Four year ago the ratio was 4:1. The average age of the father and daughter 2 years hence will be

A. 24

B. 26

C. 25

D. 36

9. Find the missing number: 1; 28; 92; 217; 433; 776; _____.

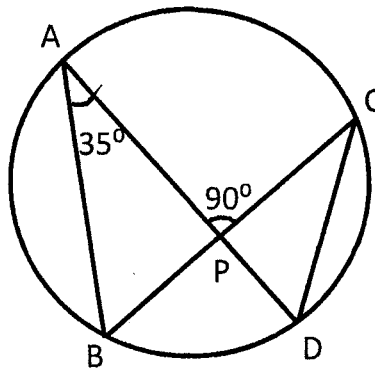A. 924

B. 1148

C. 1288

D. 1304

10. Starting from the point X, Jayant walked 15 m towards west. He turned left and walked 20 m. He then turned left and walked 15 m. After this he turned to his right and walked 12 m. How far and in which direction is now Jayant from X?

2

A. 8 m in south direction
B. 32 m in south direction
C. 30 m in west direction
D. 32 m in west direction

11. What would be the next term of the Arithmetic Progression: $\sqrt{7}, \sqrt{28}, \sqrt{63}$, ...

A. $\sqrt{70}$

B. $\sqrt{84}$

C. $\sqrt{97}$

D. $\sqrt{112}$

12. The chord AD and BC intersect each other at right angles at a point P. If $\angle$ DAB = 35°, then $\angle$ ADC would be

A. 35°
B. 45°
C. 55°
D. 65°

13. A village has 10 players. A team of 6 players is to be formed. 5 members are chosen first out of these 10 players and then the captain is chosen from the remaining players. Then the total number of ways of choosing such team is
A. 1260
B. 210
C. (10C$_5$)5!
D. (10C$_5$)6

14. In a class of 100 students there are 70 girls whose average marks in a subject are 75. If the average marks of the complete class is 72, then what is the average mark of the boys?
A. 73
B. 65
C. 68
D. 74

15. If the mean deviation of the numbers
1, 1+d, 1+2d, 1+3d,.........,1+100d from their mean is 255, then what is the value of 'd'?
A. 10
B. 20

3

C. 10.1
D. 20.2

16. Three persons work independently on a problem. If the respective probabilities that they will solve it are 1/3, 1/4 and 1/5, then find the probability that none can solve it.
A. 2/5
B. 2/15
C. 59/60
D. 1/5

17. A bag contains 3 white, 3 black, and 2 red balls. One by one three balls are drawn without replacing them, then find the probability that the third ball is red.
A. 1/4
B. 3/4
C. 1/9
D. 8/9

18. A pot contains 5 red, and 5 black balls. A ball is drawn at random, it's colour is noted and is returned to the pot. Moreover, 2 additional balls of the same colour drawn are put in the pot and then a ball is drawn at random for the second time. What is the probability that the second ball drawn is red in colour?
A. 7/12
B. 1/2
C. 5/12
D. 1/3

19. Find the number of ways in which 5 girls and 5 boys can be arranged in a row if no two boys are together.
A. 720
B. 86400
C. 43200
D. 1440

20. From 6 different novels and 3 different dictionaries, 4 novels and 1 dictionary are to be selected and arranged on a row on the shelf so that the dictionary is always in the middle. Then the number of such arrangements is
A. Less than 500
B. At least 500 but less than 750
C. At least 750 but less than 1000
D. At least 1000

21. Analyze the following table and predict the percentage of base pairs that would be unpaired in a polynucleotide having 100 bp.

Number of base pairs in the DNA	Fraction unpaired (%)
5000	0.28
1000	1.40
250	5.60

4

S-61

A. 0.14
B. 2.8
C. 5.6
D. 14

22. You plan to clone your favorite gene (YFG) in a bacterial expression vector pE at the *Bam* HI site. The size of YFG and pE are 0.5 kb and 3 kb respectively. Your advisor suggested you to keep 1:3 vector: insert ratio in the ligation mixture. Which of the following will give you the desired stoichiometry?
A. Vector 100 ng and insert 50 ng
B. Vector 100 ng and insert 100 ng
C. Vector 100 ng and insert 150 ng.
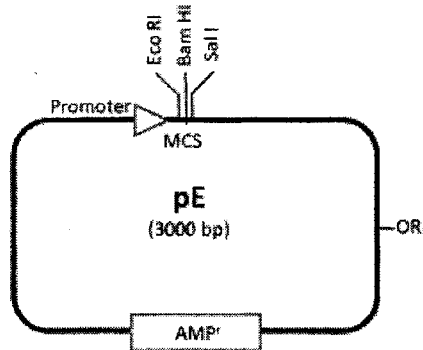D. Vector 100 ng and insert 300 ng

23. Upon ligation of YFG into pE vector you have performed transformation into competent bacterial cells. You have included several controls as listed in the accompanying Table along with the number of colonies obtained on LB-AMP plates after transformation.

