

Organelle-Mimicking Liposome Dissociates G-quadruplexes and Facilitates Transcription

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Supplementary Table 1. Thermodynamic parameters for formation of the G-quadruplex structures by mcG_n^a

POPC Concentration (mM)	ΔH° (kcal mol ⁻¹)	$T\Delta S^\circ$ (kcal mol ⁻¹)	ΔG°_{25} (kcal mol ⁻¹)	T_m (°C)
1cG₂				
0.0	-30.7 ± 0.4	-29.3 ± 0.4	-1.4 ± 0.1	38.5
2.0	-26.6 ± 0.2	-25.7 ± 0.1	-0.9 ± 0.1	33.0
1cG₄				
0.0	-62.1 ± 0.4	-54.7 ± 0.3	-7.4 ± 0.1	65.5
2.0	-38.1 ± 0.7	-33.9 ± 0.7	-4.2 ± 0.1	59.5
2cG₃				
0.0	-43.1 ± 0.1	-40.2 ± 0.1	-2.9 ± 0.1	46.0
2.0	-27.8 ± 0.4	-26.4 ± 0.4	-1.4 ± 0.1	40.5
3cG₃				
0.0	-40.2 ± 0.4	-37.9 ± 0.3	-2.3 ± 0.1	42.0
2.0	-31.7 ± 0.3	-30.3 ± 0.4	-1.4 ± 0.1	38.0
4cG₃				
0.0	-43.3 ± 0.7	-41.1 ± 0.6	-2.2 ± 0.2	40.0
2.0	-33.1 ± 0.5	-31.8 ± 0.6	-1.3 ± 0.2	36.0

^aAll experiments were carried out in a buffer containing 10 mM sodium phosphate (pH 7.0), 10 mM NaCl, and 1 mM Na₂EDTA without or with 2.0 mM POPC. Values are means ± standard deviations from three independent measurements. Melting temperatures were measured at a total strand concentration of 20 μM.

Supplementary Table 2. Changes in thermodynamic parameters for formation of G-quadruplex by 1cG_n (n = 2, 3, and 4) in the presence of 2.0 mM POPC relative to its absence

G-quadruplex	$\Delta\Delta H^\circ$ (kcal mol ⁻¹)	$\Delta(T\Delta S^\circ)$ (kcal mol ⁻¹)	$\Delta\Delta G^\circ_{25}$ (kcal mol ⁻¹)
1cG ₂	+4.1	+3.6	+0.5
1cG ₃	+17.9	+16.0	+1.9
1cG ₄	+24.0	+20.8	+3.2

Supplementary Table 3. Thermodynamic parameters for the formation of G-quadruplex structure by 1crG₃^a

POPC	ΔH°	$T\Delta S^\circ$	ΔG°_{25}	T_m
Concentration (mM)	(kcal mol⁻¹)	(kcal mol⁻¹)	(kcal mol⁻¹)	(°C)
0.0	-45.8 ± 0.5	-40.6 ± 0.6	-5.2 ± 0.1	62.5
2.0	-23.5 ± 0.4	-22.0 ± 0.3	-1.5 ± 0.1	54.5

^aAll experiments were carried out in a buffer containing 10 mM sodium phosphate (pH 7.0), 10 mM NaCl, and 1 mM Na₂EDTA without or with 2.0 mM POPC. Values are means ± standard deviations from three independent measurements. Melting temperatures were measured at a total strand concentration of 20 μM.

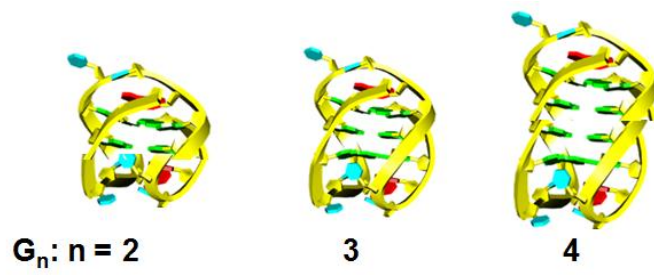
Supplementary Table 4. Thermodynamic parameters for the formation of G-quadruplex structure by 1cG₃^a

