

M. SC. BIO-TECHNOLOGY PART II EXAMINATION, 2018

MOLECULAR GENETICS, GENOMICS & PROTEONICS

MSBT - 2/2

Time : Four hours

Full Marks : 100

Use a separate Answer-Script for each Group

GROUP - A

PART - I

Answer **any (4)** questions from question No. 1

1. Answer **all** questions : 4×2
 - (a) State Mendel's Law of "independent assortment. What features of the factors/genes in terms of their locations on the chromosome was responsible for formulating this law ? 2
 - (b) State two evidences which support the idea that genes are located on the chromosomes. 2
 - (c) Which factors are responsible for sex determination in *Drosophila* ? Provide a genetic evidence to justify your answer. 2
 - (d) Explain what do you mean by the term "criss-cross" inheritance. Cite an example of such inheritance. 2

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- (e) What is the meaning of “base-calling” in next-generation sequencing platforms ? 2
- (f) What is Lod score ? Explain how this parameter can be used to assess the linkage in human pedigrees ? 2
- (g) Mention what do mean by the term “tetrad”? What advantage a tetrad offers to a geneticist during the analysis of genetic recombination ? 2

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- c) How can P1 phage be used for transduction across species barrier ?
 - d) What genetic method is used to demonstrate that two proteins interact with each other to participate in a particular biochemical reaction?
15. Among the three phages, Lambda P22 and P1, it is P1 which contributed maximally in causing genetic diversity in the bacterial kingdom. Justify the statement. 10
 16. Using P1, show that any segment of DNA can survive for many bacterial generations without replicating. 10
 17. Among the bacteriophages PhiX, G4, S13, fd, M13 and f1, which ones can be used satisfactorily for cloning DNA and Why ? 10
 18. What is meant by an amino acid requiring mutant ? Outline an experiment to isolate a *ten* auxotroph in *E coli*. 10

catalyzes the conversion of phenylalanine to tyrosine which can be represented by following simple reaction.

Phenylalanine → Tyrosine

How would you provide a secondary cure for this disease ? Would you expect this phenotype to be dominant or recessive ? 2

- c) In a three point test cross ABC/abc X abc/abc following data are obtained (only phenotypes are given)

ABC	abc	aBc	AbC	ABc	abC	aBC	Abc	Total
230	240	96	104	138	142	12	8	970

Find out correct linear order of the genes. Calculate the map distance between the genes and the co-efficient of co-incidence. 6

4. a) You are interested to uncover the genes involved in biosynthesis of aromatic amino acids namely tyrosine, tryptophan and phenylalanine in *Neurospora crassa*. You have mutagenized the conidia from a pure wild type strain of this fungus followed by usual procedures involving screening, selection and meiotic analysis. Your initial collection shows you have approximately 37 independent mutant conidia, which denote as aro (auxotrophic for aromatic amino acid) mutant. All of them grow only in

GROUP - B

Answer question no. **10** and **any one** from the rest.

10. What do you mean by structural and functional proteomics ? 2

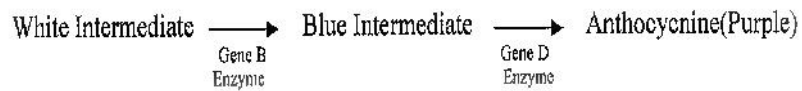
10. or

“Proteome is a dynamic component of a cell”. Justify the statement. 2

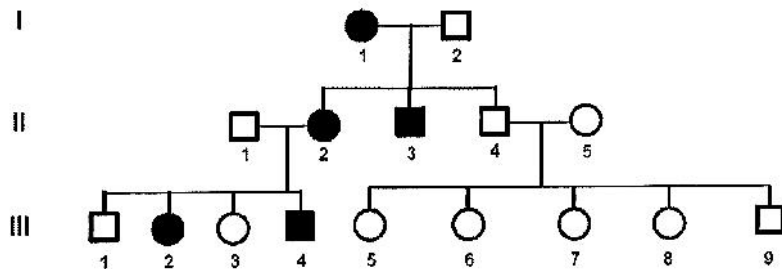
11. i) What are ionization and acceleration of a peptide in mass spectrometry ? 3
- ii) How does quadrupole analyze the mass of a peptide in a mass spectrometry ? 2
- iii) How would you perform isoelectric focusing gel electrophoresis in order to separate proteins ? 2
- iv) What are the differences between native and non-native gel electrophoresis for protein separation ? 3
12. i) What are the basic components required for a mass spectrometry ? 1
- ii) What does MALDI-TOF stand for ? Explain briefly the basis of this technique for the analysis of proteins ? 1+4=5

vermillion female X wild type male, (b) homozygous wild type female X vermillion male and (c) heterozygous female X vermillion male ? 5

6. (a) In sweet peas, the synthesis of purple anthocyanin pigment in the petals is controlled by two genes, B and D. The pathway is given below:



- What colour petals would you expect in a pure breeding plant unable to catalyze the first reaction ?
 - What colour petals would you expect in a pure breeding plant unable to catalyze the second reaction ?
 - If the plants in the question (i) and (ii) are crossed, what petals will be observed in the F_1 plants ?
 - What ratio of purple: blue:white plants would you expect in the F_2 plants ? 4
- b) The following is a pedigree of a rare human trait 4



