DNA G-quadruplexes Activate Heme for Robust Catalysis of Carbene Transfer Reactions

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Supporting Information

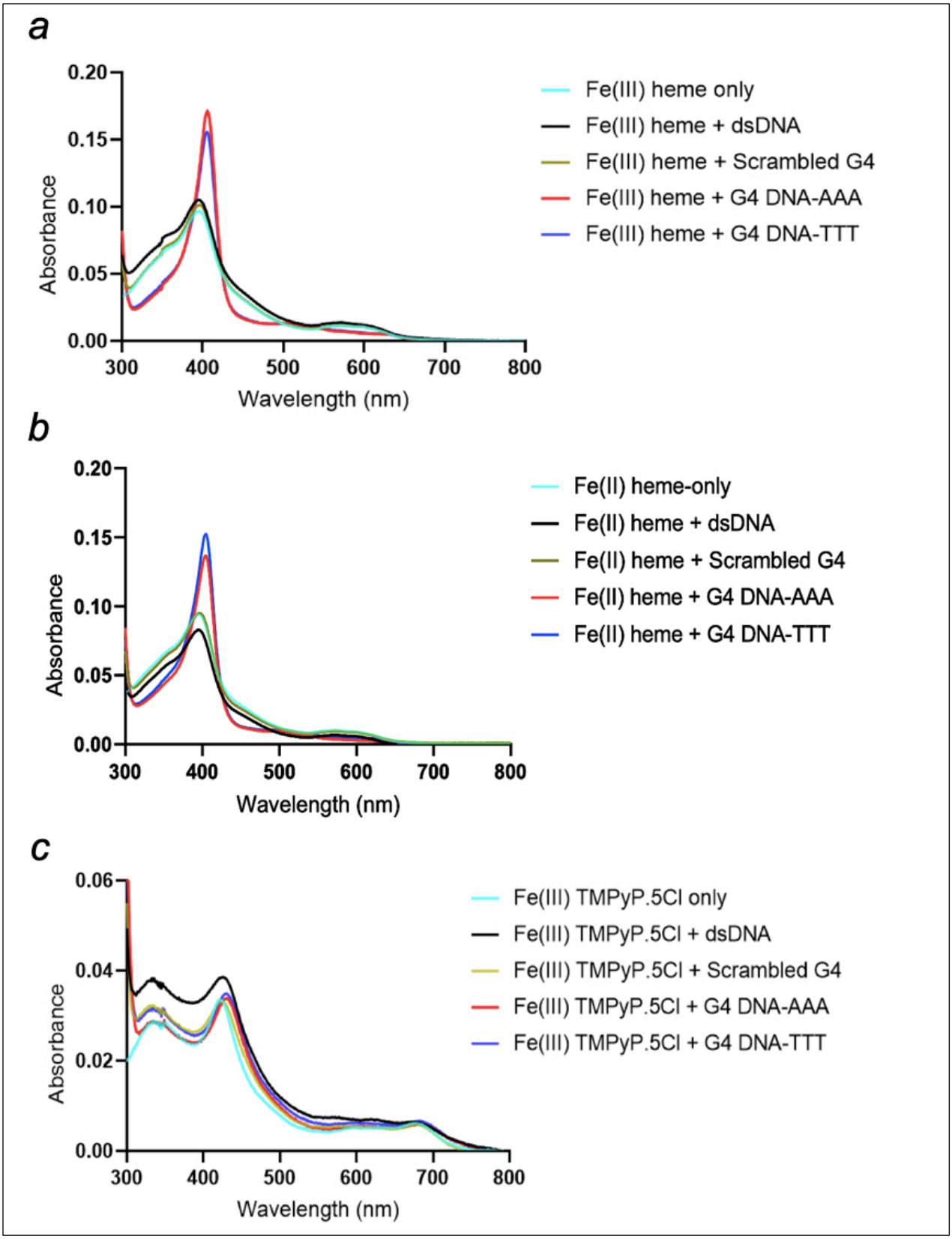

Figure S1: UV-vis absorption spectra of 2 μM (***a***) ferric (***b***) ferrous heme and (***c***) ferric TMPyP4.5Cl in the presence and absence of "dsDNA", "Scrambled G4" and "G4" DNA (10 μM DNA) in a buffer: 40 mM HEPES-NH_4OH, pH 8.0, 20 mM KCl, 1% DMF, 0.05% Triton X-100. Only (***b***) contained 10 mM $Na_2S_2O_4$.

