Supporting Information

For

Glycosyl Oxazolines Serve as Active Donors for Iterative Synthesis of Type I Oligosaccharides

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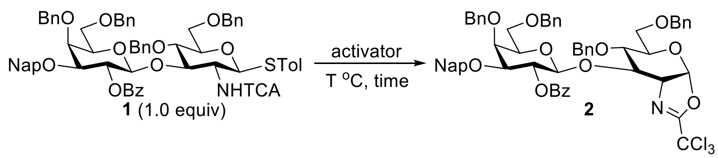
I. Supporting Tables, Schemes, and Figures

Table S1. Synthesis of Type I LacNAc Disaccharide Oxazoline **2**



entry	activator (equiv)	T (°C)	time	yield[a] (%) of **2**
1	Ph_2SO (0.5), Tf_2O (0.5), TTBP (1.14)	-60	1 h	90
2	Ph_2SO (0.65), Tf_2O (0.65), TTBP (1.14)	-60	1 h	100
3	Ph_2SO (0.65), Tf_2O (0.65)	-60	1 h	93
4	NIS (1.2), TMSOTf (0.2)	-50	15 min	100

Activation conditions: Activator, 3 Å mol. sieves (2-fold amount of **1** by wt/wt), CH_2Cl_2 (60 mM). [a]NMR yield, calculated by using dimethyl terephthalate as internal standard.

Table S2. Glycosylation of Oxazoline Donors (1.0 equiv) with Cyclohexanol (1.2 equiv) in CH_2Cl_2 by Using Different Promoters

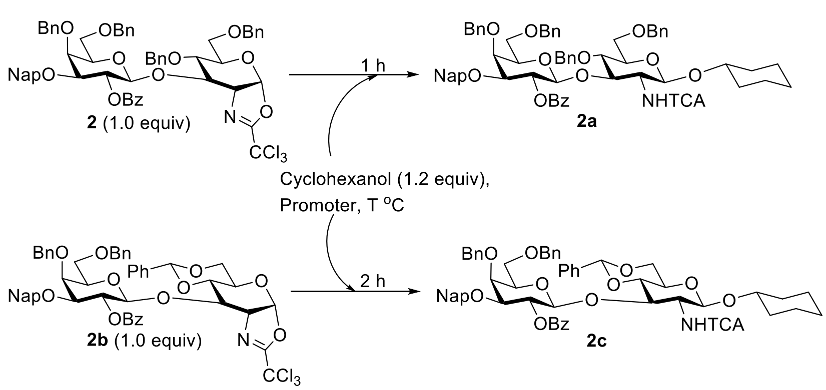


Table S2. (Continued)

entry	oxazoline	promoter (0.2 equiv)	T (°C)	product (% yield)[a]
1	**2**	TfOH	-50	**2a** (90)
2	**2**	Tf_2NH	-50	**2a** (86)
3	**2**	TMSOTf	-50	**2a** (94)
4	**2**	$Cu(OTf)_2$[a,b]	-50	**2a** (trace)
5	**2**	$Cu(OTf)_2$[b]	-20	**2a** (trace)
6	**2**	$In(OTf)_3$	-50	**2a** (24[c])
7	**2**	$Sm(OTf)_3$	-50	no reaction
8	**2**	$Sn(OTf)_2$	-50	**2a** (90)
9	**2**	$Hf(OTf)_4$	-50	**2a** (86)
10	**2**	$AuCl_3$	-50	no reaction
11	**2**	$AlCl_3$	-50	**2a** (trace)
12	**2**	$FeCl_3$	-50	**2a** (46[d])
13	**2b**	TfOH	-50	**2c** (64[e])
14	**2b**	Tf_2NH	-50	**2c** (81)
15	**2b**	TMSOTf	-50	**2c** (71[f])
16	**2b**	$Cu(OTf)_2$	-50	**2c** (trace)
17	**2b**	$In(OTf)_3$	-50	**2c** (trace)
18	**2b**	$Sn(OTf)_2$	-50	**2c** (74)
19	**2b**	$Hf(OTf)_4$	-50	**2c** (55[g])

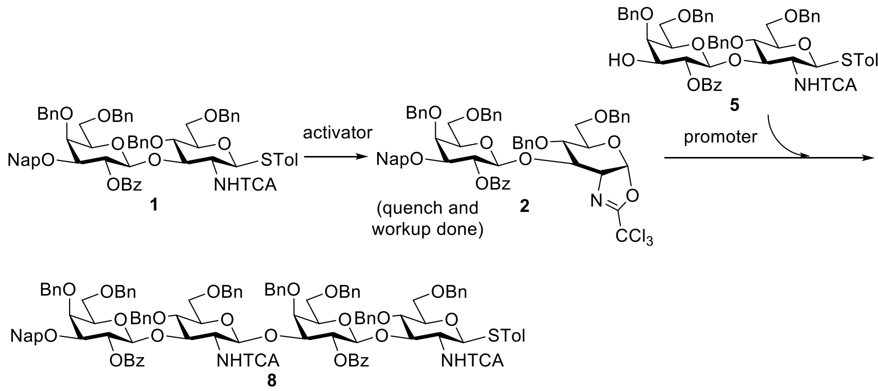
[a]NMR yield, calculated by using dimethyl terephthalate as internal standard, promoter was added by using dilution method (diluted with ACN). [b]Promoter was weighed in eppendorf, and poured into the rxn. mixture directly. [c]68% of **2** was unreacted. [d]46% of **2** was unreacted. [e]18% of **2b** was unreacted. [f]14% of **2b** was unreacted. [g]37% of **2b** was unreacted.

Table S3. Glycosylations of Oxazoline 2 with Disaccharide Acceptors **3–5** [a]

entry	donor (equiv)	acceptor	T (°C)	time (h)	product (% yield)[b]
1	**2** (1.3)	**3**	–60	1.5	**6** (84)
2	**2** (1.3)	**4**	–60	1.5	**7** (55)
3	**2** (1.3)	**4**	–50	1.5	**7** (61)[c]
4	**2** (1.3)	**5**	–60	1	**8** (75)
5	**2** (1.1)	**5**	–60	1	**8** (70)
6	**2** (1.1)	**5**	–60	2	**8** (87)[c,d]
7	**2** (1.1)	**5**	–70	2	**8** (84)
8	**2** (1.1)	**5**	–50	2	**8** (87)
9[a]	**2** (1.1)	**5**	–50	2	**8** (84)

[a]The reactions were performed in CH_2Cl_2 with an acceptor (1.0 equiv, 0.04 mmol, 40 mg) and TMSOTf (0.2 equiv), except for entry 9, in which 0.1 equiv of TMSOTf was present. [b]Isolated yield. [c] Please also refer to Scheme 1. [d] The reaction was also done with 0.72 mmol (0.76 g) of **5**.

Table S4. Glycosylation of *in situ* Oxazoline **2** with Acceptor **5** (by Quench and Workup Method) [a]



entry	donor (equiv)	activator (equiv)	promoter (equiv)	T (ºC)		time (h)		yield[b] (%) of **8**
1	**1** (1.1)	Ph_2SO (0.72), Tf_2O (0.72), TTBP (1.25)	TMSOTf (1.4)	-60[c]	-60[d]	1[c]	10[d]	58
2	**1** (1.1)	NIS (1.3), TMSOTf (0.2)	TMSOTf (0.2)	-50[c]	-60[d]	0.5[c]	2[d]	70
3	**1** (1.4)	NIS (1.6), TMSOTf (0.2)	TMSOTf (0.2)	-50[c]	-60[d]	0.5[c]	2[d]	74

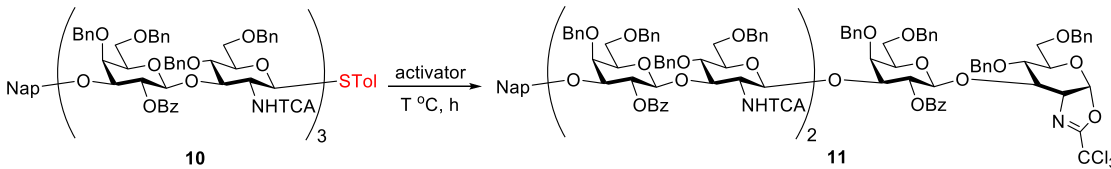
[a] The reaction was carried out in CH_2Cl_2 with 1.1 equiv of donor **1**, 1 equiv of acceptor **5**, and activator and promoter (both as indicated in the table). [b]Isolated yield. [c]Step 1: oxazoline formation. [d]Step 2: glycosylation between crude oxazoline **2** and acceptor **5**.

Table S5. Activation of **8** (60–100mM) to Form Oxazoline **9** in CH_2Cl_2 under Various Conditions.

entry	activator (equiv)	(wt of 3 Å mol. sieves)/(wt of **8**)	[**8**] (mM)	T (°C)	time	yield[a] (%) of **9**
1	Ph_2SO (0.65), Tf_2O (1.3)[b], TTBP	2	60	−60	6 h	45
2	NIS (1.2), TMSOTf (0.2)	2	60	−50	20 min	42
3	NIS (1.2), TMSOTf (0.1)	2	60	−50	20 min	55
4	NIS (1.2), TMSOTf (0.1)	2	60	−60	1.5 h	87
5	NIS (1.2), TMSOTf (0.1)	2	60	−70	1.5 h	63
6	NIS (1.2), TMSOTf (0.1)	4	60	−70	1.5 h	46[c]
7	NIS (1.2), TMSOTf (0.1)	4	60	−70	2.5 h	74
8	NIS (1.2), TMSOTf (0.1)	4	100	−70	2.5 h	76
9	NIS (1.2), TMSOTf (0.1)	4	100	−70 to −50[d]	2.5 h	82

[a]NMR yield, calculated by using dimethyl terephthalate as the internal standard. [b]Half of the total Tf_2O (0.65 equiv) was added initially, and another 0.65 equiv of Tf_2O was added 3.75 h later. [c]21% of 8 remained unreacted. [d]Reaction was stirred at −70, −60, and −50 °C for 50 min at each stage.

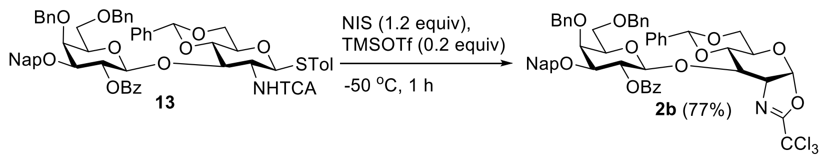
Table S6. Synthesis of Type I LacNAc Hexasaccharide Oxazoline **11**



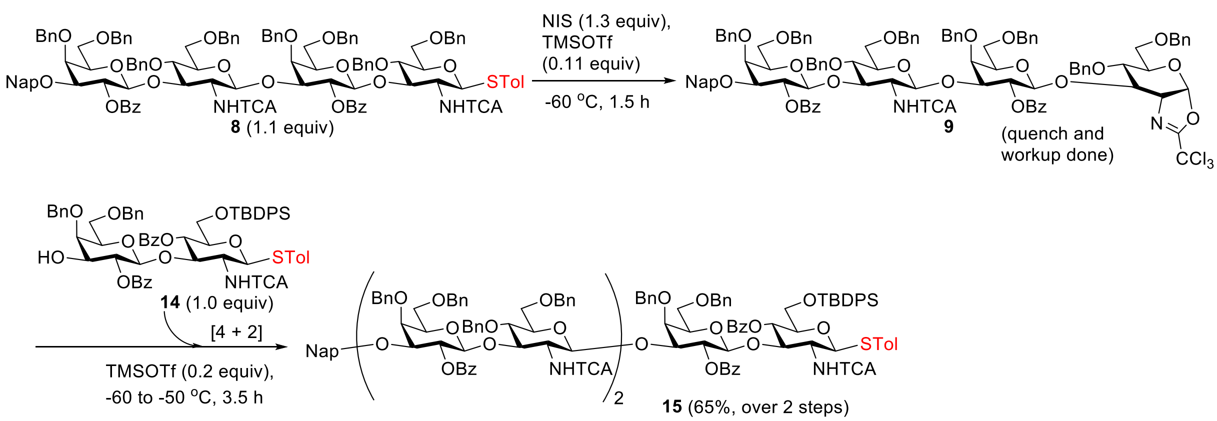
entry	T (°C)	time	yield[a] (%) of **11**
1	-70	2.5 h	50[b]
2	-70	3.5 h	53
3	-50	1 h	67

Activation conditions: NIS (1.2 equiv), TMSOTf (0.1 equiv), 3 Å mol. sieves (4 fold of **10** by wt/wt), CH_2Cl_2 (100 mM).
[a]NMR yield, calculated by using dimethyl terephthalate as internal standard. [b]9% of **10** was unreacted.