	Number of colonies obtained	
Preparation of samples	Experiment 1	Experiment 2
Cells alone	0	0
Uncut vector	> 1000	> 1000
Cut vector (no Phosphatase; no ligase)	4	6
Cut vector (no Phosphatase but ligase treated)	503	565
Cut vector (Phosphatase and ligase treated)	287	9
Experimental sample	301	334

From the above data indicate which of the following statement is correct.

A. In the first experiment the vector was not digested with *Bam* HI
B. In the second experiment ligase enzyme did not work properly
C. In the first experiment phosphatase enzyme did not work properly
D. The overall results suggest that the cloning has occurred properly in both of the experiments
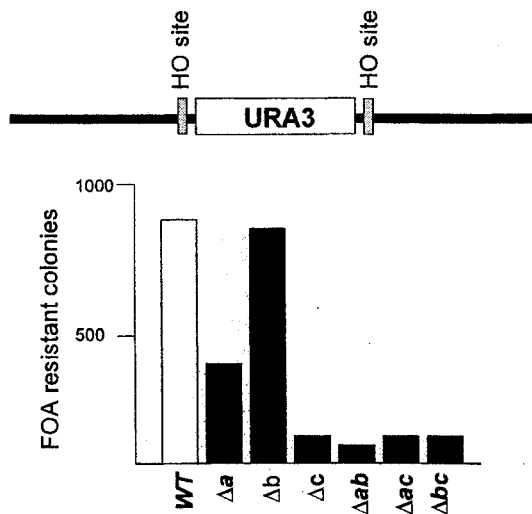
24. Since you have performed non-direction cloning of your favorite gene (YFG), which is 0.5 kb at the *Bam* HI site of the expression vector pE (3 kb) you wanted to check for the orientation of the insert. To that end you wanted to use restriction enzymes whose sites are present once in the insert and once in the vector at the multiple cloning sequences (MCS) as shown in the figure. The *Eco* RI site is present at 100 bp downstream of the start codon, while the *Sal* I site is present 250 bp downstream of the start codon of the gene.

5

Which of the following statements is correct?

A. If the insert is in the correct orientation digestion with *Eco* RI will give three fragments: 100 bp; 400 bp and 3000 bp

B. If the insert is in the correct orientation digestion with *Eco* RI will give two fragments: 400 bp and 3100 bp

C. If the insert is in the wrong orientation digestion with *Eco* RI will give two fragments: 400 bp and 3100 bp

D. If the insert is in the wrong orientation digestion with *Sal* I will give two fragments: 250 bp and 3000 bp

25. You are performing Non-homologous end joining (NHEJ) assay to find out the involvements of three genes: *GENE A*; *GENE B* and *GENE C* in NHEJ pathway. To that end you have created inducible DNA double strand breaks at the HO sites and scored for the 5-FOA resistant colonies. 5-FOA offers negative selection against the *URA3* gene. The number of 5-FOA resistant colonies in various strain backgrounds are depicted in the histogram below.

[*Δa* means deletion of *GENE A*. Similarly, *Δab* means deletion of both *GENE A* and *GENE B*.]

Based on the observations the following conclusions are made.

6

i)   *Gene C* plays important role in NHEJ pathway.
ii)   *Gene A* can compensate the loss of *Gene B* function.
iii) *Gene A* and *B* are in the same epistatic group.
iv)   *Gene B* and *C* are in the same epistatic group.

