Supporting Information

Synthesis of lipo-chitooligosaccharide analogues and evaluation of their ability to interact with the LysM receptor-like kinase LYR3, a high affinity binding protein for Nod factors and Myc-LCOs

Nathan Berthelot,¹ Antoine Brossay,¹,b Virginie Gascielli,¹ Jean-Jacques Bono,¹ Aurélie Baron,¹ Jean-Marie Beau,¹,b Dominique Urban,¹ François-Didier Boyer,¹,d Boris Vauzeilles¹,b,*

[a] Institut de Chimie des Substances Naturelles, CNRS UPR2301, Univ. Paris-Sud, Université Paris-Saclay, 1 av. de la Terrasse, F-91198 Gif-sur-Yvette, France

[b] Laboratoire de Synthèse de Biomolécules, Institut de Chimie Moléculaire et des Matériaux d’Orsay, Univ. Paris-Sud, CNRS, Université Paris-Saclay, F-91405 Orsay, France

[c] LIPM, Université de Toulouse, INRA, CNRS, Castanet-Tolosan, France

[d] Institut Jean-Pierre Bourgin, INRA, AgroParisTech, CNRS, Université Paris-Saclay, RD10, F-78026 Versailles, France

Experimental procedures for the preparation of compounds 10-14, 16 and intermediates S1-S4

NMR spectra (¹H, ¹³C) of compounds 3-8, 15-20, 3S, 4S and intermediates S1-S3
Products preparations and descriptions:

**Benzylic 2-acetamido-3,4,6-tri-O-acetyl-2-deoxy-β-D-glucopyranoside** (10).

To a mixture of 9 (1.00 g, 2.57 mmol, 1.00 equiv.) and benzylic alcohol (347 µL, 3.35 mmol, 1.30 equiv.) in anhydrous CH₂Cl₂ (19 mL) was added Fe(OTf)₃ (194 mg, 0.39 mmol, 0.15 equiv.) under an argon atmosphere. The reaction mixture was stirred at room temperature for 24 hours. The mixture was diluted in CH₂Cl₂ (30 mL), and washed with a saturated NaHCO₃ solution (100 mL). The aqueous layer was extracted with CH₂Cl₂ (5 x 30 mL). The organic layers were washed with H₂O (200 mL), dried over Na₂SO₄, filtered and concentrated. The residue was purified by silica gel column chromatography (cyclohexane/EtOAc 25:75) to give product 10 (1.01 g, 93%) as a white amorphous solid. **Rf**: 0.53 (EtOAc). **¹H NMR (500 MHz, CDCl₃)**: δ: 7.35-7.15 (m, 5H, CH arom.); 5.35 (d, 1H, Jₙₙₙ,₂ 8.7 Hz, NH); 5.18 (dd, 1H, J₂₃, 10.5, J₃₄ 9.7 Hz, H-3); 5.07 (dd, 1H, J₄₅, 9.6, J₃₄ 9.7 Hz, H-4); 4.87 (d, 1H, J₂₅CH 12.2 Hz, CHHPh); 4.61 (d, 1H, J₁₂, 8.5 Hz, H-1); 4.58 (d, 1H, J₁₂HCH 12.2 Hz, CHHPh); 4.25 (dd, 1H, J₂₆₆₆, 12.2, J₅₆₆ 4.6 Hz, H-6a); 4.15 (dd, 1H, J₂₆₆₆, 12.2, J₅₆₆ 245 Hz, H-6b); 3.95 (dd, 1H, J₁₂, 10.5, J₂₅NH 8.7, J₂₅ 8.5 Hz, H-2); 3.65 (dd, 1H, J₅₆₆ 9.6, J₅₆₆ 4.6, J₅₆₆ 2.4 Hz, H-5); 2.08, 1.99, 1.88 (4 s, 12H, 4 Ac). **¹³C NMR (125 MHz, CDCl₃)**: δ: 171.2, 171.0, 170.3, 169.6 (4 COCH₃); 137.1, 128.7, 128.3 (C arom.); 99.6 (C-1); 72.6 (C-3); 72.1 (C-5); 70.9 (CH₂Ph); 68.8 (C-4); 62.3 (C-6); 54.8 (C-2); 23.5 (NCOCH₃); 21.0, 20.9, 20.8 (OCOCH₃). Analyses are in accordance with the literature.¹

