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Evaluation of data in terms of two-dimensional random walk model: Interaction between NADH-cytochrome b5 reductase and cytochrome b5

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ABSTRACT

Normally, bimolecular reactions are analyzed in terms of the Smoluchowski theory. However, when one attempts to generalize this analysis to cases where diffusion proceeds in two other than in three dimensions, one soon encounters severe conceptual difficulties. Although kinetic studies of membrane enzymes are generally difficult because the usual kinetic formalism refers to nonaggregated homogenous solutions, a major goal of our research is to define the molecular mechanism(s) by which alterations in membrane-bound substrate contents affect the enzyme activity in the same membrane. For that purpose, a simplified random-walk model was adopted in the present work. The enzyme reaction in the two-dimensional membrane could be calculated theoretically by applying the classical analysis of heat equation. As a result, the theoretical rate equation well accounting experimental findings was derived on the model of the liver microsomal NADHcytochrome b5 reductase reaction. Furthermore, it was found that the modification of the simple rigid-sphere collision theory by including a term called the steric factor was not necessary in this derived equation.

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