Supporting Information for Synthesis of fluorescent

(benzyloxycarbonylamino)(aryl)methylphosphonates

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General information

All solvents and reagents were purchased from commercial suppliers (Aldrich, Sigma, Merck, POCh), were of analytical grade and were used without further purification. Unless otherwise specified the solvents were removed with a rotary evaporator. Infrared spectra were measured on a 1600 FT-IR Perkin-Elmer spectrometer. NMR experiments were performed on Bruker DRX AVANCE[™] 300 MHz and Bruker AVANCE[™] 600 MHz sperctrometers. Measurements were made in CDCl₃ (99.5 at. % D) or D₂O (99.8 at. % D) solutions at temperature 300 K, all solvents were supplied by Dr Glaser AG (Basel, Switzerland). Chemical shifts are reported in parts per million relative to TMS or 85% H₃PO₄ used as external standards, and coupling constants are reported in Hertz. Melting points were determined on an Electrothermal 9200 apparatus and are reported uncorrected. Elemental analyses were performed at the Chemistry Department of the University of Wroclaw on a Perkin Elmer 2400 CHN analyser. Electrospray mass spectra were recorded at the Chemistry Department of the University of Wroclaw using a Finnigan Mat TSQ 700 Electrospray mass spectrometer.

Experimental procedures with copies of representative NMR spectra

Triaryl phosphites 1

To the solution of apprioprate phenol (50 mmol) in dry acetonitrile (200 mL) phosphorus trichloride (1.47 mL, 16 mmol) was added dropwise and the obtained mixture was refluxed for 5 h. After cooling the product precipitated or deposited as an oil. It was washed with acetonitrile and dried in dessicator. Phosphites were characterized by their ³¹P NMR spectra (presence of only a single phosphorus signal) and used directly after synthesis. *Tris(4-methylphenyl) phosphite* (**1b**); 58% yield; yellow oil, ³¹PNMR (CDCl₃): δ = 129.2 ppm [1].

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Tris(*4-fluorophenyl*) *phosphite* (**1c**); 58% yield; dense colorless oil, ³¹PNMR (CDCl₃): δ = 128.2 ppm.

Tris(*4-chlorophenyl*) *phosphite* (**1d**); 88% yield; yellowish oil, ³¹PNMR (CDCl₃): δ = 127.6 ppm [1].

Tris(4-bromophenyl) phosphite (**1e**); 89% yield; yellowish oil, ³¹PNMR (CDCl₃): δ = 125.2 ppm.

Tris(*4-iodophenyl*) *phosphite* (**1f**); 78% yield; yellowish oil, ³¹PNMR (CDCl₃): δ = 126.6 ppm.

Tris(*4-N*,*N-dimethylaminophenyl*) *phosphite* (**1g**); 89% yield; brownish oil, ³¹PNMR (CDCl₃): δ = 127.6 ppm.

Tris(*4-nitrophenyl*) *phosphite* (**1h**);95% yield; yellow crystals mp. 175-176 °C (lit. mp. 174-176 °C), ³¹PNMR (CDCl₃): δ = 126.3 ppm [2].

Tris(*1-naphthyl*) *phosphite* (**1i**); 60% yield; white crystals mp. 201-203 °C (lit. m.p. not given [3]), ³¹PNMR (CDCl₃): δ = 131.1 ppm.

Tris(2-*naphthyl*) *phosphite* (**1j**); 89% yield; yellow crystals mp. 199-201 °C, ³¹PNMR (CDCl₃): δ = 129.4 ppm.

Tris(6-bromo-2-naphthyl) phosphite (**1**k); 57% yield; yellow oil, ³¹P NMR (CDCl₃): δ = 128.6 ppm.

Tris(*7-hydroxycumaryl phosphite* (**1I**); 78% yield; yellow crystals mp. 187-190 °C, ³¹PNMR (CDCl₃): δ = 127.1 ppm.

Diaryl (benzyloxycarbonylamino)(phenyl)methylphosphonates 2a-k

Benzyl carbamate (4.53 g, 30 mmol), triarylphosphite (30 mmol) and benzaldehyde (4.53 mL, 45 mmol) were dissolved in acetic acid (100 mL) and the obtained mixture was

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refluxed for 2 h. Then the acetic acid was evaporated and the oily residue was dissolved in a small volume of acetone (10–20 mL depending on product), several drops of hexane were added and left for crystallization at 4 °C.

