Draft Project Proposal: Computational Modeling of T cell Receptor Signaling Network in Formalism of Ligand-Binding Reception

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ABSTRACT

The T cell receptor signaling pathway plays a critical role in ligand recognition, T cell - antigen presenting cells interaction and tunability and robustness of activation thresholds[1]. So understanding of the orchestration of T cell receptor signaling network would benefit in all aspects listed above. The conventional research method on cellar signaling is focusing on visualization of intracellular indicators isolatedly. The object of this research is to propose a computational model on T cell receptor signaling network. (Place holder 1: Here will introduce a little bit about how to build the model and what kind of reactions will be included. This part will be made up after further study in recent.) (Place holder 2: Next, I will introduce what modeling language will be used, for example Hybrid Petri Nets and stochastic pi-calculus, but this need to further test.) The computational model on signaling network would help us fully understand the receptor communication mechanism and potentially inspire the machine-recognizable model for finding propitiate ligand-binding .

KEYWORDS

T cell receptor, cellular signal communcation, signaling pathway, ligen-binding , Conputational Models, Mathematical model, stochastic pi-calculus(potential model language)

1 INTRODUCTION

1. Why research on T cell receptor.
T cell receptor plays the most important role in cell-mediated immunity system, not only because it is the discriminator between self and foreign-derived peptides, but also the amplifier on minute differences in amino-acid sequence in its responding translation[2]. However, the T cell receptor and its ligands have great variabilities and mixtures with upstream signals and downstream integration, which requires computational modeling with formal methods to assist understanding of the diverse in their formalism.
2. Conventional methods in responding this(need further research summary)
3. Different from the conventional methods, this paper will present a computational model(maybe more than one) on T cell receptor signaling network. (we may use stochastic pi-calculus(simulation: SPiM), petri nets(Simulation: PIPE2), ODEs solver(Simulation: copasi)....)
4. Introduction on T-cell receptor signaling network: a. early TCR signals; b. signal transduction to the nucleus; c. Costimulation by CD28 family members. (more details introduction on network structure will be provide later)

2 RELATED WORK

1. Traditional research on TCP communication:
- Computational Modeling of T Cell Receptor Complexes: Timothy P. RileyNishant K. SinghBrian G. PierceZhiping WengBrian M. Baker
- Perspectives for Computer Modeling in the Study of T Cell Activation
$https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2869519/pdf/cshperspect-IMS-a005538.pdf$
2. Inspirations:
- Noise Analysis in Ligand-Binding Reception for Molecular Communication in Nanonetworks
$https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=arnumber=5875906$
- Automatic recognition of ligands in electron density by machine learning
$https://github.com/dabrze/CheckMyBlob$
3. Similar precedent
Computational modeling of the EGFR network elucidates control mechanisms regulating signal dynamics: Dennis YQ Wang, Luca Cardelli, Andrew Phillips, Nir Piterman and Jasmin Fisher
$https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2807436/pdf/1752-0509-3-118.pdf$

3 MODEL DESCRIPTION

1. Language 1: Hybrid Petri Nets(Through the lens of communication network, transition rates...)
It has been used to model gene-regulatory networks, biochemical pathways, signal transduction.
2. Language 2: Stochastic Pi-calculus(Through the lens of reactions and rate paprameters)

4 EXPERIMENTAL RESULT AND EVALUATION

(Need further work)

5 CONCLUSION

6 REFERENCE