**Benzylic 2-acetamido-2-deoxy-β-D-glucopyranoside** (11).

To a mixture of 10 (500 mg, 1.18 mmol, 1.0 equiv.) in dry CH₃OH (7.3 mL) was added NaOCH₃ (590 µL, 0.2 mol/L in CH₃OH, 0.12 mmol, 0.1 equiv.) under an argon atmosphere. The reaction mixture was stirred at room temperature for 30 min. A white precipitate formed rapidly within 10 min. The mixture was diluted in CH₂Cl₂/CH₃OH until dissolution of the precipitate, neutralized with Dowex® 50WX8 H⁺ resin, filtrated and concentrated to give product 11 (339 mg, 92%) as a white amorphous solid. **Rf**: 0.08 (CH₂Cl₂/CH₃OH 9:1). **¹H NMR (500 MHz, CD₂OD)**: δ: 7.36-7.23 (m, 5H, CH arom.); 4.88 (d, 1H, J₂HCH 12.3 Hz, CHHPh); 4.61 (d, 1H, J₂HCH 12.3 Hz, CHHPh); 5.33 (d, 1H, J₁₂, 8.4 Hz, H-1); 3.91 (dd, 1H, J₂₆₆₆, 12.0, J₅₆₆ 1.9 Hz, H-6a); 3.72 (dd, 1H, J₂₅₄, 10.0, J₂₅₄ 8.4 Hz, H-2); 3.71 (dd, 1H, J₂₆₆₆, 12.0, J₅₆₆ 5.7 Hz, H-6b); 3.45 (dd, 1H, J₂₅₄ 10.0, J₂₅₄ 8.9 Hz, H-3); 3.34 (dd, 1H, J₄₅ 9.7, J₃₄ 8.9 Hz, H-4); 3.27 (dd, 1H, J₄₅ 9.7, J₅₆₆ 5.7, J₅₆₆ 1.9 Hz, H-5); 1.95 (s, 3H, Ac). **¹³C NMR (125 MHz, CD₂OD)**: δ:

¹ Commercially available.
173.9 (COCH₃); 139.4, 129.5, 129.0, 128.8 (C arom.); 102.0 (C-1); 78.2 (C-5); 76.1 (C-3); 72.4 (C-4); 71.7 (CH₃Ph); 63.0 (C-6); 57.5 (C-2); 23.1 (COCH₃). Analyses are in accordance with the literature.³

**Benzy1 2-acetamido-2-deoxy-4,6-O-isopropylidene-β-D-glucopyranoside⁴ (12).**

![Chemical Structure](image1)

To a solution of 11 (1.61 g, 5.16 mmol, 1.0 equiv.) and 2,2-dimethoxypropane (9.5 mL, 77.4 mmol, 25.0 equiv.) in dry DMF (20.6 mL) was added PTSA (98 mg, 0.52 mmol, 0.1 equiv.) under an argon atmosphere. The reaction mixture was stirred at 40 °C and 250 mbar for 1 hour, and the acid was then quenched with triethylamine and the mixture concentrated to give crude isopropylidene product 12 as a yellowish solid used in the next step without further purification. An analytical sample of pure product 12, as a white amorphous solid, was obtained by silica gel column chromatography of an aliquot (CH₂Cl₂/CH₃OH 100:0 to 90:10) and characterized. **Rf:** 0.30 (CH₂Cl₂/CH₃OH 95:5). [α]₀²⁰ = −103.40 (c = 1.00, CHCl₃) (−110.2 (c = 1, CHCl₃) in literature⁴). **¹H NMR (500 MHz, CDCl₃) δ:** 7.40-7.22 (m, 5H, CH arom.); 5.65 (d, 1H, Jₙₙ,2 5.3 Hz, NH); 4.86 (d, 1H, ḟ₁HCH 12.0 Hz, CHHPh); 4.59 (d, 1H, J₁,₂ 8.3 Hz, H-1); 4.55 (d, 1H, ḟ₁HCH 12.0 Hz, CHHPh); 4.27 (s, 1H, OH); 3.93 (dd, 1H, ḟ₁H₆₆,6b 10.8, J₅₆₆,6a 5.3 Hz, H-6a); 3.83 (dd, 1H, J₁,₃,₃,₂ 9.6, J₃₃,₄ 9.0 Hz, H-3); 3.80 (dd, 1H, ḟ₁H₆₆,6b 10.8, J₅₆₆,6a 10.5 Hz, H-6b); 3.58 (dd, 1H, J₅,₄ 9.8, J₃,₄ 9.0 Hz, H-4); 3.51 (dd, 1H, J₁,₂,₃ 9.6, J₃,₂ 8.3, J₃,₄ 5.3 Hz, H-2); 3.27 (dd, 1H, J₅,₆₆b 10.5, J₆₆b,₆₆b 9.8, J₅₆₆,₆₆a 5.3 Hz, H-5); 1.93 (s, 3H, Ac); 1.50 (s, 3H, CH₃CCH₃); 1.41 (s, 3H, CH₃CH₃). **¹⁳C NMR (125 MHz, CDCl₃) δ:** 172.1 (COCH₃); 137.1, 128.9, 128.5, 128.4 (C arom.); 100.1 (CH₃CCH₃); 99.8 (C-1); 74.5 (C-4); 72.3 (C-3); 71.2 (CH₂Ph); 67.5 (C-5); 62.2 (C-6); 59.1 (C-2); 29.3 (CH₃CCH₃); 23.7 (COCH₃); 19.3 (CH₃CH₃). **HRMS (ESI):** calculated for C₁₈H₂₆NO₆⁺ 352.1755 [M+H⁺]; found 352.1740. **IR:** υ (cm⁻¹) = 3600-3100, 2881, 1652, 1554, 1374, 1200, 1118, 1082, 1042, 857, 754. Analyses are in accordance with the literature.⁴