Diphenyl (benzyloxycarbonylamino)(phenyl)methylphosphonate (**2a**); 86% yield; white solid mp. 161-163⁰C (lit mp. 138-140⁰C [4]); 85:15 *trans/cis* ratio; ³¹PNMR (CDCl₃): δ = 15.52 & 15.46 ppm.; ¹HNMR (CDCl₃): δ = 5.04 & 5.13 (2H, d, *J* 15 Hz, C<u>H</u>₂Ph), 5.56 (1H, d, *J*_{PH} 22 Hz, *J* 9 Hz, C<u>H</u>P), 5.84 (1H, bd, *J* 9 Hz, N<u>H</u>), 6.80 (2H, d, *J* 9 Hz, Ar), 7.05-7.47 ppm (18H, m, Ar)

Bis(p-methylphenyl) (benzyloxycarbonylamino)(phenyl)methylphosphonate (**2b**); 74% yield; white solid mp. 216-219⁰C; 86:14 *trans/cis* ratio; ³¹PNMR (CDCl₃): δ = 14.56 & 14.43 ppm.; ¹HNMR (CDCl₃): δ = 3.38 & 3.55 (6H, PhC<u>H</u>₃), 5.10 & 5.13 (2H, d, *J_{AB}* 11 Hz, C<u>H</u>₂Ph), 5.60 (1H, dd, J_{PH} 24 Hz, J 9 Hz, C<u>H</u>P), 5.89 (1H, bd, J 9 Hz, N<u>H</u>), 6.87 (2H, d, *J* 9 Hz, Ar), 7.12-7.69 ppm (16H, m, Ar) ppm.

Bis(p-fluorophenyl) (benzyloxycarbonylamino)(phenyl)methylphosphonate (**2c**); 50% yield; white solid mp. 189-193⁰C; 93:7 *trans/cis* ratio; ³¹PNMR (CDCl₃): δ= 15.72 & 15.64 ppm.; ¹HNMR (CDCl₃): δ= 5.06 (2H, d, *J* 15 Hz, C<u>H</u>₂Ph), 5.71 (1H, d, *J*_{PH} 22 Hz, *J* 9 Hz, C<u>H</u>P), 5.96 (1H, bd, *J* 9 Hz, N<u>H</u>), 7.25-7.82 ppm (18 H, m, Ar) ppm. HRMS (DMSO, TOF MS ESI⁺): MH⁺, found 532.1322 [MNa⁺], C₂₇H₂₂F₂NO₅PNa requires 532.4301

Bis(p-chlorophenyl) (benzyloxycarbonylamino)(phenyl)methylphosphonate (**2d**); 62% yield; white solid mp. 169-171⁰C; 93:7 *trans/cis* ratio; ³¹PNMR (CDCl₃): δ= 14.87 & 14.69 ppm.; ¹HNMR (CDCl₃): δ= 5.05 & 5.16 (2H, d, J_{AB} 12 Hz, CH₂Ph), 5.66 (1H, dd, J_{PH} 22 Hz, J 10 Hz, CHP), 5.77 (1H, bd, J 10 Hz, NH), 6.78 & 6.88 (4H, d, J 8 Hz, Ar), 7.25-7.65 ppm (14H, m, Ar) ppm; HRMS (DMSO, TOF MS ESI⁺): found 565.92 [MNa⁺], $C_{27}H_{22}CI_2NO_5PNa$ requires 565.3397.

Bis(p-bromophenyl) (*benzyloxycarbonylamino*)(*phenyl*)*methylphosphonate* (**2e**); 72% yield; white solid mp. 157-162⁰C; 92:8 *trans/cis* ratio; ³¹PNMR (CDCl₃): δ = 16.01 & 15.89 ppm.; ¹HNMR (CDCl₃): δ = 5.06 & 5.18 (2H, d, *J_{AB}* 13 Hz, C<u>H</u>₂Ph), 5.59 (1H, d, *J_{PH}* 22 Hz, *J* 9 Hz, C<u>H</u>P), 5.83 (1H, bd, J 9 Hz, N<u>H</u>), 6.99 (2H, d, J 8 Hz, Ar), 7.28-7.48 ppm (16H, m, Ar) ppm. HRMS (DMSO, TOF MS ESI⁺): found 654.0002 [MNa⁺], C₂₇H₂₂Br₂NO₅PNa requires 654.2415.

Bis(p-iodophenyl) (benzyloxycarbonylamino)(phenyl)methylphosphonate (2f)



74% yield; white solid mp. 162-165 0 C; 92:8 *trans/cis* ratio; ³¹PNMR (d₆DMSO): δ = 14.95 & 14.70 ppm.; ¹HNMR (CDCl₃): δ = 5.05 & 5.13 (2H, d, J_{AB} 12 Hz, C<u>H</u>₂Ph), 5.63 (1H, dd, J_{PH} 22 Hz, J 8 Hz, C<u>H</u>P), 6.92 (2H, d, J 8 Hz, Ar), 7.29-7.69, (16H, m, Ar), 8.91 (1H, d, J 8 Hz, NH); ¹³C NMR (CDCl₃): δ = 66.77, 53.31 (d, J 155.5 Hz), 123.09, 123.12, 123.19, 128.52, 128.87, 128.89, 134.40, 137.02, 139.02, 139.09, 150.17, 136.38 ppm. HRMS (DMSO, TOF MS ESI⁺): found 747.9223 [MNa⁺], C₂₇H₂₂I₂NO₅PNa requires 748.2422.