Scheme S1. Synthesis of Disaccharide Oxazoline **2b**



Scheme S2. Improved Synthesis of Hexasaccharide **15** by Oxazoline Based Approach



Scheme S3. Scheme Showing the Calculation of Overall Yield of Octasaccharide **12**

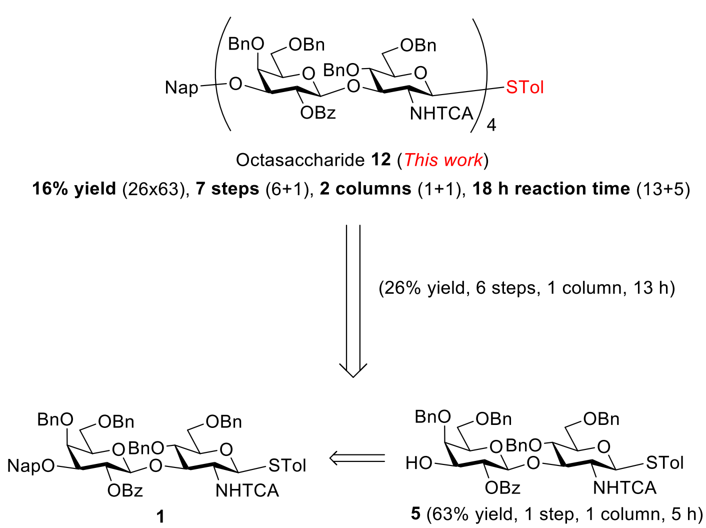
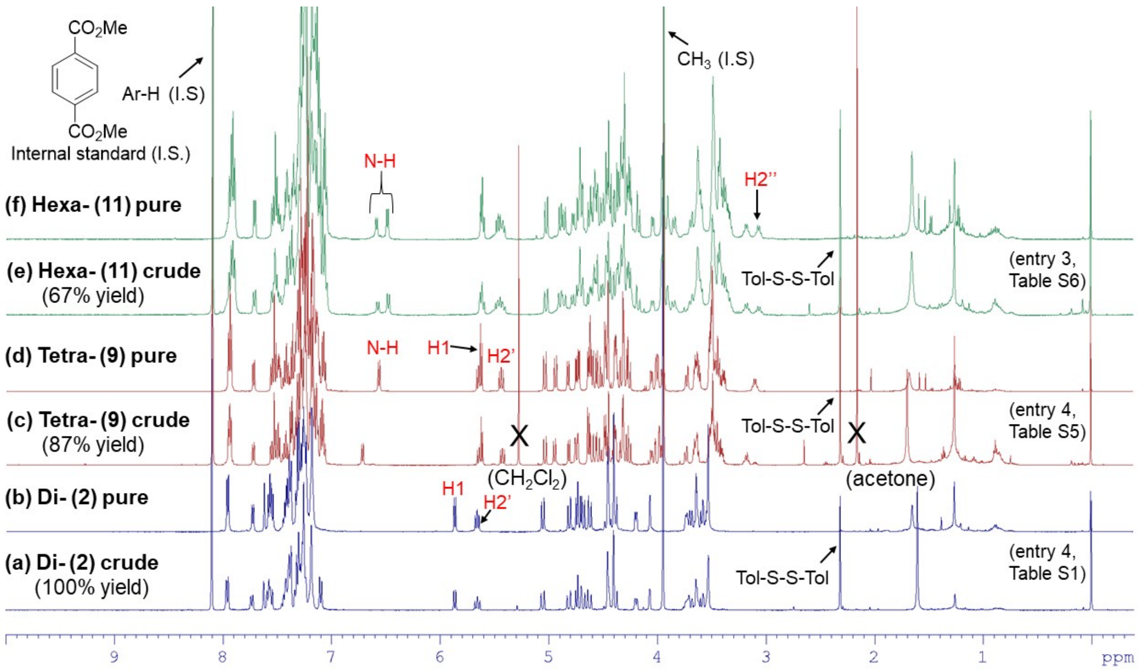
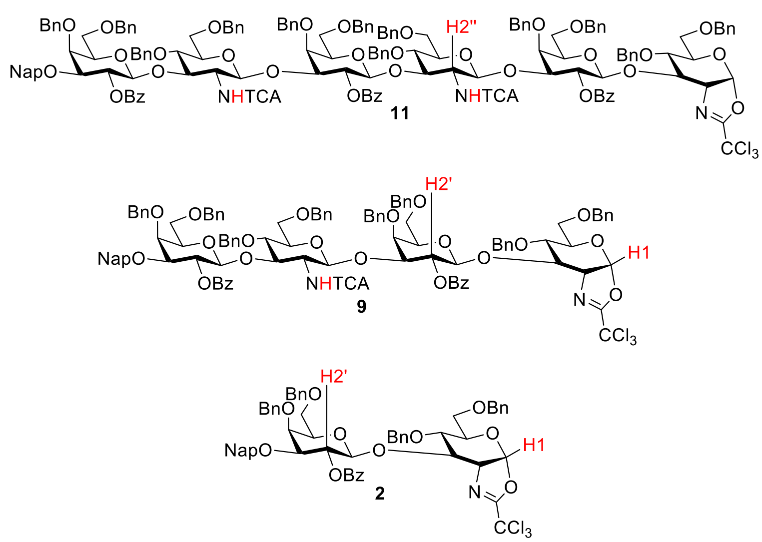


Figure S1. Formation of Di-, Tetra-, and Hexasaccharide Oxazolines (**2**, **9**, and **11**) were Confirmed by ^{1}H NMR of Crude Reaction Mixtures





II. Experimental Procedures

General experimental procedure.

All reactions were performed in an oven-dried glassware under the nitrogen atmosphere unless otherwise mentioned. The reaction mixtures were purified by using silica gel flash column chromatography. Anhydrous solvents and moisture-sensitive materials were transferred by using an oven-/vacuum-dried syringe or cannula through a rubber septum. Analytical TLC was performed on the precoated glass plates of TLC Silica gel 60 F_{254} from Merck and was detected by UV visualization (254 nm) and/or by staining with reagents that contained ceric molybdate (for general use), para-anisaldehyde (for carbohydrates), or ninhydrin (for amino-group-containing samples). Column chromatography was performed on silica gel (Geduran Silicagel 60, 0.040−0.063 mm, from Geduran). ^{1}H NMR spectra were recorded on Bruker AVII-500 (500 MHz) spectrometer by using tetramethylsilane (δ_H = 0.00 ppm) and $CDCl_3$ (δ_H = 7.26 ppm) as internal standards. ^{13}C NMR spectra were recorded on Bruker AVII-500 (125 MHz) spectrometer by using $CDCl_3$ (δ_C = 77.23 ppm, central line of a triplet) as an internal standard. Structural assignments were made with additional information from 2D-COSY, 2D-HMQC, and 2D-HMBC experiments using gradient pulses for coherence pathway selection, which were acquired on Bruker AVII-500 spectrometer. HRMS was performed on Bruker Bio-TOF III (ESITOF) or Bruker Ultraflex (MALDI-TOF/TOF) spectrometers and is reported as mass/charge (m/z) ratios with percentage relative abundance. Optical rotations were measured at the sodium D-line (589 nm) at 25 °C or 20.0 °C on a PerkinElmer model 341 polarimeter. Specific rotations based on the equation [α] = (100·α)/(*l*·*c*) are reported as unitless numbers, where the *l* is path length (in dm) and *c* is concentration (in g/l00 mL). The solvents for extraction and chromatography were of ACS grade. CH_2Cl_2 and CH_3CN were predried by using molecular sieves and then percolated through an active Al_2O_3 column. Anhydrous DMF and MeOH were purchased from Aldrich Chemical Co. and J-T Baker, respectively, in sealed packages. Diphenylsulfoxide (Ph_2SO) and 2,4,6-tri-*tert*-butylpyrimidine were purchased from Aldrich Chemical Co. All the chemicals were used without further purification unless otherwise specified. Celite 545 and 3 Å molecular sieves (powder < 50 μm) were purchased from Acros Co. and Alfa Aesar Co., respectively.

General procedure to synthesize di- (2) and tetrasaccharide (9) oxazoline donors by Ph_2SO/Tf_2O method (entries 1-3, Table S1; and entry 1, Table S5).

A mixture of thioglycoside donor (**1**[1] or **8**), Ph_2SO, and TTBP (in entry 3 of Table S1, TTBP was not used) was stirred with 3 Å molecular sieves in anhydrous CH_2Cl_2 (60 mM w.r.t. thioglycoside donor) at RT for 30 min. After cooling to -60 ºC, Tf_2O was added to reaction mixture, and allowed to stir at -60 ºC. After stirring for a period of time (see Tables S1 and S5 for the reaction time), reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed with saturated $Na_2S_2O_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the pale-yellow residue, which was dried under high vacuum. After that, known amount of dimethyl terephthalate, with distinguishable ^{1}H NMR peak at 8.1 ppm (s, 4H, Ar-H), was added as internal standard to the crude residue to determine the yield of formed oxazoline products (2^1 & **9**) by ^1H NMR spectrum. ^1H NMR peaks at 5.86 ppm (d, *J* = 7.3 Hz, 1H, H-1) was used to quantify the formation of disaccharide oxazoline **2** by crude ^1H NMR, whereas peaks at 6.56 (d, *J* = 7.6 Hz, 1H, N-H) and 5.44 (dd, *J* = 10.0, 8.0 Hz, 1H, H-2') were used to calculate the yield of tetrasaccharide oxazoline **9**.

General procedure to synthesize di- (2), tetra- (9), and hexasaccharide (11) oxazoline donors by NIS/TMSOTf method (entry 4, Table S1; entries 2-9, Table S5; and entries 1-3, Table S6). Thioglycoside donor (**1**, **8**, or **10**) was stirred with 3 Å molecular sieves in CH_2Cl_2 at RT for 30 min. After cooling the reaction mixture at low temperature (see Tables S1, S5, and S6), NIS was added and followed by the addition of TMSOTf. After stirring for a period of time (see Tables S1, 2, and S4 for the reaction time), reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed with saturated $Na_2S_2O_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the yellow residue, which was dried under high vacuum. Then, known amount of dimethyl terephthalate was added as internal standard to the crude residue to determine the yield of formed oxazoline products (**2**, **9**, and **11**) by ^1H NMR spectrum. To calculate the yield of hexasaccharide oxazoline (**11**), peak at 3.10-3.02 (m, 1H, H-2'') was integrated in ^1H NMR.

General procedure for glycosylation of disaccharide oxazoline 2 with cyclohexanol by using different promoters (entries 1-12, Table S2).

A solution of oxazoline 2^1 (30 mg, 0.028 mmol) and cyclohexanol (3.50 µL, 0.034 mmol) in anhydrous CH_2Cl_2 (0.47 mL) was stirred with 3 Å molecular sieves (60 mg) at RT for 30 min under N_2 atmosphere. After cooling to -50 ºC, promoter (0.2 equiv, 0.0056 mmol) was added to the reaction mixture. After 1 h, reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed with saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the pale-yellow crude. The crude product was mixed with the known amount of internal standard (dimethyl terephthalate) to determine the yield of product (**2a**) by using ^1H NMR. ^1H NMR peaks at 6.8 ppm (d, *J* = 7.2 Hz, 1H, N-H) and 3.18-3.07 (m, 1H, H-2) were used to calculate the yield of product (**2a**) formed. While remaining starting material (**2**) was quantified by integrating peak at 5.86 ppm (d, *J* = 7.3 Hz, 1H, H-1).

General procedure for glycosylation of disaccharide oxazoline 2b with cyclohexanol by using different promoters (entries 13-19, Table S2).

A solution of oxazoline **2b** (30 mg, 0.031 mmol) and cyclohexanol (3.82 µL, 0.037 mmol) in anhydrous CH_2Cl_2 (0.51 mL) was stirred with 3 Å molecular sieves (60 mg) at RT for 30 min under N_2 atmosphere. After cooling to -50 ºC, promoter (0.2 equiv, 0.006 mmol) was added to the reaction mixture. After 2 h, reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed with saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the pale-yellow crude. The crude product was mixed with the known amount of internal standard (dimethyl terephthalate) to determine the yield of product (**2c**) by using ^1H NMR. ^1H NMR peaks at 5.18 ppm (d, *J* = 8.1 Hz, 1H, H-1) and 3.19 (td, J = 8.0, 7.7 Hz, 1H, H-2) were used to calculate the yield of product (**2c**) formed. While remaining starting material (**2b**) was quantified by integrating peak at 6.0 ppm (d, J = 7.7 Hz, 1H, H-1).

General procedure for [2 + 2] glycosylations between disaccharide oxazoline donor 2 and thioglycoside acceptors (3-5) (Table S3).

Oxazoline 2 + Acceptor 3 (entry 1, Table S3)

A solution of oxazoline **2** (55.3 mg, 0.052 mmol) and acceptor **3**[1] (40 mg, 0.04 mmol) in anhydrous CH_2Cl_2 (0.79 mL) was stirred with 3 Å molecular sieves (96 mg) at RT for 30 min under N_2 atmosphere. After cooling to -60 °C, TMSOTf (1.43 µL, 0.008 mmol) was added to the reaction mixture. After 1.5 h, reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed with saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the pale-yellow crude that was purified by column chromatography on silica gel with EtOAc/hexanes (1/5, v/v) to yield pure tetrasaccharide **6**[1] (69.1 mg, 84% yield) as white amorphous foam. R_f 0.32 (EtOAc/toluene = 1/8, v/v, run two times). Spectroscopic data were identical to those reported previously.[1]

Oxazoline 2 + Acceptor 4 (entries 2 & 3, Table S3)

A solution of oxazoline **2** (55.9 mg, 0.052 mmol) and acceptor **4**[1] (39 mg, 0.04 mmol) in anhydrous CH_2Cl_2 (0.8 mL) was stirred with 3 Å molecular sieves (95 mg) at RT for 30 min under N_2 atmosphere. After cooling to -60 °C, TMSOTf (1.45 µL, 0.008 mmol) was added to the reaction mixture. After 1.5 h, reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed with saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the pale-yellow crude that was purified by column chromatography on silica gel with EtOAc/hexanes (1/5, v/v) to yield pure tetrasaccharide **7**[1] (45 mg, 55% yield) as white amorphous foam. R_f 0.27 (EtOAc/toluene = 1/8, v/v, run two times). Spectroscopic data were identical to those reported previously.[1]

Oxazoline 2 + Acceptor 5 (entry 6, Table S3)

A solution of oxazoline **2** (850 mg, 0.79 mmol) and acceptor **5**[1] (758 mg, 0.72 mmol) in anhydrous CH_2Cl_2 (14.33 mL) was stirred with 3 Å molecular sieves (1.61 g) at RT for 30 min under N_2 atmosphere. After cooling to -60 °C, TMSOTf (26 µL, 0.14 mmol) was added to the reaction mixture. After 2 h, reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (25 mL), and filtered. The filtrate was washed with saturated $NaHCO_3$ solution (25 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the pale-yellow crude that was purified by column chromatography on silica gel with EtOAc/hexanes (1/5, v/v) to yield pure tetrasaccharide **8**[1] (1.33 g, 87% yield) as white amorphous foam. R_f 0.49 (EtOAc/toluene = 1/8, v/v). Spectroscopic data were identical to those reported previously.[1]

Reaction procedures of [2 + 2] glycosylations between disaccharide oxazoline donor 2 and thioglycoside acceptor 5 by quench and workup method (Table S4).

Ph_2SO/Tf_2O method (entry 1, Table S4):

A mixture of donor **1** (62 mg, 0.052 mmol), Ph_2SO (6.8 mg, 0.034 mmol), TTBP (14.7 mg, 0.06 mmol) was stirred with 3 Å molecular sieves (125 mg) in anhydrous CH_2Cl_2 (867 µL) at RT for 30 min. After cooling to -60 °C, Tf_2O (5.7 µL, 0.034 mmol) was added to reaction mixture, and allowed to stir for 1 h at -60 °C. After 1 h, $P(OEt)_3$ (5.8 µL, 0.034 mmol) was added to reaction mixture to quench the remaining sulfonium intermediate in the reaction mixture, and stirred for additional 15 min at -60 °C, before quenching with Et_3N at -60 °C. Reaction mixture was diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed sequentially with saturated $Na_2S_2O_3$ solution (10 mL) and saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the crude disaccharide oxazoline **2** as pale-yellow foam.

