Total Synthesis of Lucilactaene, A Cell Cycle Inhibitor Active in p53-Inactive Cells.

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Supporting Information

General Methods: Cesium fluoride (Aldrich) was ground to a fine powder using a mortar and pestle and dried under high vacuum at 100 °C for 4 h. *n*-Bu₃SnH (Acros), CuCN (Aldrich), *n*-BuLi (Strem), CrCl₂ (Strem), LiI (Strem), Pd₂dba₃ (Strem), P(furyl)₃ (Aldrich), PdCl₂·(CH₃CN)₂ (Strem), NMP (anhydrous; Aldrich), Pd(OAc)₂ (Strem), Ph₃P (Aldrich), and Ph₃As (Aldrich) were used as received. All polyene-forming reactions were performed in the absence of light. Flasks were wrapped with foil and chromatography was performed in the dark. Most of these compounds were acid sensitive and silica gel was doped with 2% Et₃N.

2-((1E,3E)-4-(Tributylstannyl)buta-1,3-dienyl)-4,4,5,5-tetramethyl-

1,3,2-dioxaborolane (6). A solution of aldehyde **14** (2.01 g, 5.83 mmol) and borolane **15** (2.46 g, 11.7 mmol) in THF (29 mL) were added by syringe to a solution of anhydrous CrCl₂ (5.73 g, 46.6 mmol) in THF (58 mL) at 23 °C under argon. A solution of LiI (3.12 g, 23.3 mmol) in THF (29 mL) was added by syringe and the reaction mixture was stirred for 3 h at 23 °C. The reaction mixture was poured onto a large excess of water and was extracted with Et₂O. The combined organic extracts were dried (MgSO₄) and concentrated. The residue was dissolved in 5% EtOAc/hexane (25 mL) and passed through a short plug of Florisil[®], eluting with 5% EtOAc/hexane (250 mL), to afford diene **6** (2.15 g, 79%) as a yellow oil: ¹H NMR (400 MHz, CDCl₃) δ 6.95(dd, 1H, *J* = 17.6, 6.4 Hz), 6.61 (dd, 1H, *J* = 18.0, 9.6 Hz), 6.46 (d, 1H, *J* = 15.2 Hz), 5.47 (d, 1H, *J* = 17.6 Hz) 1.60-1.40 (m, 6H), 1.38-1.22 (m, 12H), 1.27 (s, 12H), 0.93-0.85 (m, 9H); ¹³C NMR (100 MHz, CDCl₃) δ 152.2, 148.5, 140.3, 83.1, 29.1, 27.2, 21.8, 13.7, 9.5; IR (KBr) ν_{max} 3464, 2957, 2897, 2871, 1616, 1557, 1345, 1120 cm⁻¹; HRMS (ESI), *m/z* calcd for C₂₂H₄₃BO₂SnNa: 493.2276; found: 493.2255.

(Z)-2-(Tributylstannyl)but-2-en-1-ol. 2,2'-Azobis(2-methylpropionitrile) (135 mg)

was added in one portion to a neat mixture of tributyltin hydride (8.5 g, 29 mmol) and 2-butyne-1-ol (5.5 g, 80 mmol). The reaction mixture was warmed to 80 °C over 30 min and was stirred at this temperature for 3 h. Distillation afforded (Z)-2-(tributylstannyl)but-2-en-1-ol (7.8 g, 74%) as a colorless oil: ¹H NMR (400 MHz, CDCl₃) δ 6.28 (q, 1H, *J* = 7.1 Hz), 4.08 (d, 2H, *J* = 6.1 Hz), 2.98 (s, 1H), 1.71 (d, 3H, *J* = 7.1 Hz), 1.60-1.08 (m, 18H), 0.86 (m, 9H); ¹³C NMR (100 MHz, CDCl₃) δ 144.4, 136.0, 70.5, 29.2, 27.7, 19.5, 13.6, 10.2; IR (KBr) ν_{max} 3320, 1630 cm⁻¹; HRMS (ESI), *m/z* calcd for C₁₆H₃₄OSnNa: 385.1532; found: 385.1532.