Bis(*N*,*N*-dimethylaminophenyl) (benzyloxycarbonylamino)(phenyl)methylphosphonate (**2g**); 59% yield; white solid mp. 168-171⁰C; 89:11 *trans/cis* ratio; ³¹PNMR (CDCl₃): δ= 14.12 & 13.93 ppm.; ¹HNMR (CDCl₃): δ= 3.21-3.52 (12H, m), 5.07 & 5.13 (2H, d, J_{AB} 12 Hz, CH₂Ph), 5.76 (1H, dd, J_{PH} 24 Hz, J 9 Hz, CHP), 5.83 (1H, bd, J 9 Hz, NH), 6.79 (2H, d, J 9 Hz, Ar), 7.31-7.88 ppm (16H, m, Ar) ppm.

Bis(p-nitrophenyl) (benzyloxycarbonylamino)(phenyl)methylphosphonate (**2h**); 68% yield; white solid mp. 175-176⁰C; 98:2 *trans/cis* ratio; ³¹PNMR (CDCl₃): δ = 14.54 & 14.45 ppm.; ¹HNMR (CDCl₃): δ = 5.19 & 5.25 (2H, d, *J_{AB}* 12 Hz, CH₂Ph), 5.69 (1H, dd, *J_{PH}* 22 Hz, *J* 10 Hz, CHP), 5.88 (1H, d, *J* 10 Hz, NH), 6.99 (2H, d, *J* 9 Hz, Ar), 7.24-7.48 (12H, m, Ar), 8.09 & 8.16 ppm (4H, m, *J* 9 Hz) ppm. HRMS (DMSO, TOF MS ESI⁺): found 586.4401 [MNa⁺], C₂₇H₂₂N₃O₉PNa requires 586.4446

Bis(1-naphthyl) (benzyloxycarbonylamino)(phenyl)methylphosphonate (**2i**); 49% yield; white solid mp. 186-188⁰C; 95:5 *trans/cis* ratio; ³¹PNMR (CDCl₃): δ = 15.21 & 15.08 ppm.; ¹HNMR (d₆DMSO): δ = 5.04 & 5.08 (2H, d, *J* 12 Hz, C<u>H</u>₂Ph), 5.72 (1H, d, *J*_{PH} 22 Hz, *J* 10 Hz, C<u>H</u>P), 6.01 & 6.04 (1H, bd, *J* 10 Hz, N<u>H</u>), 6.98-7.01 ppm (24H, m, Ar) ppm. HRMS (DMSO, TOF MS ESI⁺): found 598.0582 [MNa⁺], C₃₅H₃₀NO₅PNa requires 598.5831.

Bis(2-*naphthyl*) (*benzyloxycarbonylamino*)(*phenyl*)*methylphosphonate* (**2j**); 72% yield; white solid mp. 172-173⁰C; 93:7 *trans/cis* ratio; ³¹PNMR (CDCl₃): δ= 14.82 & 14.66 ppm.; ¹HNMR (CDCl₃): δ= 5.05 & 5.10 (2H, d, J_{AB} 12 Hz, C<u>H</u>₂Ph), 5.76 (1H, dd, J_{PH} 24 Hz, J 9 Hz, C<u>H</u>P), 5.96 (1H, bd, J 9Hz, N<u>H</u>), 6.99-7.82 ppm (24H, m, Ar) ppm.

Bis(6-bromo-2-naphthyl) (benzyloxycarbonylamino)(phenyl)methylphosphonate (2k)



66% yield; white solid mp. 186-189⁰C; 95:5 *trans/cis* ratio; ³¹PNMR (d₆DMSO): δ = 15.21 & 15.03 ppm.; ¹HNMR (CDCl₃): δ = 5.04 & 5.09 (2H, d, J_{AB} 12 Hz, CH₂Ph), 5.63 (1H, d, J_{PH} 22 Hz, J 9 Hz, CHP), 5.96 (1H, bd, J 9Hz, NH), 6.89-7.86 ppm (22H, m, Ar) ppm; HRMS (DMSO, TOF MS ESI⁺): found 758.0043 [MNa⁺], C₃₅H₃₀Br₂NO₅PNa requires 758.3913.



(Benzyloxycarbonylamino)(aryl)methylphosphonates 3

Benzyl carbamate (2.0 g, 13.2 mmol), triaryl phosphite (13.2 mmol) and appropriate aldehyde (1.98 mmol) were dissolved in acetic acid (45 mL) and the obtained mixture was refluxed for 2 h and left overnight. Then acetic acid was evaporated and the oily residue

dissolved in small volume of acetone (5–20 mL depending on product), several drops of hexane were added and left for crystallization at 4 °C.

