M.A./M.Sc.Examination, 2018

Semester - III

Mathematics

Optional Course: MMO-31 (A9) (New)

(Mathematical Pharmacology-I)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.
Notations and symbols have their usual meanings unless otherwise stated.
Answer ***any four***questions.

1. a) Define mass action law and hence obtain the relation between the concentration of drug applied and the proportion of receptor occupied at equilibrium. 1+3
   b) Define the efficacy of a drug. Using rate theory, prove that the equilibrium response $\gamma = \phi \frac{k_2 x}{x + k_2/k_1}$, k_1 is the association rate constant, k_2 is the dissociation rate constant, x is the concentration of drug applied and ϕ is a constant. 2+4

2. a) Derive the equation for simple monovalent cell surface binding. Solve the model equation in case of constant ligand concentration. 1+3
   b) Write down the model equations that exhibit interconversion of complex states with varying rate constants, and obtain the transient solutions for complexes. 2+4

3. a) Determine the mean capture time for receptor molecules to move from the vesicle into the endosome tubule in the absence of membrane current. 4
   b) Write down the base model for endocytosis. Obtain the steady-state solution for the total number of surface receptors in the absence of ligand. 3+3

4. a) Formulate a mathematical model in which monovalent ligands bind with monovalent receptors within a single endosome. Nondimensionalise the model equations. 2+2
   b) Define receptor cross-linking. Neglecting endocytic trafficking, obtain the steady-state solutions in case bivalent ligands bind with monovalent receptor on the cell surface. 2+4

5. a) Derive Fick's second law of diffusion. 4
   b) Solve one dimensional diffusion equation with no solute elimination or generation using appropriate initial and boundary conditions in cylindrical coordinate system. 6

6. a) Solve one dimensional diffusion equation in Cartesian coordinate system with elimination. 4
   b) Define:
      i) Mass and molar concentration.
      ii) Mass average and molar average velocity. 6

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