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Reactive Oxygen Species, Water, Photons and Life

Abstract. Unique properties of oxygen and of the reactions with reactive oxygen species (ROS) participation are considered, the multiple ways of ROS generation and utilization are discussed in view of evidence for the absolute necessity of ROS for the normal vital activity. Many difficulties in the realization of the real role of ROS in vital activity are caused by the attitude to them only as to chemical substances, while they should be considered in the first place as the major participants of continuous flows of highly non-linear processes in which electron excited species emerge. These processes play a significant role in energy and informational flows in all the living systems. We suggest that the mechanisms of biological action of ROS are determined by the structural patterns (frequency-amplitude patterns of electron excited states generation and their relaxation) of the processes with ROS participation taking place in the aqueous environs. Energy released in such reactions is used as an activation energy for specific biochemical processes, for the continuous “pumping” of the non-equilibrium state of inter- and intracellular structural components, while the structural patterns of ROS reactions determine biochemical and physiological rhythmic modes. Special role of water in all these phenomena is discussed. From a broader perspective the processes with ROS participation emerging in water preceded and were the necessary condition for origination and evolution of organic living forms on Earth.