Diphenyl (benzyloxycarbonylamino)(1-naphthyl)methylphosphonate (3a)



55% yield, mp.178-180⁰C; ³¹PNMR (CDCl₃): δ = 15.27 ppm.; ¹HNMR (d₆DMSO): δ = 5.01 & 5.09 (2H, d, *J*_{AB} 12.1 Hz, C<u>H</u>₂Ph), 6.099 (1H, bm, C<u>H</u>P), 7.15- 8.05 (m, 7H), 8,51 (1H, bm, N<u>H</u>) ppm. HRMS (DMSO, TOF MS ESI⁺): found 546.1523 [MNa⁺], C₃₁H₂₆NO₅PNa requires 546.5082.



Bis(p-nitrophenyl) (*benzyloxycarbonylamino*)(2-*naphthyl*)*methylphosphonate* (**3b**); 48% yield; mp.168-171⁰C; ³¹PNMR (CDCl₃): δ = 14.91 ppm.; ¹HNMR (d₆DMSO): δ = 5.01§ & 5.09 (2H, d, *J_{AB}* 11 Hz, C<u>H</u>₂Ph), 6.06 (1H, bd, *J* 9.3 Hz, N<u>H</u>), 6.58 (1H, dd, *J_{PH}* 21.0 Hz, *J* 9.3 Hz, C<u>H</u>P), 7.15- 8.05 (m, 7H), 8,51 (1H, bm, N<u>H</u>) ppm.

Diphenyl (benzyloxycarbonylamino)(2-naphthyl)methylphosphonate (**3c**); 68% yield; 186-189⁰C; 98:2 trans/cis ratio; ³¹PNMR (CDCl₃): δ = 14.40 & 14.31 ppm.; ¹HNMR (CDCl₃): δ = 5.08 & 5.17 (2H, d, *J_{AB}* 12 Hz, C<u>H</u>₂Ph), 5.69 (1H, dd, *J_{PH}* 22 Hz, *J* 9 Hz, C<u>H</u>P), 7.00-7.97 ppm (22H, m, Ar), 9.06 (1H, bd, J 9Hz, N<u>H</u>) ppm. HRMS (DMSO, TOF MS ESI⁺): found 546.1454 [MNa⁺], C₃₁H₂₆NO₅PNa requires 546.5082.

Diphenyl (benzyloxycarbonylamino)(p-nitrophenyl)methylphosphonate (**3d**); 84% yield; mp. 164-165⁰C; ³¹PNMR (CDCl₃): δ = 12.82 ppm.; ¹HNMR (CDCl₃): δ = 5.12 (2H, dd, *J* 12.0 Hz, C<u>H</u>₂Ph); 5.69 (1H, dd, *J*_{PH} 23.6 Hz, *J* 9.5 Hz, C<u>H</u>P); 6,49 (1H, bd, *J* 15Hz, N<u>H</u>), 6.92 (2H d, *J* 9 Hz, Ar), 6.92 (2H d, *J* 7.8 Hz, Ar), 7.12-7.34 (11H, m, Ar), 7.68 & 8.19 (2H each, d, *J* 8.4Hz, nitroaryl) ppm.

Diphenyl (benzyloxycarbonylamino)(m-nitrophenyl)methylphosphonate (**3e**); 76% yield; mp. 135-137⁰C; ³¹PNMR (CDCl₃): δ= 12.76 ppm.; ¹HNMR (CDCl₃): δ= 5.10 & 5.16 (2H, d, J_{AB} 12.2 Hz, CH₂Ph), 5.68 (1H, dd, J_{PH} 23.2 Hz, J 9.1 Hz, CHP), 6.28 (1H, bd, J 9.1 Hz, NH), 6.93-7.36 (15H, m, Ar); 7.52 & 7.84 (1H each, t, J 7.2 Hz, nitroaryl), 8.17 (d, 1H, J 7.2 Hz, nitroaryl), 8.36 ppm (1H, s, nitroaryl) ppm.

Diphenyl (benzyloxycarbonylamino)(o-nitrophenyl)methylphosphonate (**3f**); 73% yield; mp. 141-143⁰C; ³¹PNMR (CDCl₃): δ= 12.88 ppm.; ¹HNMR (CDCl₃): δ= 5.08 & 5.17 (2H, dd, J_{AB} 12.1 Hz, CH₂Ph), 6,32, 1H (bd, J 9.0 Hz, NH), 6.74-6.90 (3H, m, CHP overlapped with

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aryls), 7.10-7.34 (13H, m, Ar), 7.47 &7.60 (t, 1H each, *J* 7.1 Hz, t, nitoaryl), 7.74 & 8.08 (d, 1H each, d, *J* 7.1 Hz, nitoraryl) ppm.