Liposome (2.0 mM)	ΔH° (kcal mol ⁻¹)	$T\Delta S^\circ$ (kcal mol ⁻¹)	ΔG°_{25} (kcal mol ⁻¹)	T_m (°C)
-	-40.0 ± 0.6	-36.9 ± 0.5	-3.1 ± 0.1	50.0
IM	-28.0 ± 0.5	-26.0 ± 0.4	-2.0 ± 0.1	47.0
NM	-24.9 ± 0.8	-23.4 ± 0.3	-1.5 ± 0.1	45.0
ER	-23.1 ± 0.3	-21.7 ± 0.2	-1.4 ± 0.1	42.5

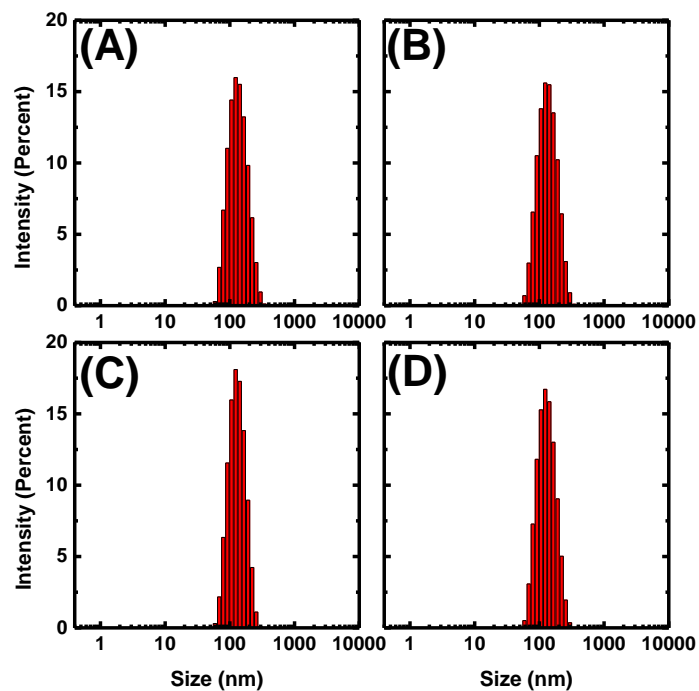
^aAll experiments were carried out in a buffer containing 10 mM sodium phosphate (pH 7.0), 10 mM NaCl, and 1 mM Na₂EDTA without or with 2.0 mM liposome. Values are means ± standard deviations from three independent measurements. Melting temperatures were measured at a total strand concentration of 20 μM.

Supplementary Table 5. Changes of thermodynamic parameters of G-quadruplex formed by 1cG₃ in the presence of IM, NM, and ER mimicking liposomes and POPC liposomes

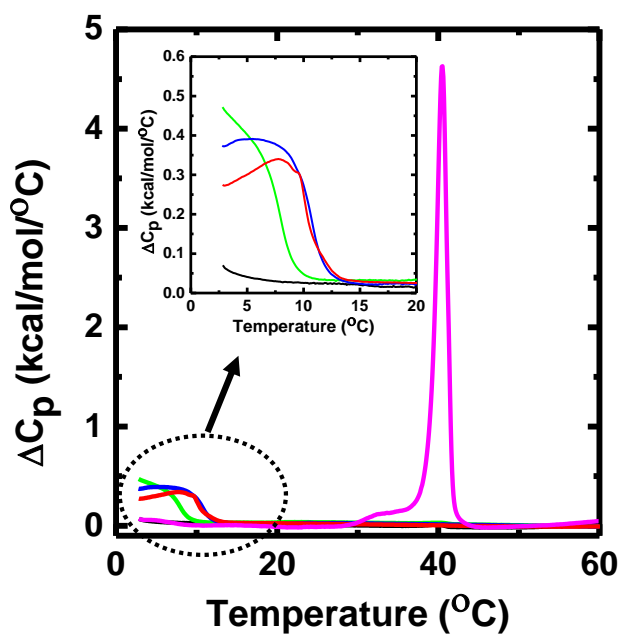
Liposome (2.0 mM)	Molar ratio of POPC (%)	$\Delta\Delta H^\circ$ (kcal mol⁻¹)	$\Delta(T\Delta S^\circ)$ (kcal mol⁻¹)	$\Delta\Delta G^\circ_{25}$ (kcal mol⁻¹)
IM	43	+12.0	+10.9	+1.1
NM	69	+15.1	+13.5	+1.6
ER	75	+16.9	+15.2	+1.7
POPC	100	+17.9	+16.0	+1.9



