細菌の低温適応と細胞の疎水度

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Cold-adaptation of bacteria and their cell surface hydrophobicity

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Long-chain polyunsaturated fatty acids (LCPUFAs) such as eicosapentaenoic acid (EPA) are considered to have an antioxidative function in psychrophilic and psychrotrophic bacterial cells, which is based on their cell membrane-shielding effect. The membrane-shielding effect is defined as a structural function of cell membrane phospholipids acylated in combination with a LCPUFA and a medium chain saturated or monounsaturated fatty acid, by which a more hydrophobic interface of alkyl chains can be formed between the phospholipid bilayer, and this hydrophobic structure has potential to hinder the entry of hydrophilic compounds such as reactive oxygen species including hydrogen peroxide (H_2O_2). Using an EPA-producing bacteriium *Shewanella marinitestina* IK-1 (IK-1) and its EPA-deficient mutant (IK-1Δ8), which were grown at 20 ºC, the cell membrane-shielding effect of EPA against H_2O_2 and *tert*-butyl hydroperoxide, an analog of H_2O_2, was confirmed. Interestingly, IK-1 was more resistant even against various hydrophilic antibiotics (ampicillin sodium, kanamycin sulfate and streptomycin sulfate) than IK-1Δ8. Analysis of the cell hydrophobicity of these strains by the bacterial adhesion to hydrocarbon method demonstrated that IK-1 was more hydrophobic than IK-1Δ8. Considering that the content of EPA was approximately 10% of total fatty acids of IK-1 cells grown at 20 ºC and that lower growth temperature led to higher contents of EPA in IK-1, it is suggested that EPA contributed to the cell surface hydrophobicity and to the adaptability to low temperature. On the other hand, IK-1 was more susceptible to a hydrophobic oxidative phosphorylation uncoupler, carbonyl cyanide *m*-chloro phenyl hydrazone (CCCP) than IK-1Δ8. CCCP could be accumulated in cells of IK-1 more effectively than those of IK-1Δ8. Taken together, it is suggested that the higher cell hydrophobicity of LCPUFA-possessing bacteria could facilitate their growth at low temperature by controlling the uptake of environmental hydrophilic and hydrophobic compounds.

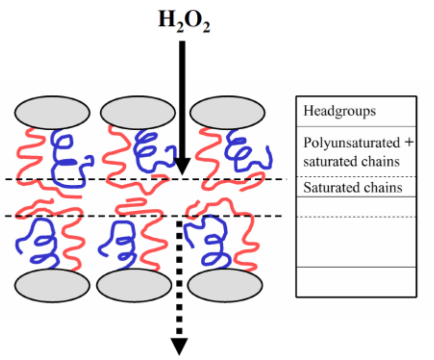

Figure 1: The membrane-shielding effects of long-chain polyunsaturated fatty acids. The hydrophobic layer (shown by two parallel broken lines) composed only of saturated chains (red) between outer and inner leaflets of the membrane may act as the shield of hydrophilic compounds such as H_2O_2. LCPUFA is in blue. The flow of H_2O_2 is illustrated by two types of arrow (Cited from ref. 1) with permission).

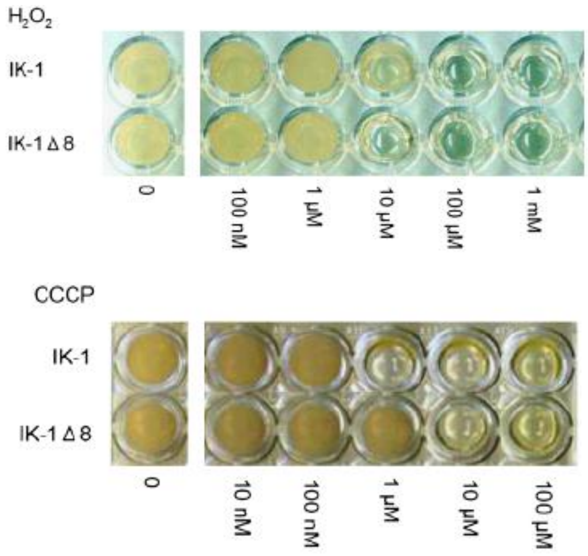

Figure 2. Effects of the concentration of H_2O_2 and CCCP on the growth of *S marinintestina* IK-1 and its EPA-deficient mutant IK-1Δ8. IK-1 was more resistant to H_2O_2 than IK-1Δ8, whereas the former was less resistant to CCCP than the latter. The surface hydrophobicity was greater in IK-1 cells (94% ± 1%) than in IK-1Δ8 cells (99% ± 1%). (Cited from ref. 2) with permission).

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