(Z)-2-Iodobut-2-en-1-ol (9). Iodine (6.3 g, 25 mmol) was added in a single portion to a

solution of (Z)-2-(tributylstannyl)but-2-en-1-ol (5.0 g, 14 mmol) in CCl₄ (175 mL) at 0 °C. The reaction mixture was stirred for 10 min at this temperature and was poured onto an excess of 10% aqueous NaHSO₃. The aqueous phase was extracted with Et₂O, and the organic extracts were dried (MgSO₄) and concentrated. The residue was purified by flash chromatography (0-50% EtOAc/hexane) to afford **9** (2.6 g, 95%) as an orange oil: ¹H NMR (400 MHz, CDCl₃) δ 5.98 (q, 1H, *J* = 6.5 Hz), 4.26 (d, 2H, *J* = 6.0 Hz), 2.12 (t, 1H, *J* = 6.0 Hz), 1.79 (d, 3H, *J* = 6.5 Hz); ¹³C NMR (100 MHz, CDCl₃) δ 131.1, 109.5, 71.4, 21.4; IR (KBr) ν_{max} 3330, 1650 cm⁻¹; HRMS (ESI), *m/z* calcd for C₄H₇IO: 197.9536; found: 197.9527.

(E)-2-Ethylidenepent-3-yn-1-ol (10). A reaction vessel was charged with PdCl₂(PPh₃)₂

(381 mg, 0.330 mmol) and flushed with argon. A solution of vinyl iodide **9** (1.30 g, 6.57 mmol) in THF (33 mL) at 23 °C was added to the flask in one portion by syringe. The reaction mixture was stirred for 5 min when a solution of propynylmagnesium bromide (0.5 M in THF, 26.3 mL, 13.1 mmol) was added dropwise over 10 min by syringe. The reaction mixture was warmed at 50 °C and was stirred 12-18 h at this temperature. The reaction mixture was cooled and poured onto saturated aqueous NH₄Cl and extracted with Et₂O. The organic extract was dried (MgSO₄) and concentrated, and the residue was purified by flash chromatography (silica doped with 2% Et₃N, 0-20% EtOAc/hexane) to afford enyne

10 (622 mg, 86%) as an orange oil: ^1H NMR (400 MHz, CDCl_3) δ 5.87 (q, 1H, $J = 6.8$ Hz), 4.00 (s, 2H), 2.24 (br s, 1H), 1.97 (s, 3H), 1.79 (d, $J = 6.8$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ 131.6, 124.2, 91.5, 76.1, 66.2, 15.6, 4.3; IR (KBr) ν_{max} 3376, 2916, 2853 cm^{-1} ; HRMS (ESI), m/z calcd for $\text{C}_7\text{H}_{10}\text{ONa}$: 133.0629; found: 133.0631.

(2E,3E)-2-Ethylidene-4-(phenyldimethylsilyl)pent-3-en-1-ol (11).

A solution of PhMe_2SiLi (1 M in THF, 5.9 mL, 5.9 mmol) was added dropwise by syringe to a solution of dry CuCN (227 mg, 2.54 mmol) in THF (2 mL) at -50 $^\circ\text{C}$. The reaction mixture was warmed to -10 $^\circ\text{C}$ and stirred at this temperature for 45 min. The reaction mixture was re-cooled to -50 $^\circ\text{C}$ and water (128 μL , 7.12 mmol) was added by syringe in a single portion. The reaction mixture was warmed to -10 $^\circ\text{C}$ and was stirred for 30 min. The flask was re-cooled to -50 $^\circ\text{C}$ and a solution of enyne **10** (112 mg, 1.02 mmol) in THF (2 mL) was added dropwise by syringe. The reaction mixture was warmed to -10 $^\circ\text{C}$ and was stirred for 2 h. The reaction mixture was poured onto saturated aqueous $\text{NH}_4\text{Cl}/\text{conc. NH}_4\text{OH}$ (90:10) and stirred for 30 min. The aqueous phase was extracted with Et_2O and the combined organic extracts were dried (MgSO_4) and concentrated. The residue was purified by flash chromatography (silica doped with 2% Et_3N , 0-15% $\text{EtOAc}/\text{hexane}$) to afford diene **11** (244 mg, 85%) as a colorless oil: ^1H NMR (400 MHz, CDCl_3) δ 7.64 (m, 2H), 7.59 (m, 3H), 6.26 (s, 1H), 5.67 (dd, $J = 6.8, 0.8$ Hz), 4.08 (s, 2H), 1.72 (d, 3H, $J = 1.6$ Hz), 1.61 (dd, 3H, $J = 0.8, 6.8$ Hz), 0.44 (s, 6H); ^{13}C NMR (100 MHz, CDCl_3) δ 140.5, 139.2, 139.2, 137.9, 133.8, 129.4, 128.9, 127.7, 66.6, 19.2, 14.7, -0.1 ; IR (KBr) ν_{max} 3327, 3068, 2957, 1428, 1250, 1115, 832, 700 cm^{-1} ; HRMS (ESI), m/z calcd for $\text{C}_{15}\text{H}_{22}\text{OSiNa}$: 269.1325; found: 269.1338.