Phenyl ((benzyloxycarbonylamino)anthracen-9-yl)methylphosphonate (**3g**); 1% yield; dcomp. At 250^oC; ³¹PNMR (CDCl₃): δ = 14.43 ppm.; ¹HNMR (d₆DMSO): δ = 4.99 (1H, d, *J*_{PH} 27.9 Hz, C<u>H</u>P), 5.16 & 5.19 (2H, d, *J*_{AB} 21 Hz, C<u>H</u>₂Ph); 6.72 (1H, d, *J* 7.8 Hz, Ar); 6.82 (1H, d, *J* 7.8 Hz, Ar); 6.94-7.01(1H m, Ar); 7.03-7.12 (3H, m, Ar); 7.17 (2H, t, *J* 7.8 Hz, Ar); 7.32 (1H, t, *J*=7.6 Hz, Ar); 7.36-7.49 (6H, m, Ar); 7.55 (2H, d, *J* 7.4 Hz, Ar); 7.56 (1H, d, *J* 7.7 Hz, Ar); 7.69 ppm (1H, d, *J* 6.9, Ar) ppm.

Diaryl (benzyloxycarbonylamino)(aryl)methylphosphonates (2m–p) prepared by Miyaura–Suzuki reaction

Phosphonate ester 2e or 2k (5 mmol) was dissolved in dioxane/water mixture (3:1, 25 mL) and phenylboronic (1.22 g, 10 mmol) or naphthylboronic acid (1.72 g, 10 mmol) was added, followed by addition of $K_3PO_4 \cdot H_2O$ (0.2 g). Then tetrakis(triphenylphosphine)palladium(0) (4-5 mol %) was added and the mixture refluxed for 5 h. After cooling to room temperature catalyst was removed by filtration and dioxane emoved on rotary evaporator. To the residue water was added (20 mL) and the product was extracted three times with chloroform (10 mL portions). In order to avoid formation of emulsion an additional portion of $K_3PO_4 H_2O$ (2.0 g) was dissolved in the aqueous solution. Combined extracts were dried over anhydrous magnesium sulfate, the drying agent was removed by filtration and chloroform evaporated under reduced pressure. The crude oily product was dissolved in acetone (4 mL) and left for crystallization in the refrigerator.

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Di(*biphenyl*) (*benzyloxycarbonylamino*)(*phenyl*)*methylphosphonate* (**2m**); 33% yield; mp. 203-206⁰C; ³¹PNMR (CDCl₃): δ= 16.04 ppm.; ¹HNMR (CDCl₃): δ = 5.12 & 5.14 (2H, d, J_{AB} 12.0 Hz, CH₂Ph), 5.66 (1H, dd, J_{PH} 22.0 Hz, J 9.0 Hz, CHP), 6.07 (dd, 1H, J 9.0 Hz, J 4.0 Hz,NH), 6.09 – 7.91 (28H, m, Ar) ppm. HRMS (DMSO, TOF MS ESI⁺): found 647.6399 [MNa⁺], C₃₉H₃₂NO₅PNa requires 648.6421.

Bis[4-(naphthyl-2-yl)phenyl] (benzyloxycarbonylamino)(phenyl)methylphosphonate (2n)



33% yield; mp. 196-199⁰C; ³¹PNMR (CDCl₃): δ= 15.89 ppm.; ¹HNMR (d₆DMSO): δ = 5.02 & 5.08 (2H, d, *J_{AB}* 12.0 Hz, C<u>H</u>₂Ph), 5.74 (1H, dd, *J_{PH}* 22.0 Hz, *J* 9.0 Hz, C<u>H</u>P), 7.21 – 7.92 (32H, m, Ar), 9.00 (1H, *J* 9.0 Hz, N<u>H</u>) ppm; ¹³C NMR (CDCl₃): δ= 66.74, 53.47 (d, *J* 314.1 Hz), 117.28, 119.24, 119.28, 121.89, 121.95, 128.41, 128.78, 129.01, 129.13, 129.66, 129.71, 130.03, 130.38, 132.12, 132.31, 134.64, 136.96, 148.21,148.34, 148.44, 148.68 ppm.





Bis(7-phenylnaphthalen-2-yl) (benzyloxycarbonylamino)(phenyl)methylphosphonate (20)



29% yield; mp. 238-240^oC decomp.; ³¹PNMR (CDCl₃): δ = 16.13 ppm.; ¹HNMR (d₆DMSO): δ = 4.76 ppm (1H, bdd, *J*_{PH} 23.1 Hz, *J* 9.0 Hz, C<u>H</u>P), 4.96 & 5.05 (2H, d, *J*_{AB} 12.2 Hz, C<u>H</u>₂Ph), 7.01- 8.14 (33H, m Ar, N<u>H</u>) ppm; ¹³C NMR (CDCl₃): δ = 66.26, 53.5 (d, *J* 285.4 Hz), 121.75, 125.08, 125.51, 126.37, 126.66, 126.86, 127.37, 127.97, 128.04, 128.48, 128.56, 128.86, 132.45, 133.87, 134.66, 135.84, 136.0, 137.33, 137.72, 140.53, 143.28, 156.00, 156.14 ppm. HRMS (DMSO, TOF MS ESI⁺): found 726.2294 [MH⁺], C₄₇H₃₇NO₅P requires 726.7783.



