Drug Release from a Biomaterial

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Biomaterial matrices for drug release are useful for in vivo tissue regeneration. The following example describes the release of a drug from a biomaterial matrix to damaged cell tissue. Specifically, a nerve guide delivers a regenerating drug to damaged nerve ends. The model examines detailed drug-release kinetics with rate expressions handling drug dissociation/association reactions as well as matrix degradation by enzyme catalysis. The enzyme reaction is described by Michaelis-Menten kinetics. With this simulation it is easy to investigate design parameters governing the rate of drug release such as drug-to-biomaterial affinity, biomaterial degradation, drug loading, and of course the influence of geometry and composition of the biomaterial matrix. The model illustrates the use of the Reaction Engineering Lab and the Chemical Engineering Module as powerful modeling tools for bioengineering applications. Model Definition In this model a drug is released into a region containing damaged nerve ends. The biomaterial holding the drug has a cylindrical shape and serves a dual purpose: It acts as a guide to help regenerating nerve cells connect, and it also stimulates the healing process through targeted drug release. The model simulates transient chemical reactions and species transport in a 2D geometry with axial symmetry. Figure shows the full 3D geometry as well as the 2D modeling domain, reduced by axial symmetry and a mirror plane. The subdomains are: • The nerve-cell tissue (Ω1) • The biomaterial matrix (Ω2) • The surrounding medium (Ω3)