After that, crude oxazoline **2** and acceptor **5** (50 mg, 0.047 mmol) were dried together under high vacuum. Then added 3 Å molecular sieves (112 mg) and anhydrous CH_2Cl_2 (946 µL), and stirred at RT under N_2 for 30 min. After cooling the reaction mixture to -60 °C, TMSOTf (0.2 equiv, 1.7 µL, 0.0095 mmol) was added to the reaction mixture. However, no reaction happened between oxazoline **2** and acceptor **5**, when checked by TLC. Therefore, after 2 h, 0.2 equiv of TMSOTf was further added, but no improvement occurred, presumably due to presence of TTBP during first step. Thus, more aliquots of TMSOTf were added (0.4 equiv after 3 h and 0.6 equiv after 4 h; in total 1.4 equiv of TMSOTf). After reaction completion, reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed with saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the pale-yellow residue that was purified by column chromatography on silica gel with EtOAc/hexanes (1/4, v/v) to yield pure tetrasaccharide **8** (58.2 mg, 58% yield) as white amorphous foam.

NIS/TMSOTf method (entries 2 & 3, Table S4):

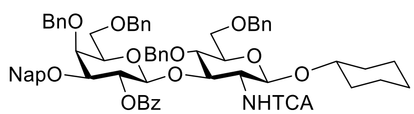
Donor **1** was stirred with 3 Å molecular sieves (2xwt of **1**) in anhydrous CH_2Cl_2 (60 mM w.r.t. **1**) at RT for 30 min. After cooling the reaction mixture to -50 °C, NIS was added, and followed by the addition of TMSOTf (see Table S1 for the NIS and TMSOTf equiv). After 30 min, reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed sequentially with saturated $Na_2S_2O_3$ solution (10 mL) and saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the crude disaccharide oxazoline **2** as yellow foam.

Crude oxazoline **2** and acceptor **5** (1.0 equiv) were dried together under high vacuum. Added 3 Å molecular sieves (Donor+Acceptor, wt./wt.) and CH_2Cl_2 (50 mM w.r.t. **5**), and stirred at RT under N_2 for 30 min. After cooling the reaction mixture to -60 °C, TMSOTf (0.2 equiv) was added. After stirring for 2 h, reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed with saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the pale-yellow residue that was purified by column chromatography on silica gel with EtOAc/hexanes (1/4, v/v) to yield pure tetrasaccharide **8** as white amorphous foam.

General quench and workup procedure used in Scheme 3 during the [2 + 2 + 2] and [2 + 2 + 2 + 2] iterative synthesis of hexa- (10) and octasaccharides (12).

After the reaction was quenched by dropwise addition of Et_3N (2xvolume of TMSOTf added in reaction), diluted with CH_2Cl_2, and filtered. The filtrate was washed sequentially with saturated $Na_2S_2O_3$ solution and saturated $NaHCO_3$ solution, dried over $MgSO_4$, and filtered. Then silica (230-400 mesh size, 4xwt of glycosides) was added to the crude in CH_2Cl_2, and dried by evaporation under rota vapor. The crude silica residue was washed sequentially with hexanes (to remove Tol-S-S-Tol impurity) and EtOAc (to elute the crude product) using filter paper. EtOAc fraction was collected and concentrated by evaporation to yield the pale yellow crude di- (**2**), tetra- (**9**), or hexasaccharide oxazolines (**11**).

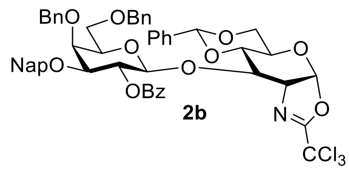
Cyclohexanyl (2-*O*-benzoyl-4,6-di-*O*-benzyl-3-*O*-(naphthalen-2-ylmethyl)-*β*-D-galactopyranosyl)-(1→3)-4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranoside (2a).



2a

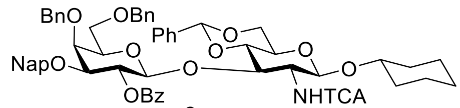
The crude reaction mixture (from Table S2) was subjected to column chromatography on silica gel with EtOAc/hexanes (1/5, v/v) to yield the pure **2a** as white amorphous foam. R_f 0.5 (EtOAc/toluene = 1/8, v/v); $[\alpha]^{20}_D$ -7.22 (c 0.83, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.94 (d, J = 7.65 Hz, 2H, Ar-H), 7.75 (d, J = 7.75 Hz, 1H, Ar-H), 7.63-7.51 (m, 4H, Ar-H), 7.49-7.40 (m, 2H, Ar-H), 7.39-7.34 (m, 4H, Ar-H), 7.33-7.22 (m, 14H, Ar-H), 7.21-7.14 (m, 3H, Ar-H), 7.12-7.06 (m, 2H, Ar-H), 6.8 (d, J = 7.2 Hz, 1H, N-H), 5.7 (dd, J = 9.8, 7.0 Hz, 1H, H-2'), 5.06 (d, J = 11.4 Hz, 1H, CH_2Ph), 4.98 (d, J = 10.2 Hz, 1H, CH_2Ph), 4.84 (d, J = 7.7 Hz, 1H, H-1), 4.79 (d, J = 12.4 Hz, 1H, CH_2 group of Nap), 4.66-4.50 (m, 6H, H-1', H-3, CH_2 group of Nap, 3xCH_2Ph), 4.44-4.36 (m, 2H, 2xCH_2Ph), 4.30 (d, J = 11.8 Hz, 1H, CH_2Ph), 4.06 (s, 1H, H-4'), 3.72 (d, J = 9.5 Hz, 1H, H-6a), 3.66 (dd, J = 10.6, 4.5 Hz, 1H, H-6b), 3.62-3.43 (m, 7H, H-3', H-4, H-5, H-5', H-6a', H-6b', cyclohexanyl), 3.18-3.07 (m, 1H, H-2), 1.84-1.77 (m, 1H, cyclohexanyl), 1.76-1.65 (m, 2H, cyclohexanyl), 1.64-1.54 (m, 2H, cyclohexanyl), 1.47-1.39 (m, 1H, cyclohexanyl), 1.24-1.06 (m, 4H, cyclohexanyl); ^{13}C NMR (125 MHz, $CDCl_3$): δ 165.47 (C), 161.50 (C), 138.85 (C), 138.41 (C), 138.38 (C), 138.05 (C), 135.02 (C), 133.24 (CH), 133.14 (C), 130.12 (C), 130.03 (CH), 128.71 (CH), 128.62 (CH), 128.58 (CH), 128.48 (CH), 128.42 (CH), 128.18 (CH), 128.15 (CH), 128.06 (CH), 127.97 (CH), 127.91 (CH), 127.80 (CH), 127.69 (CH), 127.56 (CH), 126.98 (CH), 126.29 (CH), 126.16 (CH), 126.08 (CH), 100.73 (CH), 96.62 (CH), 92.65 (C), 79.51 (CH), 77.47 (CH), 76.58 (CH), 76.45 (CH), 74.97 (CH_2), 74.71 (CH), 73.82 (CH), 73.74 (CH_2), 73.51 (CH_2), 73.04 (CH), 72.20 (CH), 71.88 (CH_2), 69.34 (CH_2), 68.19 (CH_2), 59.55 (CH), 33.49 (CH_2), 31.82 (CH_2), 25.61 (CH_2), 24.13 (CH_2), 23.98 (CH_2); HRMS (ESI-TOF): *m/z* calcd for $C_{66}H_{68}Cl_3NO_{12}Na$ $[M + Na]^+$, 1196.3692; found, 1196.3696.

2-Trichloromethyl-3-*O*-(2-*O*-benzoyl-4,6-di-*O*-benzyl-3-*O*-(naphthalen-2-ylmethyl)-*β*-D-galactopyranosyl)-4,6-*O*-benzylidene-1,2-dideoxy-*α*-D-glucopyrano-[2,1-d]-2-oxazoline (2b):



A solution of **13**[1] (200 mg, 0.18 mmol) in anhydrous CH_2Cl_2 (3.61 mL) was stirred with 3 Å molecular sieves (400 mg) at RT for 30 min under N_2 atmosphere. After cooling to -50 °C, NIS (49 mg, 0.22 mmol) was added to the reaction mixture, followed by the addition of TMSOTf (6.6 µL, 0.036 mmol). After 1 h, reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed with saturated $Na_2S_2O_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the yellow residue that was purified by column chromatography on silica gel with EtOAc/hexanes (1/5, v/v) to yield pure oxazoline **2b** (137 mg, 77% yield) as white amorphous foam. R_f 0.42 (EtOAc/hexanes = 1/3, v/v); $[\alpha]^{25}_D$ 12.7 (*c* 1.1, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.04-7.97 (m, 2H, Ar-H), 7.72 (d, J = 7.6 Hz, 1H, Ar-H), 7.61-7.50 (m, 4H, Ar-H), 7.45-7.35 (m, 7H, Ar-H), 7.34-7.19 (m, 13H, Ar-H), 6.00 (d, J = 7.7 Hz, 1H, H-1), 5.69 (dd, J = 10.0, 8.1 Hz, 1H, H-1'), 5.50 (s, 1H, CHPh), 5.00 (d, J = 11.65 Hz, 1H, Nap-CH_2), 4.80-4.73 (m, 2H, H-1', CH_2Ph), 4.68 (d, J = 11.7 Hz, 1H, CH_2Ph), 4.59 (d, J = 12.4 Hz, 1H, Nap-CH_2), 4.34-4.29 (m, 3H, H-6a, CH_2Ph), 4.20 (dd, J = 7.6, 3.0 Hz, 1H, H-2), 4.10 (dd, J = 7.1, 3.0 Hz, 1H, H-3), 4.03 (d, J = 2.4 Hz, 1H, H-4'), 3.89 (dd, J = 9.9, 7.1 Hz, 1H, H-4), 3.70-3.63 (m, 2H, H-3', H-5'), 3.62-3.56 (m, 2H, H-6b, H-6a'), 3.53-3.44 (m, 2H, H-5, H-6b); ^{13}C NMR (125 MHz, $CDCl_3$): δ 165.7 (C), 162.3 (C), 138.5 (C), 137.9 (C), 137.2 (C), 135.1 (C), 133.2 (CH), 133.2 (C), 133.1 (C), 130.2 (C), 130.1 (CH), 129.2 (CH), 128.7 (CH), 128.6 (CH), 128.5 (CH), 128.4 (CH), 128.3 (CH), 128.2 (CH), 128.1 (CH), 128.0 (CH), 127.9 (CH), 127.8 (CH), 126.7 (CH), 126.3 (CH), 126.1 (CH), 125.9 (CH), 105.1 (CH), 102.0 (CH), 101.4 (CH), 86.4 (C), 80.4 (CH), 79.9 (CH), 78.8 (CH), 74.8 (CH_2), 73.9 (CH), 73.8 (CH_2), 72.2 (CH), 71.9 (CH_2), 69.1 (CH), 68.66 (CH_2), 68.62 (CH_2), 63.4 (CH); HRMS (ESI-TOF): *m/z* calcd for $C_{53}H_{48}Cl_3NO_{11}H$ $[M+H]^+$, 980.2366; found, 980.2376.

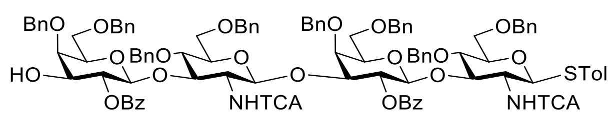
Cyclohexanyl (2-*O*-benzoyl-4,6-di-*O*-benzyl-3-*O*-(naphthalen-2-ylmethyl)-*β*-D-galactopyranosyl)-(1→3)-4,6-*O*-benzylidene-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranoside (2c).



2c

The crude reaction mixture (from Table S2) was subjected to column chromatography on silica gel with EtOAc/hexanes (1/5, v/v) to yield the pure **2c** as white amorphous foam. R_f 0.31 (EtOAc/toluene = 1/8, v/v); $[\alpha]^{20}_D$ +5.607 (*c* 1.07, $CHCl_3$); ^1H NMR (500 MHz, $CDCl_3$): δ 7.9 (d, J = 7.65 Hz, 2H, Ar-H), 7.71 (d, J = 7.7 Hz, 1H, Ar-H), 7.55-7.46 (m, 4H, Ar-H), 7.45-7.36 (m, 4H, Ar-H), 7.36-7.26 (m, 10H, Ar-H), 7.24-7.21 (m, 4H, Ar-H), 7.16 (d, J = 8.35 Hz, 1H, Ar-H), 6.98 (d, J = 6.35 Hz, 1H, N-H), 5.62 (t, J = 8.9 Hz, 1H, H-2'), 5.45 (s, 1H, PhCH), 5.18 (d, J = 8.1 Hz, 1H, H-1), 4.98 (d, J = 11.7 Hz, 1H, CH_2Ph), 4.78-4.67 (m, 2H, H-1', CH_2 group of Nap), 4.65-4.57 (m, 2H, H-3, CH_2Ph), 4.51 (d, J = 12.3 Hz, 1H, CH_2 group of Nap), 4.36 (d, J = 11.6 Hz, 1H, CH_2Ph), 4.32-4.22 (m, 2H, H-6a, CH_2Ph), 3.97 (s, 1H, H-4'), 3.75-3.67 (m, 2H, H-4, H-6a'), 3.63 (t, J = 8.0 Hz, 1H, H-6b'), 3.58-3.4 (m, 5H, H-5, H-3', H-5', H-6b, cyclohexanyl), 3.19 (td, J = 8.0, 7.7 Hz, 1H, H-2), 1.87-1.79 (m, 1H, cyclohexanyl), 1.77-1.57 (m, 4H, cyclohexanyl), 1.52-1.42 (m, 1H, cyclohexanyl), 1.34-1.27 (m, 1H, cyclohexanyl), 1.23-1.11 (m, 4H, cyclohexanyl); ^{13}C NMR (125 MHz, $CDCl_3$): δ 165.43 (C), 161.92 (C), 138.68 (C), 137.92 (C), 137.57 (C), 135.06 (C), 133.19 (C), 133.15 (CH), 133.08 (C), 130.12 (CH), 128.97 (CH), 128.64 (CH), 128.48 (CH), 128.40 (CH), 128.31 (CH), 128.23 (CH), 128.06 (CH), 128.01 (CH), 127.78 (CH), 127.70 (CH), 126.73 (CH), 126.32 (CH), 126.21 (CH), 126.08 (CH), 125.92 (CH), 101.11 (CH), 100.14 (CH), 97.14 (CH), 92.25 (C), 80.12 (CH), 79.89 (CH), 78.14 (CH), 75.25 (CH), 74.64 (CH_2), 73.78 (CH_2), 73.45 (CH), 72.56 (CH), 72.20 (CH), 71.93 (CH_2), 68.86 (CH_2), 68.69 (CH_2), 66.29 (CH), 60.10 (CH), 33. 6 (CH_2), 31.99 (CH_2), 25.58 (CH_2), 24.18 (CH_2), 24.04 (CH_2); HRMS (ESI-TOF): *m/z* calcd for $C_{59}H_{60}Cl_3NO_{12}Na$ $[M + Na]^+$, 1104.3048; found, 1104.3031.

