

## Adaptive immunity and antibody-dependent enhancement in dengue secondary infection

**Sourav Kumar Sasmal<sup>1</sup> Yasuhiro Takeuchi<sup>2</sup> Shinji Nakaoka<sup>3</sup>**

<sup>1</sup> *Department of Physics and Mathematics, Aoyama Gakuin University,  
Kanagawa 252-5258, Japan*

[sourav.sasmal@gmail.com](mailto:sourav.sasmal@gmail.com), [sourav.sasmal@gem.aoyama.ac.jp](mailto:sourav.sasmal@gem.aoyama.ac.jp)

<sup>2</sup> *Department of Physics and Mathematics, Aoyama Gakuin University,*

*Kanagawa 252-5258, Japan*

[takeuchi@gem.aoyama.ac.jp](mailto:takeuchi@gem.aoyama.ac.jp)

<sup>3</sup> *Faculty of Advanced Life Science, Hokkaido University, Sapporo, Hokkaido,  
060-0810, Japan; PRESTO, Japan Science and Technology Agency, Saitama,*

*332-0012, Japan*

[shinzy.nakaoka@gmail.com](mailto:shinzy.nakaoka@gmail.com)

Dengue is the most common mosquito-borne viral disease and causes a significant number of deaths, mostly in the tropical and subtropical regions. It is caused by the four distinct but antigenically related viruses, known as serotypes, which are transmitted to humans through *Aedes* mosquito. Currently, more than half of the World's population lives in the area where the *Aedes* mosquito present. Due to climate changing, dengue incidence is increasing day by day, and more countries are reporting their first outbreak. The desire to establish the factors determining the disease severity and the growing need for efficient drugs has prompted extensive research interest in within-host viral dynamics. However, very few mathematical models of within-host dengue dynamics pertaining to secondary dengue infection are presently available. To address this gap in the pertinent literature, in this work, a secondary dengue infection model with T - cell mediated adaptive immunity and antibody-dependent enhancement was developed by considering the memory cell and heterogeneous antibody as the main factor. In case of secondary dengue infection, both the virus and homogeneous antibody production are enhanced due to the influence of memory cells remaining from the previous dengue infection. Owing to the high model sensitivity, it was possible to establish that, among antibody-dependent enhancement mechanisms, the increased virus replication inside the infected cell, which increases the overall virus burst size, exerts the maximum effect on disease severity during secondary infection. The obtained results concur with the clinical observations and may be helpful in further research

---

\*Mini-Symposium: Complicated Population Dynamics in Ecology and Epidemiology

on antibody-dependent enhancements aimed at producing schemes relevant for the dengue vaccine design and development.

## References

- [1] S. K. Sasmal, Y. Dong, Y. Takeuchi, *Mathematical modeling on T-cell mediated adaptive immunity in primary dengue infections*. Journal of Theoretical Biology, 429, 229-240 2017.
- [2] S. K. Sasmal, Y. Takeuchi, S. Nakaoka, *T-cell mediated adaptive immunity and antibody-dependent enhancement in secondary dengue infection*. Journal of Theoretical Biology, (under revision).