



RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

Bachelor of Science Honours in Microbiology
Fourth Year - Semester I Examination – July/ August 2023

MIB4207 – MICROBIAL GENETICS

Index No.....

Time: Two (02) hours

Answer ALL questions.

1. Select the most appropriate response for the each of following parts (a to r) and underline it. (100 marks)

- a) Following is a list of scientists and the concepts they developed.
Select the correct combination.
- i. Lederburg and Tatum: One gene, One enzyme
 - ii. Beadle and Tatum: Cistron
 - iii. Benzer: Conjugation in *E. coli*
 - iv. Hershey and Chase: DNA is the heritable material
- b) Select the **incorrect** statement on DNA packaging in to the cells or nucleus of the cell.
- i. Nucleosomes consist of two each of four different proteins with DNA looped around those.
 - ii. Linker DNA joins the nucleosomes.
 - iii. Both prokaryotic and eukaryotic DNA are organized into nucleosomes.
 - iv. Prokaryotic DNA is compacted by supercoiled DNA domains joined by core proteins.
- c) The uptake of DNA from a bacterial cell's environment is called _____ and it is a means of _____ gene transfer.
- i. transformation, vertical
 - ii. transduction, vertical
 - iii. transformation, horizontal
 - iv. transformation, horizontal
- d) Complementation of mutated characters in bacteria depends on the following principles, **except**
- i. The wild type can grow on a minimal medium.
 - ii. Growth of auxotrophic mutants requires corresponding growth factors in the medium.
 - iii. When two different auxotrophic mutants of a bacterium are mixed together, some cells gain the ability to grow on minimal media.
 - iv. Complementation is possible only through conjugation.

- e) The recipient cell in a conjugating pair of bacteria changes to a donor cell when the donor is
- a F⁺ cell.
 - either F⁺ or F' cell.
 - an HFr cell.
 - either HFr or F'
- f) Bacteriophage DNA and plasmids share many common features, **except**
- both can replicate independent of the chromosomal DNA.
 - both can be transferred to other host cells.
 - both facilitate genetic transfer from a host cell to another cell.
 - both exist only as dsDNA.
- g) Replica plating
- is a negative screening technique which can be used to screen tet^s mutants.
 - is a negative screening technique which is used to screen the tet^r wild type.
 - a positive selection method which can be used to select auxotrophic mutants.
 - a positive selection method which can be used to select defective bacteriophages.
- h) Transposable elements are mobile genetic elements
- that can move from one location in a the genome of a cell to a location in the genome of another cell.
 - that are uniquely found in prokaryotic organisms.
 - that can detach from its position or make a copy before they transpose.
 - that integrate in to a different position of the genome using homologous recombination.
- j) Select the **incorrect** response.
- The "One gene – one enzyme" hypothesis changed to "one gene – protein" and then to "one cistron – one polypeptide" for several reasons, including
- proteins having other functions than catalytic function.
 - proteins having more than one polypeptide.
 - cistrons having more than one gene in them.
 - a cistron is synonymous with a gene.
- k) A silent mutation can only be detected by
- replica plating.
 - DNA sequencing.
 - complementation.
 - positive selection.
- l) Select the **incorrect** statement on integrons from the following.
- Integrons are genetic elements that carry multiple gene clusters called gene cassettes.
 - Integrons are responsible for transfer of gene clusters of antibiotic resistance.
 - Each gene cassette has its own promoter.
 - Inserted genes are expressed by an integron-encoded promoter.

