

U.G. 4th Semester Examination - 2022

MICROBIOLOGY

[HONOURS]

Course Code : MB-H-CC-L-08

(Microbial Genetics)

Full Marks : 40

Time : 2 $\frac{1}{2}$ Hours*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.*1. Answer any **five** of the following questions:

2×5=10

- a) Mention the function of P element in *Drosophila*.
- b) If 10^6 phage are mixed with 10^6 bacteria and all phage adsorb, what fraction of bacteria will not have a phage? Explain.
- c) Which of the following base-pair changes are transitions, and which are transversions?
 - (i) AT → TA; (ii) AT → GC
- d) How can tautomerization cause mutation?
- e) What are the *tra* genes of F?

- f) Does a composite transposon necessarily have terminal inverted repeats?
- g) What argument was used by Avery and co-workers to rule out protein or RNA as the genetic material?
- h) How does an Hfr cell differ from an F⁺ cell?

2. Answer any **two** of the following questions:

5×2=10

- a) A particular bacterial mutant cannot use lactose as a carbon source. If a phage adsorbs to such a bacterium and the infected cell is put in a growth medium in which lactose is the sole carbon source, can progeny phage be produced? Explain.
- b) After a brief mating between an Hfr whose genotype is pro⁺ pur⁺ lac⁺ and a recipient whose genotype is F⁻ pro⁺ pur⁻ lac Str^r, many lac⁺ pur⁺ pro Str^r recombinants are found. A few pro⁺ lac⁻ pur⁻ Str^r recombinants also arise, and all of these are Hfr donors. Explain this result and state the location of F in the Hfr. (The three genes *pro*, *lac*, and *pur* are near one another.)

[Turn Over]

- c) Genes *p*, *f*, and *q* have times of entry of 7, 11, and 19 minutes. What is the gene order, and what are the map distances, in time units, with respect to the transfer origin?
- d) Explain how insertion of a transposon that lacks a transcription-termination signal can cause genetic polarity.

3. Answer any **two** of the following: $10 \times 2 = 20$

- a) A fluctuation test was carried out to estimate the mutation rate of an *E. coli* locus conferring resistance to phage T 1. If 5 of the 12 small independent cultures contained no phage-resistant mutants after growth of the cultures was completed and the average number of bacterial cells per culture was 5×10^8 , what is the estimated rate of mutations to T 1 resistance? An Hfr strain transfers gene in alphabetical order. Would you expect to obtain F'y plasmids lacking gene *z*? $7 + 3$
- b) An *Amp^r* plasmid whose replication is temperature-sensitive is introduced into an Amps cell by the CaCl_2 transformation method. After growth for several generations, 107 cells are plated on agar containing ampicillin at 42°C.

Fifty colonies form. (i) Give three mechanisms that could explain the presence of these colonies. (ii) Which mechanisms would not occur in a *RecA⁻* cell?

On EMB-lactose agar *lac⁺* and *lac⁻* colonies are purple and white, respectively. If several thousand F1 *lac⁺/lac⁻* cells are plated, a few sectorial colonies appear. This may have a purple half and a white half or a wedge of white in a predominately purple colony. Sectorial colonies that are predominately white are not found. Explain the cause of such sectoring.

$(5 + 1) + 4$

- c) i) A *Lac⁻* bacterial strain has a *dnaA* (Ts) mutation, which prevents colony formation at 42°C. An F'*lac⁺* plasmid is introduced into the strain by conjugation. The culture is grown for many generations at 30°C, and then 106 cells are plated at 42°C. A few colonies arise, and these are capable of growth at both 30°C and 42°C.
 - I) Are these colonies *lac⁺* or *lac⁻*?
 - II) Do the cells still carry the *dnaA* (Ts) mutation?

III) What feature of the cells has changed that enables them to grow at 42°C?

IV) Can the cells grow at 42°C in the presence of acridine orange?

ii) A transformation experiment is done in which the donor strain is $A^+B^-C^+$ and the recipient is $A^-B^+C^-$. In one part of the experiment, A^+ cells are selected, and 250 are tested further. The associated unselected markers and the number of each genotype are: B^-C^+ , 12; B^-C^- , 3; B^+C^+ , 100; B^+C^- , 135. In the second part of the experiment, C^+ transformants are selected, and 250 of these are also tested. The unselected genotypes and their numbers are: A^+B^- , 17; A^+B^+ , 85; A^-B^- , 13; A^-B^+ , 142. What is the order of the three genes? 4+6

d) i) A competent culture of *S. pneumoniae* is mixed with [^{14}C] DNA having a radioactivity of 10^4 counts per minute. After 5 minutes, the cells are centrifuged. No acid-precipitable radioactivity can be found in the supernatant fluid. (Recall that

only nucleic acid polymers are acid precipitable; nucleotides are not.) How much radioactivity do you expect to find associated with the cells?

ii) How does auxotrophic mutant help to select yeast recombinant cell? 5+5
