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THE USE OF CURVE-FITTING IN MATLAB FOR FINDING THE MAIN PARAMETERS OF THE COMPARTMENT MODEL OF EPIDEMICS

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Compartmental models are used to predict a worldwide spread of infection and declaration of a pandemic. For such cases, researchers use the SIR model. It was used when the outbreak of Ebola virus had happened. It started in Guinea and then spread across land borders to Sierra Leone and Liberia. The epidemiology data were analyzed, and processed using the SIR model.

The SIR compartmental model is based on three linear differential equations with two main parameters β (t) and γ (t) for three chambers or categories of people:

$$\frac{dS}{dt} = -\beta IS, \qquad \frac{dI}{dt} = \beta IS - \gamma I, \quad \frac{dR}{dt} = \gamma I,$$

where S (t) - susceptible to infection people, I (t) – infected ones, R (t) – recovered ones.

Modeling the dynamics of infectious diseases requires to determine whether the spread of the disease can reach epidemic levels or can be gradually eradicated. According to the SIR model, the slowdown in epidemics occurred after the number of infected people reaches its peak. The theoretical model of SIR allows predicting the results of epidemics and the factors that determine its severity.

The physical meaning of β (t) is the number of contacts during which the infection gets transmitted per person per unit time. By reducing the coefficient β by various anti-epidemiological measures, we can reduce the rate of spread of infection

The physical meaning of γ (t) is the share of infected people who have recovered per unit time. It demonstrates how effective the treatment of the infected is.

The development and course of the epidemic depends on these two factors. From the equations it is seen that in the case when $\beta S(t) < \gamma$, then $dI / dt < 0$ and the epidemic dies off on its own. If $\beta S(t) > \gamma$, then $dI / dt > 0$ and the number of the infected people increases dramatically. This leads to a rapid spread of the epidemic. Thus, the way to limit the epidemic may include immunization, which leads to a decrease in the number of susceptible to infection S (t), or a decrease in the coefficient β (t), i.e. the rate of transmission from one person to another. The latter can be achieved through quarantine, lockdown, promotion of disinfection culture.

The values of the parameters β (t) and γ (t) can be determined on the basis of statistical data obtained for three categories of people. The collected data are stochastic in nature and are characterized by strong variability. To more accurately determine the parameters of the chamber model, we used the utility Curve Fitting software environment MATLAB (Mathworks, MA, USA) to determine the analytical function that describes this data set. Having determined the analytical function that most accurately describes the statistics, it is possible to estimate the values of parameters β(t) and γ (t) during a certain period of the epidemic. For example at the beginning of quarantine and accordingly at the end of it. This analysis allows us assessing the effectiveness of anti-epidemiological measures.

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NANOTECHNOLOGIES - HEALTH HAZARDS

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Identification and unification of the properties of most nanomaterials (NMs) clearly outlined the area of their application. Exceptional properties of nanoparticles (NPs) have become the driving force of their widespread use in the biomedical field. High photostability, significant quantum yield and absorption coefficient in a wide spectral range allowed to obtain molecular imaging (e.g., NP can be used as probesin vivo by their attach to molecules of proteins, antibodies and nucleic acids; NP can be used as an instrument of evaluation of molecular reactions in the body, etc.).

The issues of targeted delivery and improved bioavailability of drugs are also promising. An interesting potential use of NP forcancer treatment is the study of tumor-specific thermal scalpels for heating and burning tumors (e.g., gold of nanocoating with polyethylene coveringwhich absorb near-infrared radiation can be used to inhibit tumor growth). Cosmetic products also merit special attention. For example, gold and silver NP shave significant antifungal, antibacterial and anti-inflammatory properties and are used in compound of anti-aging creams, deodorants, medicines for burns treatment etc.

Nowadays, the potential impact of NPs and rawNMs on humans will increaseas result of development and commercialization of nanotechnology programs. One of the most serious problems is the workplace (research laboratories, placeswhere NMs are synthesized, processed, used, disposed or recycled). In order to determine whether the unique chemical and physical properties of new NPs lead to specific toxicological properties, the nanotechnology community needs new ways of hazards and risk factors estimation.

Toxicity of NP sdepends on their surface properties, coating, structure, size and aggregation ability. Poor NPs solubility may cause a risk of cancer. This is due to the fact that in this case the NPs have a larger ratio of surface area to volume, which increases the chemical and biological reactivity.

NPs can penetrate intothe body in different ways: transdermal, by inhalation, injection or implantation. Transdermal exposure is especially common in cases of using skin care products, hair care products or lip balms, including sunscreens and anti-aging creams. The danger consists in the fact that cosmetic products do not require clinical trials, but contain the maximum amount of components with NP that can cause erythema (Cobalt and Chromium NPs, for example, cross the skin barrier and damage fibroblasts).

Nowadays, many mechanisms have been proposed to explain the negative effects of NPs, which can lead to cardiopulmonary disease. NPs sometimes affect reactive oxygen species and can also stimulate neurons in the lungs, affecting the CNS and cardiovascular autonomic function. Having the possibility of circulation in the body, NPs can cause an acute inflammatory reaction, as they are recognized and identified by the immune system as foreign.

WHO has already identified a number of health effects toNP exposure, but risk levels and regulations and policies have not yet been articulated. A new type of environmental pollution has appeared – it is nano-pollution. Norms of nanoproductsuse (cosmetics, drugs, implants, food packaging, etc.) have not yet been introduced. Therefore, protection during working with nanomaterials and rules for the disposal of these materials after the completion of experiments is an important component in the prevention of nanocontamination, and therefore risks to human health.

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THE FORMATIONS AND CHARACTERISTICS OF NANOCOMPOSITE MATERIALS BASED ON NANOPARTICLES OF 2D LAYERED CRYSTAL INSE AND GASE AND SOLID ME(NO_3) ION SALTS (ME K, NA, RB, CS)

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For manufacturing of nanocomposites based on ionic MeNO3 salts (Me= K, Na, Rb, Cs) and 2D nanoparticles of InSe and GaSe used the results of studies of ionic self-organization of nanostructures on van der Waals surfaces of layers of oxides of In and Ga in the implementation of the melts of the ionic salts in the space between the layers of these crystals . Taking into account : different wetting by molten ionic salt crystal surfaces with molecular linkages and surfaces of oxides, which is due to different values of the surface energy of the interphase boundaries; thermal decomposition of ionic molten salts according to the chemical reaction 2 MeNO3 = 2 MeNO2 + O2↑and burnim is accompanied by release of molecular oxygen, which creates excessive pressure on the layers of crystal and oxidizes their surface; the processes selfwetting ion salts in the wetting of nanoscale oxides; the formation nano composites type “oxide-ion salt ”with high ionic conductivity at the boundaries of 2D nanoparticles. The structure, composition and morphology of