**Benzy1 2-acetamido-3-O-benzyl-2-deoxy-4,6-O-isopropylidene-β-D-glucopyranoside⁵ (13).**

![Chemical Structure](image2)

To a solution of crude 12 in dry DMF (25 mL) were added BaO (2.38 g, 15.52 mmol, 3.0 equiv.) and Ba(OH)₂·2H₂O (814 mg, 2.58 mmol, 0.5 equiv.) under an argon atmosphere. The mixture was stirred at room temperature for 1 hour. Benzyl bromide (925 µL, 7.73 mmol, 1.5 equiv.) was then added and the mixture was stirred at room temperature for 19 hours. The mixture was diluted in CH₂Cl₂/CH₃OH, filtered over Celite® plug and concentrated. The residue was purified by silica gel column chromatography (CH₂Cl₂/CH₃OH 99:1) to give product 13 (1.99 g, 87% over 2 steps) as yellow crystalline solid. **Rf:** 0.18 (CH₂Cl₂/CH₃OH 99:1). [α]₀²⁰ = −21 (c = 1, CHCl₃) (−21.00 (c = 1.10, CHCl₃) in literature⁵). **¹H NMR (300 MHz, CDCl₃) δ:** 7.36-7.21 (m, 10H, CH arom.); 5.36 (d, 1H, Jₙₙ,2 7.8 Hz, NH);
4.89 (d, 1H, J1,2 8.3 Hz, H-1); 4.83 (d, 1H, J1,2JCH 11.9 Hz, CHHPh-1); 4.80 (d, 1H, J1,2JCH 11.9 Hz, CHHPh-3); 4.57 (d, 1H, J1,2JCH 11.9 Hz, CHHPh-3); 4.53 (d, 1H, J1,2JCH 11.9 Hz, CHHPh-1); 3.98 (dd, 1H, J2,3 9.9, J3,4 9.0 Hz, H-3); 3.94 (dd, 1H, J6a,6b 10.8, J5,6a 5.5 Hz, H-6a); 3.79 (dd, 1H, J6a,6b 10.8, J5,6b 10.2 Hz, H-6b); 3.70 (dd, 1H, J4,5 9.5, J3,4 9.0 Hz, H-4); 3.35 (ddd, 1H, J4,5 9.9, J1,2 8.3, JNH,2 7.8 Hz, H-2); 3.32 (ddd, 1H, J3,4 9.0, J5,6a 5.5 Hz, H-5); 1.81 (s, 3H, Ac); 1.48 (s, 3H, CH3CCH3); 1.41 (s, 3H, CH3CCH3). 13C NMR (125 MHz, CDCl3) δ: 170.4 (COCH3); 138.9, 137.5, 128.6, 128.5, 128.3, 128.2, 128.1, 127.9 (C arom.); 99.9 (C-1); 99.5 (CH3CCH3); 77.2 (C-3); 75.6 (C-2); 74.2 (CH3Ph-3); 71.4 (CH3CCH3); 67.1 (C-5); 62.5 (C-6); 57.7 (C-2); 29.4 (CH3CCH3); 23.7 (COCH3); 19.3 (CH3CCH3). HRMS (ESI): calculated for C25H32NO6+ 442.2224 [M+H]+; found 442.2211. IR: ν (cm⁻¹) = 3277, 3100-2800, 1654, 1563, 1374, 1201, 1117, 1084, 859, 737, 697.

Benzy1 2-acetamido-3-O-benzyl-2-deoxy-β-D-glucopyranoside (14).