4-Methylphenyl (2-*O*-benzoyl-4,6-di-*O*-benzyl-*β*-D-galactopyranosyl)-(1→3)-(4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranosyl)-(1→3)-(2-*O*-benzoyl-4,6-di-*O*-benzyl-*β*-D-galactopyranosyl)-(1→3)-4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-1-thio-*β*-D-glucopyranoside (8a).

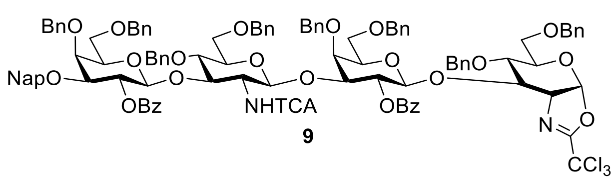


8a

To a solution of compound **8** (250 mg, 0.12 mmol) in a 2.4:1 (v/v) mixture of CH_2Cl_2 (2.07 mL) and dd. H_2O (0.86 mL), DDQ (40 mg, 0.18 mmol) was added at RT. After 1 h 15 min, additional 20 mg (0.09 mmol) of DDQ was added, and let the reaction stirred for another 1 h. Saturated $NaHCO_3$ solution (1 mL) was then slowly added to the reaction mixture under the ice bath to quench the reaction. Solvent extraction was done to wash the CH_2Cl_2 layer with saturated $NaHCO_3$ solution (10 mL, 2 times). CH_2Cl_2 layer was collected, dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the yellow viscous crude that was purified by column chromatography on silica gel with EtOAc/hexanes (1/5 to 1/4, v/v) to yield the desired pure product

8a (88.2 mg, 38%) as white amorphous foam. R_f 0.24 (EtOAc/hexanes = 1/3, v/v, run two times); $[\alpha]^{20}_D$ -21.82 (*c* 2.2, $CHCl_3$); ^1H NMR (500 MHz, $CDCl_3$): δ 8.06-8.02 (m, 2H, Ar-H), 8.00-7.96 (m, 2H, Ar-H), 7.51 (t, *J* = 7.3 Hz, 1H, Ar-H), 7.44 (t, *J* = 7.4 Hz, 1H, Ar-H), 7.41-7.38 (m, 2H, Ar-H), 7.38-7.32 (m, 3H, Ar-H), 7.32-7.06 (m, 41H, Ar-H), 6.90 (d, *J* = 7.9 Hz, 2H, Ar-H), 6.82 (d, *J* = 7.8 Hz, 1H, N-H), 6.77 (d, *J* = 8.0 Hz, 1H, N-H), 5.55 (dd, *J* = 9.9, 8.0 Hz, 1H, H-2'), 5.22 (dd, *J* = 9.9, 8.1 Hz, 1H, H-2'''), 4.94-4.86 (m, 2H, 2xCH_2Ph), 4.85-4.78 (m, 3H, H-1, H-1'', CH_2Ph), 4.76-4.70 (m, 2H, H-1''', CH_2Ph), 4.67-4.60 (m, 2H, H-1', CH_2Ph), 4.55-4.28 (m, 12H, H-3, H-3'', 10xCH_2Ph), 4.24 (d, *J* = 11.8 Hz, 1H, CH_2Ph), 4.00-3.95 (m, 2H, H-3', H-4'), 3.83 (d, *J* = 3.0 Hz, 1H, H-4'''), 3.74-3.35 (m, 16H, H-2'', H-3', H-4, H-4'', H-5, H-5', H-5'', H-5''', H-6a, H-6b, H-6a', H-6b', H-6a'', H-6b'', H-6a''', H-6b'''), 3.31-3.22 (m, 1H, H-2), 2.51 (d, *J* = 8.6 Hz, 1H, O-H), 2.25 (s, 3H, $PhCH_3$); ^{13}C NMR (125 MHz, $CDCl_3$): δ 167.24 (C), 165.16 (C), 161.38 (C), 161.14 (C), 139.12 (C), 138.43 (C), 138.24 (C), 138.19 (C), 138.13 (C), 138.09 (C), 137.70 (C), 133.53 (CH), 133.46 (CH), 132.97 (CH), 130.11 (CH), 129.98 (C), 129.78 (CH), 129.63 (C), 129.0 (C), 128.77 (CH), 128.67 (CH), 128.63 (CH), 128.59 (CH), 128.56 (CH), 128.54 (CH), 128.46 (CH), 128.32 (CH), 128.28 (CH), 128.20 (CH), 128.16 (CH), 128.05 (CH), 128.03 (CH), 127.93 (CH), 127.87 (CH), 127.72 (CH), 127.67 (CH), 127.63 (CH), 127.45 (CH), 100.49 (CH), 99.68 (CH), 99.51 (CH), 92.80 (C), 92.51 (C), 84.81 (CH), 78.86 (CH), 77.63 (CH), 77.31 (CH), 76.84 (CH), 76.78 (CH), 76.54 (CH), 76.28 (CH), 75.97 (CH), 75.69 (CH_2), 75.20 (CH), 75.11 (CH_2), 74.89 (CH_2), 74.83 (CH_2), 74.56 (CH), 74.23 (CH), 73.62 (CH_2), 73.50 (CH_2), 73.44 (CH), 72.81 (CH), 69.37 (CH_2), 69.08 (CH_2), 68.62 (CH_2), 68.25 (CH_2), 59.07 (CH), 57.13 (CH), 21.27 (CH_3); HRMS (ESI-TOF): *m/z* calcd for $C_{105}H_{105}Cl_6N_2O_{22}S$ $[M + H]^+$, 1991.4995; found, 1991.4990.

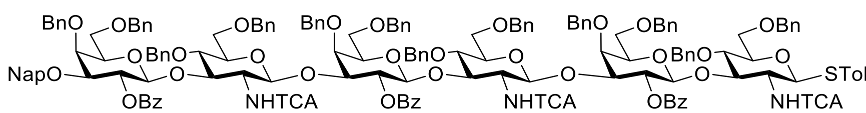
2-Trichloromethyl-3-*O*-(2-*O*-benzoyl-4,6-di-*O*-benzyl-3-*O*-(naphthalen-2-ylmethyl)-*β*-D-galactopyranosyl)-(1→3)-(4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranosyl)-(1→3)-(2-*O*-benzoyl-4,6-di-*O*-benzyl-*β*-D-galactopyranosyl)-4,6-di-*O*-benzyl-1,2-dideoxy-*α*-D-glucopyrano-[2,1-d]-2-oxazoline (9).



The crude reaction mixture (from Table S5) was subjected to column chromatography on silica gel with EtOAc/toluene (1/13 to 1/8, v/v) to yield the pure **9** as white amorphous foam. R_f 0.38 (EtOAc/toluene = 1/8, v/v, run two times); $[\alpha]^{20}_D$ -6.35 (*c* 2.05, $CHCl_3$); ^1H NMR (500 MHz, $CDCl_3$): δ 7.99-7.90 (m, 4H, Ar-H), 7.72 (d, *J* = 7.7 Hz, 1H, Ar-H), 7.58-7.46 (m, 5H, Ar-H), 7.46-7.35 (m, 4H, Ar-H), 7.35-7.31 (m, 5H, Ar-H), 7.31-7.27 (m, 9H, Ar-H), 7.27-7.25 (m, 3H, Ar-H), 7.25-7.24 (m, 3H, Ar-H), 7.24-7.23 (m, 4H, Ar-H), 7.21-7.16 (m, 12H, Ar-H), 7.15-7.11 (m, 5H, Ar-H), 7.10-7.05 (m, 2H, Ar-H), 6.56 (d, *J* = 7.6 Hz, 1H, N-H), 5.68-5.60 (m, 2H, H-1, H-2'''), 5.44 (dd, *J* = 10.0, 8.0 Hz, 1H, H-2'), 5.03 (d, *J* = 11.5 Hz, 1H, CH_2Ph), 4.94 (d, *J* = 10.3 Hz, 1H,

CH_2Ph), 4.82 (d, *J* = 8.1 Hz, 1H, H-1''), 4.77-4.71 (m, 2H, CH_2Ph, CH_2 group of Nap), 4.65-4.24 (m, 18H, H-1', H-1''', H-3, H-3'', CH_2 group of Nap, 13xCH_2Ph), 4.05 (dd, *J* = 7.3, 1.7 Hz, 1H, H-2), 4.01 (d, *J* = 2.5 Hz, 1H, H-4'), 3.99 (d, *J* = 2.1 Hz, 1H, H-4'''), 3.94 (dd, *J* = 10.2, 2.8 Hz, 1H, H-3'), 3.73 (d, *J* = 10.3, 1.9 Hz, 1H, H-6a''), 3.68-3.59 (m, 3H, H-4, H-5', H-6b''), 3.54-3.36 (m, 11H, H-3''', H-4'', H-5, H-5'', H-5''', H-6a, H-6b, H-6a', H-6b', H-6a''', H-6b'''), 3.10 (dd, *J* = 16.4, 8.2 Hz, 1H, H-2''); ^{13}C NMR (125 MHz, CDCl3): δ 165.69 (C), 164.94 (C), 162.85 (C), 161.22 (C), 138.97 (C), 138.79 (C), 138.19 (C), 138.15 (C), 137.95 (C), 137.91 (C), 137.82 (C), 134.92 (C), 133.60 (CH), 133.32 (CH), 133.17 (C), 133.11 (C), 130.02 (CH), 129.91 (CH), 128.78 (CH), 128.70 (CH), 128.61 (CH), 128.57 (CH), 128.48 (CH), 128.41 (CH), 128.32 (CH), 128.24 (CH), 128.16 (CH), 128.08 (CH), 127.98 (CH), 127.94 (CH), 127.91 (CH), 127.88 (CH), 127.86 (CH), 127.77 (CH), 127.74 (CH), 127.68 (CH), 127.56 (CH), 126.91 (CH), 126.26 (CH), 126.14 (CH), 125.97 (CH), 104.16 (CH), 100.97 (CH), 100.38 (CH), 99.28 (CH), 92.34 (C), 86.47 (C), 79.48 (CH), 78.25 (CH), 76.74 (CH), 76.40 (CH), 76.22 (CH), 75.45 (CH), 75.07 (CH_2), 75.02 (CH_2), 74.97 (CH_2), 74.68 (CH), 74.15 (CH), 73.75 (CH), 73.67 (CH_2), 73.62 (CH_2), 73.33 (CH_2), 73.07 (CH), 72.36 (CH), 72.15 (CH), 71.95 (CH_2), 71.62 (CH_2), 71.23 (CH), 69.74 (CH_2), 69.44 (CH_2), 68.90 (CH_2), 68.23 (CH_2), 66.28 (CH), 59.45 (CH); HRMS (ESI-TOF): *m/z* calcd for $C_{109}H_{105}Cl_6N_2O_{22}$ $[M + H]^+$, 2007.5277; found, 2007.5284.

4-Methylphenyl (2-*O*-benzoyl-4,6-di-*O*-benzyl-3-*O*-(naphthalen-2-ylmethyl)-*β*-D-galactopyranosyl)-(1→3)-(4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranosyl)-(1→3)-(2-*O*-benzoyl-4,6-di-*O*-benzyl-*β*-D-galactopyranosyl)-(1→3)-(4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranosyl)-(1→3)-(2-*O*-benzoyl-4,6-di-*O*-benzyl-*β*-D-galactopyranosyl)-(1→3)-4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-1-thio-*β*-D-glucopyranoside (10).



10

Synthesis of hexasaccharide 10 by [4 + 2] glycosylation between tetrasaccharide oxazoline 9 and thioglycoside disaccharide acceptor 5 (Scheme 2)

A mixture of tetrasaccharide oxazoline donor **9** (59.8 mg, 0.03 mmol) and disaccharide acceptor **5** (29 mg, 0.027 mmol) was stirred with 3 Å molecular sieves (90 mg) in anhydrous CH_2Cl_2 (550 μL) for 30 min at RT under N_2 atmosphere. After cooling the reaction mixture to -60 °C for about 25 min, 10 μL of diluted TMSOTf (0.0054 mmol) solution in CH_2Cl_2 was then added, and reaction mixture was allowed to continuously stir at -60 °C for 2.5 h. Reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), filtered, and washed with saturated $NaHCO_3$ solution (10 mL). CH_2Cl_2 layer was collected, dried over $MgSO_4$, filtered, and concentrated by evaporation to yield pale yellow crude that was subjected to column chromatography on silica gel with EtOAc/hexanes (1/4, v/v) to yield the pure hexasaccharide **10** (63.6 mg, 77%) as white amorphous foam.