Bis(6-naphthylnaphthalene-2-yl) (benzyloxycarbonylamino)(phenyl)methylphosphonate (**2p**); 14.5% yield; mp. 244-246⁰C decomp.; ³¹PNMR (DMSO): δ = 15.78 ppm.; ¹HNMR

(CDCl₃): δ = 5.08 & 5.14 (2H, d, J_{AB} 12.0 Hz, C<u>H</u>₂Ph), 5.74 (1H, bdd, J_{PH} 22.1 Hz, J 9.0 Hz, C<u>H</u>P), 5.96 (1H, bd, J 9.0 Hz, N<u>H</u>), 7.03-7.76 (36H, m, Ar) ppm.HRMS (DMSO, TOF MS ESI⁺): found 825.6881 [MH⁺], C₅₅H₄₀NO₅P requires 826.8964.

Phenyl (benzyloxycarbonylamino)(phenyl)methylphosphonate (4)



Diphenyl (benzyloxycarbonylamino)(phenyl)methylphosphonate (5.0 g, 10 mmol) and potassium hydroxide (5.8 g, 100 mmol) were suspended in a mixture of 1 M sodium hydroxide solution (20 mL) and dioxane (20 mL) and several crystals of 18-crown-6 were added (5-10 mg). The resulting mixture was refluxed for 10 min and left at room temperature for 24 h while stirring. Then the mixture was concentrated with a rotary evaporator, the aqueous residue was acidified to pH 1 with concentrated hydrochloric acid and extracted three times with 10 mL-portions of ethyl acetate. The organic fraction was dried over anhydrous sodium sulfate and the organic solvent was evaporated in vacuo. The resulting oil was dissolved in acetone (3 mL) and left for crystallization in the refrigerator (4 °C). In this manner 3.2 g of the desired product was obtained (81% yield); mp. $159-160^{\circ}C$ (lit.²⁵ m.p. $163-164^{\circ}C$); ³¹PNMR (CDCl₃): δ = 16.00 ppm; ¹HNMR (CDCl₃): δ = 5.00 & 5.10 (2H, d, J_{AB} 12.6 Hz, C<u>H</u>₂Ph), 5.14 (1H, dd, J_{PH} 22.3 Hz, J 10.1 Hz, C<u>H</u>P), 7.0-7.15 (15 H, m, Ar), 8.43 (dd, J 10.1 Hz & 2.8 Hz, NH); ¹³C NMR (CDCl₃): δ= 53.6 (d, J 308.2 Hz, CHP), 66.27, 120.80, 120.85, 128.83, 128.85, 128.48, 128.51, 128.70, 128.78, 129.9, 136.84, 137.32, 151.33, 151.45, 156.38, 156.50. HRMS (DMSO, TOF MS ESI⁺): found 397.1034 [MH⁺], C₂₁H₂₀NO₅P requires 397.3630.



Phenyl (benzyloxycarbonylamino)(phenyl)methylphosphonic chloride (5)

Phenyl (benzyloxycarbonylamino)(phenyl)methylphosphonate (1 g, 2.5 mmol) was dissolved in dry chloroform (20 mL). This solution was warmed up to reflux and then thionyl chloride was added (3.65 ml, 5 mmol) and the mixture was refluxed for additional 2 h. Then volatile components of the reaction mixture were evaporated in vacuo, which resulted in 0.8 g (74%) of the desired product as dense oil. ³¹PNMR (CDCl₃): δ = 33.32 & 33.79 (55:45) ppm; ¹HNMR (CDCl₃): δ = 5.02 & 5.14 (2H, d, *J_{AB}* 10.0 Hz, C<u>H</u>₂Ph), 5.34 (1H, dd, *J_{PH}*22.0 Hz, *J* 9.0 Hz, C<u>H</u>P), 5.81 (1H, bd, *J* 9.0 Hz, N<u>H</u>), 6.99-7.78 (15H, m, Ar).

Phenyl (benzyloxycarbonylamino)(phenyl)methylphosphonic bromide (6)

This compound was obtained by using the procedure identical as described above for the synthesis of compound **5**. 0.5 g (42% yield) of the desired bromide as a yellowish oil was obtained. ³¹PNMR (CDCl₃): δ = 32.09 & 32.64 (58:42) ppm; ¹HNMR (CDCl₃): δ = 4.88 & 4.97 (2H, d, *J*_{AB} 10.0 Hz, CH₂Ph), 5.07 (1H, dd, *J*_{PH}23.8 Hz, *J* 9.0 Hz, CHP), 5.74 (1H, bd, *J* 9.0 Hz, NH), 6.71-7.38 (15H, m, Ar).