(2E,3E)-2-Ethylidene-4-(phenyldimethylsilyl)pent-3-enoic acid methyl ester (12).

Manganese dioxide (2.61 g, 30.0 mmol) was added in one portion to a solution of alcohol **11** (370 mg, 1.50 mmol) in CH_2Cl_2 (5 mL) at 25 $^\circ\text{C}$ and the reaction mixture was stirred for 3 d or until complete by TLC. The mixture was filtered through a pad of Celite[®] and the solids were washed several times with THF. The filtrate was concentrated *in vacuo*. The residue was dissolved in MeOH (1.7 mL) and acetic acid (214 μL , 3.75 mmol) was added by syringe followed by NaCN (368 mg, 7.50 mmol) in one portion. The reaction mixture was stirred for 1 h at 25 $^\circ\text{C}$ when additional MnO_2 (2.61 g,

30 mmol) was added in one portion. The reaction mixture was stirred for 18 h at 25 °C. The reaction mixture was filtered through a pad of Celite[®] and the solids were washed several times with THF. The filtrate was concentrated and the residue was suspended in Et₂O, poured onto H₂O, and extracted with Et₂O. The combined organic extracts were dried (MgSO₄) and concentrated, and the residue was purified by flash chromatography (silica doped with 2% Et₃N, 0-5% EtOAc/hexane) to afford dienoate **12** (370 mg, 90%) as a pale yellow oil: ¹H NMR (400 MHz, CDCl₃) δ 7.58 (m, 2H), 7.38 (m, 3H) 6.92 (dq, 1H, *J* = 7.1, 1.2 Hz), 6.35 (d, 1H, *J* = 1.2 Hz), 3.74 (s, 3H), 1.57 (d, 3H, *J* = 1.6 Hz), 0.42 (s, 3H), 0.41 (s, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 167.7, 141.1, 139.2, 139.1, 137.9, 133.9, 129.4, 128.9, 127.7, 51.7, 16.9, 15.6, -0.1; IR (KBr) ν_{max} 3068, 2954, 1719, 1636, 1605, 1431, 1378, 1248, 1132, 1113, 834, 815 cm⁻¹; HRMS (ESI), *m/z* calcd for C₁₆H₂₄OSiNa: 297.1287; found: 297.1270.

(2E,3E)-2-Ethylidene-4-iodopent-3-enoic acid methyl ester (7). A solution of

vinylsilane **12** (0.82 g, 3.0 mmol) in hexafluoroisopropanol (9 mL) was treated with 2,6-lutidine (0.14 mL, 4.5 mmol) at 25 °C. The reaction mixture was cooled to 0 °C and *N*-iodosuccinimide (4.5 g, 4.5 mmol) was added in one portion. After stirring for 90 sec at 0 °C, the reaction mixture was poured onto a mixture of saturated aqueous Na₂SO₃ and CH₂Cl₂. The organic layer was washed with saturated aqueous NaHCO₃ and NaCl. The combined organic layers were dried (Na₂SO₄) and concentrated. The residue was purified by flash chromatography (hexane) to afford vinyl iodide **7** (0.71 g, 89%) as an orange oil: ¹H NMR (400 MHz, CDCl₃) δ 6.94 (qd, 1H, *J* = 7.1, 1.2 Hz), 6.69 (dd, 1H *J* = 1.4, 2.8), 3.73 (s, 3H), 2.27 (d, 3H, *J* = 1.4 Hz), 1.74 (dd, 3H, *J* = 1.4, 7.1 Hz); ¹³C NMR (100 MHz, CDCl₃) δ 177.7, 140.6, 134.1, 130.3, 99.2, 52.0, 29.6, 15.8; IR (KBr) ν_{max} 2952, 1720, 1637, 1434, 1377, 1251, 1196, 1072, 832 cm⁻¹; HRMS (ESI), *m/z* calcd for C₈H₁₁O₂INa: 288.9702; found: 288.9711.