Synthesis of hexasaccharide 10 by [2 + 4] glycosylation between disaccharide oxazoline 2 and thioglycoside tetrasaccharide acceptor 8a (Scheme 2)

A mixture of disaccharide oxazoline donor **2** (24 mg, 0.022 mmol) and tetrasaccharide acceptor **8a** (40 mg, 0.020 mmol) was stirred with 3 Å molecular sieves (64 mg) in anhydrous CH_2Cl_2 (402 μL) for 30 min at RT under N_2 atmosphere. After cooling the reaction mixture to -60 ºC for about 25 min, 10 μL of diluted TMSOTf (0.004 mmol) solution in CH_2Cl_2 was then added, and reaction mixture was allowed to continuously stir at -60 ºC for 2.5 h. Reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), filtered, and washed with saturated $NaHCO_3$ solution (10 mL). CH_2Cl_2 layer was collected, dried over $MgSO_4$, filtered, and concentrated by evaporation to yield pale yellow crude that was subjected to column chromatography on silica gel with EtOAc/hexanes (1/4, v/v) to yield the pure hexasaccharide **10** (46.6 mg, 76%) as white amorphous foam.

Synthesis of hexasaccharide 10 by [2 + 2 + 2] iterative glycosylation (Scheme 3)

*Synthesis of disaccharide oxazoline **2** (Step I)*

A solution of disaccharide **1** (80 mg, 0.067 mmol) in dry CH_2Cl_2 (1.11 mL) was stirred with 3 Å powdered molecular sieves (160 mg) at RT under N_2 for 30 min. NIS (18.03 mg, 0.08 mmol) and TMSOTf (2.42 μL, 0.013 mmol) were sequentially added to the reaction mixture after cooling to -50 °C. The reaction was quenched after 15 min by dropwise addition of Et_3N (4.84 μL) at -50 °C, diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed sequentially with saturated $Na_2S_2O_3$ solution (10 mL) and saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, and filtered. Then silica (230-400 mesh size, 320 mg) was added to the crude in CH_2Cl_2, and dried by evaporation under rota vapor. The crude silica residue was washed sequentially with hexanes (30 mL, to remove Tol-S-S-Tol impurity) and EtOAc (40 mL, to elute the crude product) using filter paper. EtOAc fraction was collected and concentrated by evaporation to yield the pale yellow crude disaccharide oxazoline **2**.

*[2 + 2] glycosylation and synthesis of tetrasaccharide oxazoline **9** (Steps II & III)*

A mixture of crude oxazoline **2** and acceptor **5** (59 mg, 0.056 mmol) was stirred with 3 Å molecular sieves (139 mg) in anhydrous CH_2Cl_2 (1.11 mL) for 30 min at RT under N_2 atmosphere. After cooling the reaction mixture to -50 ºC, TMSOTf (1 μL, 0.0056 mmol) was added. After stirring for 2 h 10 min, temperature was decreased to -60 ºC, and NIS (13.8 mg, 0.061 mmol) was added. After 1 h 45 min, reaction was quenched by dropwise addition of Et_3N (2 μL) at -60 ºC, and filtered. The filtrate was washed sequentially with saturated $Na_2S_2O_3$ solution (10 mL) and saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, and filtered. Then silica (230-400 mesh size, 560 mg) was added to the crude in CH_2Cl_2, and dried by evaporation under rota vapor. The crude silica residue was washed sequentially with hexanes (30 mL, to remove Tol-S-S-Tol impurity) and

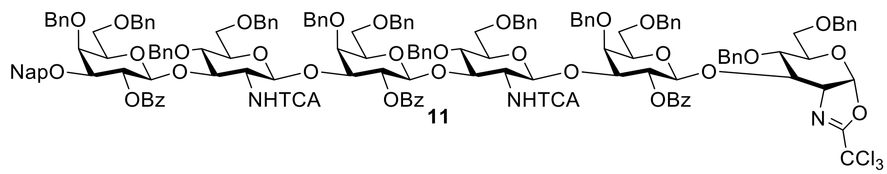
EtOAc (40 mL, to elute the crude product) using filter paper. EtOAc fraction was collected and concentrated by evaporation to yield the pale yellow crude tetrasaccharide oxazoline **9**.

*[4 + 2] glycosylation to synthesize hexasaccharide **10** (Step IV)*

A mixture of crude tetra oxazoline donor **9** and disaccharide acceptor **5** (59 mg, 0.056 mmol) was stirred with 3 Å molecular sieves (144 mg) in anhydrous CH_2Cl_2 (1.11 mL) for 30 min at RT under N_2 atmosphere. After cooling the reaction mixture to -60 °C for 25 min, 10 µL of diluted TMSOTf (0.008 mmol) solution in CH_2Cl_2 was then added, and reaction mixture was allowed to continuously stir at -60 °C. After 1 h, temperature was increased from -60 °C to -50 °C, and reaction was allowed to stir for another 1.5 h. Reaction was quenched by dropwise addition of Et_3N (3 µL), diluted with CH_2Cl_2 (5 mL), filtered, and washed with saturated $NaHCO_3$ solution (10 mL). CH_2Cl_2 layer was collected, dried over $MgSO_4$, filtered, and concentrated by evaporation to yield pale yellow crude that was subjected to column chromatography on silica gel with EtOAc/hexanes (1/4, v/v) to yield the pure hexasaccharide **10** (78.1 mg, 47% yield over 4 steps) as white amorphous foam.

R_f 0.22 (EtOAc/hexanes = 1/3, v/v, run two times); $[\alpha]^{20}_D$ -24.64 (*c* 1.38, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.94 (d, *J* = 7.6 Hz, 2H, Ar-H), 7.92-7.87 (m, 4H, Ar-H), 7.70 (d, *J* = 7.7 Hz, 1H, Ar-H), 7.56-7.46 (m, 4H, Ar-H), 7.45-7.38 (m, 3H, Ar-H), 7.38-7.33 (m, 2H, Ar-H), 7.33-7.29 (m, 8H, Ar-H), 7.28-7.22 (m, 21H, Ar-H), 7.22-7.13 (m, 29H, Ar-H), 7.12-7.10 (m, 4H, Ar-H), 7.09-7.03 (m, 6H, Ar-H), 6.89 (d, *J* = 7.8 Hz, 2H, Ar-H), 6.76 (d, *J* = 7.4 Hz, 1H, N-H), 6.60 (d, *J* = 7.5 Hz, 1H, N-H), 6.55 (d, *J* = 7.6 Hz, 1H, N-H), 5.61 (t, *J* = 9.0 Hz, 1H, H-2’’’’’), 5.53-5.42 (m, 2H, H-2’, H-2’’’), 5.02 (d, *J* = 11.5 Hz, 1H, CH_2Ph), 4.93-4.80 (m, 4H, H-1, 3xCH_2Ph), 4.77-4.66 (m, 5H, H-1’’, H-1’’’’, CH_2 group of Nap, 2xCH_2Ph), 4.63-4.15 (m, 25H, H-1’, H-1’’’, H-1’’’’’, H-3, H-3’’, H-3’’’’, CH_2 group of Nap, 18xCH_2Ph), 3.97-3.86 (m, 4H, H-3’’’, H-4’, H-4’’’, H-4’’’’’), 3.83 (d, *J* = 10.2 Hz, 1H, H-3’), 3.74-3.31 (m, 22H, H-3’’’’’, H-4, H-4’’, H-4’’’’, H-5, H-5’, H-5’’, H-5’’’, H-5’’’’, H-5’’’’’, H-6a, H-6b, H-6a’, H-6b’, H-6a’’, H-6b’’, H-6a’’’, H-6b’’’, H-6a’’’’, H-6b’’’’, H-6a’’’’’, H-6b’’’’’), 3.27-3.10 (m, 3H, H-2’’, H-2, H-2’’’’), 2.24 (s, 3H, $PhCH_3$); ^{13}C NMR (125 MHz, $CDCl_3$): δ 165.72 (C), 165.29 (C), 165.11 (C), 161.13 (C), 139.13 (C), 139.10 (C), 138.74 (C), 138.44 (C), 138.21 (C), 138.12 (C), 137.93 (C), 137.88 (C), 134.91 (C), 133.44 (CH), 133.19 (CH), 133.15 (C), 133.09 (C), 133.00 (CH), 130.03 (CH), 129.86 (C), 129.79 (CH), 128.96 (C), 128.76 (CH), 128.70 (CH), 128.60 (CH), 128.55 (CH), 128.47 (CH), 128.40 (CH), 128.34 (CH), 128.28 (CH), 128.19 (CH), 128.11 (CH), 128.04 (CH), 128.00 (CH), 127.93 (CH), 127.89 (CH), 127.82 (CH), 127.76 (CH), 127.68 (CH), 127.61 (CH), 127.47 (CH), 127.38 (CH), 126.88 (CH), 126.24 (CH), 126.12 (CH), 125.94 (CH), 100.58 (CH), 100.35 (CH), 100.16 (CH), 99.33 (CH), 99.27 (CH), 92.78 (C), 92.54 (C), 92.41 (C), 84.74 (CH), 79.48 (CH), 78.87 (CH), 77.47 (CH), 77.35 (CH), 76.85 (CH), 76.69 (CH), 76.30 (CH), 76.20 (CH), 75.99 (CH), 75.26 (CH), 75.15 (CH), 75.03 (CH_2), 75.01 (CH_2), 74.94 ((CH_2), 74.91 (CH_2), 74.86 (CH_2), 74.21 (CH), 73.94 (CH), 73.80 (CH), 73.66 (CH_2), 73.61 (CH_2), 73.51 (CH_2), 73.49 (CH_2), 73.44 (CH_2), 73.15 (CH), 72.80 (CH), 72.76 (CH), 72.09 (CH), 71.98 (CH_2), 69.36 (CH_2), 69.07 (CH_2), 69.02 (CH_2), 68.60 (CH_2), 68.58 (CH_2), 68.46 (CH_2) , 59.17 (CH), 59.06 (CH), 57.25 (CH), 21.27 (CH_3); HRMS (ESI-TOF): *m/z* calcd for $C_{165}H_{160}Cl_9N_3O_{33}SNa$ $[M + Na]^+$, 3086.7752; found, 3086.7692.

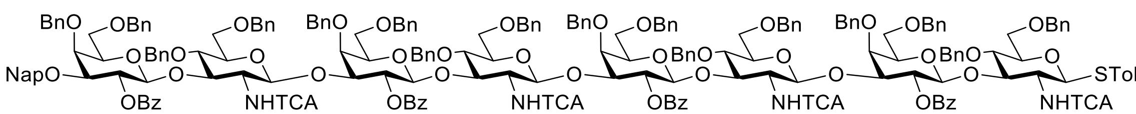
2-Trichloromethyl-3-*O*-(2-*O*-benzoyl-4,6-di-*O*-benzyl-3-*O*-(naphthalen-2-ylmethyl)-*β*-D-galactopyranosyl)-(1→3)-(4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranosyl)-(1→3)-(2-*O*-benzoyl-4,6-di-*O*-benzyl-*β*-D-galactopyranosyl)-(1→3)-(4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranosyl)-(1→3)-(2-*O*-benzoyl-4,6-di-*O*-benzyl-*β*-D-galactopyranosyl)-4,6-di-*O*-benzyl-1,2-dideoxy-*α*-D-glucopyrano-[2,1-d]-2-oxazoline (11).



The crude reaction mixture (from Table S6) was subjected to column chromatography on silica gel with EtOAc/hexanes (1/5 to 1/3, v/v) to yield the pure hexasaccharide oxazoline **11** as white amorphous foam. R_f 0.32 (EtOAc/toluene = 1/8, v/v, run two times); $[\alpha]^{20}_D$ -20.7 (*c* 1.74, $CHCl_3$); ^1H NMR (500 MHz, $CDCl_3$): δ 7.96-7.92 (m, 3H, Ar-H), 7.92-7.89 (m, 3H, Ar-H), 7.71 (d, J = 7.8 Hz, 1H, Ar-H), 7.55 (d, J = 8.0 Hz, 1H, Ar-H), 7.53-7.50 (m, 2H, Ar-H), 7.50-7.46 (m, 1H, Ar-H), 7.45-7.42 (m, 1H, Ar-H), 7.42-7.38 (m, 3H, Ar-H), 7.38-7.34 (m, 3H, Ar-H), 7.34-7.30 (m, 6H, Ar-H), 7.29-7.28 (m, 5H, Ar-H), 7.28-7.26 (m, 6H, Ar-H), 7.26-7.24 (m, 13H, Ar-H), 7.23-7.22 (m, 2H, Ar-H), 7.22-7.21 (m, 1H, Ar-H), 7.21-7.19 (m, 3H, Ar-H), 7.19-7.18 (m, 5H, Ar-H), 7.18-7.17 (m, 2H, Ar-H), 7.17-7.14 (m, 8H, Ar-H), 7.14-7.13 (m, 4H, Ar-H), 7.13-7.11 (m, 3H, Ar-H), 7.11-7.10 (m, 2H, Ar-H), 7.08-7.07 (m, 1H, Ar-H), 7.07-7.03 (m, 3H, Ar-H), 6.59 (d, J = 7.6 Hz, 1H, N-H), 6.49 (d, J = 7.9 Hz, 1H, N-H), 5.65-5.58 (m, 2H, H-1, H-2’’’’’), 5.49-5.39 (m, 2H, H-2’, H-2’’’), 5.02 (d, J = 11.4 Hz, 1H, CH_2Ph), 4.89 (d, J = 10.3 Hz, 1H, CH_2Ph), 4.86 (d, J = 10.4 Hz, 1H, CH_2Ph), 4.77 (d, J = 8.0 Hz, 1H, H-1’’), 4.75-4.67 (m, 4H, H-1’’’’, CH_2 group of Nap, 2xCH_2Ph), 4.64-4.23 (m, 25H, H-1’, H-1’’’, H-1’’’’’, H-3, H-3’’, H-3’’’’, CH_2 group of Nap, 18xCH_2Ph), 4.17 (d, J = 11.8 Hz, 1H, CH_2Ph), 4.04 (dd, J = 7.1, 1.8 Hz, 1H, H-2), 3.97-3.92 (m, 3H, H-3’, H-4’, H-4’’’’’), 3.91-3.88 (m, 1H, H-4’’’), 3.84 (dd, J = 10.3, 2.5 Hz, 1H, H-3’’’), 3.71-3.31 (m, 22H, H-3’’’’’, H-4, H-4’’, H-4’’’’, H-5, H-5’, H-5’’, H-5’’’, H-5’’’’, H-5’’’’’, H-6a, H-6b, H-6a’, H-6b’, H-6a’’, H-6b’’, H-6a’’’, H-6b’’’, H-6a’’’’, H-6b’’’’, H-6a’’’’’, H-6b’’’’’), 3.21-3.14 (m, 1H, H-2’’’’), 3.10-3.02 (m, 1H, H-2’’); ^{13}C NMR (125 MHz, $CDCl_3$): δ 165.72 (C), 165.30 (C), 164.92 (C), 162.88 (C), 161.23 (C), 161.11 (C), 139.18 (C), 138.92 (C), 138.78 (C), 138.23 (C), 138.19 (C), 138.16 (C), 137.99 (C), 137.93 (C), 137.85 (C), 134.95 (C), 133.63 (CH), 133.56 (CH), 133.22 (CH), 133.18 (C), 133.11 (C), 130.03 (CH), 129.90 (CH), 128.82 (CH), 128.79 (CH), 128.71 (CH), 128.63 (CH), 128.58 (CH), 128.55 (CH), 128.50 (CH), 128.42 (CH), 128.33 (CH), 128.28 (CH), 128.24 (CH), 128.20 (CH), 128.12 (CH), 128.08 (CH), 128.02 (CH), 127.99 (CH), 127.91 (CH), 127.84 (CH), 127.78 (CH), 127.75 (CH), 127.70 (CH), 127.63 (CH), 127.40 (CH), 126.90 (CH), 126.26 (CH), 126.13 (CH), 125.96 (CH), 104.18 (CH), 100.97 (CH), 100.53 (CH), 100.24 (CH), 99.26 (CH), 92.48 (C), 92.41 (C), 86.48 (C), 79.50 (CH), 78.04 (CH), 77.46 (CH), 76.87 (CH), 76.46 (CH), 76.38 (CH), 76.28 (CH), 76.23 (CH), 75.48 (CH), 75.18 (CH), 75.16 (CH), 75.09 (CH_2), 74.96 (CH_2), 74.90 (CH_2), 74.67 (CH), 74.16 (CH), 73.92 (CH), 73.78 (CH), 73.69 (CH_2), 73.64 (CH_2), 73.61 (CH_2), 73.52 (CH_2) , 73.47 (CH_2), 73.34 (CH_2), 73.14 (CH), 72.82 (CH), 72.46 (CH), 72.12 (CH), 71.98 (CH_2), 71.65 (CH_2), 71.24 (CH), 69.75 (CH_2), 69.41 (CH_2), 69.03 (CH_2), 68.91 (CH_2), 68.42 (CH_2), 68.37 (CH_2), 66.29 (CH), 59.42 (CH), 59.18 (CH); HRMS (ESI-TOF): *m/z* calcd for $C_{158}H_{153}Cl_9N_3O_{33}$ $[M + H]^+$, 2940.7586; found, 2940.7446.