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\[\text{C22H22NO6}^-\]
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To a solution of 13 (1.7 g, 3.8 mmol, 1 equiv.) in CH2Cl2 (5.8 mL) was added a solution of trifluoroacetic acid (50% in water, 5.8 mL, 37.9 mmol, 10 equiv.) at 0 °C. The mixture was stirred at room temperature for 2 hours. The reaction mixture was then diluted with H2O, cooled at 0 °C and the acid was quenched with triethylamine (5.3 mL, 10 equiv.). A white precipitate was filtered off, yielding a first crop of product 14. Sodium chloride was added to the filtrate and the layers separated. The aqueous layer was then extracted with CH2Cl2 (3 x 50 mL). The combined organic layers were dried over Na2SO4, filtered and concentrated yielding a second crop. The two samples were combined and purified by silica gel column chromatography (CH2Cl2/CH3OH 96:4) to give product 14 (1.3 g, 88%) as a white amorphous solid. RF: 0.30 (CH2Cl2/CH3OH 95:5). [α]D20 = −24.00 (c = 1.00, CH3OH) (−20 (c = 0.5, EtOH) in literature⁶). 1H NMR (300 MHz, CD3OD) δ: 7.36-7.20 (m, 10H, CH arom.); 4.88 (d, 1H, J1,2JCH 12.2 Hz, CHHPh-1); 4.87 (d, 1H, J1,2JCH 11.3 Hz, CHHPh-3); 4.63 (d, 1H, J1,2JCH 11.3 Hz, CHHPh-3); 4.61 (d, 1H, J1,2JCH 12.2 Hz, CHHPh-1); 4.50 (d, 1H, J1,2JCH 11.3 Hz, CHHPh-1); 3.93 (dd, 1H, J6a,6b 12.0, J5,6a 2.0 Hz, H-6a); 3.82 (dd, 1H, J3,4 10.1, J1,2 8.4 Hz, H-2); 3.72 (dd, 1H, J6a,6b 12.0, J5,6a 6.0 Hz, H-6b); 3.57-3.45 (m, 2H, H-3 and H-4); 3.34-3.26 (m, 1H, H-5); 1.85 (s, 3H, Ac). 13C NMR (125 MHz, CD3OD) δ: 173.5 (COCH3); 140.4, 139.3, 129.5, 129.4, 129.0, 128.9, 128.8, 128.6 (C arom.); 101.8 (C-1); 84.3 (C-3); 78.2 (C-5); 78.8 (CH3Ph-3); 72.2 (C-4); 71.7 (CH3Ph-1); 62.9 (C-6); 56.5 (C-2); 23.2 (COCH3). HRMS (ESI): calculated for C25H32NO6+ 402.1911 [M+H]+; found 402.1899. IR: ν (cm⁻¹) = 3400-3100, 2867, 1654, 1551, 1373, 1111, 1074, 1053, 737, 699.
Preparation of compound 16 from chitin. (a) Ac₂O, H₂SO₄, 55 °C, then r.t. then 55 °C ; (b) (CF₃CO)₂O, CH₃CN, 135 °C, then CH₃OH, r.t. ; (c) ethylenediamine, AcOH, THF, r.t. ; (d) (CH₃SO₂)O, CH₃CN, r.t. then Et₃N, r.t. ; (e) Boc₂O, 4-DMAP, THF, 85 °C.

2-Acetamido-3,4,6-tri-O-acetyl-2-deoxy-β-β-glucopyranosyl-(1→4)-2-acetamido-1,3,6-tri-O-acetyl-2-deoxy-α-β-glucopyranoside⁷ (S1).

To an ice-cold mixture of acetic anhydride (400 mL) and sulfuric acid (40 mL) was added chitin (80 g) portion-wise. The suspension was stirred at 55°C for 3 hours to give a heterogeneous brown mixture, kept at room temperature for 14 hours and then heated at 55°C for 1 hour to give a homogenous solution. This mixture was then poured into an ice-cold solution of sodium acetate in water (1.6 L, 100 g/L). The resulting solid was filtered off. The filtrate was extracted with CH₂Cl₂ (3 x 2 L). The combined organic layers were washed with an ice-cold saturated NaHCO₃ solution (6 L), dried over Na₂SO₄, filtered and concentrated to afford a yellow solid (73 g). The residue was purified by silica gel chromatography (CH₂Cl₂/acetone: from 9:1 to 1:9) to afford four fractions. After concentration, the first three fractions were recrystallized from CH₃OH/Et₂O. The second fraction was identified as peracetylated α-GlcNAc S1 (7.5 g, 5.6%) obtained as a white solid. The first and third fractions were respectively identified as peracetylated α-chitose (3.8 g, 2.5%) and peracetylated α-chitotriose (5.8 g, 4.6%). The highly impure fourth fraction contained longer chitoooligosaccharides. Rf: 0.60 (CH₂Cl₂/acetone 1:1).