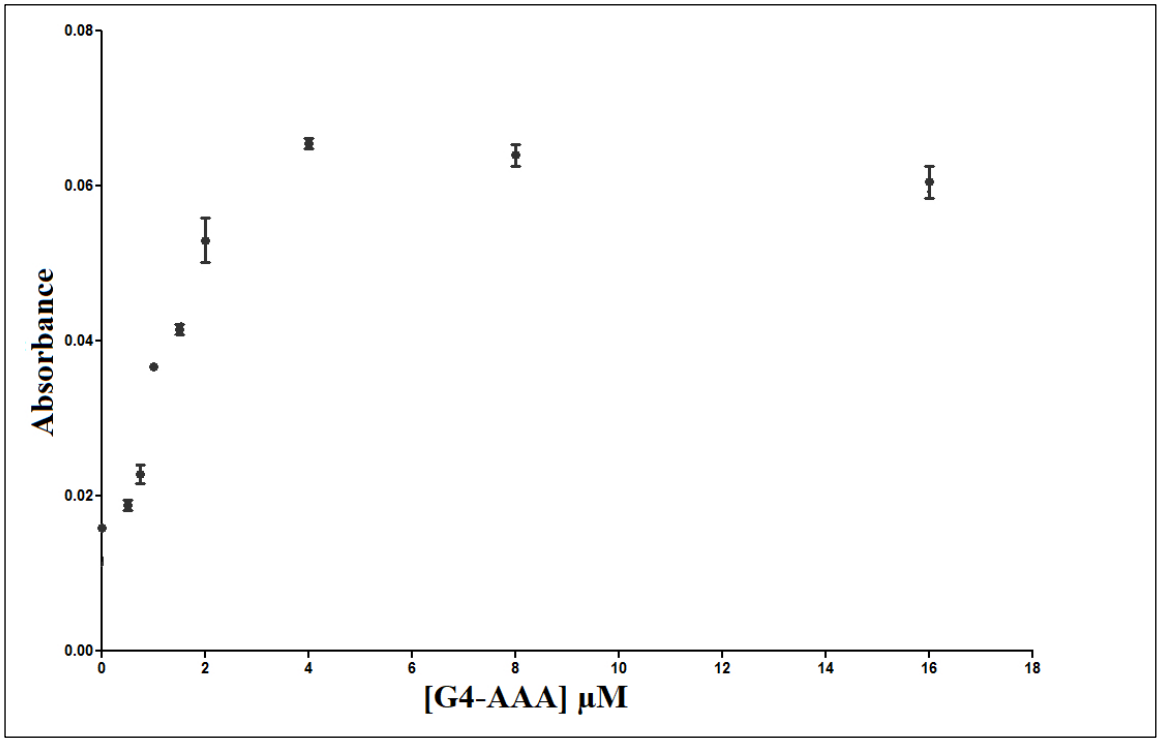

Figure S2: Absorbance measurements at 404 nm of 0.5 µM ferrous heme titrated with 0-16 µM "G4" DNA in a buffer: 40 mM HEPES-NH_4OH, pH 8.0, 20 mM KCl, 1% DMF, 0.05% Triton X-100. The error bars represent one standard deviation from the mean, obtained from two independent experiments.

Table S1: Yields of cyclopropanation reaction using Fe(III)-heme catalysts under aerobic and anaerobic conditions with and without the reducing agent. $Na_2S_2O_4$. Product yields were determined by GC analysis: 80 µM DNA, 30 µM Hemin, 1 mM Styrene, 7 mM EDA, 10 mM $Na_2S_2O_4$ in an aqueous buffer: 40 mM NH_4-HEPES, pH 8.0, 20 mM KCl, 1% DMF, 0.05% Triton-X100.