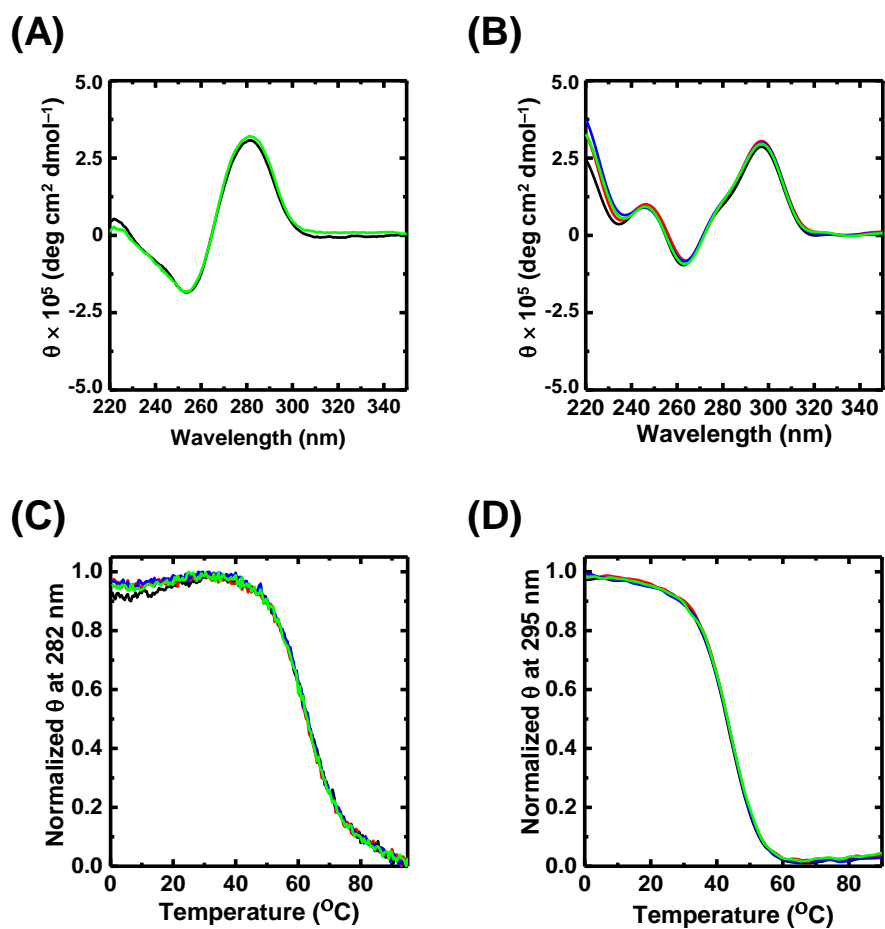
Supplementary Figure 1. Schematic representations of G_n ($n = 2, 3,$ and 4) structures.



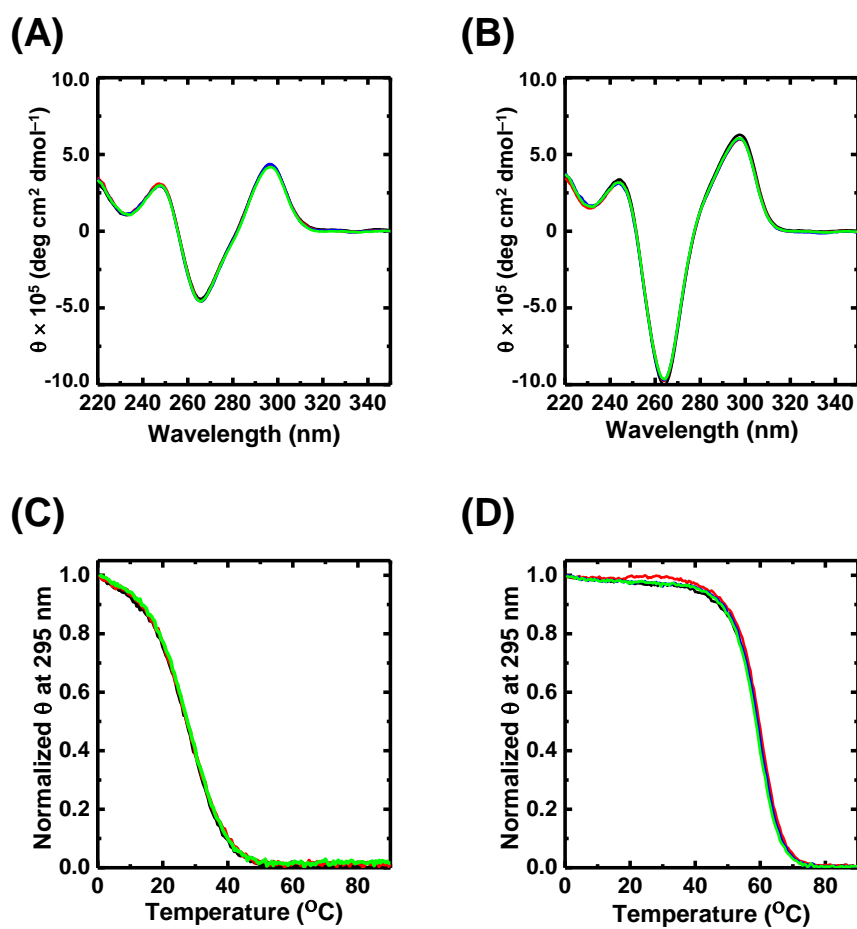
Supplementary Figure 2. Diameter distributions of (A) POPC, (B) IM, (C) NM, and (D) ER liposomes at 25 °C.



