NUCLEAR SPIN CATALYSIS IN NANOREACTORS OF LIVING CELLS: BIOPHYSICAL PREMISES AND BIOMEDICAL PROMESES

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Cells are composed from atoms of chemical elements some of which have magnetic and nonmagnetic stable isotopes. In chemistry and physics, magnetic isotope effects (MIEs) have long been known [1]. Not long ago, it has been discovered that living cells perceive the nuclear magnetism. For example, the *E. coli* cells, enriched with magnetic magnesium isotope, ^{25}Mg, demonstrate the reduced activity of the important antioxidant enzyme, superoxide dismutase, by comparison to the cells, enriched with the nonmagnetic magnesium isotope [2]. With another cell model, *S. cerevisiae* irradiated by UV light or ionizing radiation, it was revealed that the post-radiation recovery of the yeast cells, enriched with ^{25}Mg, proceeds two times faster than the recovery of the cells, enriched with nonmagnetic ^{24}Mg [3]. Furthermore, MIEs have been revealed in studies of the important bio-molecular motor, myosin isolated from smooth muscle. The rate of ATP hydrolysis, driven by myosin, is 2.0-2.5 times higher with ^{25}Mg than that with nonmagnetic ^{24}Mg or ^{26}Mg. The similar MIE has been revealed with zinc. While Zn^{2+} performs the cofactor function less efficiently than Mg^{2+}, the rate of the ATP hydrolysis driven by myosin is 40-50 percent higher with magnetic ^{67}Zn as compared to nonmagnetic ^{64}Zn or ^{68}Zn [4]. Besides, the beneficial MIE of ^{25}Mg was observed in the ATP hydrolysis catalyzed by mitochondrial H^+-ATPase isolated from the yeast cells. On its own, evidence of MIE unambiguously indicates that there is a spin-selective rate-limiting step, the “bottle-neck” in the chemo-mechanical cycle of the enzyme, that is accelerated by the nuclear spin of ^{25}Mg or ^{67}Zn [5]. Detailed physical mechanisms of the nuclear spin catalysis in biomolecular motors, as well as biological mechanisms of enhancement of these effects in living cells, require further investigations. Nevertheless, there are the grounds to believe that pharmaceutical agents enriched with the magnetic isotopes will find use for creating novel anti-stress drugs including anti-radiation protectors and radiomitigators.

References

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