	– argon – $Na_2S_2O_4$	– argon + $Na_2S_2O_4$	+ argon – $Na_2S_2O_4$	+ argon + $Na_2S_2O_4$
Fe(III)-heme no DNA	-	-	1	2
Fe(III)heme dsDNA	-	-	1	3
Fe(III)-heme Scrambled G4	-	-	6	13
Fe(III)-heme G4	4	8	36	75

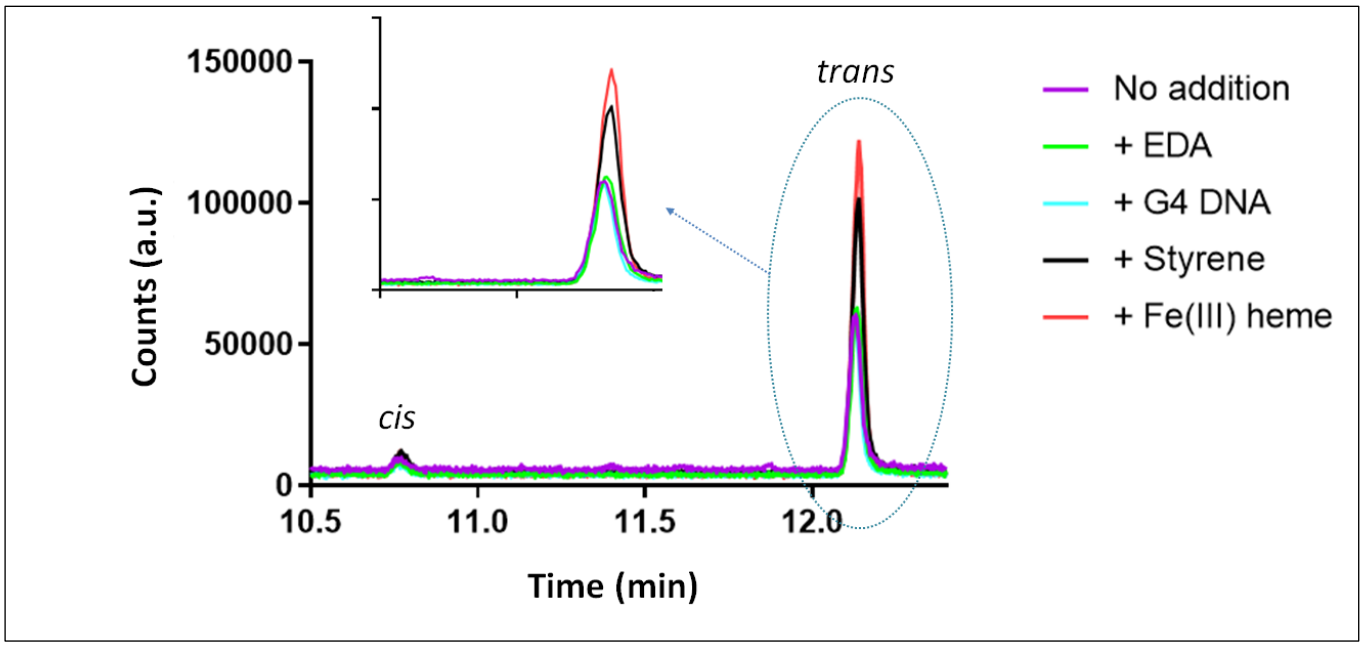

Figure S3: Effect of different reagent supplementations on the yield of 1-carbethoxy-2-phenylcyclopropane (cPr) products by the "G4" heme•DNAzyme. Five identical reaction solutions were prepared, each containing 17 µM heme, 83 µM G4 DNA, 1 mM styrene, 7 mM EDA, and 10 mM $Na_2S_2O_4$ in a buffer solution consisting of 40 mM NH_4-HEPES, pH 8.0, 20 mM KCl, 1% DMF, and 0.05% Triton X-100. Following one hour of reaction, 10 µl supplementations of one of the reaction components was added to a given reaction tube, in anaerobic fashion: (1) heme (to a final concentration of 33 µM); (2) styrene (to 2 mM); EDA (to 13 mM); "G4" DNA (to 116 µM). Following these single reagent supplementations, the various reactions were allowed to continue for one further hour prior to termination and extraction using ethyl acetate.

Table S2 : Yields of carbene insertion reaction of styrene with EDA in the presence of heme•DNAzymes made of different GQs ("G4-T", "G4-A", "G4-TTT", "G4-AAA" and "$(dA_4G_5A_4)_4$"). Reactions were carried out at 21°C for 1 hr, with 80 μM GQ DNA (asterisked samples contained 80 μM $dA_4G_5A_4$; hence, ≤ 20 μM $(dA_4G_5A_4)_4$ GQ following KCl incubation), 30 μM hemin, 7 mM EDA, 10 mM $Na_2S_2O_4$ in a buffer (40 mM NH_4-HEPES, pH 8.0, 20 or 500 mM KCl, 1% DMF, 0.05% Triton X-100) under anaerobic conditions. cPr product yields were determined from GC analysis and are based on EDA as the limiting reagent.