- m) An inducer is a small effector molecule
- which binds to a repressor to increase the affinity of the repressor to DNA binding.
 - that induces the activity of a corepressor.
 - which regulates expression of a gene by negative control by binding to an activator.
 - which binds to an activator protein increasing its binding to an inducible promoter.
- n) Select the correct response regarding the lac operon and the trp operon.
- In the presence of lactose, the repressor is activated and binds to the operator of the lac operon.
 - In the presence of tryptophan, the repressor is activated and binds to the operator of the trp operon.
 - The lac operon is also induced by cAMP by binding to an activator protein in the presence of glucose.
 - The lac operon is expressed either when glucose is absent or when lactose is present.
- o) Common features shared by fission yeast and budding yeast include
- having haploid and diploid vegetative stages.
 - being able to switch between mating types.
 - having four-celled asci.
 - being able to carry out fermentation as well as aerobic growth.
- p) Pattern Ab AB ab aB in an ordered tetrad resulted after a cross α Ab X aB, where the two genes reside on the same chromosome in *Schizosaccharomyces pombe*. This pattern may be due to
- double crossover and segregation in meiosis I.
 - single crossover or double crossover and segregation during meiosis I.
 - single crossover and segregation during meiosis II.
 - single crossover or double crossover and segregation during meiosis II.
- q) If α m1 X a m2 cross in *S. pombe* resulted in a $\frac{\alpha m1M2}{a M1m2}$ diploid with wild type phenotype, this is an example for having the mutations in
- the same gene and complementation.
 - different genes and complementation.
 - the same complementation group.
 - the same cistron.
- r) In the genetic control of heterocyst differentiation,
- reduction of cellular concentration of 2-oxoglutarate provides a key signal.
 - the ntcA gene is repressed due to nitrogen deprivation.
 - ntcA mutants are not sensitive to elevated levels of 2-oxoglutarate.
 - once initiated cannot be reversed.

2. Answer **ALL** parts (a – g) in the space provided. (100 marks)

a) Genetic transfer in prokaryotes is **unidirectional**, resulting in a **merozygote**.

Elaborate this statement emphasizing the highlighted words. (09 marks)

.....

.....

.....

b) What would be the fate of an exogenote when it (15 marks)

i. has a complementary sequence with the host DNA?

.....

.....

ii. has no complementarity with host DNA and has an Ori?

.....

.....

iii. has neither complementarity nor Ori?

.....

.....

c) Illustrate the process of formation of an F' plasmid loaded with *leu*, using labelled diagrams only. (28 marks)

d) Deduce the genetic map of the markers *leu*⁺ *ile*⁻, *gly*⁺, *tet*^s, using the following information.

The genotype *leu*⁺, *ile*⁻, *gly*⁺, *tet*^s, of F⁻ cells population has been changed as follows after allowing conjugation with an HFr having *leu*⁻, *ile*⁺, *gly*⁻, *tet*^r for the indicated time in an interrupted mating experiment. (16 marks)

<i>leu</i> ⁺ , <i>ile</i> ⁻ , <i>gly</i> ⁺ , <i>tet</i> ^s	10 mins
<i>leu</i> ⁺ , <i>ile</i> ⁺ , <i>gly</i> ⁺ , <i>tet</i> ^s	17 mins
<i>leu</i> ⁻ , <i>ile</i> ⁺ , <i>gly</i> ⁺ , <i>tet</i> ^r	32 mins
<i>leu</i> ⁻ , <i>ile</i> ⁺ , <i>gly</i> ⁻ , <i>tet</i> ^r	56 mins

.....

- e) List **four (04) natural** functions of bacterial plasmids. (16 marks)

.....

.....

.....

.....

- f) State the function of each of the following. (08 marks)

i. OriV:

ii. OriT:

- g) State **two (02)** contrasting features of specialized transduction and generalized transduction. (08 marks)

Specialized transduction

i.

ii.

Generalized transduction

i.

ii.

3. a) Relate the structure of IS elements to the mechanism of transposition (exact sequences are not expected). (60 marks)

- b) Give a comparative account of the structure of composite and noncomposite transposons. (40 marks)

4. a) Discuss the process of Rolling Circle Replication in F plasmid in bacterial conjugation. (55 marks)

- b) Describe how the Ames test is performed and its application. (45 marks)

--- END ---