hydroxyl radical ($OH^{\bullet}$), arise in water under the action of ionizing radiation and that toxic products of free radical-induced lipid oxidation appear in animal tissues on exposure to ionizing radiation.[3,4]

The idea that free radicals of oxygen are responsible for the oxygen toxicity was stated by Gershman and Gilbert in 1954 (quoted from ref. 4). At the same time, the free radical hypothesis of aging was put forward by Harman.[5–7] In his works, inhibitors of free radical chain oxidation, the so-called antioxidants, were proposed for prolongation of life of humans and animals. Harman was the first to test this hypothesis in experiments with laboratory animals. It was discovered that the antioxidant, radiation-protector 2-mercaptoethylamine, prolongs life spans of C3H female mice (26%) and AKR male mice (29.2%).[6,7] Since then, the beneficial effects of antioxidant therapy were experimentally proved over and over again (see ref. 7 and 8). Currently, however, the mechanism of action of antioxidants in living systems (*in vivo*) does not seem as unambiguous as half a century ago.

At the end of the 20th century, a new approach to the problems of aging was developed on the basis of theory of reliability.[9–19] This review is designed to show that the systems theory of reliability allows the programmed and stochastic events to be integrated into a single united theory. In addition, this review presents the data that antioxidants provide preventive protection from free radicals *via* the beneficial effects of the antioxidants on the system of neuro-hormonal regulation along with their systems reliability effects on microbiota cells.

8.2 Aging *Versus* Reliability

8.2.1 Theory of Reliability: Basic Ideas

Biological objects are constructs, *i.e.* all of them are designed according to special genetic programs with the aim to perform predetermined functions. Similarly to technical devices, biological constructs are not perfectly reliable in operation: malfunctions happen alternating with the normal operation function acts. In engineering, reliability is defined as the ability of an object to perform its function for a given time under given conditions. The same intuitive definition of reliability fits biological systems.[10–19] Conferences that were initiated by Ukrainian Academy of Sciences in Kiev, Ukraine, starting from 1975,[9] spurred the studies on reliability ("robustness") of biological systems, confirming the old saying of the Middle Ages that "Teaching comes from Kiev".

In engineering, the longevity of a device is programmed inasmuch as structures of functional elements, their quality and quantity, interconnections between them, the means of replacing failed elements and so on are predetermined, *i.e.* "preset". At the same time, a device is subjected to the influence of random factors of internal and external origin: load fluctuations, noises in the elements, random disturbances in interconnections, *etc.* Thus, both the constructional particularities of the device (program) and