Which of the above statements are correct?
A. Only statement i is correct
B. Only statements i and ii are correct
C. Only statements i; ii; and iii are correct
D. Only statements i; ii; and iv are correct

26. A cross is made between an Hfr that is met^+ thr^+ str^r and an F– that is $met-$ $thr-$ str^s. Interrupted-mating studies show that met^+ enters the recipient last, so met^+ recombinants are selected on a medium containing threonine and streptomycin. These recombinants are tested for the presence of the *thr+* and *str^r* alleles. Based on the recombinants obtained as shown below, what would be the order of genes in this strain and the distance between the markers?

met^+ thr^+ str^r	280
met^+ thr^+ str^s	1
met^+ thr^- str^r	7
met^+ thr^- str^s	60

A. Order is *met str thr;* and distances are respectively 17.2 mu and 2 mu
B. Order is *met str thr;* and distances are respectively 21 mu and 2.5 mu
C. Order is *met thr str;* and distances are respectively 17.2 mu and 2 mu
D. Order is *met thr str;* and distances are respectively 21 mu and 2.5 mu

27. The frequency of two alleles in a gene pool of a population that is in Hardy-Weinberg equilibrium is 0.19 (A) and 0.81(a). The percentage heterozygous and homozygous recessive individuals in this population is
A. 66 and 31 respectively
B. 31 and 66 respectively
C. 38 and 62 respectively
D. 62 and 38 respectively

28. A 100% pure kinase, monomeric, with molecular weight of 47 kDa showed specific activity of 200 U/mg, at 25 °C in pH 7.5 phosphate buffer. During purification only 50 µg of the enzyme was found in purified form in 100 mL buffer. Later the same buffer was saturated with substrate and enzymatic assay was performed. Calculate the rate of the reaction? (Note: 1 U = 1 µmol of substrate consumed or product formed/min).
A. 1×10^{-4} M/min
B. 1×10^{-3} M/min
C. 1×10^{-2} M/min
D. 1×10^{-1} M/min

29. The binding affinity (Ka) of a protein for its ligand at pH 7.0 and room temperature is 2×10^5 M^{-1}. At what ligand concentration will be 80% of the protein bound?
A. 20 µM
B. 40 µM
C. 4 µM

7

D. 2 µM

30. A protein was purified from anaerobic bacteria and analyzed by polyacrylamide gel electrophoresis containing SDS. Following protein staining, a single band was observed. The same protein was analyzed on a second electrophoresis under native conditions (i.e. non-denaturing, or without SDS). This gel shows two bands after staining. Assuming no errors was committed during these experiments. What is best possible explanation about the protein?
A. Two proteins with identical molecular mass having same pI
B. Two proteins of identical molecular mass having different pI
C. Two identical polypeptides attached with disulfide bond
D. Two different polypeptides attached with disulfide bond

PART B

[Total 40 marks. Questions 31-70 carries 1 mark each. There is no negative marking.]

31. Match the following.

Set I (Hormone excess/deficiency)	Set II (Disease)
i) Estrogen deficiency	a) Diabetes insipidus
ii) Cortisol excess	b) Exothalmia
iii) Thyroid hormone excess	c) Amenorrhea
iv) Vasopressin deficiency	d) Gitelman syndrome
	e) Cushing syndrome

The correct match is

	(i)	(ii)	(iii)	(iv)
A.	e	d	c	a
B.	c	e	b	a
C.	d	b	e	a
D.	a	b	d	e

32. Serine proteases are named so because
A. Their 1st amino acid is serine.
B. The catalytic mechanism is initiated by one of the serines of the enzyme.
C. They hydrolyze peptide bond in the C-terminal of the serine present at the cleavage site.
D. They hydrolyze peptide bond in the N-terminal of serine present at the cleavage site.

33. NAD$^+$ is a cofactor used in cellular oxidation. What is the net charge of this molecule?
A. +1
B. 0
C. −1
D. −2

34. Kinetic parameters of a lipase were found to be: k_{cat} of 25.0 s^{-1} and K_m of 0.0048 M. At what substrate concentration it would show one-fifth of its maximum rate?
A. 9.6 x 10^{-4} M
B. 1.2 x 10^{-3} M
C. 2.4 x 10^{-2} M

D. 1.2×10^{-1} M

35. Which one of the following hydrogen bonds (shown as dotted bonds) best represents the type of hydrogen bond that keep the -helix and the -sheet in a protein from falling apart?
A. O-H·····O=C
B. O-H·····NH=C
C. N-H·····NH=C
D. N-H·····O=C

36. A sequence of amino acids in a certain protein is found to be -Ser-Gly-Pro-Gly-. The sequence is most probably part of a
A. Sheet
B. Turn
C. Helix
D. Loops