¹H NMR (500 MHz, CDCl₃) δ: 6.07 (d, 1H, J¹,² 3.5 Hz, H-1A); 6.00 (d, 1H, JNH₂ 9.2 Hz, NH²B); 5.64 (d, 1H, JNH₂ 9.0 Hz, NH³B); 5.20 (dd, 1H, J² 10.8, J³ 9.3 Hz, H-3A); 5.10 (dd, 1H, J² 10.1, J³ 9.6 Hz, H-3B); 5.03 (dd, 1H, J² 9.6, J³ 9.6 Hz, H-4B); 4.44 (d, 1H, J² 8.6 Hz, H-1²); 4.42 (dd, 1H, J³ 12.4, J³ 4.4 Hz, H-6A); 4.36 (dd, 1H, J³ 12.4, J³ 4.4 Hz, H-6A); 4.34 (ddd, 1H, J³ 12.4, J³ 4.4 Hz, H-6A).
10.8, J_{NH}^{A,A} 9.0, J_{1,2}^{A,A} 3.5 Hz, H-2A); 4.16 (dd, 1H, J_{6a}^{A,A,6b} 12.2, J_{5,6b}^{A} 1.5 Hz, H-6bA); 4.00 (dd, 1H, J_{6a}^{B,B} 12.4, J_{5,6b}^{B,B} 1.7 Hz, H-6bB); 3.94 (ddd, 1H, J_{2,3}^{B} 10.1, J_{NH}^{B,B} 9.2, J_{1,2}^{B} 8.6 Hz, H-2B); 3.87 (ddd, 1H, J_{4,5}^{A,A} 9.8, J_{6a}^{A,A} 3.5, J_{5,6b}^{A,A} 1.5 Hz, H-5A); 3.71 (dd, 1H, J_{3}^{A,A} 9.8, J_{4,5}^{A,A} 9.3 Hz, H-4A); 3.60 (ddd, 1H, J_{4,5}^{B,B} 9.6, J_{5,6b}^{B,B} 4.4, J_{5,6b}^{B,B} 1.7 Hz, H-5B): 2.16-1.90 (8 s, 24H, 8 Ac). $^{13}$C NMR (125 MHz, CDCl$_3$) δ: 171.7-169.1 (8 COCH$_3$); 102.0 (C-1$^B$); 90.7 (C-1$^A$); 76.1 (C-4$^A$); 72.8 (C-3$^B$); 72.2 (C-5$^B$); 71.0 (C-5$^A$); 68.1 (C-4$^A$); 61.9 (C-6$^B$); 61.7 (C-6$^A$); 56.7 (C-2$^B$); 51.4 (C-2$^A$); 23.4-20.8 (8 COCH$_3$). Analyses are in accordance with the literature.$^7$

2-Acetamido-3,4,6-tri-O-acetyl-2-deoxy-β-D-glucopyranosyl-(1→4)-1,3,6-tri-O-acetyl-2-deoxy-2-trifluoroacetamido-α-D-glucopyranoside$^7$ (S2).

![Structural diagram](attachment:diagram.png)

To a solution of peracetylated α-chitobiose S1 (800 mg, 1.18 mmol, 1.0 equiv.) in dry CH$_3$CN (220 mL) was added trifluoroacetic anhydride (1.15 mL, 8.28 mmol, 7.0 equiv.) under an argon atmosphere. The reaction mixture was stirred at 135°C for 7 min in a sealed tube, then allowed to cool to room temperature, diluted with CH$_3$OH and stirred for 1 hour. After concentration, the residue was purified by silica gel column chromatography (CH$_2$Cl$_2$/methyl tert-butyl ether/CH$_3$OH 100:0:0 to 70:28:2) to give product S2 (631 mg, 73%) as a white amorphous solid. Rf: 0.36 (CH$_2$Cl$_2$/acetone 4:1). $^1$H NMR (500 MHz, CDCl$_3$) δ: 6.72 (d, 1H, J_{NH}^{A,A} 8.7 Hz, NH$^B$); 6.16 (d, 1H, J_{1,2}^{A,A} 3.6 Hz, H-1$^A$); 5.97 (d, 1H, J_{NH}^{B,B} 9.2 Hz, NH$^B$); 5.28 (dd, 1H, J_{4,5}^{A,A} 10.9, J_{5,6b}^{A,A} 9.2 Hz, H-3$^B$); 5.12 (dd, 1H, J_{2,3}^{B} 10.2, J_{5,6b}^{B,B} 9.5 Hz, H-3$^B$); 5.02 (dd, 1H, J_{3}^{B,B} 9.7, J_{5,6b}^{B,B} 9.5 Hz, H-4$^B$); 4.48 (d, 1H, J_{1,2}^{B,B} 8.4 Hz, H-1$^B$); 4.42 (ddd, 1H, J_{6a}^{A,A} 12.2, J_{5,6b}^{A,A} 3.7 Hz, H-6a$^A$); 4.37 (dd, 1H, J_{6a}^{B,B} 12.5, J_{5,6b}^{B,B} 4.2 Hz, H-6a$^B$); 4.31 (ddd, 1H, J_{1,2}^{A,A} 10.9, J_{NH}^{A,A} 8.7, J_{1,2}^{A,A} 3.6 Hz, H-2$^A$); 4.19 (dd, 1H, J_{6a}^{A,A} 12.2, J_{5,6b}^{A,A} 1.5 Hz, H-6b$^A$); 4.00 (ddd, 1H, J_{6a}^{B,B} 12.5, J_{5,6b}^{B,B} 2.2 Hz, H-6b$^B$); 3.92 (ddd, 1H, J_{6a}^{A,A} 9.7, J_{5,6b}^{A,A} 3.7, J_{5,6b}^{A,A} 1.5 Hz, H-5$^A$); 3.91 (ddd, 1H, J_{2,3}^{B} 10.2, J_{NH}^{B,B} 9.2, J_{1,2}^{B,B} 8.4 Hz, H-2$^B$); 3.75 (dd, 1H, J_{3}^{A,A} 8.7, J_{4,5}^{A,A} 9.2 Hz, H-4$^A$); 3.62 (ddd, 1H, J_{4,5}^{B,B} 9.7, J_{5,6b}^{B,B} 4.2, J_{5,6b}^{B,B} 2.2 Hz, H-5$^B$); 2.18-1.94 (7 s, 21H, 7 Ac). $^{13}$C NMR (125 MHz, CDCl$_3$) δ: 171.8-168.8 (7 COCH$_3$); 157.7 (J_{C,F} 38.0 Hz, COF3); 115.6 (J_{C,F} 288 Hz, COF3); 102.0 (C-1$^B$); 89.7 (C-1$^A$); 75.9 (C-4$^A$); 72.7 (C-3$^B$); 72.3 (C-5$^B$); 71.1 (C-5$^A$); 70.3 (C-3$^A$); 68.1 (C-4$^A$); 61.9 (C-6$^B$); 61.5 (C-6$^A$); 54.8 (C-2$^B$); 52.2 (C-2$^A$); 23.4-20.8 (7 COCH$_3$). Analyses are in accordance with the literature.$^7$
2-Acetamido-3,4,6-tri-O-acetyl-2-deoxy-β-D-glucopyranosyl-(1→4)-3,6-di-O-acetyl-2-deoxy-2-trifluoroacetamido-D-glucopyranose\(^7\) (S3).

