Influence of 910 MHz Electromagnetic Fields on Brain Collagen. A Theoretical Construct

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Studies on humans suggest that electromagnetic fields (EMF) emitted by cellular telephones may be responsible for a variety of biological effects. They influence the synthesis of proteins. Among them, collagen is subject to this influence to a great extent.

Collagen is a protein that is optically active. In a collagen molecule three polypeptide chains (α-chains) are wound together to form a 'triple helix' (secondary structure). It is this secondary structure that gives the collagen molecule its optical properties. When molecules assemble together to form fibrils, they pack in roughly parallel array and are mutually displaced axially by D (axial periodicity) or integral multiples of D. The intermolecular interactions that are particularly important in stabilizing the fibrillar structure are those between the larger hydrophobic side chains and between oppositely charged side chains.

Our previous results show that when male and female Wistar rats are exposed for 2 h/day for 30 consecutive days to radiation at 910-MHz, the axial periodicity and the diameter of collagen fibrils are dramatically affected. The effect on the axial periodicity may mean that the intermolecular interactions, particularly those between the larger hydrophobic side chains might be disturbed by the applied electromagnetic radiation and therefore they are not any more the maximum. In addition, upon exposure, the collagen fibril diameter is significantly decreased. Among other factors, the possibility that growth of collagen fibrils is an entropy-driven mechanism needs to be considered. In such a mechanism, entropy change is associated with free energy change. Growth stops when no further decrease in free energy of the system can be caused which is related to the entropy increase limitation. In the case of collagen, limitation in entropy would result in the reduction of hydrophobic interactions between collagen molecules that occur when they assemble for the fibril formation. Decrease in hydrophobic interactions between apolar residues means decrease in hydrogen bonding between excluded water molecules. Thus hydrogen bonds may be viewed as centers of EMF and as a consequence the collagen triple-helical conformation, could be a target.

From the quantum perturbation theory, the possibility that a molecule reaches an excited state when it interacts with an electromagnetic wave is proportional to the electric dipole transition moment. Applying the quantum perturbation theory, we come up with the following expression for the electric dipole moment: $<\vec{p}>=\alpha\vec{E}-\gamma\vec{B}+\beta\partial\vec{B}/\partial t$ where α is the electric polarizability and β the optical rotatory parameter. The latter is present only in optical active materials. This property gives the additional term in the expression for the electric dipole moment, whereas in non-optical active materials only the first term survives: $\vec{p}=\alpha\vec{E}$. Consequently, the optical active molecules such as collagen are the most likely to be excited.

Piezoelectricity may be the common denominator for the non-specific actions of the various non-ionizing, order-inducing biological physical effects. Collagen fibrils are piezoelectric substances with molecules having an ordered polypeptide structure and a set of ordered dipoles which correspond to the definition of eletret. Eletrets fulfill the requirement for an ideal cooperative system in which the entropy, due to the ordered structure, is retained at a minimum and biologically ordered free energy is made available by the interaction with an external stimuli such as electromagnetic radiation. Therefore collagen α-helices being piezoelectric polypeptide chains, are able to transform chemical and electromagnetic energy into mechanical energy, and mechanical energy into electromagnetic energy, i.e. photon-phonon transductions, as other such systems.