

## Differential Effects of Surfactants on DNA and Protein Transport through a Semipermeable Membrane

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**Statement of Purpose/Introduction:** Surfactants are key factor in many of our body functions and their effects on cell signaling other biological implications are not well understood, especially in homogeneous systems. We systemically investigated the effects of non-ionic, cationic, and anionic surfactants to elucidate their roles on enzyme proteins and DNA and interfacial transport of proteins and DNA under controlled environment.

**Methods:** The DNA for this study of molecular transport came from herring sperm (Sigma Chemical Co.), the DNA contained 6.1 % of sodium. The initial concentration of DNA used was about 10 mg/100 ml. For proteins, three well-characterized enzyme proteins were used in this study. They were: L-glutamate dehydrogenase (Sigma Chemical Co.; from bovine liver, MW 2,200,000), L-lactate dehydrogenase (Sigma Chemical Co.; from rabbit muscle, MW = 135,000), and L-malate dehydrogenase (Sigma Chemical Co.; from porcine heart, MW = 70,000). These molecules were chosen as representative of proteins with small (MDH), medium (LDH), and larger (GDH) molecular weight. The concentrations used for GDH, LDH, and MDH were  $1.42 \times 10^{-7}$  M,  $2.86 \times 10^{-8}$  M, and  $1.82 \times 10^{-7}$  M, respectively. For surfactants: The cationic surfactants used were C-573 (low molecular weight) and C-581 (high molecular weight) (Cytec Industries, Inc.). The anionic surfactants were IB-45 (hydrophilic) and TR-70 (hydrophobic) (Cytec Industries, Inc.). Non-ionic surfactant was Triton-X 100 (Sigma Chemical Co.). Experiments setup and surfactant concentrations were similar to studies that we previously reported (1,2).

**Results/Discussion:** Enzyme activities in general decrease with time and in the presence of surfactants, activities decrease significantly in high surfactant concentrations. As small as 0.2 ppm of surfactant can change enzymatic activities significantly. Therefore, if activity is used to access enzyme mass balance, caution must be taken in the presence of surfactants. Non-ionic surfactant can increase enzymatic activities, in particular at moderately high concentration (10-5000 ppm). Hydrophilicity of anionic surfactants is important to activities of enzymes, molecular weight of cationic surfactants does not seem to be important to activities of enzymes. Enzymatic activities changes with pH and surfactant concentrations. Molecular size affects enzyme permeabilities, but not linearly. Surfactants definite affect enzyme permeabilities, but the combined effect of activity enhancement/depression should also be taken into consideration when assessing mass balance of enzymes during the interfacial transport (Figure 1). Herring DNA reacted with the cationic surfactant in different manners, depending on the surfactant

concentrations. For the hydrophilic anionic surfactant, the DNA did not show any structural alternation for concentration of surfactant as high as 5000 ppm. For the non-ionic surfactant, the DNA appeared to have structural alternations, according to the UV-VIS absorption, the absorption peak shifted differently depending on the concentration of surfactant (Figure 2). The herring DNA permeated through the  $5 \mu$  membrane significantly might indicate that the molecular size of the DNA is in the same order as the membrane pore. Surfactants have drastic effect on the interfacial transport of the DNA, the amount of DNA permeated for the anionic surfactant was several times more than a cationic surfactant.

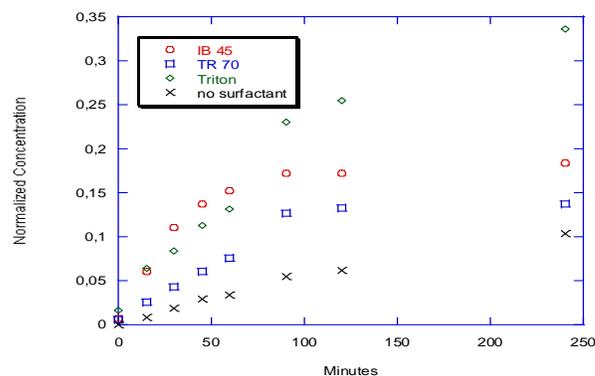


Figure 1: Effect of Various Surfactants (0.1 ppm in right-cell) on LDH Permeabilities with  $1 \mu$  of Polycarbonate Membrane at pH 6.95

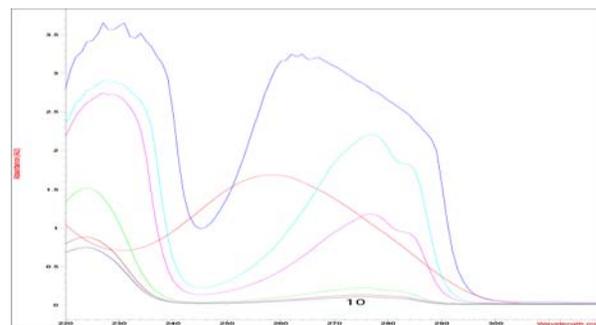


Figure 2 : DNA and Triton X-100 non-ionic surfactants from 0.05 to 5000 ppm.

**Conclusions:** This research study has many implications and applications in bioengineering and cell signaling, further research is ongoing and needed.

**References:** (1. S. Leung and J. Lai. *Biochem Eng.* 2005:25: 79-88. 2. J.C.K. Lai and S. W. Leung. *Encyc of Biomet and Biomed Eng* (Wnek GE & Bowlin GL, eds. Marcel Dekker). 2006: 1-11.)