



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Studies on controlled drug release and drug transport are important in the realm of pharmacokinetics for the development of medical treatment. The present dissertation aims to begin with a comprehensive mathematical model for drug release from microparticles to the adjacent tissues. In order to study the whole process, a two-phase mathematical model describing the dynamics of drug transport in two coupled media is presented. Drug release is described taking into consideration both solubilisation dynamics of drug crystallites and diffusion of the solubilised drug through the microparticle. The advocated model points out the influences of diffusion, mass-transfer and reaction parameters, which are the main architects behind drug kinetics across two layers.

The second work provides an appropriate mathematical model for drug release from a porous polymeric matrix to biological tissues through endocytosis. In order to establish the potency of the model, the simulated results are compared with the existing experimental data. A quantitative analysis is carried out through numerical simulations in order to illustrate the behaviour of drug concentrations with time under various situations.

The next work is concentrated on the formulation of mathematical model elucidating degradation of drug loaded polymeric matrix followed by drug release to the adjacent biological tissues. Polymeric degradation is modelled with mass conservation equations. Drug release phenomenon is mathematized by considering solubilisation dynamics of drug particles, diffusion of the solubilised drug through polymeric matrix along with reversible dissociation / recrystallization process.

Subsequently, the fourth study leads to another updated mathematical model illustrating the integrated kinetics of drug release in a polymeric matrix and its ensuing drug transport to the encompassing biological tissue. The model embodies drug diffusion, dissolution, solubilisation, polymer degradation and dissociation / recrystallisation phenomena in the polymeric matrix accompanied by diffusion, advection, reaction, internalization and specific / non-specific binding in the biological tissue. The model simulations deal with the comparison between a drug delivery from a biodegradable polymeric matrix and that from a biodegradable one.

Furthermore, the fifth endeavour is to include liposomal drug delivery in order to wisely modulate the targeted drug delivery system. Temperature-sensitive liposomes function as prospective weapons to combat toxic side effects corresponding to direct infusion of anticancer drugs. The main objective of the present study is to model liposomal drug release, subsequent drug transport in solid tumour along with integrated actions of tumour cell surface and endosomal events. The proposed model and the simulated results act as tools in designing a more effective drug delivery system for cancerous tumours.

Finally, the present dissertation ends with a concluding study of stability analysis for a mathematical model of drug release from polymeric matrix and consequent intracellular drug transport. Modelling of drug release is done through solubilisation dynamics of drug particles, diffusion of the solubilised drug through the polymeric matrix in addition to reversible dissociation / recrystallization process. Furthermore, besides the stability of the proposed model, several sub-models are also studied for their stability criteria. The underlying study confirms the necessity of stability analysis so that advocated mathematical model can effectively complement the real physiological behaviour of pharmacokinetics.