37. Which type of Quantum Transition takes place in Ultra Violet and Visible spectroscopy?
A. Rotation of molecules
B. Nuclear
C. Bonding electrons
D. Spin of nuclei in magnetic field

38. What is the fraction of deprotonated histidine at pH =7, the pKa of histidine is 7.4
A. 0.28
B. 0.21
C. 0.50
D. 0.38

39. During lagging strand synthesis, to join together two precursor fragments, several enzymatic activities happen in a sequential manner. From the following, pick the relevant activities and arrange them in the correct order. Note that the two Okazaki fragments are already synthesized.
    i) 5'-3' polymerase activity of DNA Pol III.
    ii) 5'-3' helicase activity of DnaB.
    iii) 5'-3' polymerase activity of DNA Pol I
    iv) 3'-5' exonuclease activity of DNA Pol III.
    v) Ligase activity.
    vi) 5'-3' exonuclease activity of DNA pol I.

A. ii; i; iii, vi; v
B. vi; iii; v
C. ii; iii; iv; v
D. ii; I; iv; v

40. Consider a Messelson-Stahl experiment, in which cells are grown for a long time in ^{15}N medium and then transferred to ^{14}N medium for one generation. If only ^{15}N ^{15}N -DNA and ^{14}N ^{14}N -DNA are found, what would be your interpretation?
A. DNA replication occurs via semiconservative mode
B. DNA replication occurs via non-semiconservative mode
C. The cells are not undergoing replication when transferred to ^{14}N medium
D. The cells are not synchronous with respect to the time of initiation of replication

41. Which of the following statements about a point mutation is <u>incorrect</u>?
A. Can be induced by chemicals
B. Can be responsible for genetic disease
C. Can be mapped by a technique similar to Sanger sequencing
D. Can be detected easily by Southern blotting

42. Which of the following DNA polymerase exhibits template independent polymerase activity?
A. Telomerase
B. Reverse transcriptase
C. Terminal transferase
D. Sequanase

43. Which of the statements about proteins that bind to hnRNA is <u>incorrect</u>?
A. Can cycle between the nucleus and cytoplasm.
B. Are components of spliceosomes
C. Can contain a conserved RNA-binding motif called the RGG box
D. Can act like ssDNA binding protein

44. Among the following statements about noncoding DNA in eukaryotes which statements are correct?
i) It includes introns.
ii) It includes pseudogenes.
iii) It includes simple-sequence DNA.
iv) It includes mobile genetic element.
A. Only i; and ii are correct
B. Only i; ii; and iii are correct
C. Only i; and iii are correct
D. All i; ii; iii; and iv are correct

45. The following sequence alignment is an example of:

1   15
CAA TCG CGT AAA CCT

———CG GGT AAA———
       1   8

A. Local alignment
B. Global alignment
C. Multiple sequence alignment
D. None of the above

46. The outer membrane of mitochondria is permeable to ions and solutes with molecular weight less than 10 kDa is due to the presence of
A. TOM complex
B. Porins
C. Pores
D. Carriers

47. Proton transport in cytochrome c oxidase takes place via two channels denoted as the D and K pathways. In each catalytic cycle how many protons pass through the K and D pathway respectively?
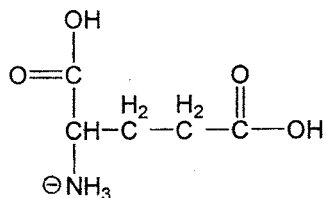A. 2 and 2
B. 2 and 6
C. 2 and 4
D. 2 and 8

48. Which group of peptides are produced after cleavage of the following peptide with trypsin?
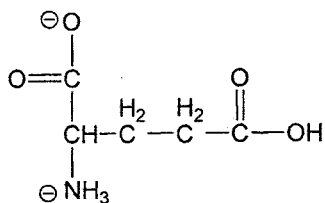Met-Ala-Tyr-Met-Phe-Arg-Gly-Asp-Lys-Glu-Trp
A. Met-Ala-Tyr-Met-Phe-Arg; Gly-Asp-Lys; Glu-Trp
B. Met-Ala-Tyr; Met-Phe; Arg-Gly-Asp-Lys-Glu-Trp
C. Met-Ala-Tyr-Met-Phe-Arg-Gly-Asp; Lys-Glu-Trp
D. Met; Ala-Tyr-Met; Phe-Arg-Gly-Asp-Lys-Glu-Trp

49. Which one of the following ionic species of glutamate would be prevalent at pH 9.0?
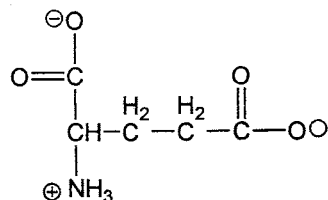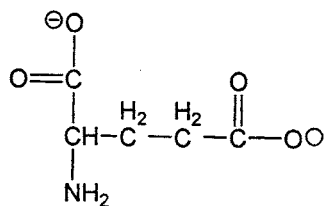A.

