

## THE EMERGING CONCEPT OF AQUEOUS SYSTEMS AS DISPERSE AND DISSIPATIVE ENTITIES. IS IT A POSSIBLE FOUNDATION OF HOMEOPATHY?

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Homeopathy, more than 200 years old therapeutic system, has recently been subjected to harsh criticism. The critics claim that it is absolutely inefficient and that its principles contradict the “firmly established laws of biology, physics and chemistry”. Indeed according to the major principle of homeopathy “like cures like” a patient may be cured with minute doses of natural materials that in larger doses cause the pathological condition from which the patient suffers. Minute doses are prepared from water or aqueous/ethanol extracts of original materials by their serial dilutions with considerable agitation (succussion) at each dilution step. Dilutions may reach such degrees that a homeopathic remedy may lack molecules of the original extract. According to critics such ultra-high dilutions (UHD) should not differ from the solvent used and they should be devoid of any biological activity. Therefore the first questions to be answered before any disputes about homeopathy clinical efficiency are: 1) do serially agitated UHD of biologically active substances (BAS) practically are lacking molecules of the original substance retain any activity and 2) do they differ in their physical-chemical properties from a pure solvent? If the answers are ‘NO’ – homeopathy is an illusion, if ‘YES’ – homeopathy has a scientific foundation.

The first reports about biological activity of UHDs (down to  $10^{-4000}$  degree) of some BAS appeared already in 1880ies. Contemporary reviews contain hundreds of references to publications demonstrating biological effects of UHD of BAS. Their number steadily grows especially after the noteworthy paper of J. Benveniste group published in Nature in 1988 that triggered the hot discussion about the ability of water to be the subject for a “memory”. In most of publications the necessary controls were done. Independent authors replicated positive results of analogous experiments. Therefore it is proved that UHD of original extracts may differ in their activity from the solvent treated in the same way as UHD.

Discoveries concerning the properties of aqueous systems representing both UHD and aqueous solutions with “normal” concentrations of different solutes were made during the last two decades. Contrary to the current theory of solutions considering them as homogenous systems it turned out that structures with sizes of hundreds of nanometers are present in them. These “domains” gradually form after dissolution the solutes in water. They contain both the solvent and solutes and are long-lived. Upon dilution domains do not disappear, on the contrary their size usually grows up. Nanosized (100-500 nm) inclusions do not disappear in sequential dilutions even when calculated concentration of original solutes in them tends to zero and when these molecular ensembles practically do not contain solutes. As they differ from “domains” in “normal” solutions they were called “nanoassociates” (NA) by A.I. Kononov. NA appear in UHD of about only 75% of tested substances. They are negatively charged; their charge and sizes change nonmonotonically with successive serial dilutions. Patterns of NA parameters are specific for each particular BAS and correlate with the occurrence of biological effects produced by UHD in different test systems. It was discovered that shielding of UHD from ambient EMF prevents NA appearance in UHD below the “threshold concentration” ( $10^{-5}$  –  $10^{-8}$  M for different substances). Only those UHD that contained NA, that are prepared from “active” substances and are not shielded from ambient EMF displayed biological effects. UHD that contained NA demonstrated different from pure water electrical conductivity and surface tension.

Thus contrary to current models of aqueous solutions real solutions of water-soluble molecules and their UHD are nano-heterogeneous. They should be defined not as solutions in a classical sense of the term but as nanodisperse systems. In such systems disperse phase is represented by “domains” containing both solute and solvent molecules or by NA composed of only solute molecules in UHD. As the number of water molecules may reach hundreds of millions in NA, UHD may represent a disperse system of a “water in water” kind. The emergence of domains and NA in disperse systems represents the process of self-organization of an aqueous system and they should be considered as dissipative non-equilibrium systems possessing free energy and capable to perform work. Notably those processes of self-organization especially the process of NA emergence in UHD depend on the ambient EMF. NA present in UHD prepared from particular molecular disperse systems are likely to be organized in accordance with the program specified by solute molecules. We suppose that newly discovered physical-chemical properties of UHD containing NA prove that they are basically different from a pure solvent. Therefore the answer to both questions posed above is YES meaning that homeopathy has a scientific foundation.