To a solution of ethylenediamine (52 \(\mu\)L, 0.78 mmol, 1.2 equiv.) in dry THF (500 \(\mu\)L) was added acetic acid (45 \(\mu\)L, 0.78 mmol, 1.2 equiv.) at 0°C. The reaction mixture was stirred at room temperature for 30 min. A white salt was formed and a suspension of S2 (465 mg, 0.64 mmol, 1.0 equiv.) in dry THF (3 mL) was added. The reaction mixture was stirred at room temperature for 22 hours. The mixture was concentrated and the residue was purified by silica gel column chromatography (CH\(_2\)Cl\(_2\)/CH\(_3\)OH 10:0 to 9:1) to give product S3 (317 mg, \(\alpha/\beta\) mixture, 72%) as a white amorphous solid. \(\text{RF } \alpha\text{ isomer}: 0.34 \text{ (CH}_2\text{Cl}_2/\text{CH}_3\text{OH} 95:5), \text{RF } \beta\text{ isomer}: 0.21 \text{ (CH}_2\text{Cl}_2/\text{CH}_3\text{OH} 95:5). \text{ } \Delta\text{H NMR } \alpha\text{ isomer (500 MHz, CDCl}_3\) \(\delta:\) 8.11 (d, 1H, \(J_{NH, A}^B = 9.7 \text{ Hz, NH}^A\)); 6.00 (d, 1H, \(J_{NH, A}^B = 8.6 \text{ Hz, NH}^B\)); 5.75 (dd, 1H, \(J_{NH, A}^B = 9.3 \text{ Hz, H-3}^A\)); 5.42 (brd, 1H, \(J_{OH, A}^B = 2.8 \text{ Hz, OH}^A\)); 5.27 (brdd, 1H, \(J_{A}^B = 3.6, J_{OH, A}^B = 2.8 \text{ Hz, H-1}^A\)); 5.05 (dd, 1H, \(J_{A}^B = 9.7, J_{A}^B = 9.5 \text{ Hz, H-4}^A\)); 4.94 (dd, 1H, \(J_{A}^B = 10.0, J_{A}^B = 9.5 \text{ Hz, H-3}^B\)); 4.41 (dd, 1H, \(J_{A}^B = 12.4, J_{A}^B = 4.2 \text{ Hz, H-6}^A\)); 4.32 (dd, 1H, \(J_{A}^B = 11.9, J_{A}^B = 3.7 \text{ Hz, H-6}^A\)); 4.29 (dd, 1H, \(J_{A}^B = 10.9, J_{NH, A}^B = 9.7, J_{A}^B = 3.1 \text{ Hz, H-2}^A\)); 4.12 (dd, 1H, \(J_{A}^B = 11.9, J_{A}^B = 1.8 \text{ Hz, H-6}^B\)); 4.11-4.04 (m, 2H, H-2^B and H-1^B); 4.05 (dd, 1H, \(J_{A}^B = 9.8, J_{A}^B = 3.7, J_{A}^B = 1.8 \text{ Hz, H-5}^A\)); 4.00 (dd, 1H, \(J_{A}^B = 12.4, J_{A}^B = 4.7 \text{ Hz, H-6}^B\)); 3.60 (dd, 1H, \(J_{A}^B = 9.8, J_{A}^B = 9.3 \text{ Hz, H-4}^A\)); 3.55 (dd, 1H, \(J_{A}^B = 9.7, J_{A}^B = 4.2, J_{A}^B = 1.7 \text{ Hz, H-5}^B\)); 2.14-1.92 (6 s, 18H, 6 Ac). \(\Delta\text{C NMR } \alpha\text{ isomer (125 MHz, CDCl}_3\) \(\delta:\) 172.1-169.4 (6 COCH\(_3\)\)); 102.6 (C-1^B); 91.4 (C-1^A); 77.0 (C-4^A); 72.4 (C-3^B); 72.1 (C-3^A); 69.8 (C-3^A); 68.8 (C-5^A); 67.8 (C-4^B); 62.2 (C-6^B); 61.7 (C-6^A); 54.5 (C-2^B); 52.9 (C-2^A); 23.4-20.2 (6 COCH\(_3\)\). HRMS (ESI\(^+\)) calculated for C\(_{26}\)H\(_{33}\)F\(_3\)N\(_2\)O\(_{16}\): 689.2011 [M+H\(^+\)]; found 689.1989. IR: \(\nu \text{ (cm}^{-1}\) = 3300, 1714, 1714, 1663, 1371, 1227, 1181, 1160, 1040.