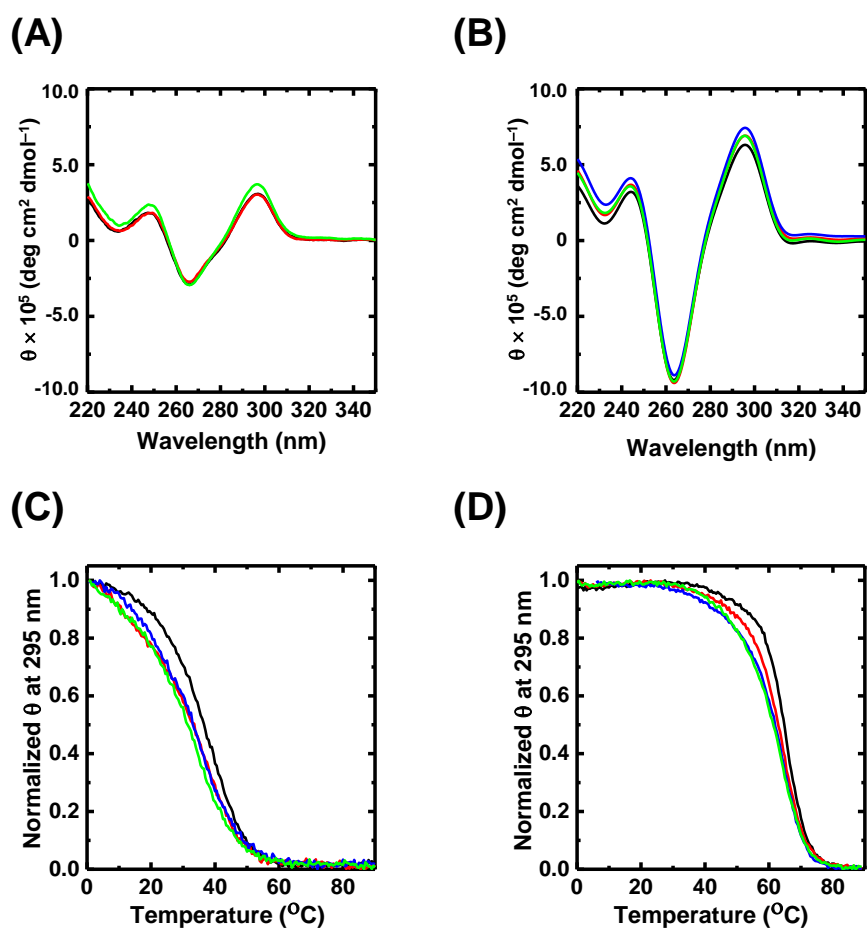
Supplementary Figure 3. DSC heating thermograms for POPC (black), IM (red), NM (blue), ER (green), and DPPC (pink) liposomes. The inset shows DSC profiles in the region from 0 to 20 °C.



