工学系研究科専攻間横断型教育プログラム
「機械システム・イノベーション」

最先端融合科学イノベーション
教育研究コンソーシアム

東京大学
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A Numerical Method for the Oxygen Transfer Efficiency in Microcirculatory System at Cellular Scale

Professor Xiaobo Gong

Shanghai Jiao Tong University（上海交通大学）

日 時：2017年3月1日（水）10:30～12:00
場 所：東京大学工学部 2号館 3F 31A会議室

Abstract:
In biomedical applications, understanding the effect of mechanical properties of the erythrocytes on oxygen delivery is important for identifying the biophysical origins of several diseases related to metabolic activities at the cellular level. In order to improve drug delivery efficiency, we also need to understand the effects of the physical and geometric properties of the liposome on the mass transfer rate. Our main objective in the present research is to extend the immersed boundary method for fluid flow problems with mass transfer across permeable moving interfaces, which is well-known for solving fluid-structure interaction problems.
We present an immersed boundary method for mass transfer across permeable deformable moving interfaces interacting with the surrounding fluids based on Huang et al's recent work (Huang, et al, J. Comp. Physics, 228(2009)). One of the key features of our method is the introduction of the mass flux as an independent variable, governed by a non-standard vector transport equation. The flux equation, coupled with the mass transport and the fluid flow equations, allows for a natural implementation of an immersed boundary algorithm when the flux across the interfaces is proportional to the jump in concentration (Gong et al, J. Comp. Physics, 278 (2014))
As an example, the oxygen transfer from red blood cells in a capillary vessel is used to illustrate the applicability of the proposed method. We show that our method is capable of handling multi-physics problems involving luid-structure interaction with multiple deformable moving interfaces and interfacial mass transfer simultaneously.

主催：　東京大学大学院工学系研究科「機械システム・イノベーション」プログラム（GMSI）
「最先端融合科学イノベーション教育研究コンソーシアム」（CIAiS）
本件連絡先：　東京大学大学院工学系研究科機械工学専攻 教授 高木 周
GMSIプログラム事務局 E-mail: office@gmsi.t.u-tokyo.ac.jp Phone: 03-5841-0696