Mixed aliphatic-phenyl esters of (benzyloxycarbonylamino)(phenyl)methylphosphonic acid (7a–f)

Phosphonic chloride 5 (0.5 g, 1 mmol) was dissolved in alcohol (10 mmol) and refluxed for 3 h. Then the solvents were evaporated under reduces pressure and the resulting oil was dissolved in acetone (3 ml) and left at 4^{0} C for crystallization or purified by silica gel column chromatography using mixture of hexane-ethyl acetate (4:6 v/v) as eluent.

n-Pentyl phenyl (benzyloxycarbonylamino)(phenyl)methylphosphonate (7a)



79% yield; mp. 124-127⁰C; ³¹PNMR (CDCl₃): δ= 18.31 & 18.36 (23:77 after crystallization) ppm.; ¹HNMR (CDCl₃): δ = 0.76 (3H, t, *J* 7.0 Hz, C<u>H</u>₃), 1.11-1.21 (4H, m, 2xC<u>H</u>₂), 1.30-1.50 (2H, m, C<u>H</u>₂), 3.80-4.12 (2H, m, OC<u>H</u>₂), 4.91 & 5.10 (major) and 5.06 & 5.11 (minor) (2H, d, *J*_{AB} 12.3 Hz, C<u>H</u>₂Ph), 5.30 (dd, *J*_{PH} 22.1 Hz, *J* 9.2 Hz, C<u>H</u>P), 6.90-7.50 (15H, m, Ar); 8.69 (d, *J* 9.2 Hz, N<u>H</u>); ¹³C NMR (CDCl₃): δ= 14.26, 22.01, 27.35, 28.48, 30.00 (d, *J* 8.5 Hz), 53.03 (d, *J* 311.1 Hz, CHP), 67.47 (d, *J* 12.2 Hz), 120.73, 120.78, 128.34, 128.41, 128.74, 128.83, 130.14, 135.52, 137.20, 150.79, 150.92, 156.41, 156.52; HRMS (DMSO, TOF MS ESI⁺): found 490.1768 [MNa⁺], $C_{26}H_{30}NO_5PNa$ requires 490.4861.





n-Undecyl phenyl (benzyloxycarbonylamino)(phenyl)methylphosphonate (**7b**); 54.5% yield; mp. 148-150^oC; ³¹PNMR (CDCl₃): δ = 17.81 & 18.04 (15:85 by chromatography) ppm; ¹HNMR (CDCl₃): δ = 0.89 (3H, t, *J* 7.0 Hz, C<u>H</u>₃), 1.12-1.65 (18H, m, 9xC<u>H</u>₂), 1.30-1.50 (2H, m, C<u>H</u>₂), 3.61-3.94 (2H, m, OC<u>H</u>₂), 5.07 & 5.17 (2H, d, *J*_{AB} 12.0 Hz, C<u>H</u>₂Ph), 5.34 (dd, *J*_{PH} 22.0 Hz, *J* 8.9 Hz, C<u>H</u>P), 5.91 (d, *J* 8.9 Hz, N<u>H</u>), 7.12-7.46 (15H, m, Ar).

n-Docosyl phenyl (benzyloxycarbonylamino)(phenyl)methylphosphonate (**7c**); 27% yield; mp. 167-169⁰C; ³¹PNMR (CDCl₃): δ = 18.09 & 18.65 (10:90 by chromatography) ppm; ¹HNMR (CDCl₃): δ = 0.79 (3H, t, *J* 8.0 Hz, C<u>H</u>₃), 1.26-1.75 (40H, m, 20xC<u>H</u>₂), 3.71-4.03 (2H, m, OC<u>H</u>₂), 5.24 & 5.34 (2H, d, *J*_{AB} 12.0 Hz, C<u>H</u>₂Ph), 5.56 (dd, *J*_{PH} 22.0 Hz, *J* 9.0 Hz, C<u>H</u>P), 5.79 (d, *J* 9.0 Hz, N<u>H</u>), 7.33-7.89 (15H, m, Ar).

3-Methoxyethyl phenyl (benzyloxycarbonylamino)(phenyl)methylphosphonate (7d)



72.5% yield; mp. 110-113^oC ; ³¹PNMR (CDCl₃): δ = 19.12 & 19.18 (65:35 by chromatography) ppm; ¹HNMR (CDCl₃): δ = 3.17(major) and 3.20 (minor) (3H, s, C<u>H</u>₃), 3.37-3.42 (major) and 3.35-3.45 (minor) (2H, m, C<u>H</u>₂OCH₃), 4.00-4.15 (2H, m, OC<u>H</u>₂), 5.02 & 5.10 (major) and 5.06 & 5.12(minor) (2H, d, J_{AB} 12.0 Hz, C<u>H</u>₂Ph), 5.38 (1H, dd, J_{PH} 21.0 Hz, J 9.0 Hz, C<u>H</u>P), 6.95-7.55 (15H, m, Ar), 8.66 (major) and 8.70 (minor) (1H, d, J 9.0 Hz, N<u>H</u>); ¹³C NMR (CDCl₃): δ = 53.04 (minor) and 53.05 (d, J 314.1 Hz, CHP), 58.45, 66.59 (major) and 66.61 (minor) (d, J 12.0 Hz), 66.85 (d, J 12.2 Hz), 71.23 (d, J 8.5 Hz), 120.69, 120.75, 125.32, 128.39, 128.77, 128.85, 130.14, 135.54, 135.65, 137.22, 137.23,

150.69, 150.82, 156.36, 156.51; HRMS (DMSO, TOF MS ESI⁺): found 478.1396 [MNa⁺], $C_{24}H_{26}NO_6PNa$ requires 478.4322.







