UDC 611.08:616-006.03:517.977

A.A. Novicova

NANOTECHNOLOGIES USE STUDYING FOR REDUCTION OF GROWTH OF TUMORAL CELLS

У статті розглянуто актуальну на сьогоднішній день проблему – вивчення й аналіз зменшення або повного знищення ракових клітин, що могло б призвести до зниження "зараження" і загибелі населення від онкологічних захворювань. Роботу проведено за допомогою морфологічного, функціонального, системного, а також регресійного аналізів.

The urgency of a problem of preventive maintenance of a cancer doesn't cause doubts as at present the cancer is one of the most widespread reasons of disease and death rate. According to the WHO (The World Health Organization) annually all over the world is registered more 10 million new cases of disease by a cancer and more 6 million cases of death rate. To this day in a problem of preventive maintenance of a cancer the basic accent became on disease decrease. Not less important party of preventive maintenance of a cancer is prevention of death rate from this illness. The urgency of search of effective methods of treatment among which the considerable attention is taken away to researches of different variants of nanotechnologies use becomes aggravated. Therefore a work theme it's considered by the actual.

The work purpose is the modelling analysis of nanotechnologies use for reduction/destruction of cancer cells. For achievement of the work purpose it's necessary to solve following problems:

- To consider classification and oncological diseases pathogenesis;
- To spend modelling oncological diseases pathogenesis;
- To analyze and spend application modelling nanobiotechnologies for reduction of growth or utter annihilation of cancer cells.

As object of research are the process of reduction of cancer cells acts; cancer cells, nanoparticles.

Research methods are the system analysis, the regression analysis.

Scientific novelty – the modelling oncological diseases pathogenesis is spent, for the first time nanoparticles' modelling for reduction/destruction of cancer cells is spent.

The practical importance of the received results - results of work have social character as can be used for reduction of the population's death rate.

For application studying nanotechnologies in a problem of reduction of growth of cancer cells, it's necessary to learn a question of morphology and functional features of cancer cells [1-4], and also nanotechnologies to bioengineering [5-8] from the point of view of the modelling analysis.

The system 1 represents one of versions of the model developed by us which reflects morphological and functional features of a tumour.

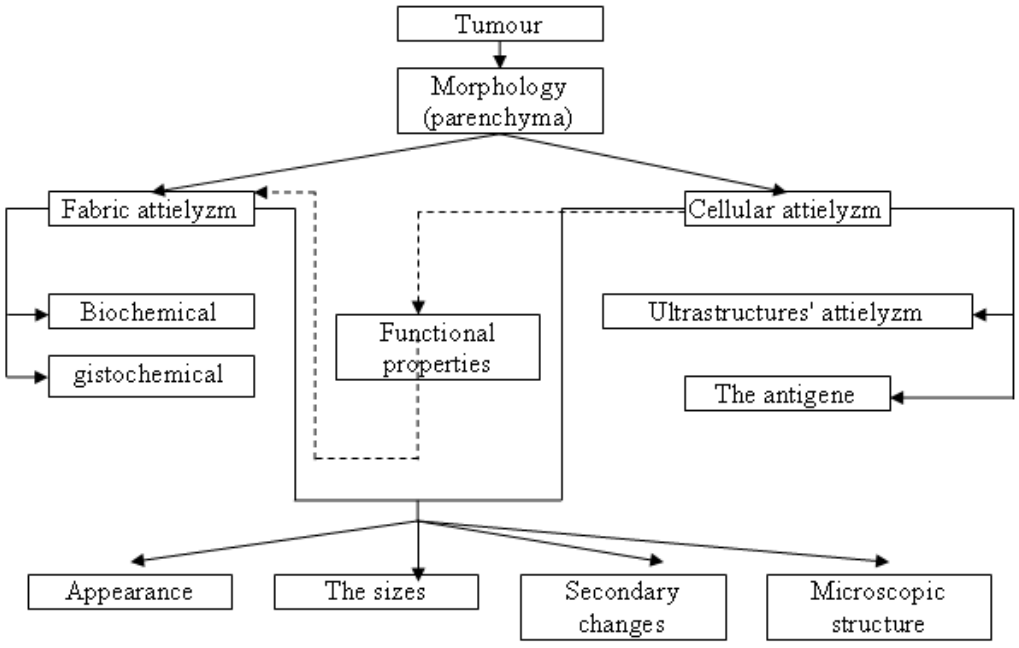

Fig. 1. System model of a tumour

On the basis of system constructed earlier it's possible to construct mathematical model.

Let's consider that the tumour is formed either fabric, or cellular changes. Thus cellular changes have functional properties which are reflected further in fabric changes. The tumour is defined by the basic morphological features. Thus, the mathematical model of the told is shown further:

$$f_{k_j} + t_i = \{M_r\}, \quad (1)$$

where f_{k_j} – functional properties of a cell;

t_i – fabric attielyzm;

$\{M_r\}$ – set of morphological changes.

Here r it's represented appearance of a tumour, in the size, secondary changes and a microscopic structure.