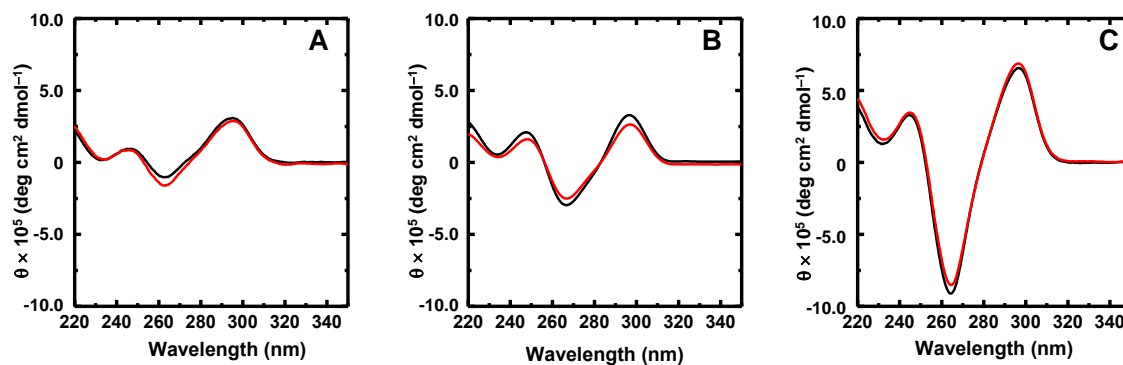
Supplementary Figure 4. CD spectra of 20 μM (A) D and (B) G_3 at 4 $^\circ\text{C}$ and normalized CD melting profiles of (C) D at 282 nm and (D) G_3 at 295 nm in the absence (black) and presence of 2.0 mM IM (red), NM (blue), and ER (green) liposomes.



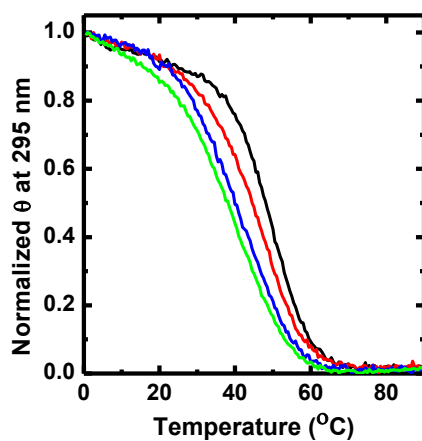
Supplementary Figure 5. CD spectra of 20 μ M (A) G_2 and (B) G_4 at 4 °C and normalized CD melting profiles of (C) G_2 and (D) G_4 at 295 nm in the absence (black) and presence of 2.0 mM IM (red), NM (blue), and ER (green) liposomes.



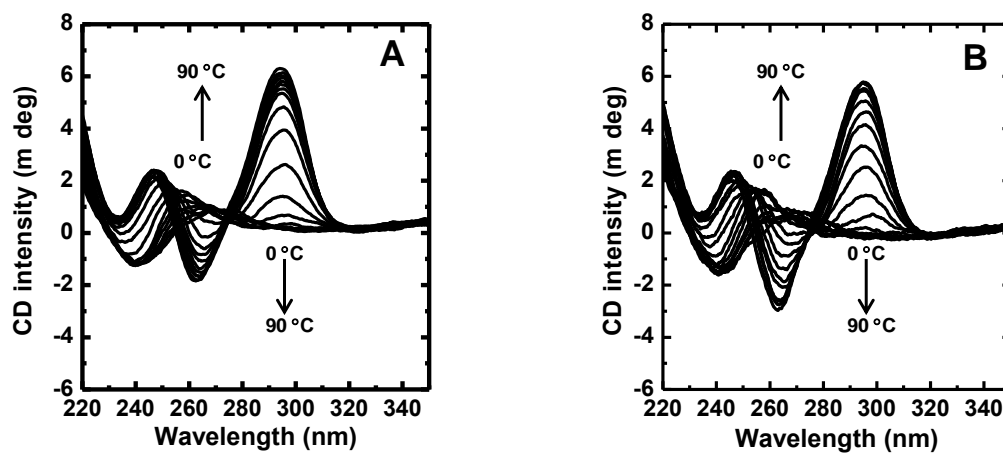
Supplementary Figure 6. CD spectra of 20 μ M (A) 1cG₂ and (B) 1cG₄ at 4 °C and normalized CD melting profiles of (C) 1cG₂ and (D) 1cG₄ at 295 nm in the absence (black) and presence of 2.0 mM IM (red), NM (blue), and ER (green) liposomes.



