Supporting Information

Experimental Section

Hind III (Haemophilus influenzae Rd III, MW 130,000, Nippon Gene), λ-DNA (Bacteriophage λ cI 857 Sam7, Nippon Gene, 48502 bp), dipalmitoyl phosphatidyl choline (DPPC, Sigma) and Nitr-5 (Dojin) were used as received.

Aqueous dispersions of amphiphiles (2 mM, neutralized with equimolar tris(hydroxymethyl)aminomethane, Tris) were dispersed in Tris-HCl buffer (10 mM, pH 8.0) by ultrasonication (Branson Sonifier Model W-185). HindIII in a commercially supplied buffer solution (1 μl, 10 – 12 unit) was diluted with de-ionized water (8.5 μl) and then added to aqueous bilayers (2 mM, 2 μl). The mixture was incubated at 37 °C for 30 min, after which λ-DNA (4 x 10^{-14} mol, ca 3 μl) was added to this solution (1+HindIII←DNA, [nucleotide] = [amphiphile] = 0.25 mM). When necessary, larger amounts of bilayer 1 was employed (2.5 mM).

Alternatively, HindIII was added to the mixtures of λ-DNA and bilayer 1 (DNA+1←HindIII, [nucleotide] = 0.25 mM, [amphiphile] = 0.25 or 2.5 mM). Under these competitive conditions, bilayer 1 did not interfere with the enzymatic activity, and hydrolysis of DNA occurred as described in the text. Binding of proteins to DNA involves their initial encounter and non-specific binding processes, which are largely driven by long-distance
operating forces such as electrostatic interactions. The above results indicate that the equimolar condition ([nucleotide] = [amphiphile]) employed is not in larger excess of bilayers.

In the Ca$^{2+}$ ion-induced activation experiments, aqueous CaCl$_2$ (2 mM, 4 μl) or aqueous Nitr-5 containing equimolar Ca$^{2+}$ (2 mM, 4 μl) was also added (final Ca$^{2+}$ concentration, 0.5 mM). Photoillumination was conducted for 10 min by using a 500-W high pressure Hg lamp (Ushio Denki Co.) with a glass filter to eliminate light at wavelengths shorter than 310 nm. Enzymatic reactions were initiated by the addition of reaction buffers (1.5 μl, Nippon Gene) to achieve suitable reaction conditions (50 mM NaCl, 30 mM Tris-HCl (pH 7.9), 10 mM MgCl$_2$, and 10 mM 2-mercaptoethanol). The resultant mixtures were then incubated at 37 °C for 1 h. The reaction was quenched by the addition of EDTA (10 mM, 4 μl), and the bilayer component was removed from the reaction mixture by extraction with phenol (20 μl, saturated with 1M Tris buffer (pH 8)). Gel electrophoresis was performed using 1 % agarose gels (nacalai tesque) under standard conditions (Tris-borate-EDTA buffer, pH 8.4, typically for 2 h at 100 V). After electrophoresis, gels were stained by ethidium bromide and then visualized under UV light. Differential scanning calorimetry (DSC) was performed for aqueous phosphate bilayers (20 mM) with a Seiko SSC/5200H calorimeter.