It's represented expedient to use different studying ways of a cancer's occurrence which if will not give at once a full solution of a problem can promote in a new fashion, digest already known facts, formulate new hypotheses and open new areas for concrete experimental researches.

One of such approaches is the approach from positions of the general theory of systems. As it's known, the cancer tumour represents set of the reborn cells which quickly share. Therefore for the system analysis of a problem of a cancer, first of all, it's necessary to describe (in the simplified kind) the mechanism of development of cells. Without going into subtleties of a structure of a human body's cells, we'll allocate two basic parts of which each cell consists, - a kernel and the cytoplasm separated from each other and from environment by thin seminontight covers - membranes. On fig. 2 the system analysis of development of a cancer is presented.

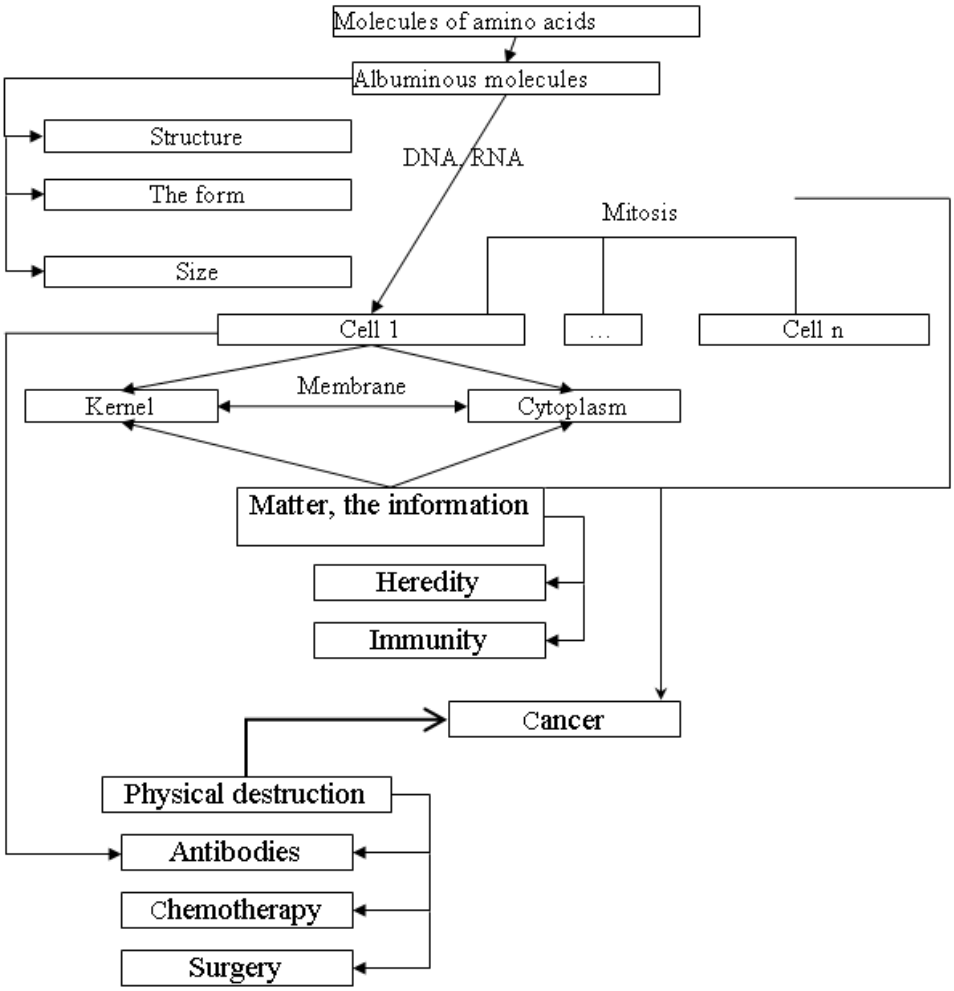

Fig. 2. The system analysis of a cancer's pathogenesis

Further we result mathematical modelling of the aforesaid.

The cancer develops at division of a sick cell. With a blood current all organism can "be ill". Considering time of distribution and reproduction of cells, we'll have the likelihood law of development of illness:

$$P(Y) = a\frac{n}{t}, \tag{2}$$

where $P(Y)$ – probability of a cancer's development;
a – "information" factor (a heredity, immunity);
n – quantity of the "ill" cells;
t – time of a cell's distribution.

With the advent of a sick cell, its further division and reproduction occurs in a geometrical progression. The total of the "ill" cells is defined from the equation:

$$n = \frac{(N-m)^N - 1}{(N-m)-1}, \tag{3}$$

where N – quantity of healthy cells;
m – quantity of cells received at distribution of an initial cell.

Substituting the equation (3) in (2) it's received:

$$P(Y) = a\frac{(N-m)^N - 1}{t(N-m-1)}. \tag{4}$$

Let's consider further nanotechnologies' application, as innovative product, at studying of a problem of reduction of cancer cell' growth.