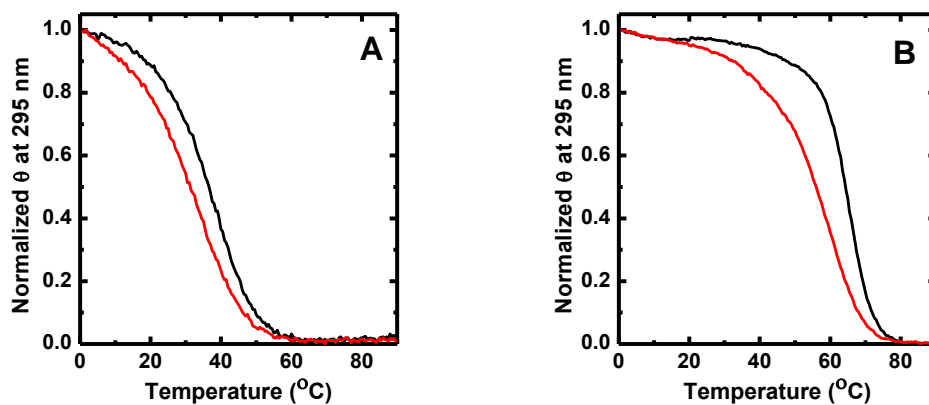
Supplementary Figure 7. CD spectra of 20 μM (A) 1cG₃, (B) 1cG₂, and (C) 1cG₄ in the absence (black) and presence (red) of 2.0 mM POPC liposomes at 4 °C.



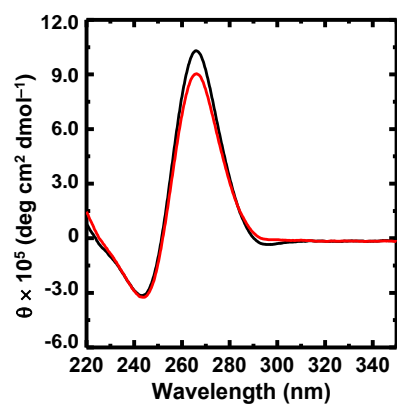
Supplementary Figure 8. Normalized CD melting profiles at 295 nm of 20 μM total strand concentration of 1cG₃ in the absence (black) and presence of 0.5 (red), 1.0 (blue), and 2.0 mM (green) POPC liposomes.



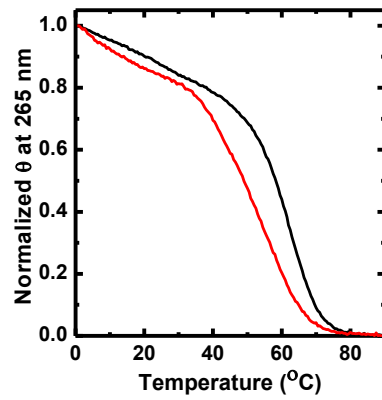
Supplementary Figure 9. CD spectra of 20 μM 1cG₃ in (A) the absence and (B) presence of 2.0 mM POPC liposomes at temperatures from 0 to 90 $^{\circ}\text{C}$.



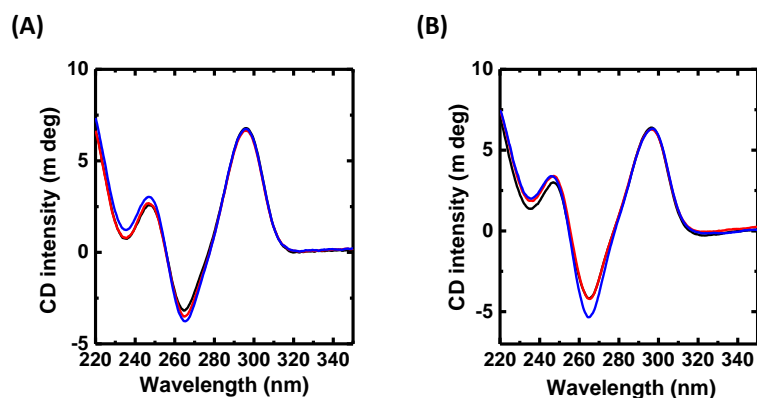
Supplementary Figure 10. Normalized CD melting profiles at 295 nm of 20 μ M total strand concentration of (A) 1cG₂ and (B) 1cG₄ in the absence (black) and presence (red) of 2.0 mM POPC liposomes.