B.

C.

D.

50. Match the following characteristic of sugars to the correct sugar
i. Maltose

ii. Sucrose
iii. Fructose
iv. Galactosomine
   1. Possesses a beta anomeric ring
   2. Is not a reducing sugar
   3. Is most likely to be present in proteoglycans
   4. Is a ketone

A. 1-i, 2-ii, 3-iv, 4-iii
B. 1-iv, 2-i, 3-iii, 4-ii
C. 1-iv, 2-iii, 3-ii, 4-i
D. 1-iv, 2-iii, 3-i, 4-ii

51. Which one of the following pairs of lipids and related compounds exhibit opposite biologic activities?
A. 5-HPETE and leukotriene D_4
B. Cholic acid and lithocholic acid
C. Thromboxane A_2 and prostacyclin
D. Lactosylceramide and galactocerebroside

52. Pyridoxal phosphate is a cofactor required for which of the following enzyme/enzymatic reaction?
A. Fixation of carbon dioxide
B. Oxidation and reduction
C. Aminotransferase
D. Decarboxylation of alpha keto acids

53. What is common among the sugars sucrose; isomaltose; and lactose?
A. They are all Monosaccharides
B. They are all Trisaccharides
C. They are all Disaccharides
D. They contain one carboxyl group

54. Phenyl Ketoneuria and Alkaptoneuria are metabolic disorders
A. Associated with fatty acid metabolism
B. Associated with branched chain amino acid metabolism
C. Associated with Phenylalanine and Tyrosine metabolism
D. Associated with Tryptophan metabolism

55. In *E.coli* the fatty acid synthesis intermediates are attached to
A. CoA
B. Isoprene units
C. SH group of phosphopantetheine
D. Dolichol phosphate

56. In urea cycle the enzymes are compartmentalized in mitochondria and cytosol because
A. No specific reason
B. To prevent reductive amination of α-ketoglutarate in the mitochondria
C. Metabolites cannot pass through the mitochondrial membrane
D. Urea is formed in the mitochondria only

57. Polyuria can occur in
A. Diabetes mellitus
B. Diarrhoea
C. Acute glomerulonephritis
D. High fever

58. Serum cholesterol is decreased in
A. Endemic goitre
B. Thyrotoxicosis
C. Myxoedema
D. Cretinism

59. In cells that have entered metaphase, anaphase cannot be initiated until
A. Sic1 is phosphorylated
B. Securin is degraded
C. Cdc14 is released from the nucleolus
D. Chromosomes are condensed

60. Proteins are anchored to membrane in all of the following ways except
A. Glycosylphophatidyl inositol
B. Prenylation of cysteine
C. Acylation of N-terminal amino acid
D. Trimethylation of lysine

61. Match protein in column P to the most appropriate structure/function in column Q

	P		Q
1	Actin	a	Spindle fibre
2	Kinesin and dyenin	b	Desmosomes
3	Tubulin	c	Nucleoskeleton
4	Cadherin	d	Moving organelles
5	Lamin A	e	Focal adhesion

A. 1:e; 2:b; 3:a, 4:d; 5:e
B. 1:d; 2:c; 3:b; 4:e; 5:a
C. 1:e; 2:d; 3:a; 4:e; 5:c
D. 1:b; 2:c; 3:e; 4:a; 5:b

62. A cross between pink (p-) yeast strain of mating type a and a cream strain p+ of mating type alpha produced the following tetrads.

$$p^+a \quad p^+a \quad p^-\alpha \quad p^-\alpha \quad 18$$
$$p^+a \quad p^-a \quad p^+\alpha \quad p^-\alpha \quad 8$$
$$p^+\alpha \quad p^+\alpha \quad p^-\alpha \quad p^-\alpha \quad 20$$

