

General. All reagents were of the highest commercial grade and used as received. Solvents were of spectrophotometric quality or better and used without further purification. Aqueous solutions were prepared from Millipore purified water. Oligonucleotides were prepared on an ABI (Applied Biosystems, Inc.) model 394 DNA synthesizer. NMR spectra were recorded on Varian 500 MHz spectrometer in the solvents noted and chemical shifts are given relative to TMS. Abbreviations used in this section include: **1** = 5'-O-(4,4'-dimethoxytrityl)-2'-iminomethylpyridyl-2'-deoxyuridine; HOBT = hydroxybenzotriazole; BOP = benzotriazol-1-yloxytris(dimethylamino)phosphonium hexafluorophosphate; DMT = 4,4'-dimethoxytrityl; LCAA-CPG = long-chain alkyl-amine-controlled pore glass.

Instrumental Details. Cyclic voltammograms were collected of **2** and Ru(acac)₂(impy) in a traditional two-compartment cell using a polished and sonicated 3 mm-diameter glassy carbon or platinum disk working electrode (BAS), Pt wire auxiliary electrode, and Ag/AgCl reference electrode. Square wave voltammograms were collected of **3** and **4**. Measurements were conducted at room temperature with a CH instruments 660 electrochemical workstation. Solutions for electrochemical measurements were performed in either acetonitrile or dichloromethane (Burdick and Jackson) containing 0.1 M n-tetrabutylammonium hexafluorophosphate (SACHEM) or in phosphate buffer (50 mM, pH 7.0, 0.5 M NaCl) in nanopure water and were fully deaerated with argon.

Emission spectra were collected with a Hitachi F-4500 Fluorescence Spectrometer with the following instrumental parameters: 10 nm slits, 750 V PMT, 480 nm excitation, 500-900 nm scan wavelengths. Quantum yield measurements were calculated using [Ru(bpy)₃]²⁺ as an actinometer. Lifetimes were collected as previously described: Chang, I-JY, Gray, H.B., Winkler, J.R. *J. Am. Chem. Soc.* **1991**, *113*, 7056-7057.

Excitation of the samples was provided by 441.6 nm (He:Cd Liconix) or 514.5 nm (Ar⁺ Coherent Innova 70) and scattered light was dispersed with a Spex 1403 Double Monochromator and intensities were measured by single-photon counting. Samples were prepared (~1 mM) in

NMR tubes and the Raman signal was collected at 90° during irradiation with dwell times of 10 sec/cm⁻¹ at 1 cm⁻¹ intervals. Absorption spectra before and after data collection confirmed that decomposition did not occur.

Thermal denaturation curves were collected using a Hewlett-Packard HP 8452A diode array spectrophotometer equipped with a Peltier temperature controller (20-70 °C range). Individual oligonucleotides were hybridized to their complementary strands in 50 mM sodium phosphate buffer (pH 7.0) containing 0.5 M sodium chloride, to give solutions that were 2.7 μM in each strand. The samples were heated for 20 minutes at 70 °C and slowly cooled to 4 °C overnight. Thermal denaturation values were calculated from absorbance changes at 260 nm as the average of the heating and cooling traces collected for each hybrid; values were obtained from 2-4 separate heat-cool cycles.

Synthesis of Ru(acac)₂(1) (2): 2'-amino-5'-O-(4,4'-dimethoxytrityl)-2'-deoxyuridine (93 mg, 0.17 mmol) was dissolved in ethanol (5 mL) containing molecular sieves, and the solution was flushed with argon for 15 minutes. 2-pyridinecarboxaldehyde (15 μL, 0.16 mmol) was added incrementally, and the reaction was refluxed for 2 hours. The solution was cooled, filtered to remove the molecular sieves, and evaporated to dryness under reduced pressure to give the intermediate nucleoside **1**. The nucleoside was redissolved in ethanol (5 mL) and the solution was deaerated. In a separate flask Ru(acac)₂(CH₃CN)₂ (0.17 mmol) was dissolved ethanol (25 mL) and the solution was deaerated. The two solutions were combined and heated to reflux for 1 hour. The solvent was removed under reduced pressure and the green residue was purified by flash chromatography on silica using 1.5:1 THF/hexanes mobile phase (yield 79%). ¹H-NMR (500 MHz, CDCl₃) δ 8.93 (s, 1H), 8.74 (d, 1H), 7.81 (d, 1H), 7.73 (d, 1H), 7.48 (t, 1H), 7.43 (d, 2H), 7.20-7.34 (m, 7H), 7.11 (t, 1H), 6.81 (dd, 4H), 5.36 (dd, 1H), 5.28 (s, 1H), 5.02 (s, 2H), 4.88-4.92 (m, 1H), 4.84 (s (br), 1H), 4.68-4.76 (m, 1H), 3.79 (d, 6H), 3.41-3.56 (m, 2H), 2.20 (s, 3H), 2.12 (s, 3H), 1.82 (s, 3H), 1.60 (s, 3H). UV-vis (EtOH) nm (ε): 234 (33400), 276 (27000), 396 (3600), 592 (3600). ESI-MS calculated for C₄₆H₄₈N₄O₁₁Ru [M+H⁺] 934.96, found 934.4 [M+H⁺].