3-Bromo-1-((2-(trimethylsilyl)ethoxy)methyl)pyrrole-2,5-dione (17). A solution of bromomaleimide (5.15 g, 27.0 mmol) in DMF (1 L) at -40 °C was treated with diisopropylethylamine (5.60 mL, 32.3 mmol) and 2-(trimethylsilyl)ethoxymethyl chloride (3.60 mL, 20.4 mmol) dropwise. The reaction mixture was stirred for 2 h at -40 °C, and was allowed to warm to 25 °C. The reaction was quenched by the addition of saturated aqueous NH₄Cl (200 mL) and was concentrated to

200 mL. The mixture was diluted with deionized water and was extracted with Et₂O (5 x 300 mL). The combined organic extracts were washed with saturated aqueous NaCl (400 mL), dried (Na₂SO₄), and concentrated to afford the crude product as an oil (6.7 g, 81%), which was used without further purification: ¹H NMR (400 MHz, CDCl₃) δ 6.93 (s, 1H), 4.94 (s, 2H), 3.56 (dd, 2H, *J* = 8.4, 7.6 Hz), 0.90 (dd, 2H, *J* = 8.4, 8.0 Hz), 0.03 (s, 9H); ¹³C NMR (100 MHz, CDCl₃) δ 168.0, 165.0, 132.1, 131.9, 67.2, 67.1, 17.8, -1.5; IR (neat) ν_{max} 2954, 2889, 1780, 1725, 1585, 1332 cm⁻¹.

3-Iodo-1-((2-(trimethylsilyl)ethoxy)methyl)pyrrole-2,5-dione (18). A solution of NaI (18.3 g, 122 mmol) and maleimide **17** (6.20 g, 20.3 mmol) in acetone (20 mL) was warmed at reflux for 12 h. The reaction mixture was cooled to room temperature and filtered, and the filtrate was concentrated to afford a brown solid. Purification by flash chromatography (5% EtOAc/hexane) provided iodomaleimide **18** (7.17 g, 100%): ¹H NMR (400 MHz, CDCl₃) δ 7.23 (s, 1H), 4.97 (s, 2H), 3.58 (dd, 2H, *J* = 8.4, 8.0 Hz), 2.93 (dd, 2H, *J* = 8.4, 8.4 Hz), 0.00 (s, 9H); ¹³C NMR (100 MHz, CDCl₃) δ 169.4, 166.4, 140.8, 108.1, 67.4, 67.3, 17.9, -1.5; IR (neat) ν_{max} 3074, 2948, 2894, 1769, 1714, 1562, 1338 cm⁻¹.

5-Allyl-5-hydroxy-3-iodo-1-((2-(trimethylsilyl)ethoxy)methyl)-1,5-dihydropyrrol-2-one (19). A solution of allyl indium was generated from allyl iodide (0.92 g, 1.0 mmol) and indium (0.72 g, 6.3 mmol) in DMF (10 mL), and was added to a solution of iodomaleimide **18** (2.65 g, 4.70 mmol) in 56 mL DMF dropwise at -10 °C over 30 min. After stirring at -10 °C for 3 d, the reaction was quenched by the addition of saturated aqueous NH₄Cl. The aqueous layer was extracted with Et₂O (4 x 100 mL), and the combined organic extracts were washed with saturated aqueous NaCl, dried (Na₂SO₄) and concentrated to afford a yellow oil. Purification by flash chromatography (10-40% EtOAc/hexane) afforded alcohol **19** (1.6 g, 81%) as a white solid: ¹H NMR (400 MHz, CDCl₃) δ 7.38 (s, 1H), 5.65 (m, 1H), 5.16 (dd, 1H, *J* = 11.6, 2.1), 5.10 (s, 1H), 4.89 (ABq, 2H, *J* = 11.2 Hz, Δν = 28.0 Hz), 3.58 (m, 2H), 3.28 (br s, 1H) 2.55 (ABX, 2H, *J*_{AB} = 14.2 Hz, *J*_{AX} = 7.2 Hz, *J*_{BX} = 6.8 Hz, Δν = 90.2 Hz), 0.91 (m, 2H), 0.00 (s, 9H); ¹³C NMR (100 MHz, CDCl₃) δ 166.5,

155.5, 130.8, 120.2, 94.8, 92.7, 68.9, 66.6, 41.1, 18.1, -1.4; IR (neat) $\nu_{\max}$ 3363, 2933, 2905, 1710, 1691, 1247, 1078, 855 cm^{-1} ; HRMS (ESI), m/z calcd for $\text{C}_{13}\text{H}_{22}\text{NO}_3\text{SiNa}$: 418.0311; found: 418.0311.

