THE INTERACTION OF THE ABSORBED RADIATION WITH THE MICROSTRUCTURES OF TISSUE

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The distribution of absorbed energy (quantity of gamma-quanta) in small, micro volumes of tissue and molecules depending on their partial atomic composition and presence of microelements has been studied. A great variability of microstructures absorptivity and nonlinear dependence between the energy capacity of tissue microstructures and constant change of molecules and atomic concentration in the unit volume has been established. The possibility of density guiding (regulation), absorptivity and energy capacity of tissue for better diagnostics, treatment and population protection from irradiation has been discovered. The reason for using the elaborate quantum-chemical model for the evaluation of the interaction with ATM and microdosimetry for accounting the distribution of absorbed photons in microstructures of biosystem has been shown. The unitary theory of appearance of the pathological processes has been formulated.

The actuality of the investigated problem is stipulated by the following. The modern achievements of radiology are mainly based on the account of the results of the X-ray and gamma-quanta (GQ) effect on the microvolumes of heterogeneous tissues. Their density and absorptive power (AP) are considered. The mean density value of the "soft" tissue, biological media and AP are taken for the unit. These indices hide the atomic, molecular and cellular inhomogeneity, the differences in their densities and AP of the microstructures of tissue (MST). Consequently, so far nobody has discussed and taken into account the possible variability of the density and AP of MST in different molecules, ferments, hormones, vitamins, genes, chromosomes, cells, etc. [1, 2].

That is why the traditional methodological approach to the evaluation of the photon action on human organism doesn't allow one to estimate objectively the efficiency of their influence on the most radiosensitive microstructures of biosystems. It cannot answer many unsolved questions of radiobiology, radiotherapy, genetics, etc. The dependence of the absorbed energy value (AE) upon the density of biomicrostructures and their partial atomic composition (PAC), particularly upon the presence of microelements in them has not been clarified. The role of the violated chemical balance, energy capacity (EC) and energy state of MST in the appearance of the pathological processes has not been understood. The peculiarity of our methodological approach is that we considered complex interaction between two microsystems, the energy receivers (atoms, molecules, molecular concentration in small and microvolumes of tissue) and energy carriers (photons, electrons).

We have evaluated the constant change of density and EC of MST, AP of molecules (total effective cross section) depending on their atomic composition, the distribution of AE in molecules and their atomic complexes, and the role of heavy atoms (HA) in the energy absorption by molecules, the atomic-molecular and cellular inhomogeneity of the tissue, its AP in different pathological states. In the evaluation of the interaction of the radiation particles with the MST, we started from the statement that the value of the AP of a molecule is the sum of the effective ranges of interaction of photons with atoms entering the molecule composition. The effective cross section of GQ interaction with atoms in barns (1 barn = 10^{-24} cm^2) was taken as the measure of the AP of molecules. For more accurate quantitative characteristics of AP of molecules the relative value of their AP compared to the water molecule was determined. Such approach also considers the wide radiation energy spectrum.

This methodology of the scientific research enabled us to obtain a useful information about the interaction of the radiation particles with the biomicrostructures. This formed the base for the creation of preconditions for profound and objective evaluation of the complex influence of the chemical compounds and particles of radiation on human organism.

The objects of the research are as follow: chemical models of pathological processes with the known variability of the atomic-molecular inhomogeneity of small volumes of tissue (USSR Patent No 874064) and small volumes of pathologycally changed tissue (PCT), biological media and human excretions (USSR Patent No 950319).

The following methods of the investigation were used:

- microroentgenography of thin experimental and biological media with the 50-100 times enlarged picture (USSR Patent No 1639634);
- the definition of the optical density and AP of the blood according to the Hounsfield scale on CT *in vitro*;
- the methods of visualization of molecular and cellular inhomogeneity (Roentgenography, CT, MRT, microdensitometry, the system of digital processing of medical patterns etc.), allowing one to differentiate the optical density of two volumes of tissue (0.1-0.5 mm^3);
- the effective cross sections of the interaction of photons with atoms and molecules [3];
- the quantum-chemical model for the evaluation of the efficiency of interaction of radiation with the real PAC in MST;
- the microdosimetry, which allowed one to define the relative number of the absorbed GQ in separate atoms, molecules and atomic complexes.

In such a way we have studied the PAC, the partial value of AP in small and micro-volumes of the tissue, the AP of the HA of separate atoms and atomic complexes of various molecules.

The experimental, clinical and theoretical investigations [4-11] resulted in the establishment of the essential variability and dynamism of AP, EC of molecules (tenths and hundreds times), stimulated by different atomic content and different blood density (+60 - +120) units according to the Hounsfield relative scale, (*in vitro*) in pathological processes. So, for example, AP of each B_{12} vitamin and thyroxin hormone molecule is 89 and 1055 times larger than that of the water molecules, and the optical density of the blood according to the Hounsfield scale in different diseases is 10 - 15 times larger (to +120 HF) than that of water (+7 - +10 HF, 60 KeV).

