

Contents

1	Introduction	4
1.1	Introduction to Immunity	4
1.1.1	Two forms of Immunity	5
1.1.2	Cells and molecules of the innate immune system	7
1.1.3	Cells and molecules of the adaptive immune system.	7
1.1.4	Activation of cells of the immune system.	9
1.1.5	Receptors, antigens, and lymphocyte antigen receptors.	10
1.2	T Cell Development	19
1.2.1	Mechanisms for T-cell receptor triggering	22
2	Random Energy Model	30
2.1	Introduction	30
2.2	Direct Evaluation of the Entropy	33
2.3	Modeling and Monte - Carlo Simulation of the T-cell and APC interaction with Random Energy Model	41
2.3.1	Algorithm for simulation of T cell - APC system	44
2.3.2	Specific Entropy of the interaction between T-cell - APC system	46
2.4	Phase transitions in the Random Energy Model and activation of T-cell	49
3	T cell receptor clusters and T cell activation	51
3.1	The immune synapse, T-cell receptor clusters and T cell activation	52
3.1.1	Spatial and Temporal Dynamics of T-cell and APC interaction	54
3.2	Modeling the interaction between TCR -pMHC in clusters	56
3.3	Simulation Algorithm	58
3.4	Generation Time and Inverse Temperature	58
3.4.1	Free energy with respect to generation time (\tilde{T}).	62
3.4.2	Behavior of free energy with respect to cluster size.	65

3.4.3	Behavior of free energy with respect to variance of the random energy distribution.	68
3.4.4	Behavior of free energy with respect to \tilde{T} with variable interaction between clusters.	70
4	Random Energy Model in Recognition of altered peptide ligands by T-cells	73
4.1	Interactions within a subdomain of the TCR	78
4.2	Interaction between subdomains of the TCR	79
4.3	Indirect Interactions between the TCR and the pMHC - complex	80
4.4	Direct Interactions between the TCR and pMHC	80
4.5	The T - Cell Maturation Process	81
5	Discussion and Conclusions	86
6	Appendix	90