5-Hydroxy-5-(2-hydroxyethyl)-3-iodo-1-((2-(trimethylsilyl)ethoxy)methyl)-1,5-dihydropyrrol-2-one. A solution of alkene **19** (260 mg, 0.66 mmol) in $\text{CH}_2\text{Cl}_2/\text{MeOH}$ (1:1, 66 mL) was cooled to -78°C and a solution of ozone in oxygen was bubbled into the reaction mixture until a blue color developed. Nitrogen was bubbled into the reaction for 30 min to purge excess ozone, and was followed by the addition of sodium borohydride (27.4 mg, 0.73 mmol). The reaction was warmed to 0°C and was stirred for 2 h. The reaction was quenched by the addition of saturated aqueous NH_4Cl and concentrated to remove 80 percent of the CH_2Cl_2 and MeOH. The mixture was extracted with CH_2Cl_2 (4 x 50 mL) and the combined organics were washed with saturated aqueous NaCl, dried (Na_2SO_4), and concentrated to afford a colorless oil. Purification by flash chromatography (10-40% EtOAc/hexane) afforded diol **20** (220 mg, 92%) as a colorless oil: ^1H NMR (400 MHz, CDCl_3) δ 7.53 (s, 1H), 4.89 (ABq, 2H, $J = 11.2$ Hz, $\Delta\nu = 28.0$ Hz), 4.54 (br s, 1H), 3.78 (m, 2H), 3.57 (m, 2H), 2.88 (br s, 1H) 2.38, (m, 1H), 1.95 (m, 1H), 0.89 (m, 2H), 0.0 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3) δ 166.6, 155.8, 94.1, 92.9, 68.7, 66.5, 58.5, 38.6, 18.1, -1.4; IR (neat) $\nu_{\max}$ 3546, 3465, 2959, 1731, 1437, 1234, 1048 cm^{-1} ; HRMS (ESI), m/z calcd for $\text{C}_{12}\text{H}_{22}\text{NO}_4\text{SiNa}$: 422.0261; found: 422.0261.

3-Iodo-5-(triethylsilanyloxy)-5-(2-(triethylsilanyloxy)ethyl)-1-((2-(trimethylsilyl)ethoxy)methyl)-1,5-dihydropyrrol-2-one (20). 2,6-Lutidine (1.3 mL, 11.5 mmol) and Et_3SiOTf (1.2 mL, 5.7 mmol) were added sequentially to a solution of the above diol (575 mg, 2.6 mmol) in CH_2Cl_2 (16 mL) at -40°C . The reaction mixture was allowed to warm to room temperature over 3 h and was quenched by the addition of saturated aqueous NaCl. The aqueous layer was extracted with CH_2Cl_2 (4 x 50 mL) and the combined organic extracts were washed with saturated aqueous NaCl, dried (Na_2SO_4), and were concentrated to afford a yellow oil. Purification by flash chromatography (5% EtOAc/hexane) afforded vinyl iodide **20** (900 mg, 91%) as a colorless oil: ^1H NMR (400 MHz,

CDCl₃) δ 7.54 (s, 1H), 4.80 (ABq, 2H, J = 11.2 Hz, $\Delta\nu$ = 120 Hz), 3.75 (m, 2H), 3.57 (m, 2H), 2.27 (m, 1H), 1.93 (m, 1H), 1.95 (m, 1H), 0.90 (m, 20H), 0.58 (q, 6H, J = 5.3 Hz) 0.49 (q, 6H, J = 5.3 Hz) 0.00 (s, 9H); ¹³C NMR (100 MHz, CDCl₃) δ 166.4, 156.8, 93.4, 93.1, 68.4, 66.4, 58.1, 42.8, 18.1, 6.8, 6.6, 5.6, 4.4, -1.4; IR (neat) $\nu_{\max}$ 2958, 2916, 2870, 2342, 1734, 1234, 1100 cm⁻¹; HRMS (ESI), m/z calcd for C₂₄H₅₀NO₄SiNa: 650.1990; found: 650.1989.

