MATH MODELING OF INFECTIOUS DISEASE (ACUTE FORM) USING GOOGLE DOCS SPREADSHEETS

Melanchuk T. V., Velma S. V.
Scientific supervisor: Velma S. V.
National University of Pharmacy, Kharkiv, Ukraine
0679267726.lana@gmail.com

Introduction. Today mathematical modeling is the priority direction in the studies of the new and rapidly developing science of infectious immunology that describes the processes of an organism's defense against antigen invasions. Aspects of an organism's defense against viral and bacterial infections and the reaction of immune system to infection are the main problems in practical immunology. Understanding of regularities in immune response provides the researchers and clinicians new powerful tools for the stimulation of the immune system and for increasing its efficiency in the struggle against antigen invasion. In this connection, the construction of mathematical models of immune response to an antigen irritant is considered as the only right tactics in the cognition of the above regularities.

The **aim** of the work is to develop the simple mathematical model of acute form of infectious disease based on an equilibrium relation for each component that participates in an immune response (antigen, antibody, plasma cell, and degree of damage of an organ subjected to antigen attack); and to realize this mathematical model using Google Docs Spreadsheets.

Materials and methods. The mathematical model of acute form of disease have to represent the main theoretical conceptions on the defense system of organism and the basic immunological models. Really, in designing the simplest model of immune defense we have used the main conception of immunology: an antibody binds an antigen and forms antibody-antigen complexes. In proportion to the quantity of these complexes, plasma cells are formed in an organism in a time (t) which carry out the mass production of antibodies. The quantity of plasma cells forming in response to antigenic stimulation depends on the viability of the affected organ: the more severe is the damage to this organ the less is the quantity of plasma cells because of the deficiency arising that affects the immune defense activity. It is seen that many details are missing in this model; however, all the essential components of the immune defense mechanism are taken into account.

Therefore, the basic acting factors of an infectious disease are concentration of pathogenic multiplying antigens; concentration of antibodies; concentration of plasma cells; relative characteristic of affected organ.

Results and discussion. Fig. 1 shows the diagram of the simple model's solutions, which we interpret as the course of the acute form of disease with recovery

in the case of a normal immune system. This diagram represents that for a given rate of virus multiplication, the higher is the dose of infection, the faster the maximum value of antigen quantity is achieved, and the faster this process stops.

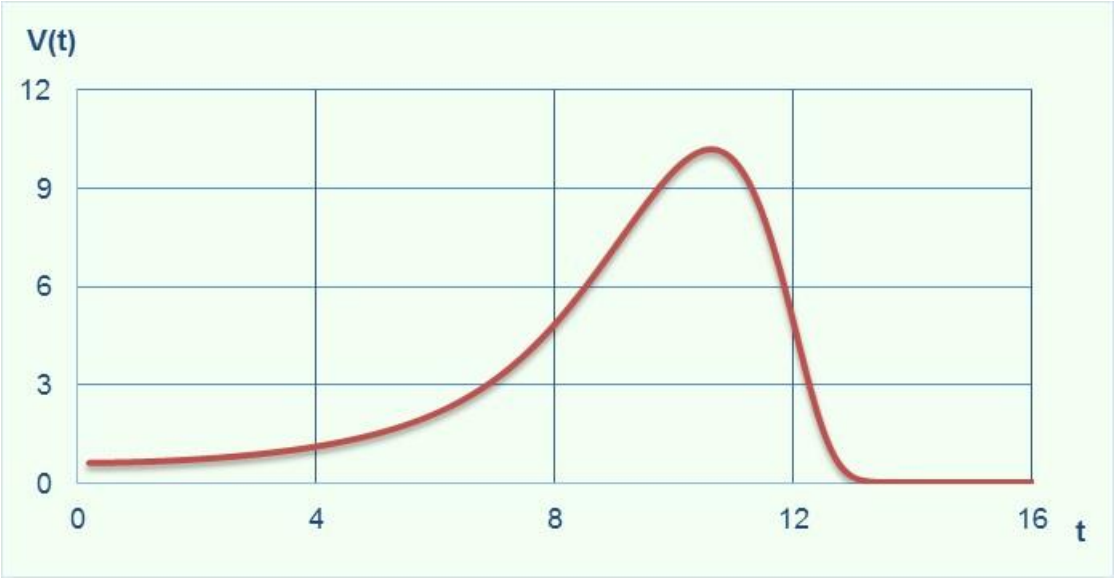

Fig. 1. *Dynamics of antigen concentration in case of acute form of disease*

One can see that the acute form of disease is characterized by a rapid (over several days) increase of antigen quantity in an organism up to the values exceeding the infection dose by several orders, and by rapid elimination of antigens. This character of the disease's course is conditioned by rapid multiplication of antigens which results in rapid accumulation of antigens in an organism, and by strong and effective immune response that leads to production of antibodies in quantities sufficient for the elimination of antigens. The second is the consequence of the first in the case when an affected organ has a weak influence on the immune system's reactivity, i.e., in the case of weak pathogenic antigen.

The above results enable us to make a conclusion: in order to prevent the transition of the acute form into the heavier form, one should try to lower the antigen pathogenicity.

The simple mathematical model of acute form of infectious disease, of course, is approximate and requires further detailed elaboration. However, even in this form it allows one to include in the system various essential factors of infectious disease dynamics.

Conclusions. Realization of simple mathematical model of acute form of infectious disease with the help of Google Sheets allows computing the main parameters of disease and representing them graphically. This model is useful for exploration of general picture of a disease course and for explanation of some results of observations. Some theoretical results may be used in searching for effective methods of treatment.