【Grant-in-Aid for Scientific Research(S)】
Integrated Science and Innovative Science (Comprehensive fields)

Title of Project : Computational nano-biomechanics for diagnosis, treatment, and prediction of human diseases

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Research Area : Biomedical engineering
Keyword : Biomechanics

【Purpose and Background of the Research】

We will establish computational nano-biomechanics by modeling multi-scale physical and biomedical phenomena, from the molecular level to the cellular, tissue, and organ levels, and finally to the whole-body level. We will study physiological and pathological conditions at the macro-, micro-, nano-scale in our body, and will develop a new medicine for diagnosis, treatment and prediction of the blood, cardiovascular, digestive, and respiratory diseases.

【Research Methods】

At the molecular level, we will model receptor-ligand interactions. This model will be integrated into cellular level modeling, to investigate thrombogenesis, adhesion of red blood cells infected by malaria, and that of cancer cells. The cellular model will be integrated into multicellular simulations at the tissue level to determine macroscopic properties. We will study flow, mass transport, and infection in small blood vessels. We will also apply our method to the metastasis of cancer cells and bacterial flora in the intestines. Finally, a new continuum model will be developed for simulating flows in large arteries, pulmonary airways and the gastrointestinal tract at the organ level.

【Expected Research Achievements and Scientific Significance】

By establishing computational nano-biomechanics, we will be able to reveal physiological and pathological conditions from mechanical point of view. This will provide a novel tool for clinical treatment, and the reliability of treatment should be improved considerably compared to existing empirics based treatments. Computational nano-biomechanics will also accelerate the development of new medicine, since one will be able to discuss the effects of medicine by computational simulations.

【Publications Relevant to the Project】

Shimogonya et al., J Biomech 42, 550 (2009).
Imai et al., J Biomech 43, 1386 (2010)

【Term of Project】 FY2011-2015

【Budget Allocation】 165, 800 Thousand Yen

【Homepage Address and Other Contact Information】

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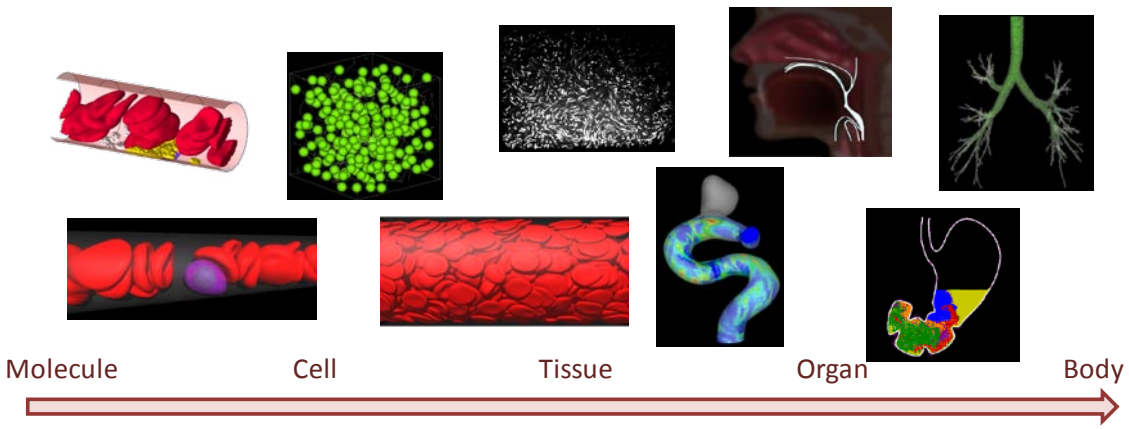

Fig. 1. Computational nano-biomechanics.