2-Trifluoromethyl-\{2-(N-acetyl-tert-butylxycarbonylamino)-3,4,6-tri-O-acetyl-2-deoxy-β-D-glucopyranosyl\}-(1→4)-3,6-di-O-acetyl-1,2-dideoxy-α-D-glucopyranosyl[2,1-d]oxazoline\(^7\) (16).

To a solution of compound S3 (314 mg, 0.46 mmol, 1 equiv.) in dry CH\(_3\)CN (7.5 mL) was added methanesulfonic anhydride (238 mg, 1.4 mmol, 3 equiv.) under argon atmosphere. The reaction mixture was stirred at room temperature for 35 min to form a mesyl intermediate. Triethylamine (1.3 mL, 9.1 mmol, 20 equiv.) was then added and the reaction mixture was stirred at room temperature for 2 hours. The mixture was
diluted with CH₂Cl₂ and washed with saturated NaHCO₃ solution (50 mL). The aqueous layer was then extracted with CH₂Cl₂ (3 x 50 mL). The combined organic layers were washed with brine (50 mL), dried over Na₂SO₄, filtered and concentrated to give oxazoline S₄ product (325 mg, quantitative yield) as a yellow solid. A solution of this solid S₄ in dry THF (3.1 mL) was then treated with di-tert-butyldicarbonate (Boc₂O) (524 µL, 2.3 mmol, 5.0 equiv.) and 4-dimethylaminopyridine (4-DMAP) (11 mg, 0.091 mmol, 0.2 equiv.) under an argon atmosphere. The reaction mixture was stirred at room temperature for 30 min and then concentrated. The residue was purified by silica gel column chromatography (CH₂Cl₂/CH₃OH 100:0 to 98:2) to give product 16 (306 mg, 87%) as a yellow oil. 

**RF:** 0.56 (Heptane/ EtOAc 3:7). [α]ᵣ° = -6.20 (c = 1.00, CHCl₃). ¹H NMR (500 MHz, CD₂CN, 70 °C) δ: 6.27 (d, 1H, J₁,₂ = 7.5 Hz, H-1¹⁺); 5.63 (dd, 1H, J₂,₃ = 10.6, J₃,₄ = 8.8 Hz, H-3³⁺); 5.62 (dd, 1H, J₁,₂ = 2.5, J₃,₄ = 1.5 Hz, H-3³⁺); 5.40 (brs, 1H, H-1¹⁺); 4.99 (dd, 1H, J₄,₅ = 10.1, J₅,₆ = 8.8 Hz, H-4⁵⁺); 4.41 (dd, 1H, J₁,₂ = 7.5, J₂,₃ = 2.5 Hz, H-2¹⁺); 4.24 (dd, 1H, J₅,₆ = 12.2, J₆,⁷ = 4.7 Hz, H-6a³⁺); 4.19 (brd, 1H, J₆,⁷ = 12.4 Hz, H-6a³⁺); 3.82 (dd, 1H, J₄,₅ = 10.1, J₅,₆ = 4.7, J₆,⁷ = 2.7 Hz, H-5³⁺); 3.79 (dd, 1H, J₄,₅ = 9.1, J₃,₄ = 1.5 Hz, H-4⁵⁺); 3.42 (dd, 1H, J₄,₅ = 9.1, J₃,₄ = 6.2, J₅,₆ = 1.9 Hz, H-5³⁺); 2.30-1.93 (6s, 18H, 6Ac); 1.54 (s, 9H, Boc). ¹³C NMR (125 MHz, CD₂CN, 70 °C): 172.1-171.1 (6 COCH₃); 157.4 (q, J₂,₃ = 40.0 Hz, OCNCF₃); 118.2 (q, J₁,₂ = 274 Hz, OCNCF₃); 104.4 (C-1⁴⁺); 103.3 (C-1³⁺); 86.8 (brs, C(CH₃)₃); 78.6 (C-4⁵⁺); 73.9 (C-5³⁺); 72.4 (brs, C-3³⁺); 71.8 (C-4⁵⁺); 71.5 (C-3³⁺); 70.9 (C-5³⁺); 66.2 (C-2³⁺); 65.1 (C-6⁵⁺); 64.0 (C-6⁵⁺); 29.1 (3C, C(CH₃)₃); 27.9 (brs, COCH₃ NAc); 21.9-21.5 (5 COCH₂ OAc). HRMS (ESI⁺): calculated for C₂₉H₃₃F₃N₂O₁₅⁺ 671.1906 [M-Boc+H⁺]; found 671.1925. IR: ν (cm⁻¹) = 2980, 1744, 1690, 1370, 1227, 1154, 1043. Analyses are in accordance with the literature.⁷