In work the problem of a cancer's development, and also a problem of disease's reduction by nanotechnologies which at present widely develop, is considered. For this purpose in work are considered nanoparticles which can take root into an organism, being there long time, without disturbing an organism in existence. Also are considered the material from which particles can be executed, level of toxicity of particles, their quantity etc.

A priori it's supposed that reduction of cell' growth depends on time of nanoparticles' influence, their quantity and other factors which are considered in experiment, thus the law has no linear character. We suppose that reduction of the sizes or utter annihilation of cancer cells should occur under the hyperbolic law.

Let's construct the system analysis shown on fig. 3.

Under the system analysis further it's spent mathematical modelling.

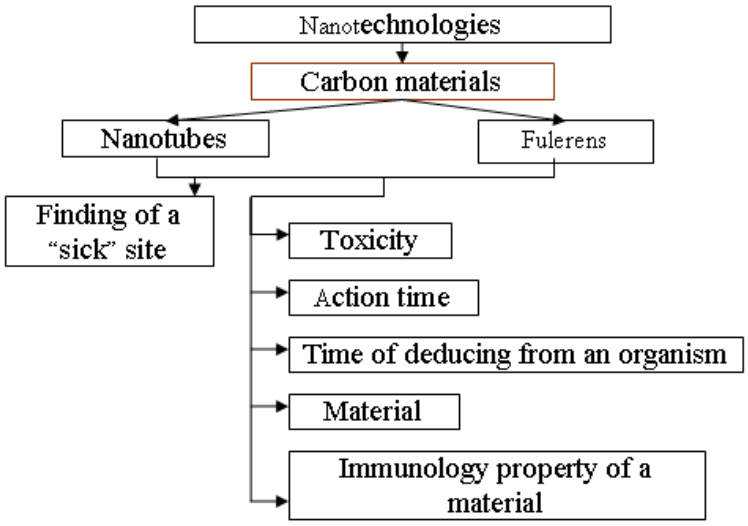

Fig. 3. The system analysis of nanotechnologies' use for reduction of tumoral cell' growth

Change of the size is a set of different parametres (from the point of view of the mathematical analysis):

$$\Delta R = \{l, m, t, \tau, M\},$$

where ΔR – change of the size or utter annihilation of cancer cells;
l – nanoparticles' toxicity;
m – immunology properties of nanoparticles;
t – time of influence for a cancer cell;
τ – time of deducing of particles (indirectly connected with influence on an organism and further isn't considered);
M – a material of particles.

The given parameter reflects not only a material, but also the sizes of particles, their quantity.

We assume that with time growth the cancer cell should decrease, then:

$$\frac{1}{\Delta r} \sim \Delta t.$$

Let's write down definitive model of application of technologies in oncology:

$$\frac{\Delta r}{\Delta t} = \frac{n}{ab}, \qquad (5)$$

where n – quantity of particles;

Δt – an interval of time which is reached at present researches;

a – factor of properties of a material (silver, gold);

b – factor of toxicity/immunology properties.

Reliability of models (1, 4, 5) proves to be true high indicators of the varianrt-informativity (0,9; 0,95; 0,8) and adequacy (1,2; 1,3; 1,15) accordingly. Models steady, have predicting properties (properties of a nanoparticle's stuff, toxicity quotients etc.), and also describing properties (nanoparticles' quantity, influence time, time of deducing of nanoparticles from an organism).

As a result of work performance conclusions are drawn: the morphological functional system analysis of pathological genesis of oncological diseases is carried out. Application modern bioengineering and nano - technologies in modern medicine at system level is studied. On the basis of the given analyses modelling of use of technologies for reduction/destruction of an organism's cancer cells is spent.

THE LITERATURE:

1. Классификация злокачественных опухолей. TNM. Пятое изд. / Под ред. Н. Н. Блинова. СПб.: Эскулап, 1998. – 345 с.
2. Переводчикова Н.И., Бычков М.Б. Мелкоклеточный рак легкого. М.; Медицина, 1984. –160 с.
3. Чиссов В.И., Трахтенберг А.Х., Франк Г.А. О классификациях и терминологии злокачественных опухолей легких (полемические аспекты) // Хирургия. – 1995. – № 1. – С. 14-17.
4. Давыдов М.И., Полоцкий Б.Е. Рак легкого. М.: Радикс, 1994. – 216 с.
5. Жаоким К. Функциональные наноматериалы: – Физмалит, 2010. – 300 с.
6. Сергеев Г.Б. Нанохимия. Учебное пособие. 3-е изд: – КДУ, 2009.– 89 с.
7. Гусев А.И. Наноматериалы, наноструктуры, нанотехнологии: - Физматлит, 2009. – 106 с.
8. Баллюзек Ф.В. Нанотехнологии для медицины. – Сезам, 2008. – 16 с.

НОВІКОВА Анастасія Олександрівна – к.т.н., доцент кафедри інформаційно-вимірювальних технологій електроніки та інженерії Херсонського національного технічного університету.

Наукові інтереси:

– біомедична інженерія;
– медична статистика;
– системний аналіз.