

This question paper contains 7 printed pages.]

Your Roll No.

1375

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B.Sc. (Hons.)/III
BIOCHEMISTRY—Paper XI
(Molecular Biology—I)

(Admissions of 2000 and onwards)

Time : 3 Hours

Maximum Marks : 60

*(Write your Roll No. on the top immediately
on receipt of this question paper.)*

*Attempt Five questions in all, including
Question No. 1 which is compulsory.*

1. (A) Indicate whether each of the following statements is **true or false**. If you think it is false, explain why.
 - (i) $5' \rightarrow 3'$ processivity of DNA polymerase necessitates the use of telomerase in eukaryotes.
 - (ii) Linkage is always incomplete and genes on the same chromosome can switch between homologous chromosomes.
 - (iii) Bacterial transposable elements transpose by a cut – and paste mechanism.

[P.T.O.]

- (iv) A Chi square Value lower than the critical value demonstrates that the hypothesis is correct.
- (v) All DNA repair pathways require DNA polymerase.
- (vi) In a rare blood group referred to as the Bombay phenotype individuals are unable to attach the A or B antigens to their RBC. They are homozygous recessive for the gene 'H' and their blood group is type 'O' regardless of their ABO genotype. This is an example of epistatic interaction.
- (vii) Mis sense mutations do not have a significant effect on protein function as they affect only a single amino acid.
- (viii) Resistance to sudden death syndrome (SDS) is inherited as a dominant condition. In some cases, individuals that are not resistant to SDS (but whose parents were) can pass on the trait to their progeny. This is due to variable expressivity of the trait.

8

(B) . Answer the following questions :

- (i) If you mix together an equal number of F^+ and F^- cells, how would you expect the proportions to change over time ? 1
- (ii) If a eukaryotic chromosome has 25 origins of replication, how many replication forks does it have at the beginning of DNA replication ? 1

(iii) Differentiate between Euchromatin and heterochromatin. 2

(iv) Predict the sex of *Drosophila* with the following chromosome constitution :

(a) $4X + 4A$ (b) $1X + 2A$

(c) $3X + 4A$ (d) $2X + 2A$

Where, A = haploid set of autosomes 2

(v) Why do DNA ligases need another source of energy (NAD^+ or ATP) to join two nucleotides, but DNA polymerase needs nothing more than the incoming nucleotide and the existing DNA strand ? 1

(vi) For an individual expressing a dominant trait, how can you tell if it is a heterozygote or homozygote ? 1

2. (A) What is the effect of the following on DNA structure ?

(i) Low Humidity (ii) High pH (iii) Decrease in ionic strength 3

(B) DNA replication is amazingly accurate :

(i) Why there is a need to maintain high fidelity ?

(ii) How is it accomplished (at least 2 ways) ? 6

(C) A variety of compounds inhibit topoisomerases. Some such as novobiocin and ciprofloxacin are effective antibiotics while others (doxorubicin) are anti-cancer agents. Why they can't be used interchangeably ? 2

3. (A) Consider the cross $AaBb \times AaBb$. If trait A exhibits complete dominance and trait B exhibits incomplete/partial dominance, what phenotypic ratio is expected in the offspring? 2
- (B) (i) Explain why maternal effect genes exert their effect during the early stages of development. 1½
- (ii) Compare extra nuclear inheritance and maternal effect. 2
- (C) Highlight the similarities and differences between nucleotide excision repair system and mismatch repair systems. 5½
4. (A) (i) Differentiate between LINES & SINES. 3
- (ii) What is the basis of trinucleotide expansion. 2
- (B) Assume that the frequency of PKU (a recessive disorder) in your state is 1/2500. What is the frequency of PKU allele in this population? 2
- (C) Name the different mechanisms used to equalise the level of X-linked gene expression in the two sexes. Give details of how dosage compensation is achieved in mammals. 4
5. (A) If 2 genes are more than 50 map units apart, how can you experimentally show that they are on the same chromosome? 2

- (B) Two genes in groundnut are 65 map units apart; normal number of leaves (Lf) is dominant to leafy (lf) and normal fruit (F) is dominant to fasciated fruit (f).

A true breeding plant with normal leaves and fruit was crossed to a leafy plant with fasciated fruit. The F_1 offspring were test crossed. This cross produced 800 offspring. What are the expected number of plants in each of the four possible categories ?

3

- (C) Write a note on lethal alleles.

3

- (D) From the fungal cross :

$arg-6^- . al-2^- \times arg-6^+ . al-2^+$

What will be the spore genotype in unordered tetrads that are :

(i) Parental ditype (PD)

(ii) Tetra type (T)

(iii) Non-parental ditype (NPD)

3

6. (A) What is the difference between a selected marker and a counter selected marker ? Why are both necessary in analysing the progeny of an $M_{fr} \times F^-$ mating ?

3

- (B) In a generalised transduction experiment, phages are collected from an *E. coli* donor strain of genotype $cys^+ leu^+ thr^-$ and used

to transduce a recipient of genotype $cys^- leu^- thr^-$. Initially the recipient population is plated on a minimal medium supplemented with leu and threonine. Many colonies are obtained.

- (i) What are the possible genotypes of these colonies ?
- (ii) These colonies are then replica plated onto 3 different media :
 - (a) minimal + threonine only
 - (b) minimal + leucine only
 - (c) minimal.

What genotypes could in theory, grow on these three media? 3

- (C) Explain by taking two examples how gene interaction can result in modified dihybrid ratios. 3
 - (D) What are the two mechanisms by which Down's Syndrome can be passed on to the progeny. 2
7. (A) In the Meselson and Stahl experiment, what percentage of DNA is labelled with light nitrogen (N^{14}) after 3 generations of replication? $1\frac{1}{2}$
- (B) What is the role of DNA pol I of *E. coli*? How does it catalyse nick translation? 4
 - (C) Explain the cis-trans test of allelism. Differentiate between inter- and intra- cistronic complementation. $3\frac{1}{2}$

- (D) Prader-Willi and Angelman Syndrome are both associated with deletions of the same bands from the long arm of chromosome 15. However, the physical expression associated with each disorder is very different, why ? 2
8. (A) Give the key features of the Holiday model of recombination. Indicate the role of the various enzymes required. 5
- (B) Briefly describe the steps by which a duplex DNA, 2 nm in width is packaged to become a chromosome that is 700 nm in width. 6