2,5-Dioxopyrrolidin-1-yl palmitate⁸ (21).

![Structure of 2,5-Dioxopyrrolidin-1-yl palmitate](image)

Solutions of palmitic acid (100 mg, 0.39 mmol, 1.0 equiv.) in dry THF (600 µL), N-hydroxysuccinimide (63 mg, 0.55 mmol, 1.4 equiv.) in dry THF (900 µL) and N,N'-dicyclohexylcarbodiimide (129 mg, 0.62 mmol, 1.6 equiv.) in dry THF (700 µL) were mixed and stirred a room temperature under an argon atmosphere for 2 days. The mixture was then filtered and concentrated. The residue was resuspended in EtOAc and left overnight at 4 °C. The precipitate was filtered again and the filtrate was concentrated. The crude residue was purified by silica gel column chromatography (CH₂Cl₂/CH₃OH 100:0 to 96:4) to afford product 21 (113 mg, 82%) as a white amorphous solid. ¹H NMR (500 MHz, CDCl₃) δ: 2.81 (brs, 4H, 2 CH₂Succ); 2.58 (t, 2H, J₂,₃ = 7.5 Hz, H-2); 1.72 (tt, 2H, J₃,₄ = 7.5, J₃,₄ = 7.5 Hz, H-3); 1.38 (brtt, 2H, J₃,₄ = 7.5, J₄,₅ = 7.5 Hz, H-4); 1.33-1.19 (m, 22H, H-5 to H-1⁵⁺); 0.86 (t, 3H, J₁₅,₁₆ = 6.8 Hz, H-1⁵⁺). ¹³C NMR (125 MHz,
References:
Compound (10) $^1$H NMR

Compound (10) $^{13}$C NMR
Compound (12) $^1$H NMR

Compound (12) $^{13}$C NMR
Compound (13) $^1$H NMR

Compound (13) $^{13}$C NMR
Compound (14) $^1$H NMR

Compound (14) $^{13}$C NMR
Compound (15) HMBC NMR
Compound (8) $^1$H NMR

Compound (8) COSY NMR
Compound (7) $^1$H NMR
Compound (7) HMBC NMR
Compound (S1) $^1$H NMR
Compound (S2) COSY NMR

Compound (S2) $^{13}$C NMR
Compound (S2) HSQC NMR

Compound (S2) HMBC NMR
Compound (S3) HSQC NMR

Compound (S3) HMBC NMR
Compound (16) $^1$H NMR
Compound (6) $^1$H NMR

[Compound diagram 1]

Compound (6) $^1$H NMR

[Compound diagram 2]
Compound (6) COSY NMR

[Diagram of Compound (6) COSY NMR]
Compound (5) COSY NMR
Compound (5) HMBC NMR
Compound (18) $^1$H NMR
Compound (18) $^{13}$C NMR

Compound (18) HSQC NMR
Compound (19) HMBC NMR
Compound (20) COSY NMR
Compound (20) $^{13}$C NMR

Compound (20) HSQC NMR
Compound (20) HMBC NMR
Compound (21) $^1$H NMR

Compound (21) $^{13}$C NMR
Compound (22) $^1$H NMR

Compound (22) $^{13}$C NMR
Compound (3) $^{13}$C NMR

Compound (3) HSQC NMR
Compound (3) HMBC NMR
Compound (4) HMBC NMR
Compound (4S) COSY NMR

Compound (4S) COSY NMR