Synthesis of octasaccharide 12 by [2 + 2 + 2 + 2] iterative glycosylation (Scheme 3)

4-Methylphenyl (2-*O*-benzoyl-4,6-di-*O*-benzyl-3-*O*-(naphthalen-2-ylmethyl)-*β*-D-galactopyranosyl)-(1→3)-(4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranosyl)-(1→3)-(2-*O*-benzoyl-4,6-di-*O*-benzyl-*β*-D-galactopyranosyl)-(1→3)-(4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranosyl)-(1→3)-(2-*O*-benzoyl-4,6-di-*O*-benzyl-*β*-D-galactopyranosyl)-(1→3)-(4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranosyl)-(1→3)-(2-*O*-benzoyl-4,6-di-*O*-benzyl-*β*-D-galactopyranosyl)-(1→3)-4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-1-thio-*β*-D-glucopyranoside (12).



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*Synthesis of disaccharide oxazoline **2** (Step I)*

A solution of compound **1** (100 mg, 0.084 mmol) in dry CH_2Cl_2 (1.39 mL) was stirred with 3 Å powdered molecular sieves (200 mg) at RT under N_2 for 30 min. NIS (22.54 mg, 0.10 mmol) and TMSOTf (3.02 μL, 0.017 mmol) were sequentially added to the reaction mixture after cooling to -50 °C. The reaction was quenched after 15 min by dropwise addition of Et_3N (6 μL) at -50 °C, diluted with CH_2Cl_2 (10 mL), and filtered. The filtrate was washed sequentially with saturated $Na_2S_2O_3$ solution (10 mL) and saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, and filtered. Then silica (230-400 mesh size, 400 mg) was added to the crude in CH_2Cl_2, and dried by evaporation under rota vapor. The crude silica residue was washed sequentially with hexanes (50 mL, to remove Tol-S-S-Tol impurity) and EtOAc (60 mL, to elute the crude product) using filter paper. EtOAc fraction was collected and concentrated by evaporation to yield the pale yellow crude disaccharide oxazoline **2**.

*[2 + 2] glycosylation and synthesis of tetrasaccharide oxazoline **9** (Steps II & III)*

A mixture of crude oxazoline **2** and acceptor **5** (73.6 mg, 0.0696 mmol) was stirred with 3 Å molecular sieves (174 mg) in anhydrous CH_2Cl_2 (1.39 mL) for 30 min at RT under N_2 atmosphere. After cooling the reaction mixture to -50 ºC, TMSOTf (1.26 µL, 0.007 mmol) was added. After stirring for 2 h 10 min, temperature was decreased to -60 ºC, and NIS (17.22 mg, 0.077 mmol) was added. After 1 h 45 min, reaction was quenched by dropwise addition of Et_3N (2.6 µL) at -60 ºC, and filtered. The filtrate was washed sequentially with saturated $Na_2S_2O_3$ solution (10 mL) and saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, and filtered. Then silica (230-400 mesh size, 696 mg) was added to the crude in CH_2Cl_2, and dried by evaporation under rota vapor. The crude silica residue was washed sequentially with hexanes (50 mL, to remove Tol-S-S-Tol impurity) and EtOAc (60 mL, to elute the crude product) using filter paper. EtOAc fraction was collected and concentrated by evaporation to yield the pale yellow crude tetrasaccharide oxazoline **9**.

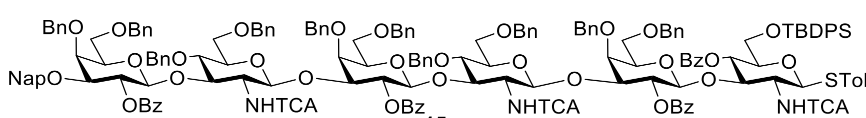
*[4 + 2] glycosylation and synthesis of hexasaccharide oxazoline **11** (Steps IV and V)*

A mixture of crude tetra oxazoline donor **9** and disaccharide acceptor **5** (73.6 mg, 0.0696 mmol) was stirred with 3 Å molecular sieves (180 mg) in anhydrous CH_2Cl_2 (1.39 mL) for 30 min at RT under N_2 atmosphere. After cooling the reaction mixture to -60 ºC for about 25 min, 10 µL of diluted TMSOTf (0.0097 mmol) solution in CH_2Cl_2 was then added, and reaction mixture was allowed to continuously stir at -60 ºC. After 1 h, temperature was increased from -60 ºC to -50 ºC, and reaction was allowed to stir for another 1.5 h. NIS (15.7 mg, 0.0696 mmol) was then added, and reaction was stirred for another 1 h. Reaction was quenched by dropwise addition of Et_3N (3.6 µL), diluted with CH_2Cl_2 (10 mL), and filtered. The filtrate was washed sequentially with saturated $Na_2S_2O_3$ solution (10 mL) and saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, and filtered. Then silica (230-400 mesh size, 1 g) was added to the crude in CH_2Cl_2, and dried by evaporation under rota vapor. The crude silica residue was washed sequentially with hexanes (50 mL, to remove Tol-S-S-Tol impurity) and EtOAc (60 mL, to elute the crude product) using filter paper. EtOAc fraction was collected and concentrated by evaporation to yield the pale yellow crude hexasaccharide oxazoline **11**.

*[6 + 2] glycosylation to synthesize type I LacNAc thioglycoside octasaccharide **12** (Step VI)*

A mixture of crude hexasaccharide oxazoline donor **11** and disaccharide acceptor **5** (73.6 mg, 0.0696 mmol) was stirred with 3 Å molecular sieves (154 mg) in anhydrous CH_2Cl_2 (1.39 mL) for 30 min at RT under N_2 atmosphere. After cooling the reaction mixture to -60 ºC for about 25 min, 10 µL of diluted TMSOTf (0.0055 mmol) solution in CH_2Cl_2 was then added, and reaction mixture was allowed to continuously stir at -60 ºC. After 1 h, temperature was increased from -60 ºC to -50 ºC, and reaction was allowed to stir for another 1 h before raising the temperature to -40 ºC. After 3.5 h, another aliquot of TMSOTf (0.0055 mmol) was added, and reaction was continuously stirred for 2 h more. Reaction was quenched by dropwise addition of Et_3N (4 µL), diluted with CH_2Cl_2 (10 mL), filtered, and washed with saturated $NaHCO_3$ solution (10 mL). CH_2Cl_2 layer was collected, dried over $MgSO_4$, filtered, and concentrated by evaporation to yield pale yellow crude that was subjected to column chromatography on silica gel with EtOAc/hexanes (1/5 to 1/3, v/v) to yield the pure octasaccharide **12** (70 mg, 26% yield over 6 steps) as white glassy solid. R_f 0.16 (EtOAc/hexanes = 1/3, v/v, run three times); $[\alpha]^{20}_D$ -26.67 (*c* 2.1, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.97-7.85 (m, 8H, Ar-H), 7.71 (d, J = 7.7 Hz, 1H, Ar-H), 7.56-7.47 (m, 4H, Ar-H), 7.44-7.34 (m, 6H, Ar-H), 7.29-7.21 (m, 36H, Ar-H), 7.21-7.12 (m, 38H, Ar-H), 7.11-7.02 (m, 16H, Ar-H), 6.93-6.85 (m, 2H, Ar-H), 6.66 (d, J = 7.4 Hz, 1H, N-H), 6.48-6.34 (m, 3H, N-H), 5.65-5.55 (m, 1H, H-2’’’’’’’), 5.54-5.38 (m, 3H, H-2’, H-2’’’, H-2’’’’’), 5.02 (d, J = 11.3 Hz, 1H, CH_2Ph), 4.90-4.75 (m, 6H, H-1, H-1’’, 4xCH_2Ph), 4.74-4.62 (m, 6H, H-1’’’’, H-1’’’’’’, 3xCH_2Ph, CH_2 group of Nap), 4.59-4.14 (m, 33H, H-1’, H-1’’’, H-1’’’’’, H-1’’’’’’’, H-3, H-3’’, H-3’’’’, H-3’’’’’’, CH_2 group of Nap, 24xCH_2Ph), 3.96 (s, 1H, H-4’’’’’’’), 3.92-3.86 (m, 3H, H-3’’’, H-4’, H-4’’’’’), 3.85-3.77 (m, 3H, H-3’, H-3’’’’’, H-4’’’), 3.72-3.26 (m, 29 H, H-3’’’’’’’, H-4, H-4’’, H-4’’’’, H-4’’’’’’, H-5, H-5’, H-5’’, H-5’’’, H-5’’’’, H-5’’’’’, H-5’’’’’’, H-5’’’’’’’, H-6a, H-6b, H-6a’, H-6b’, H-6a’’, H-6b’’, H-6a’’’, H-6b’’’, H-6a’’’’, H-6b’’’’, H-6a’’’’’, H-6b’’’’’, H-6a’’’’’’, H-6b’’’’’’, H-6a’’’’’’’, H-6b’’’’’’’), 3.19-3.09 (m, 2H, H-2, H-2’’’’), 3.08-2.96 (m, 2H, H-2’’, H-2’’’’’’), 2.24 (s, 3H, $PhCH_3$); ^{13}C NMR (125 MHz, $CDCl_3$): δ165.69 (C), 165.28 (C), 165.24 (C), 165.13 (C), 161.17 (C), 161.10 (C), 139.16 (C), 138.81 (C), 138.49 (C), 138.25 (C), 138.21 (C), 138.14 (C), 138.03 (C), 137.98 (C), 134.97 (C), 133.52 (CH), 133.46 (CH), 133.19 (CH), 133.10 (CH), 130.01 (CH), 129.93 (CH), 129.82 (CH), 128.69 (CH), 128.63 (CH), 128.56 (CH), 128.50 (CH), 128.42 (CH), 128.22 (CH), 128.11 (CH), 128.08 (CH), 127.94 (CH), 127.78 (CH), 127.69 (CH), 127.62 (CH), 127.51 (CH), 127.45 (CH), 127.39 (CH), 126.89 (CH), 126.25 (CH), 126.13 (CH), 125.96 (CH), 100.71 (CH), 100.56 (CH), 100.45 (CH), 100.28 (CH), 99.17 (CH), 99.05 (CH), 92.76 (C), 92.50 (C), 92.38 (C), 84.50 (CH), 79.51 (CH), 78.90 (CH), 77.48 (CH), 77.20 (CH), 76.86 (CH), 76.71 (CH), 76.68 (CH), 76.45 (CH), 76.30 (CH), 76.23 (CH), 76.05 (CH), 75.29 (CH), 75.19 (CH), 75.09 (CH_2), 75.06 (CH_2), 75.04 (CH_2), 74.96 (CH_2), 74.94 (CH_2), 74.86 (CH_2), 74.78 (CH_2), 74.16 (CH), 73.86 (CH), 73.74 (CH), 73.69 (CH_2), 73.62 (CH_2), 73.53 (CH_2), 73.48 (CH_2), 73.12 (CH), 72.81 (CH), 72.76 (CH), 72.12 (CH), 71.97 (CH_2), 69.39 (CH_2), 69.07 (CH_2), 69.03 (CH_2), 68.97 (CH_2), 68.44 (CH_2), 68.34 (CH_2), 68.32 (CH_2), 68.26 (CH_2), 59.46 (CH), 59.23 (CH), 57.38 (CH), 22.88 (C), 21.30 (CH_3); HRMS (ESI-TOF): *m/z* calcd for $C_{214}H_{208}Cl_{12}N_4O_{44}SNa_2$ $[M + 2Na]^{2+}$, 2017.4964; found, 2017.4961.

