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Modelling conjugation with stochastic differential equations

Conjugation is an important mechanism involved in the transfer of resistance between bacteria. In this article a stochastic differential equation based model consisting of a continuous time state equation and a discrete time measurement equation is introduced to model growth and conjugation of two Enterococcus faecium strains in a rich exhaustible media. The model contains a new expression for a substrate dependent conjugation rate. A maximum likelihood based method is used to estimate the model parameters. Different models including different noise structure for the system and observations are compared using a likelihood-ratio test and Akaike's information criterion. Experiments indicating conjugation on the agar plates selecting for transconjugants motivates the introduction of an extended model, for which conjugation on the agar plate is described in the measurement equation. This model is compared to the model without plate conjugation. The modelling approach described in this article can be applied generally when modelling dynamical systems.

General information
Publication status: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Philipsen, K. R., Christiansen, L. E., Hasman, H., Madsen, H.
Pages: 134-142
Publication date: 2010
Peer-reviewed: Yes

Publication information
Journal: Journal of Theoretical Biology
Volume: 263
Issue number: 1
ISSN (Print): 0022-5193
Ratings:
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.081 SNIP 0.971
Web of Science (2010): Impact factor 2.371
Web of Science (2010): Indexed yes
Original language: English
DOI:
10.1016/j.jtbi.2009.11.011
Source: orbit
Source ID: 251602
Research output: Contribution to journal › Journal article – Annual report year: 2010 › Research › peer-review