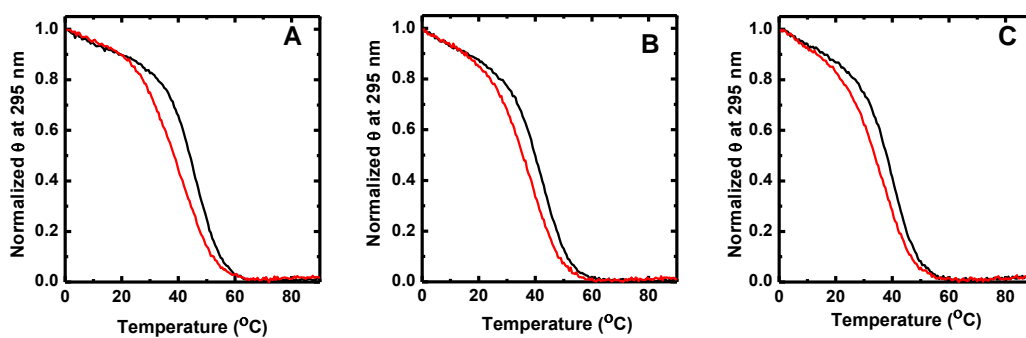
Supplementary Figure 11. CD spectra of 20 μM 1crG₃ in the absence (black) and presence (red) of 2 mM POPC liposomes at 4 °C.



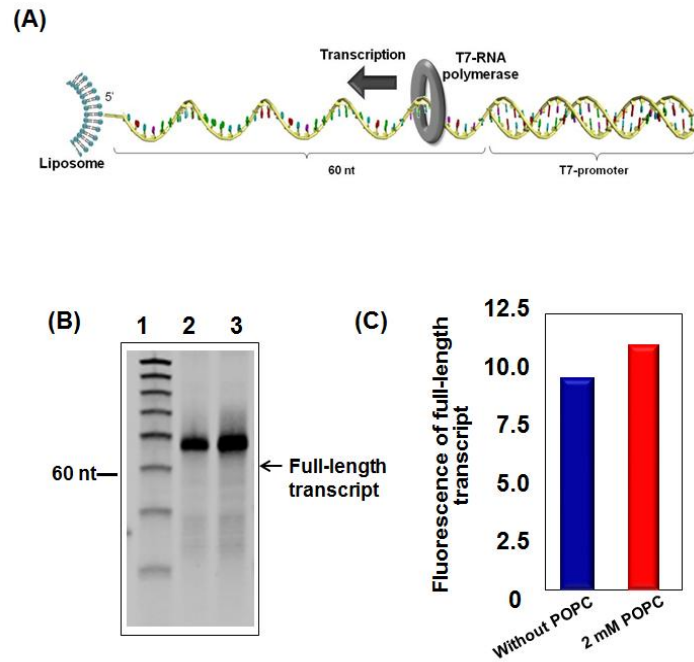
Supplementary Figure 12. Normalized CD melting profiles at 265 nm of 20 μM total strand concentration of 1crG₃ in the absence (black) and presence (red) of 2.0 mM POPC liposomes.



Supplementary Figure 13. CD spectra of 20 μM 2cG₃ (black), 3cG₃ (red), and 4cG₃ (blue) in (A) absence and (B) presence of 2.0 mM POPC liposomes at 4 °C.



Supplementary Figure 14. Normalized CD melting profiles at 295 nm of 20 μM total strand concentration of (A) 2cG₃, (B) 3cG₃, and (C) 4cG₃ in the absence (black) and presence (red) of 2.0 mM POPC liposomes.



Supplementary Figure 15. Effects of membrane surface on transcription of a linear template DNA sequence. (A) Illustration of the template DNA immobilized on a liposome. (B) Denaturing gel electrophoresis of products of transcription reactions performed for 90 min at 37 °C. Reaction mixtures contained 0.3 μ M T7 polymerase and 1.5 μ M DNA template in a buffer containing 10 mM NaCl, 40 mM Tris-HCl (pH 8.0), 8 mM MgCl₂ and 2 mM spermidine in the absence and presence of 2.0 mM POPC. Lane 1, size marker; lane 2, transcription products in the absence of POPC; lane 3, transcription products in the presence of 2.0 mM POPC. (C) Comparison of fluorescence intensities of full-length transcripts from gel bands in panel B.