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Mechanisms Of Influence Of Ionizing Radiation On Phospholipide Bilayer

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The possible mechanisms of the influence of ionizing radiation (IR) on the structure and properties of the phospholipid bilayer were studied by computer simulation, optical polarization microscopy, and X-ray diffraction simultaneously at large and small angles. Three mechanisms of the influence of IR on model membranes obtained in an aqueous medium of an amphiphilic substance have of different concentrations been established. In this work a phosphatidylcholine (lecithin) -water lamelar system was used as a phospholipid bilayer. In this study the sample contained lecithin at a concentration of more than 40%, since starting from these concentrations the lamellar structure of the phospholipid bilayer, separated by a thin layer of water, is formed.
As a result of the research, it has been established that the direct target of IR is the dipole fragments of phospholipid molecules. Under the influence of the electrical component of the electromagnetic field, the dipole heads rotate about a certain axis along the orbit, since they are connected to the hydrocarbon tails with one of its end. Since H+ positive charge rotates in a certain orbit, a rotational (magnetic) moment is induced, which already is subject to the influence of the magnetic component of the electromagnetic field. As a result of the influence of both components, the dipolar fragment of the phospholipid molecule changes the angle relative to the surface of the bilayer, which leads to a change in the strength of the electrostatic interaction, and, consequently, to the imbalance between electrostatic and van der Waals forces. Due to the imbalance, the structure of the bilayer and, consequently, their biophysical properties are changed. The priority of this mechanism depends on the frequency and intensity of IR. At high frequencies, the period of rotation of the charge increases, i.e. the molecular current increases, but the radius of rotation decreases. At low frequencies, on the contrary, the rotation period decreases, but the radius of rotation increases, i.e. an optimum frequency of IR waves for a given phospholipid molecule exists.
The second possible mechanism for the action of electromagnetic waves on the phospholipid bilayer can occur through the formation of peroxides,lipids and other radicals, which result in peroxide and lipid oxidation of the hydrocarbon hydrophobic component of the phospholipid molecule. As a result, van der Waals forces of attraction change, and the balance between electrostatic and van der Waals interactions is disturbed. Such changes can lead to a change in the membrane structure and its permeability. Radicals formed during peroxide oxidation were recorded by the method of chemiluminescence detection. Peroxide oxidation of lipids caused significant and intensely dependent changes in the basic physical structure of the phospholipid bilayer. X-ray diffraction data simultaneously at large and small angles showed a noticeable decrease in the width of the bilayer from 36 A to 32 A and a decrease in the identity parameter, including surface hydration from 48.7 A to 44.6 A. These data are direct evidence of changes in the membrane structure resulting from peroxide oxidation of phospholipids.
The third proposed mechanism and the object of the influence of IR influence, which has a secondary nature of the influence, is the pre membrane water that is structured at the interface between the two liquid-solid phases and has a pentagonal structure, in which counterions are distributed. IR affect both structured water and the distribution of counterions, as a result of which the forces of electrostatic repulsion between dipole fragments change, and as a result the balance of forces between electrostatic and van der Waals interactions is disturbed.
These three mechanisms act in combination or separately, depending on the parameters and the profile of the IR.

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