(*E*)-3-(3-Bromo-2-methylacryloyl)-5-triethylsilanyloxy-5-(2-(triethylsilanyloxy)ethyl)-1-(2-(trimethylsilyl)ethoxy)methyl-1,5-dihydropyrrol-2-one. (23). A solution of isopropylmagnesium chloride in Et₂O (2.0 M, 25 μ L, 0.05 mmol) was added to a solution of vinyl iodide **20** (27 mg, 0.04 mmol) at -60 °C. The reaction was allowed to warm to -50 °C and a solution of CuCN·2LiCl (1 M, 50 μ L, 0.05 mmol) was added. The reaction was allowed to warm to -40 °C and (*E*)-3-bromo-2-methylacryloyl chloride (8.5 μ L, 0.07 mmol) was added in one portion. After 1 min, the reaction was quenched by the addition of pH 7.0 buffer and was extracted with Et₂O (4 x 40 mL). The combined organic extracts were washed with saturated aqueous NaCl, dried (Na₂SO₄), and concentrated to provide a colorless residue. Purification by preparative TLC (10% EtOAc/hexane) afforded vinyl bromide **23** (18 mg, 65%): ¹H NMR (400 MHz, CDCl₃) δ 7.49 (s, 1H), 7.40 (s, 1H), 4.79 (ABq, 2H, J = 11.2 Hz, $\Delta\nu$ = 138 Hz), 3.81 (m, 1H), 3.59 (m, 3H), 2.35 (m, 1H), 2.05 (s, 3H), 1.99 (m, 1H), 0.90 (m, 20H), 0.58 (q, 6H, J = 5.3 Hz) 0.49 (q, 6H, J = 5.3 Hz) 0.00 (s, 9H); ¹³C NMR (100 MHz, CDCl₃) δ 187.2, 166.3, 152.4, 142.9 134.4, 128.8, 90.3, 67.9, 66.5, 58.2, 43.4, 18.2, 14.8, 6.8, 6.7, 5.8, 4.4, -1.4; IR (neat) $\nu_{\max}$ 2938, 2883, 2343, 1739, 1720, 1074, 743 cm⁻¹; HRMS (ESI), m/z calcd for C₂₈H₅₄BrNO₅SiNa: 670.2391; found: 670.2391.

(2*E*,3*E*,5*E*,7*E*)-2-Ethylidene-4-methyl-8-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)octa-3,5,7-trienoate methyl ester (24). In a dry box, Pd₂dba₃ (3 mg, 3.0 μ mol) and Ph₃As (2 mg, 6.0 μ mol) were added to a Schlenk flask equipped with a stir bar, which was capped with a septum and removed from the dry box. A solution of diene **6** (106 mg, 0.226 mmol) and

vinyl iodide **7** (50.0 mg, 0.188 mmol) in DMF (1.3 mL) was added by syringe at 23 °C. The flask was wrapped with foil and stirred at 23 °C for 24 h. The reaction mixture was diluted with Et₂O and poured onto saturated aqueous NH₄Cl. The aqueous layer was extracted with Et₂O, and the combined organic extracts were dried (MgSO₄) and concentrated. The residue was purified by flash chromatography (Florisil[®], 0-5% EtOAc/hexane) to afford **24** (48.2 mg, 81%) as a yellow oil: ¹H NMR (400 MHz, CDCl₃) δ 7.09 (dd, 1H, *J* = 17.2, 10.4 Hz), 6.91 (q, 1H, *J* = 14.4 Hz), 6.53 (d, 1H, *J* = 15.2 Hz), 6.35 (dd, 1H, *J* = 15.6, 10.4 Hz), 6.13 (s, 1H), 5.60 (d, 1H, *J* = 17.6 Hz), 3.74 (s, 3H), 1.74 (dd, 3H, *J* = 7.4, 0.8 Hz), 1.69 (d, 3H, *J* = 1.2 Hz), 1.29 (s, 12H); ¹³C NMR (100 MHz, CDCl₃) δ 167.7, 149.9, 140.2, 138.1, 133.2, 130.6, 130.5, 128.4, 126.6, 83.2, 51.9, 24.8, 15.9, 14.3; IR (KBr) ν_{max} 2979, 2933, 1722, 1620, 1452, 1358, 1263, 1145, 1009, 982, 850 cm⁻¹; HRMS (ESI), *m/z* calcd for C₁₈H₂₇BO₄Na: 341.1900; found: 341.1899.