4-Methylphenyl (2-*O*-benzoyl-4,6-di-*O*-benzyl-3-*O*-(naphthalen-2-ylmethyl)-*β*-D-galactopyranosyl)-(1→3)-(4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranosyl)-(1→3)-(2-*O*-benzoyl-4,6-di-*O*-benzyl-*β*-D-galactopyranosyl)-(1→3)-(4,6-di-*O*-benzyl-2-deoxy-2-trichloroacetamido-*β*-D-glucopyranosyl)-(1→3)-(2-*O*-benzoyl-4,6-di-*O*-benzyl-*β*-D-galactopyranosyl)-(1→3)-4-*O*-benzoyl-6-*O*-*tert*-butyldiphenylsilyl-2-deoxy-2-trichloroacetamido-1-thio-*β*-D-glucopyranoside (15).



15

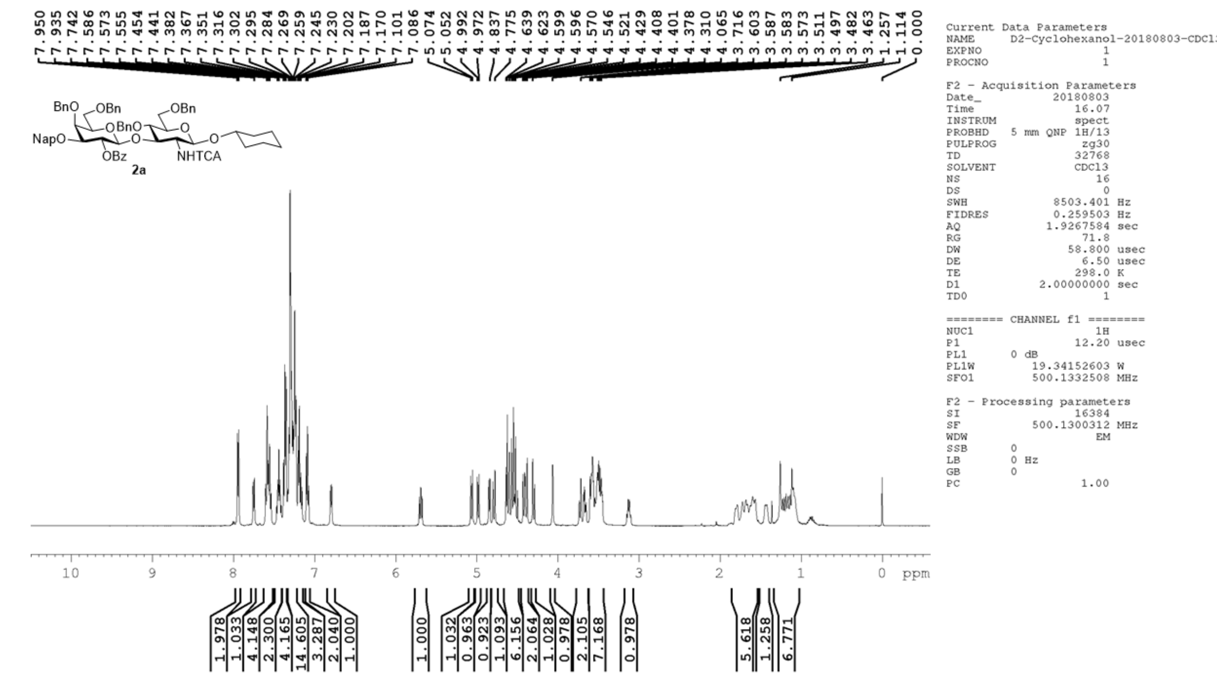
Tetrasaccharide donor **8** (60 mg, 0.028 mmol) was stirred with 3 Å molecular sieves (120 mg) in anhydrous CH_2Cl_2 (470 μL) at RT for 30 min. After cooling the reaction mixture to -60 °C, NIS (7.6 mg, 0.034 mmol) was added, and followed by the addition of TMSOTf (0.51 μL, 0.0028 mmol). After 1.5 h, reaction was quenched by dropwise addition of Et_3N (2 μL), diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed sequentially with saturated $Na_2S_2O_3$ solution (10 mL) and saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the crude tetrasaccharide oxazoline **9** as yellow foam.

Crude tetrasaccharide oxazoline **9** and acceptor **14**[1] (31 mg, 0.0256 mmol) were dried together under high vacuum. Added 3 Å molecular sieves (91 mg) and CH_2Cl_2 (512 μL), and stirred at RT under N_2 for 30 min. After cooling the reaction mixture to -60 °C, TMSOTf (0.93 μL, 0.0051 mmol) was added. After 1.5 h, temperature was raised to -50 °C. Then after stirring for more 2 h, reaction was quenched by dropwise addition of Et_3N, diluted with CH_2Cl_2 (5 mL), and filtered. The filtrate was washed with saturated $NaHCO_3$ solution (10 mL), dried over $MgSO_4$, filtered, and concentrated by evaporation to yield the pale-yellow residue that was purified by column chromatography on silica gel with EtOAc/hexanes (1/4, v/v) to yield pure hexasaccharide **15**[1] (53 mg, 65% over two steps) as white amorphous foam. R_f 0.17 (EtOAc/hexanes = 1/3, v/v). Spectroscopic data were identical to those reported previously.[1]

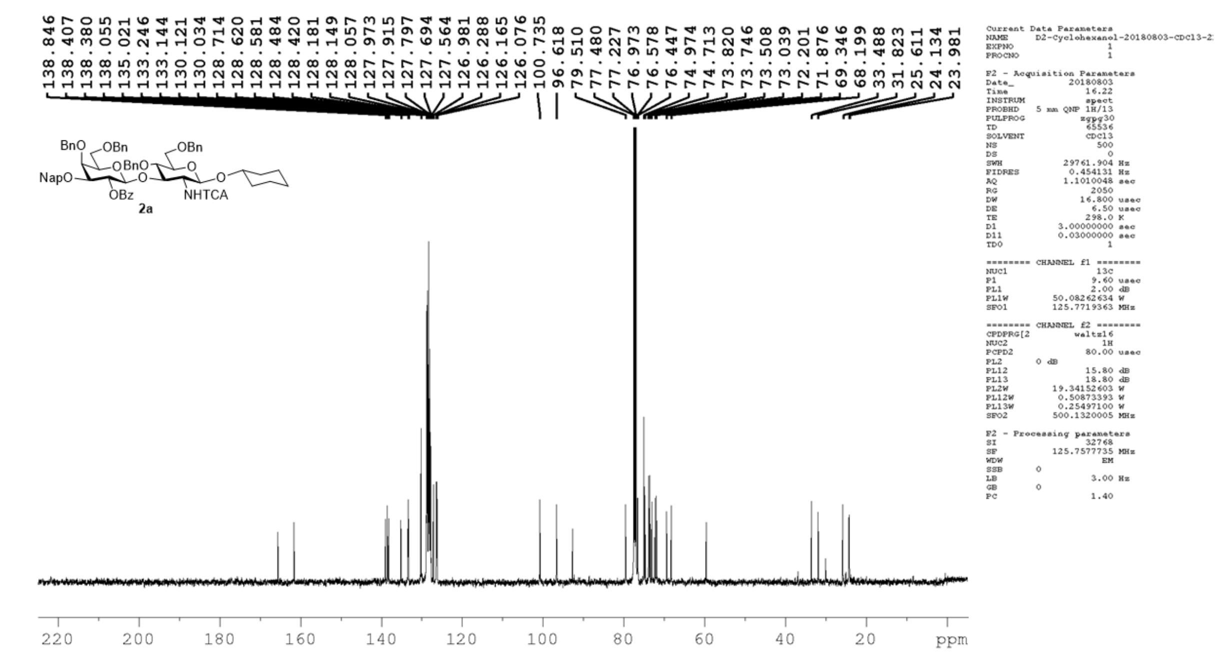
Reference

1. Verma, N.; Tu, Z.; Lu, M.-S.; Liu, S.-H.; Renata, S.; Phang, R.; Liu, P.-K.; Ghosh, B.; Lin, C.-H., *J. Org. Chem.* **2021**, *86*, 892-916.

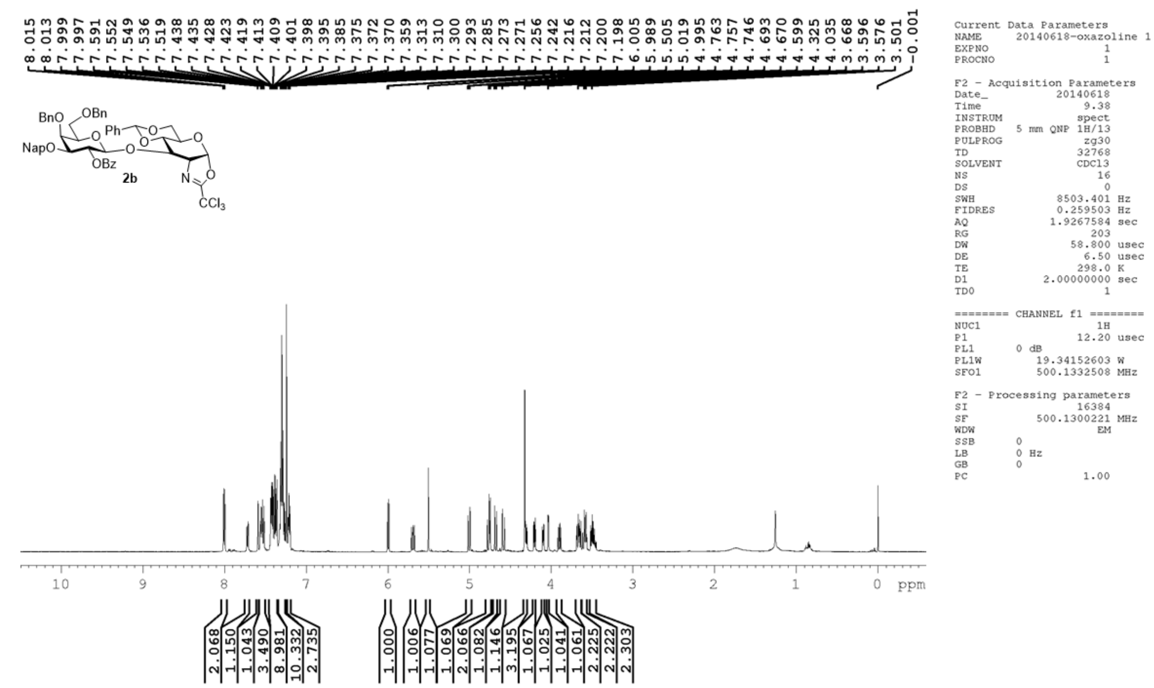
III. NMR Spectra



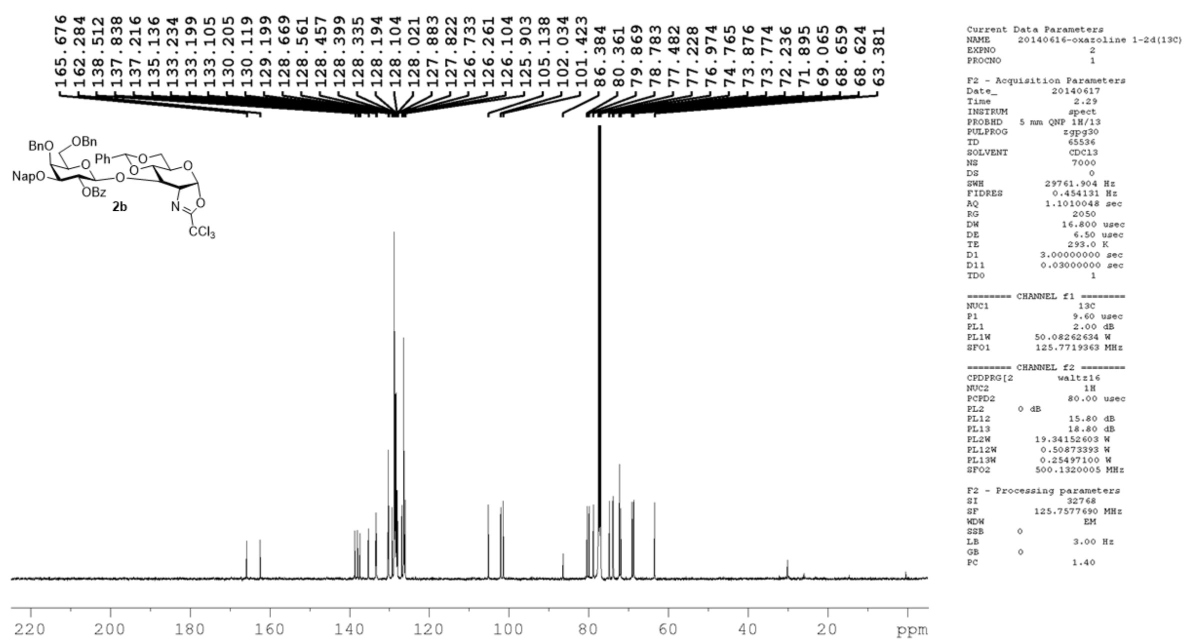
^1H NMR spectrum of compound **2a** (500 MHz, $CDCl_3$)



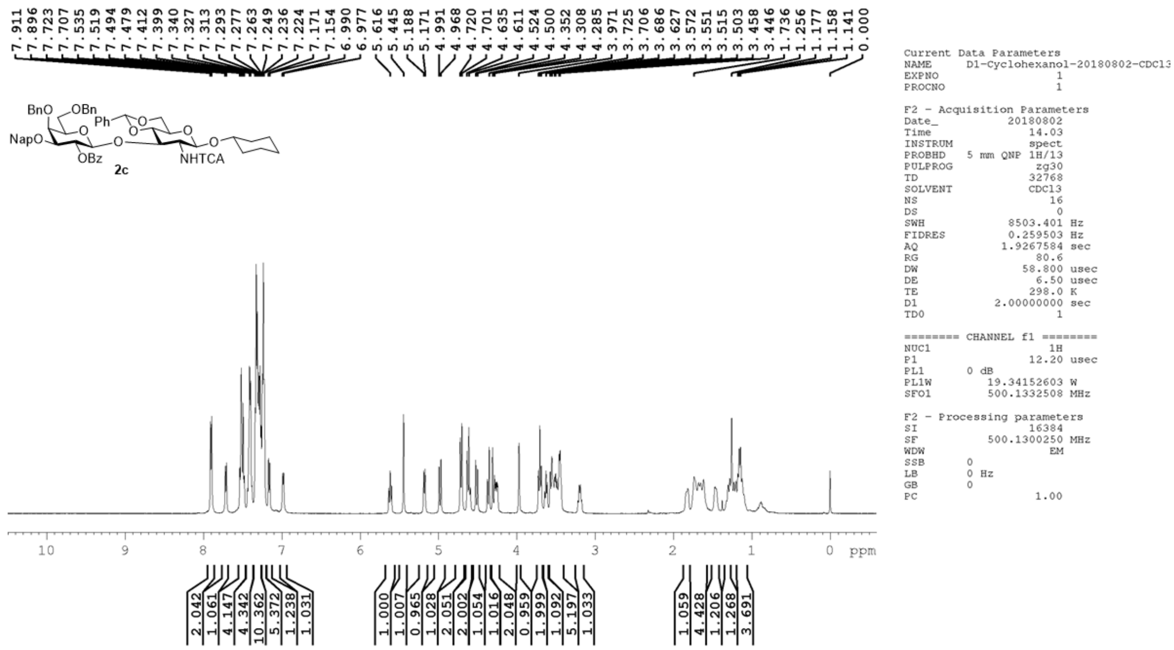
^{13}C NMR spectrum of compound **2a** (125 MHz, $CDCl_3$)