3,6,9-*Trioxaundecyl phenyl (benzyloxycarbonylamino)(phenyl)methylphosphonate* (**7e**); 57.5% yield; mp. 71-78^oC ; ³¹PNMR (CDCl₃): δ = 19.07 & 19.13 (41:59 by chromatography) ppm; ¹HNMR (CDCl₃): δ = 1.05 (3H, t, *J* 7.1 Hz, CH₃), 3.30-3.55 (24H, m, 12xCH₂), 3.90-4.10 (2H, m, CH₂O), 5.06 (major) & 5.07 (minor) (2H, AB system, *J_{AB}* Hz, 12.0Hz), 5.38 (1H, dd, *J_{PH}* 24.0 Hz, *J* 9.0 Hz, C<u>H</u>P), 7.00-7.60 (15H, m, Ar), 8.65 (1H, t, *J* 9.0 Hz, N<u>H</u>); ¹³C NMR (CDCl₃): δ = 15.58, 53.3 (d, *J* 315.6 Hz, <u>C</u>HP), 66.05, 66.51, 69.70, 70.11, 120.72, 120.77, 125.33, 128.37, 128.77, 238.85, 130.13, 135.51,

135.65, 137.20, 150.43; HRMS (DMSO, TOF MS ESI⁺): MH⁺, found 536.1814 [MNa⁺], C₂₇H₃₂NO₇PNa requires 536.5116.

4,8-Dioxaduodecyl phenyl (benzyloxycarbonylamino)(phenyl)methylphosphonate (**7f**); 51% yield; mp. 102-104⁰C ; ³¹PNMR (CDCl₃): δ = 17.72 & 17.79 (40:60 by chromatography) ppm; ¹HNMR (CDCl₃): δ = 0.79 (3H, bt, *J* 6.8 Hz, CH₃), 1.12-1.22 (4 H, m, 2xCH₂), 1.43-1.67 (12H, m, 6xCH₂), 3.68-5.02 (26H, m, 13xCH₂), 5.09 (major) & 5.17 (minor) (2H, AB system, *J_{AB}* Hz, 12.0Hz), 5.42 (major) & 5.42 (minor) (1H, dd, *J_{PH}* 24.0 Hz, *J* 9.0 Hz, C<u>H</u>P), 6.03 (1H, m, N<u>H</u>), 7.24-7.89 (15H, m, Ar).

Mixed

aromatic-phenyl

esters

(benzyloxycarbonylamino)(phenyl)methylphosphonic acid (7g,h)

Phosphonic chloride 5 (1.07 g, 2.5 mmol) was dissolved in dry chloroform (20 ml) and corresponding alcohol (5 mmol) was added. This solvent was heated up to boiling and then triethylamine (0.18 ml, 2.6 mmol) was added dropwise. The resulting solution was additionally refluxed for 5 h. Then the solvents were evaporated under reduces pressure and the resulting brown oil was dissolved in chloroform and left for crystallization. Second portion of product was purified by flash chromatography using a gradient of hexane and chloroform (solvent containing 5% of chloroform more after each 10 minutes of elution) as eluent.

2-Naphthyl phenyl N-(benzyloxycarbonylamino)(phenyl)methylphosphonate (**7g**); 33% yield; mp. 156-159^oC ; ³¹PNMR (CDCl₃): δ = 14.73 ppm; ¹HNMR (CDCl₃): 5.16 (2H, AB system, *J_{AB}* Hz, 12.1 Hz), 5.68 (1H, dd, *J_{PH}* 21.8 Hz, *J* 10.6 Hz, C<u>H</u>P), 5.98 (1H, bd, *J* 10.6 Hz, N<u>H</u>), 6.88-7.69(22H, m, Ar).

Anthracen-9-ylmethyl phenyl (benzyloxycarbonylamino)(phenyl)methylphosphonate (**7h**); 4% yield; mp. 124-126⁰C; ³¹PNMR (CDCl₃): δ = 13.50 ppm; ¹HNMR (CDCl₃): 5.01 (2H, AB system, *J_{AB}* Hz, 12.2 Hz), 6.31 (1H, bdd, C<u>H</u>P), 7.00-7.41(24H, m, Ar), 8.12 (1H, bs, N<u>H</u>).

Fluorescence studies

Solutions of the studied compounds in DMSO (0.05-0.1 mmole) were prepared in Eppendorf tubes (300μ L). These solutions were transferred to wells of CELLSTAR geiner black 96 wells plate and were irradiated with 254 and 366 nm UV light. The fluorescence was observed visually and presented schematically in Figure S1. Photographic documentation (Olympus MJU) of the results is not fully reasonable and therefore also negative pictures have been analyzed with moderate success (Figure S1).

of



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