2-Ethylidene-4,10-dimethyl-11-oxo-11-(2-oxo-5-

(triethylsilanyloxy)-5-(2-(triethylsilanyloxy)ethyl)-1-(2-(trimethylsilyl)ethoxymethyl)-2,5-

dihydro-1H-pyrrol-3-yl)-undeca-3,5,7,9-tetraenoic acid methyl ester (25). A reaction vessel was charged with Pd(OAc)₂ (1.6 mg, 7.0 μmol) and Ph₃P (3.7 mg, 14 μmol) and was flushed with argon. A solution of borinate **24** (22 mg, 70 μmol) and vinyl bromide **23** (30 mg, 46 μmol) in MeOH (130 μL) and THF (130 μL) was added by syringe, followed by aqueous Na₂CO₃ (1 M, 97 μL, 97 μmol) in one portion. The flask was wrapped with foil and stirred at 23 °C until TLC indicated starting halide was consumed. The reaction mixture was concentrated and the residue was purified by preparative TLC (10% EtOAc/hexane containing 2% Et₃N) to afford **25** (30 mg, 85%) as a yellow oil: ¹H NMR (400 MHz, CDCl₃) δ 7.31 (s, 1H), 7.0-6.96 (m, 2H), 6.71-6.40 (m, 4H), 6.18 (s, 1H), 4.99 (d, 1H, *J* = 8.8 Hz), 4.65 (d, 1H, *J* = 10.8 Hz), 3.85 (m, 1H), 3.77 (s, 3H), 3.70-3.56 (m, 3H), 2.40 (m, 1H), 2.01 (s, 3H), 1.99 (m, 1H), 1.75 (dd, 3H, *J* = 0.8, 7.4 Hz), 1.71 (d, 3H, *J* = 1.2 Hz), 0.90 (m, 20H), 0.58 (m, 12H), 0.00 (s, 9H); ¹³C NMR (100 MHz, CDCl₃) δ 168.9, 167.6, 149.9, 140.2, 140.0, 139.7, 138.4, 138.0, 130.6, 130.4, 128.6, 127.9, 126.7, 126.6, 126.55, 90.2, 68.2, 65.8, 58.3, 51.9, 45.7, 29.3, 23.8, 18.2, 15.3, 8.8, 6.8, 5.8, 4.4, -1.4; IR (KBr) ν_{max} 3248, 2940, 1714, 1632, 1431, 1251, 994, 728 cm⁻¹; HRMS (ESI), *m/z* calcd for C₄₀H₆₉NO₇Si₃Na: 783.2246; found: 783.2281.

Lucilactaene (1). Trifluoroacetic acid (0.25 mL) was added slowly by syringe to a solution of **25** (2.5 mg, 5.4 μ mol) in CH_2Cl_2 (2.5 mL) at 0 $^\circ\text{C}$ and the reaction mixture was stirred at 23 $^\circ\text{C}$ for 5 h. The reaction mixture was concentrated and the residue was purified by preparative TLC (Et_2O , 2% Et_3N) to afford **1** (1.4 mg, 64%) as a yellow solid: ^1H NMR (500 MHz, CDCl_3) 7.49 (d, 1H, $J = 11.5$ Hz), 7.01 (qd, 1H, $J = 7.2, 0.8$ Hz), 6.85 (dd, 1H, $J = 14.4, 10.8$ Hz), 6.68 (dd, 1H, $J = 14.4, 10.8$ Hz), 6.62 (d, 1H, $J = 15.2$ Hz), 6.47 (dd, 1H, $J = 15.4, 10.8$ Hz), 6.24 (s, 1H), 5.06 (br s, 1H), 4.40 (br s, 1H), 4.22 (br s, 1H), 4.12 (ddd, 1H, $J = 8.7, 8.6, 3.6$ Hz), 4.00 (ddd, 1H, $J = 8.8, 8.8, 6.3$ Hz), 3.76 (s, 3H), 2.40 (ddd, 1H, $J = 12.9, 8.7, 8.7$ Hz), 2.28 (ddd, 1H, $J = 12.9, 8.7, 3.6$ Hz), 1.95 (s, 3H), 1.75 (dd, 3H, $J = 7.2, 1.2$ Hz), 1.72 (d, 3H, $J = 0.8$ Hz); HRMS (ESI), m/z calcd for $\text{C}_{22}\text{H}_{27}\text{NO}_6\text{Na}$: 424.1736; found: 424.1739.