Model of antibiotic diffusion in a biofilm

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The diffusion of an antibiotic in a biofilm is a specific process, because bacteria in a biofilm can initiate various defense mechanisms against antibiotic molecules. One of the defense mechanisms is the creation of a diffusion barrier. Bacteria attacked by the antibiotic produce more and more mucus, which causes that the antibiotic diffusion is slowed down. In a very dense biofilm, antibiotic molecules can be stopped. Because the biofilm has a gel-like consistency, we assume that the antibiotic diffusion process is described by the subdiffusion-absorption equation with the Riemann–Liouville fractional time derivative. The boundary conditions at the border between the biofilm and a diffusive medium, where the antibiotic is initially located, have been derived using a particle random walk model in a system with discrete space variable and time [1, 2]. These conditions take a non-standard form because they contain a fractional order derivative. The solutions to equations describing the process will be shown. These solutions coincide with empirical data. Based on the obtained results, we discuss the opportunity to experimentally determine whether absorption occurs in the biofilm if measurement of particles concentration is possible in the diffusive medium only [3]. The absorption coefficient of antibiotic molecules in the biofilm, which can be determinecd experimentally, will be related to the defense intensity of bacteria against antibiotics.

REFERENCE

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