Which of the following statements is correct?
A. p and a are on different chromosomes.
B. p and a are on the same chromosome.
C. Gene conversion between p+ and p- is observed.
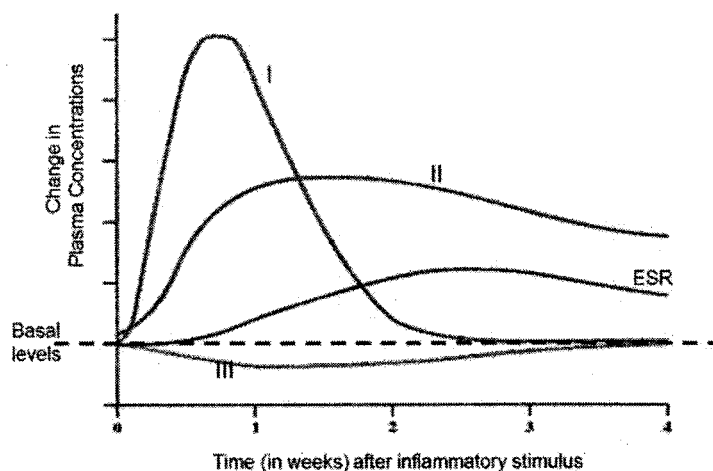D. p and a are closely linked.

63. In peanuts, a plant may be either bunch or runner. Two strains, V4 and G2 were crossed. Although both V4 and G2 were true breeding, i.e., V4 x V4 and G2xG2 produced all bunch plants, when V4 was crossed to G2, F1 produced all runners and F1xF1 produced F2 in the ratio of 9 runner: 7 bunch. Which of the following explanations is the best fit for this observation?
A. Case of incomplete dominance
B. Shows strong linkage
C. Case of duplicate recessive epistasis
D. Case of dominant epistasis

64. A tetrahybrid cross involving 4 heterozygous loci was performed (P/p; Q/q; R/r; S/s). Which of the following options correctly represents the possible genotype for each locus and the total number of possible genotypes in the progeny?
A. 3 and 81
B. 4 and 64
C. 2 and 64
D. 4 and 256

65. Pattern of change in plasma concentrations of some acute-phase proteins after a moderate inflammatory stimulus over weeks is given below along with erythrocyte sedimentation rate (ESR).

Time (in weeks) after inflammatory stimulus

Which acute-phase proteins are possibly represented by plot I, II and III?
A I: Fibrinogen; II: Transthyretin; III: Albumin
B I: Mannose binding protein; II: Albumin; III: Transthyretin
C I: Serum amyloid A; II: Albumin; III: Fibrinogen
D I: C-reactive protein; II: Fibrinogen; III: Album

66. Dinitrophenol (DNP) is a hapten. A mouse (M-1) was primed with Dinitrophenol conjugated with bovine serum albumin (BSA) or DNP-BSA. Another mouse (M-2) was injected with unrelated carrier Bovine gamma Globulin (BGG) which was not conjugated with DNP. Spleen cells from both these mice were mixed and injected into a lethally irradiated syngeneic recipient (M-3). Which of the following will NOT generate a secondary antibody response to DNP?
A. Secondary immunization of M-1 with DNP-BSA
B. Secondary immunization of M-1 with DNP-BGG

14

C. Secondary immunization of M-2 with DNP-BGG

D. Secondary immunization of M-3 with DNP-BGG

67. Corneal grafts are not rejected because they
A. Are resistant to lymphocytotoxic activity
B. Have no lymphatic drainage
C. Do not possess histocompatibility antigens
D. Are not exposed to antibodies

68. One reason why vaccines fail to work in very young infants is the presence of
A. Maternal antibodies
B. Glucoproteins
C. Endotoxins
D. Adjuvant

69. Match the enzyme in set I with its first digit E.C. number in set II.

I	II
i. Lipase	3
ii. Alkaline phosphatase	2
iii. α-amylase	4
iv. Purine nucleosidase	6

A. i-3, ii-2, iii-4, iv-6
B. i-3, ii-4, iii-3, iv-6
C. i-3, ii-3, iii-3, iv-6
D. i-3, ii-3, iii-3, iv-3

70. E-value in BLAST alignment refers to:
I. Value describing number of "hits" one can observe by chance while searching a database of similar size
II. Value describing significance of scoring for the top "hits"
III. It increases exponentially as score 'S' of the match "hit" increases.
Which of the above statements are correct?
A. Only I and III
B. Only I and II
C. Only II and III
D. All of I, II, and III

ROUGH WORK