Mathematical modeling of immunopathogenesis of rheumatoid arthritis

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Rheumatoid arthritis is a systemic autoimmune disease characterized by the joint inflammation and the cartilage destruction. Autoreactive B lymphocytes represent integral elementsof the pathophysiology of rheumatoid arthritis. Immune balance between the effector and the regulatory T cell subsets guide the production of autoantibodies by B lymphocytes and, therefore, play a cardinal role in disease severity. While targeted therapeutic approaches are successfully emerging in medical practice, refinedpersonalized analyses of T and B lymphocyte subsets in patients with rheumatoid arthritisare critically needed for rigorous disease management.

Mathematical models of immune mediated disorders provide an analytic framework in which we can address specific questions concerning disease immune dynamics and the choice of treatment.Herein, we present a novel mathematical model that describes the immunopathogenesis of rheumatoid arthritis using non-linear differential equations. The model exploresthe functional dynamics of cartilage destruction during disease progression, in which a system of differential equationsdeciphers the interactions between autoreactive B lymphocytes and T helper cells. Immunomodulatory relationbetween pro-inflammatory and regulatory T lymphocyte subsetsis also solved in these equations. Of importance, our model provides a mechanistic interpretation of targeted immunotherapy which deals with the intervention of pathophysiological immune processes in rheumatoid arthritis.

In conclusion, we propose a novel mathematical model that best describes the immunopathogenic dynamics in patients with rheumatoid arthritis and, therefore, may take a rapid pace towards its implementation in biomedical and clinical research.

References:

[1] JM. Murray: *Mathematical Biology*, 2nd ed. Springer Verlag, 1993.

[2] L.G. de Pillis, A.E.Rudinskaya, C.L.Wiseman: A Validated Mathematical Model of Cell-Mediated Immune Response to Tumor Growth Cancer, *Cancer Res.,* 65 (2005), 7950-7958.

[3] L.G. de Pillis and A.Rudinskaya: A Mathematical Tumor Model with Immune Resistance and Drug Therapy: an Optimal Control Approach, *Journal of Theoretical Medicine*, 3 (2001), 79-100.