

M.Sc. (Biotechnology) Examination, 2023
Advance Molecular Biology and Genetics
PAPER: SC/BT/PG/231T

Full Marks - 40

Time - 2 hours

Group A

Answer Question Number 1 and any four questions from the rest

Q. 1. Answer any five questions**1 X 5 = 5**

- (a) What does it mean when an organism is said to "breed true" for a trait? What does this mean in terms of the organism's genotype?
- (b) What is the role of U2AF 65/35 protein in the splicing reaction?
- (c) Linkage analysis in a hypothetical organism leads to the conclusion that the organism has eight linkage group. How many chromosomes the organism is expected to have in its body cell?
- (d) Briefly explain what is a 'Molecular Marker'? How the molecular marker can be used to make genetic map?
- (e) Indicate whether the following statement is true or false: Poly(A) polymerase is an enzyme that requires a DNA template.
- (f) What should be two essential criteria of a bacterial strain to act as a "donor" strain in the bacterial conjugation?
- (g) Why is the Mediator Complex only required for transcription *in vivo*, but is dispensable *in vitro*?
- (h) What kind of plaque you would expect to see if a strain of bacteriophage λ carries a mutation in *cIII* gene?
- (i) What is the major difference between generalized and specialized transduction?
- (j) Why 'self-splicing' reaction does not require any ancillary proteins/factors?

2. (a). In humans, the genotypes DD and Dd are Rh positive (Rh^+), and dd is Rh negative (Rh^-).

- (i) If a Rh^+ man and a Rh^- woman gave birth to a Rh^- child, what would be the genotype of the man?
- (ii) If a Rh^+ man and a Rh^- woman had six children, all of whom were Rh^+ , what would be the genotype of the man?

2

(b) In certain Norwegian families there is an inherited condition known as "woolly hair". Individuals showing this characteristics have hair which resembles sheep's wool. A study of family pedigrees shows that a person never has woolly hair unless at least one parent also has woolly hair. How would this character most likely be inherited? Explain.

3

3. Signed bristle (sn), cross vein less wings (cv) and vermilion eye colour (v) are due to recessive mutant alleles of three sex-linked genes in *Drosophila melanogaster*. When a female heterozygous for each of three genes was test crossed with a signed, cross vein less, vermilion male, following progenies were obtained:

<u>Phenotypes</u>	<u>Number</u>
Signed crossveinless vermilion	3
Cross vein less vermilion	392
Vermilion	34
Crossveinless	61
Signed crossveinless	32
Signed, vermilion	65
Signed	410
Wild type	3
Total	1000

- (i) Determine the relative order of these genes on the chromosome and map distance.
 (iii) Is there any crossover interference? If yes, how much?

5

4. (a) Provide an evidence that crossing over involves breakage and rejoining of strands of two non-sister homologous chromosome. 3

(b) Two black guinea pigs were mated and over several years produced 29 black and 11 white offspring. Explain these results, giving genotypes of the parents and progeny. 2

5. (a) The following table summarizes the result of a cross between two strains of *Neurospora* having the alleles A and a respectively. The table shows the different patterns of octad arrangements and the number of ascus observed of each type:

	<u>Octads</u>					
	A	a	A	a	A	a
	A	a	A	a	A	a
	A	a	A	a	A	a
	A	a	a	A	a	A
	A	a	a	A	a	A
	a	A	A	a	a	A
	a	A	A	a	a	A
	a	A	a	A	A	a
	a	A	a	A	A	a
Number of ascus observed	176	164	13	17	16	14

Total = 400

3

Deduce the map distance of the allele A/a with respect to centromere.

(b) Explain why bacteriophage λ always carries either one of the gal or bio genes, whereas the bacteriophage P1 carry any host genes during the transduction? 2

6. (a) What is the role of Pol II CTD phosphorylation in the regulation of transcription and RNA processing? 3+2=5
- (b) Compare the self-splicing reactions carried out by group I and group II introns. Which one is most similar to the reaction carried out by the spliceosome on pre-mRNAs? Are these self-splicing introns enzymes? Why or why not? 3+2=5
7. (a) Is it possible to infect an *E. coli* (λ) lysogen (in which bacteriophage λ remains in the lysogenic state) with another bacteriophage λ . Explain the reasons in favor of your response. 2
- (b) To establish lysogeny, which genes of bacteriophage λ need to be co-expressed? Justify your response. 2
- (c) "Among the three phages, λ , P22 and P1, it is P1 which contributed maximally in causing genetic diversity in the bacterial kingdom" - Justify the statement. 1
8. (a) Which events are carried out during the maturation event at the 3'-end of the mRNAs? List the proteins/factors that are involved in this process. 2
- (b) Explain what is "Exon-Definition". How this process forms the basis for carrying out alternative splicing? 3
9. (a) Describe how "Chi" sites protect *E. coli* from the infection by bacteriophages? 1
- (b) Describe how different activities of RecBCD enzyme are altered after encountering Chi site that eventually produces a 5'-recessed 3'-extended termini for recognition by RecA protein. 2
- (c) Describe the two types of RNA editing, outlining the different steps involved in each of them. Which of these involves the most significant changes in the mRNA sequence? 3

[Turn over

Group-B

10. What are the causes and consequences of non-disjunction? Write one difference between pericentric and paracentric inversion of chromosome. (2+1 = 3)

OR

Differentiate between Down's Syndrome and Klinefelter's syndrome. (3)

11. What do you mean by Robertsonian Translocation of chromosomes? Explain in brief. (1+2 = 3)

OR

Write briefly about the role of SRY gene in determining the sex of human being. (3)

12. Write one difference between miRNA and Lnc RNA. Write briefly about nuclear processing of pri-miRNA to pre-miRNA. (1+2 = 3)

OR

Based on their localization in the genome what are the different types of Lnc RNA. Explain in brief. (3)

13. Write the role of release factors in termination of eukaryotic translation. What is circularization of mRNA during eukaryotic translation? (2+1 = 3)

OR

Describe briefly the role of different eukaryotic initiation factors in the formation of 43S pre-initiation complex during translation. (3)

14. What do you mean by enhancer and repressor in eukaryotic gene expression? How do enhancers work if they are present far away from the promoter? (2+1 = 3)

OR

How acetylation and methylation of Histone protein regulates gene expression? DNA methylation at promoters usually inhibits the transcription of eukaryotic genes. Mention the site of methylation of DNA. (2+1 = 3)