Synthesis of [Ru(bpy)₂(1)](PF₆)₂ (3): 2'-amino-5'-O-(4,4'-dimethoxytrityl)-2'-deoxyuridine (1.8 g, 3.31 mmol) was dissolved in ethanol (30 mL) containing molecular sieves, and the solution was flushed with argon for 15 minutes. 2-pyridinecarboxaldehyde (295 μ L, 3.1 mmol) was added incrementally, and the reaction was refluxed for 6 hours. The solution was cooled, filtered to remove the molecular sieves, and evaporated to dryness under reduced pressure. The residue was re-dissolved in EtOH (180 mL) and Ru(bpy)₂Cl₂ (Strem, 1.6 g, 3.31 mmol) was added to the solution. The reaction was refluxed over molecular sieves for 4 hours under argon. The solution was filtered and the solvent was removed under reduced pressure. The residue was purified by flash chromatography [(a) silica, 2% saturated aqueous KNO₃, 7% water in acetonitrile; (b) basic alumina after conversion to the PF₆⁻ salt, 0.5% saturated aqueous KPF₆, 2.5% water in acetonitrile]. The product fractions were concentrated, dissolved in dichloromethane, and filtered to remove excess salt. The product was obtained as a red film (yield 19%). ¹H-NMR (500 MHz, CD₃CN) δ 7.15-8.5 (m, 31H), 6.89 (d, 4H), 6.60 (d, 1H), 6.35 (d, 1H), 5.39 (d, 1H), 4.77 (d, 1H), 4.18-4.20 (m, 2H), 3.79-3.84 (m, 6H), 2.87-3.04 (m, 2H). UV-vis (MeOH) nm (ϵ): 210 (70100), 238 (38900), 256 (25800), 284 (51900), 480 (9100). ESI-MS calculated for C₅₆H₅₀N₈O₇RuP₂F₁₂ [M-PF₆]⁺ 1193.08, found 1193.0 [M-PF₆]⁺.

Synthesis of Ru(acac)₂(impy): The model complex was prepared by first reducing Ru(acac)₃ (99.6 mg, 0.25 mmol) (Knowles, T. S.; Howells, M. E.; Howlin, B. J.; Smith, G. W.; Amodio, C. A. *Polyhedron* **1994**, *13*, 2197-2203) over Zn/Hg amalgam under argon in 6:1 ethanol/water solution. Following reduction, 2-(aminomethyl)pyridine (28.4 μ L, 0.25 mmol) was added dropwise in 1 mL EtOH and the solution was refluxed for 2 hours. The reaction mixture was cooled, filtered and purified by flash chromatography on silica under argon using 1.5:1 THF/hexanes mobile phase (yield 58%). UV-vis (EtOH) nm (ϵ): 206 (21,800), 274 (16,800), 402 (4600), 576 (4600). ESI-MS calculated for C₁₆H₂₀N₂O₄Ru [M+H]⁺ 406.41, found 406.2 [M+H]⁺.

Synthesis of Ru(bpy)₂(1-succinate)(PF₆)₂: To a solution of **3** (46.5 mg, 35 μmol) and dimethylaminopyridine (2.1 mg, 17.5 μmol) in 0.5 mL anhydrous pyridine was added succinic anhydride (3.1 mg, 31.5 μmol). The reaction was stirred for 19 hours at room temperature under an argon atmosphere. The solvent was removed under reduced pressure and the residue was co-evaporated with toluene. The residue was purified by flash chromatography (basic alumina, 1% saturated aqueous KNO₃, 19% water in acetonitrile). The product fractions were combined and the acetonitrile was removed. A saturated aqueous solution of ammonium hexafluorophosphate was added to the resulting solution to precipitate the product. The red solid was collected by filtration and dried under vacuum (yield 54%). ESI-MS calculated for C₆₀H₅₄N₈O₁₀RuP₂F₁₂ [M-PF₆]⁺ 1293.26, found 1293.2 [M-PF₆]⁺.

Synthesis of Ru-CPG: To a solution of Ru(bpy)₂(1-succinate)(PF₆)₂ (179 mg, 125 μmol) in 4 mL of anhydrous dichloromethane was added anhydrous triethylamine (350 μL), HOBT (22.6 mg, 166 μmol), and BOP (91, 205 μmol). This solution was transferred to a flask containing LCAA-CPG (250 mg, 500 Å pore size) and agitated gently overnight at room temperature. The resin was filtered and washed with fresh dichloromethane. A portion of the rinsed CPG was removed, washed with methanol and ether, and assayed for nucleoside loading (38-47 μmol/g resin). The remaining resin was rinsed with methanol and ether and dried under vacuum. The washed resin was resuspended in 2 mL of acetic anhydride/pyridine/THF solution (supplied by ABI) and 1 mL 1-methyl-imidazole/THF solution (ABI) and was agitated for 30 minutes. The resin was filtered, washed with pyridine (3 x 20 mL), methanol (3 x 20 mL), dichloromethane (3 x 20 mL), and ether (3 x 20 mL), and dried under vacuum. The nucleoside loading after capping was 28 μmol/g resin.

Synthesis of TCT CCT ACA CUimpyRu(bpy)₂ (4): Ru-CPG (40 mg, 1 μmol) was packed into an ABI column and two columns were used for oligonucleotide synthesis. The reaction time for the first coupling was 10 minutes: the yield of the first coupling step was routinely > 95%. Upon completion of the synthesis (trityl off), the contents of the columns were transferred to two glass

tubes and suspended in 30% aqueous ammonia (5 mL/tube). The oligonucleotide solutions were incubated either at room temperature for 1 hour followed by 6 hours at 55°C or at room temperature for 18 hours. The solvent was evaporated in a speed vacuum and the red pellets were purified by ion-exchange HPLC (Dionex NucleoPac PA-100 column; A = 10% acetonitrile in water, B = 10% acetonitrile in water, 1.5 M NH₄OAc, pH = 6, 37-47% B over 17 minutes). The product fractions were collected and the solvent was removed under vacuum. The resulting pellets were desalted using Waters C18 SepPak cartridges. Yield after isolation: 28%. MALDI-TOF mass spectrometry: found: 3728.55 [M-H]⁻; calculated: 3730.76 [M].