- Explain the approach that you would apply to sequencing the genome of a newly discovered bacterial species. 4
 - How the next-generation technology can be utilized to analyze the transcriptome of cell under two different environmental cues. 4
9. a) You would like to analyze and compare the transcriptome of primary mammary epithelial cell line and a cell line, Hs-274. T that is derived from the breast a cancer patient. After comparing them you have found almost 1570 genes which were upregulated in the tumour line and 377 genes which were down regulated. Suggest a control experiment, which would justify the validity of your finding with appropriate reasoning. 3
- Mention one advantage for using oligonucleotide based microarray. How the oligonucleotides are spotted onto the substratum ? What is major disadvantages of the microarray technique ? How that problem was solved in modern technology. 3
 - Why is it necessary to validate the expression dataset obtained from microarray analysis performed at the “transcriptomic” scale. Mention two methods. which are routinely used to validate the expression datasets. 2+2

- c) What is “molecular marker” ? Cite two examples of such markers. How molecular markers help establishing the genetic map of a large segment of eukaryotic chromosome ? 2

Part - III

(Answer **any one** question)

8. a) How are sequence maps of the genome of a given organism produced ? What do you mean by the term “contig”? Mention briefly the basic principle involved in Pyro-sequencing technique. 2+1+2
- b) You are studying a newly discovered organism. In particular, you are interested to identify the genes which either become upregulated or shut down when this organism is grown in D-glucose vs D-galactose as principle sources of carbon. Mention the strategy of a technique which can be very conveniently used to uncover the identity these genes. Briefly mention the rationale on which this technique is based on. 5

8. or

- a) Two particular contigs are suspected to be adjacent. possibly separated by repetitive DNA. How would you bridge these two gaped contigs ? Would you expect this approach to work in every occasion ? 3

- (i) What kind of inheritance pattern is reflected in the pedigree ?
- (ii) Give the genotype of each of the following persons : II-1, II-3, III-2, III-4
- (iii) What sort of genetic cross is represented by the if there is marriage between II-1 and II-2 ?
- c) What do you mean by “penetrance” and “expressivity”? Provide examples. 2
7. (a) What is the genetic basis of the linkage map ? Explain how Sturtevant came up with the idea of constructing genetic map based on the recombination frequency ? 3
- (b) Following phenotypic data were obtained from a test cross progeny in *Drosophila melanogaster*

	Phenotypes	Number
1.	+ m +	218
2.	W + f	236
3.	+ + f	168
4.	w m +	178
5.	+ m f	95
6.	W + +	101
7.	+ + +	3
8.	W m f	1
	Total	1000

Construct a genetic map.

5

[Turn over

9. or

- a) “A global analysis of gene expression can be accomplished by using a DNA microarray.” What is a DNA microarray? How DNA microarrays are used for studying gene expression? 3
- b) What do you mean by “probe set” in a microarray experiment. Briefly explain why a combination of perfectly matched and a mismatched oligonucleotide is used to design such a probe set. 2
- c) You have identified a new protein in *Saccharomyces cerevisiae*. A preliminary biochemical analysis indicated that this protein can act as transcription activator because it has a putative homeo domain and a stretch of poly-glutamine towards the c-terminal end of the primary sequence. Suggest an experiment to identify the putative target genes of this newly identified transcription activator in genome wide scale. 5

synthetic minimal medium supplemented with one of the tyrosine, tyrosine, tryptophan or phenylalanine, but none of them support their growth on SD/minimal medium. Describe experimental strategy to

- i) Find out whether all 37 mutant strains belong to one single variety of mutation or belong to more than one classes? 3+3
- ii) If they do not belong to one class how would you assign the number of classes these mutations belong to? 3+3
- b) Write Short notes on any two from the following: 2×2
- i) Synthetic Lethality
- ii) Suppressor Mutation
- iii) Epistasis
- iv) One-gene one enzyme hypothesis
5. (a) Provide an evidence that crossing over involves breakage and rejoining of strands of two non-sister homologous chromosomes. 5
- (b) Vermilion eye colour in *Drosophila* is determined by the recessive allele *v* of an x-linked gene; the wild type eye colour produced by the *v*⁺ allele is brick red. What phenotypic ratios are expected from the crosses (a)

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- iii) What is the function of electron multiplier in mass spectrometry ? 2
- iv) Following is the amino acid sequence, subjected to tryptic digestion for mass spectrometric analysis. Write down the different peptide fragments that you would get after tryptic digestion of the following peptide. 2

REVEALGKIGGGANTRGYEVALVNITKFWMCSMVALPGMSWFRH

GROUP - C

Answer **any four** from the followings

13. For high frequency gene transfer in conjugation, the donor cell should be Hfr. Is there any specific genetic requirement for the recipient F⁻-cell ? Why cannot the transducing P1 phage go back to the lytic mode of development. 10
14. Answer **any four** : 21/2×4=10
- a) Describe briefly how did Jacob and Wollman show that *E coli* chromomome is circular ?
- b) The lambda transducing phage maintains one copy in *E coli* and so does the P1 transducing phage. Explain, which one would be more damanding on the replication machinery of the host.

[3]

PART - II

Answer **any 3** questions

2. a) Give the prople genotypes of the following pairs of parents with respect to the A, B, O Blood type alleles.
- i) An A type father and an O type mother who have one child with blood type O
- ii) An AB type father and an A type mother who have one child with blood with type B and another one with blood type A 3
- b) Briefly describe the experimental outline of Morgan's experiment with *Drosophila melanogaster* which displayed a deviation from independent assortment and led to the discovery of linkage. Make sure you mention both the experiments. 4
- c) Mention what are the major advantage of using *Neurospora crassa* as genetic model organism ? 3
3. a) Two black guinea pigs ware mated and over several years produced 29 black and 11 white offspring. Explain these result, giving genotypes of the parents and progeny. 2
- b) In humans, PKU (Phenylketonuria) is a disease caused by the insufficienct of Phenylalanine hydroxylase which

[Turn over