The data, which characterize PAC and the distribution of AP of small and micro-volumes of tissue, show that the major part of radiating photons accept the atoms of oxygen, sulphur, phosphor, calcium and others. Different pattern is observed at the molecular level. The atoms of microelements present in the molecules are capable to absorb the major part (90-95%) of GQ. They transform the molecules into the targets for the photon action. The "specific" atomic content of the molecules determines their AP, EC and biochemical activity. The glucose and cystine molecules containing 24 and 26 atoms have relative AP 8 and 40 times larger than that of the water molecules (E=20keV). Thus, the value of AP in MST depends on the partial atomic content and, especially, on the presence of heavy metals in molecules. The efficiency of the radiation interaction with MST depends mainly on the presence of microelements in molecules and atoms. For example, the relative value of AP in the of KJ and CaJ_2 molecules is, respectively, 605, 1200 times larger than that in the water molecule (E=40 KeV). The variability of AP and EC of a cell and subcellular structures depends on heterogeneity of their micro-structures (the effective area of the interaction, the value of atoms, the molecular concentration).

The PAC of the molecule determines its "specific" value of the AE microdose. The value of microabsorbed dose in a molecule is determined by the spatial and structural distribution of its atoms, while in a cell it is determined by the concentration of the energy carriers and energy receivers. That is why for the estimation of the radiobiological effects it is reasonable to summarize not only the radiation dose but mainly the amount of the damaged molecules within the period of the photon action on MST. The correlation of AP and biological activity of a molecule is present. The molecules which are "marked" by heavy atoms due to their specific EC are able to stimulate, depress or destroy other molecules. Based on the obtained data we conclude that the "viruses", cancerogenes, immunodepressants and other chemical complexes entering a cell destabilize its material and energetic state.

Radiosensitivity and radiodistruction of molecules, cells and tissue depend on MST of its microstructures, on the dynamism and rate of AP and EC of the molecule and a cell. Biologically active and PCT as well as medical plants are a kind of a "collector" of energy receivers and under the radiation - of the energy carriers too. The efficiency of the photon action on MST depends on their concentration and the number of the acts of their interaction. Thus for example, the change of the concentration of ampycillin molecules in small volumes of PCT results in the change of AE value, because only one of molecule has AP 30-50 times larger than that of the water molecule. Thus, by changing the concentration of the energy carriers and energy receivers, it is possible to control the efficiency of the energy interaction with MST and the value of the absorbed dose.

Thus, we have obtained new data including those indicated in the papers [4-11], which characterize the PAC, MST and the partial value of AP, that is the number of absorbed GQ in the small volumes of tissue and also the distribution of AP and MST and separate molecules, atomic complexes depending on structural and spatial distribution of atoms, the characteristics of the molecule EC, which contain microelements.

On the basis of the obtained data new fundamental statements were formulated, in particular:

- the property of MST to change its density and AP;
- the relationship of the constant change of density (the concentration of atoms, molecules and small volumes of tissue), AP, EC and energy functional state of MST;
- the property of physical-chemical factors (oxygen, heavy atoms, chemical compounds from the environment and others) to change the density and AP of MST;
- the dependence of diagnostic, curative and radiobiological effects on the rate of the change of concentration of the energy receivers and energy carriers in MST and also a unitary chemical-energy (quantum) theory of medical-biological processes.

The pathological processes in tissue appear first of all as the initial cause, the starting mechanism resulted from the essential change of chemical and energetic balance in MST (PAC, AP, EC and energetic balance), molecular inhomogeneity in a cell and small volumes of tissue. HA, cancerogens, immunodepressants, allergens, viruses DNA, etc. lead to the violation of chemical and energy balance in molecules and cells and, as a rule, increase the atomic-molecular and energy inhomogeneity. This is the main cause of the appearance of pathological and ecological processes. The observed increased or decreased local molecular unhomogeneity during this process serves as a material basis for the diagnostic patterns.

The relatively large EC is peculiar for the polyatomic molecules, specific chemical complexes (hormones, vitamins, ferments, radiosensibilizators, allergens, immunodepressants, cancerogenes, viruses, etc.), which contain several atoms of oxygen, sulphur, potassium, chloride, etc. Radiosensitivity of molecules (the system of atoms) and cells (the system of molecules) is determined by the concentration of the energy receivers and energy carriers, by the quantity of acts of interaction of photons with the molecules-targets. The micro structures of DNA, chromosomes, genes, mytochondries, the structures of a cell, PCT is a kind of special "collector" of the most energy-intensive material and, correspondingly, the "collector" of the absorbed energy. Radiation causes the energy disbalance in molecules and cells with corresponding consequences.

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ВЗАЄМОДІЯ ВИПРОМІНЮВАННЯ З МІКРОСТРУКТУРАМИ ТКАНИНИ

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Результати визначення поглинальної спроможності мікроструктур біосистеми на атомно-молекулярному рівні розкрили велику різноманітність кількісної характеристики ефективних перерізів взаємодії в залежності від атомно-молекулярного складу та енергії випромінювання. Отримана кількісна характеристика поглинальної спроможності має суттєве значення для мікрорадіології та екології.