GQ DNA species	**cPr Yield (%)**
G4-AAA (20 mM KCl)	77 ± 3
G4-AAA (500 mM KCl)	79 ± 2
G4-TTT (20 mM KCl)	80 ± 2
G4-TTT (500 mM KCl)	79 ± 2
G4-A (20 mM KCl)	78 ± 2
G4-T (20 mM KCl)	77 ± 1
RNA G4-AAA (20 mM KCl)	78 ± 2
*$(dA_4G_5A_4)_4$ (20 mM KCl)	51± 4
*$(dA_4G_5A_4)_4$ (500 mM KCl)	49 ± 3
$(dA_4G_5A_4)_4$ (20 mM KCl)	92 ± 2

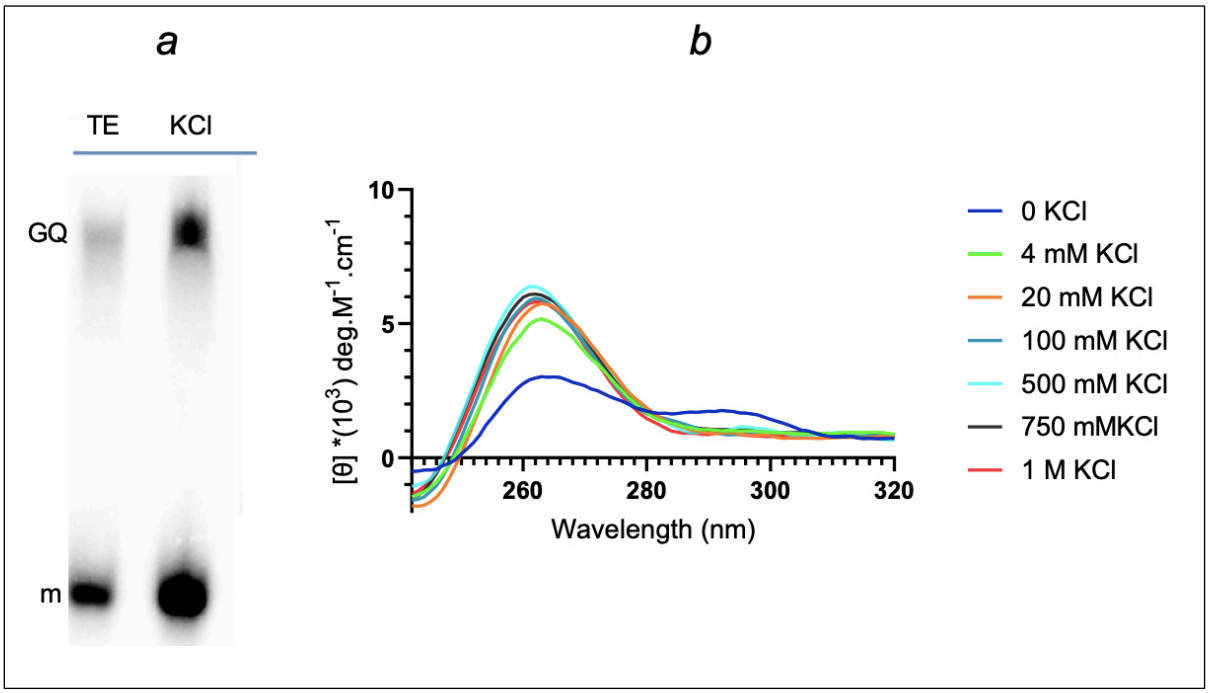

Figure S4 *a*: Native gel electrophoresis to show the formation of a unique intermolecular GQ product from $dA_4G_5A_4$ upon incubation with buffered KCl ("m": single-strand; "GQ": G-quadruplex). ***b***: Circular Dichroism (CD) spectra of the products of incubation of the DNA oligonucleotide "G4" ("G4-AAA"), at 20 µM, in the absence and presence of different KCl concentrations (0, 4, 20 100, 500, 750, and 1000 mM, respectively) within the buffer of 40 mM HEPES-NH_4OH, pH 8.0, 1% DMF, and 0.05% Triton X-100.