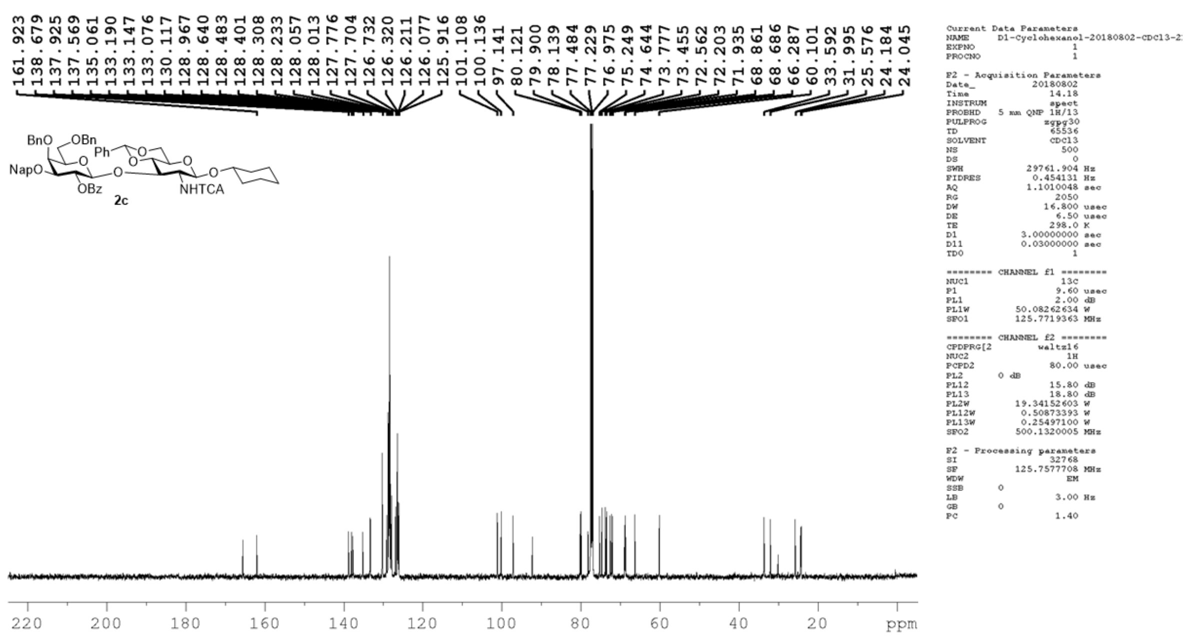
^{1}H NMR spectrum of compound **2b** (500 MHz, $CDCl_3$)



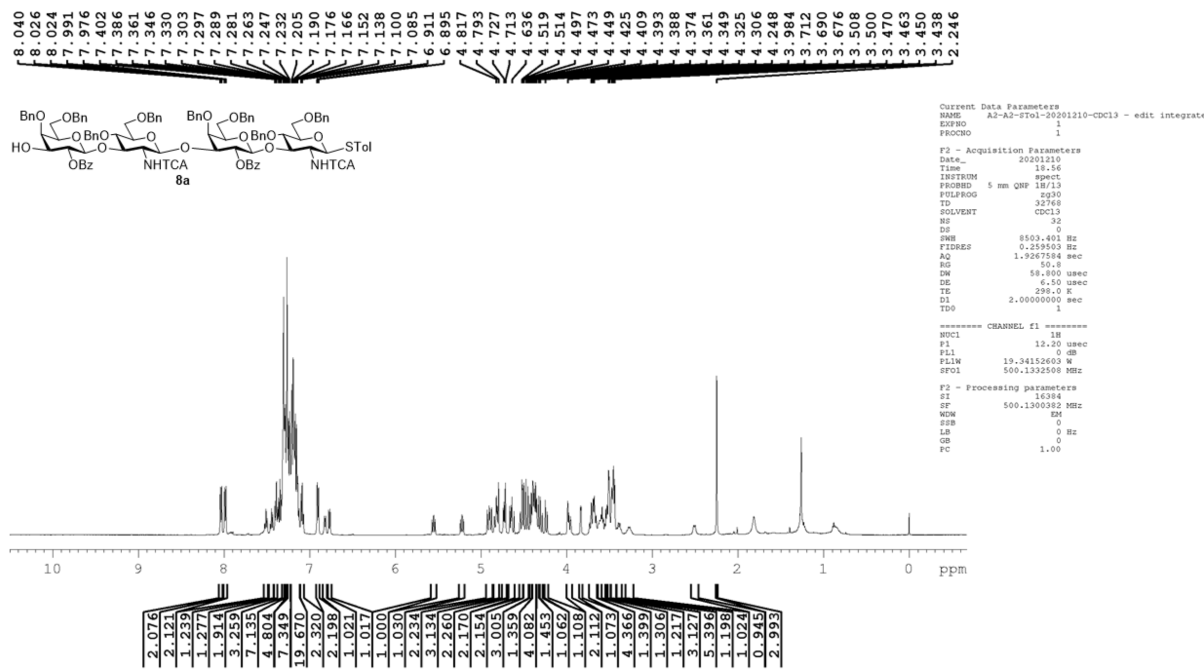
^{13}C NMR spectrum of compound **2b** (125 MHz, $CDCl_3$)



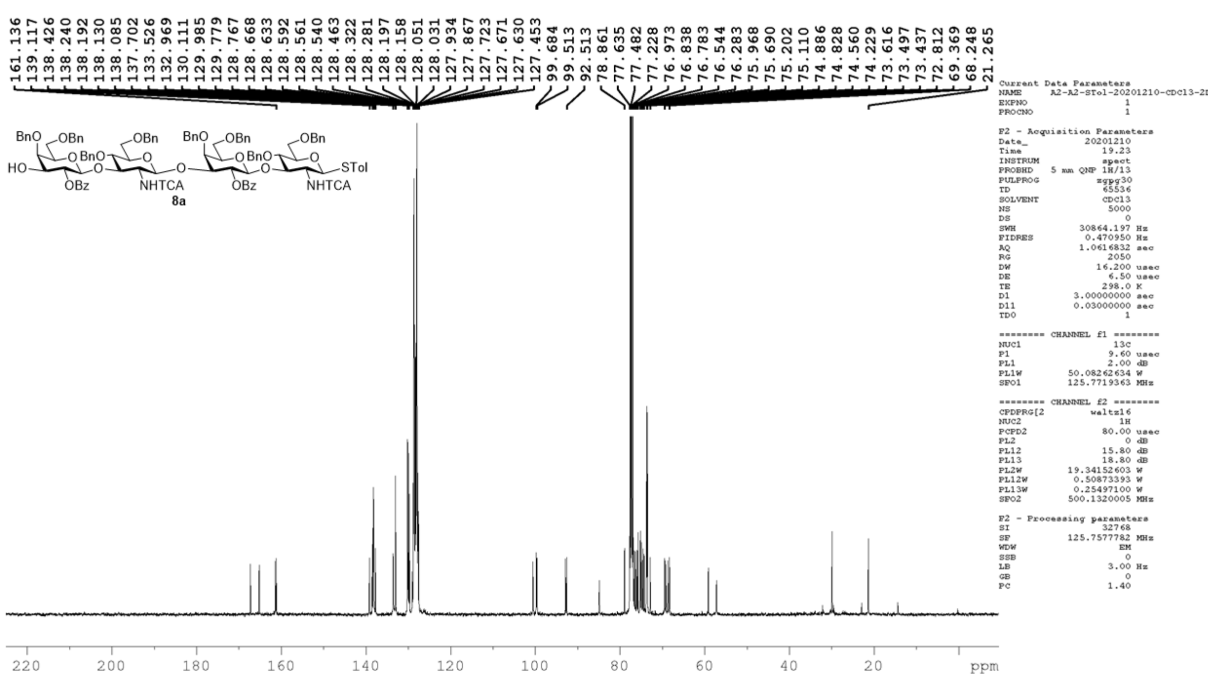
^{1}H NMR spectrum of compound **2c** (500 MHz, $CDCl_3$)



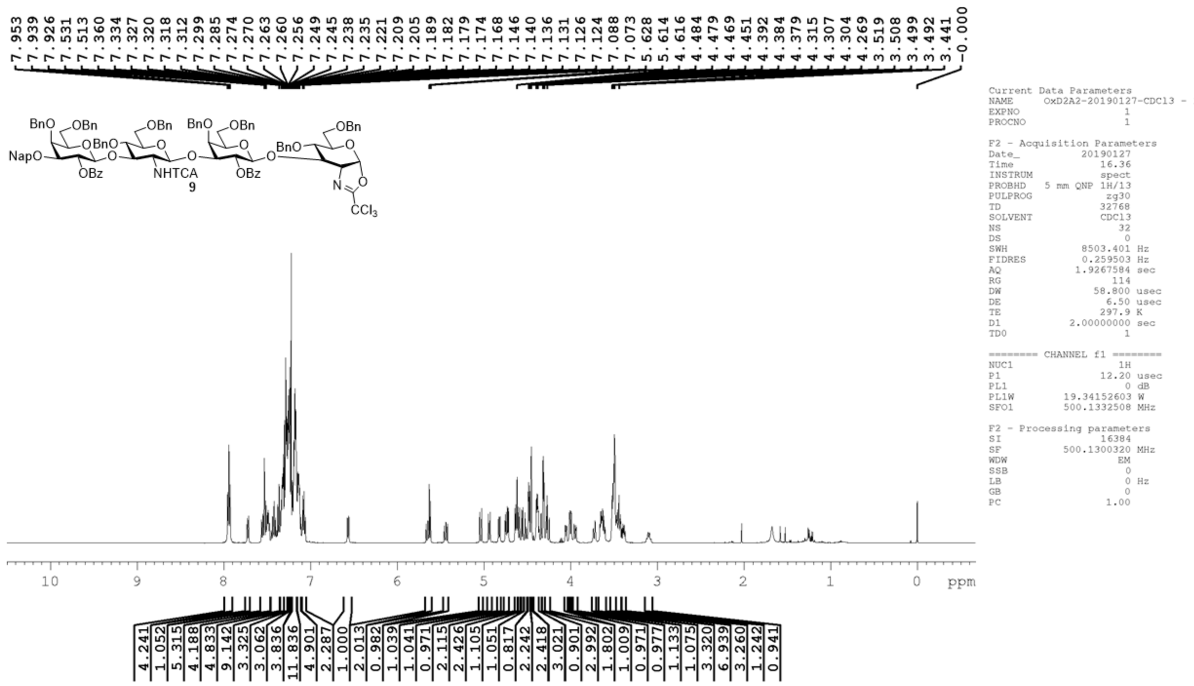
^{13}C NMR spectrum of compound **2c** (125 MHz, $CDCl_3$)



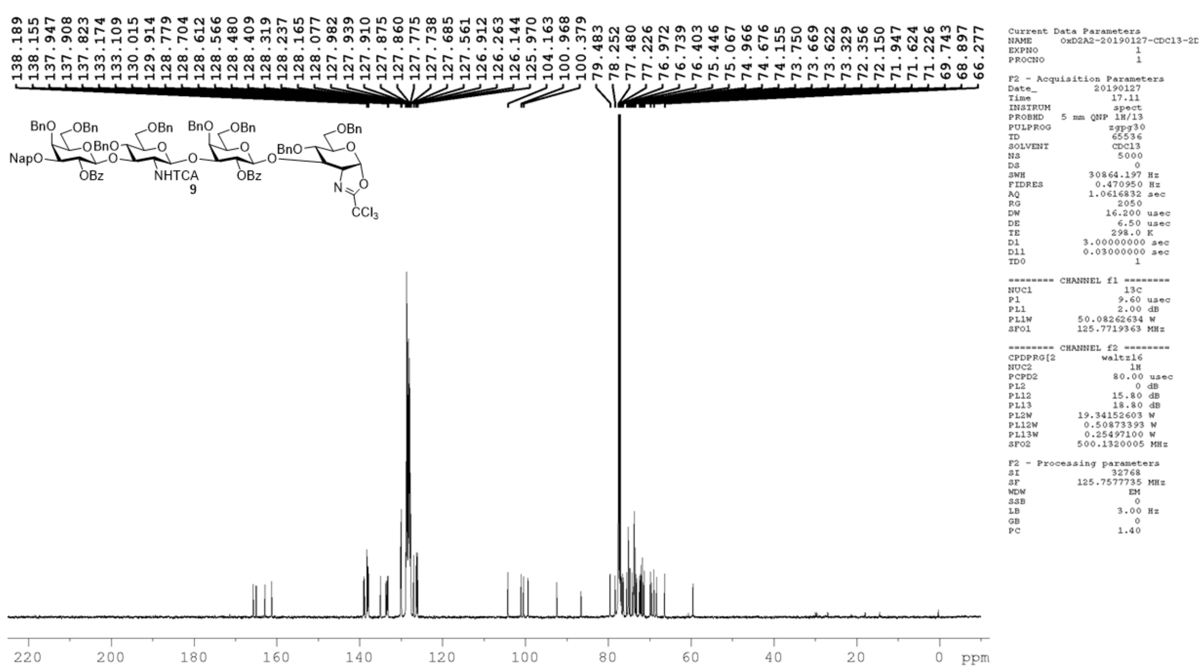
^{1}H NMR spectrum of compound **8a** (500 MHz, $CDCl_3$)



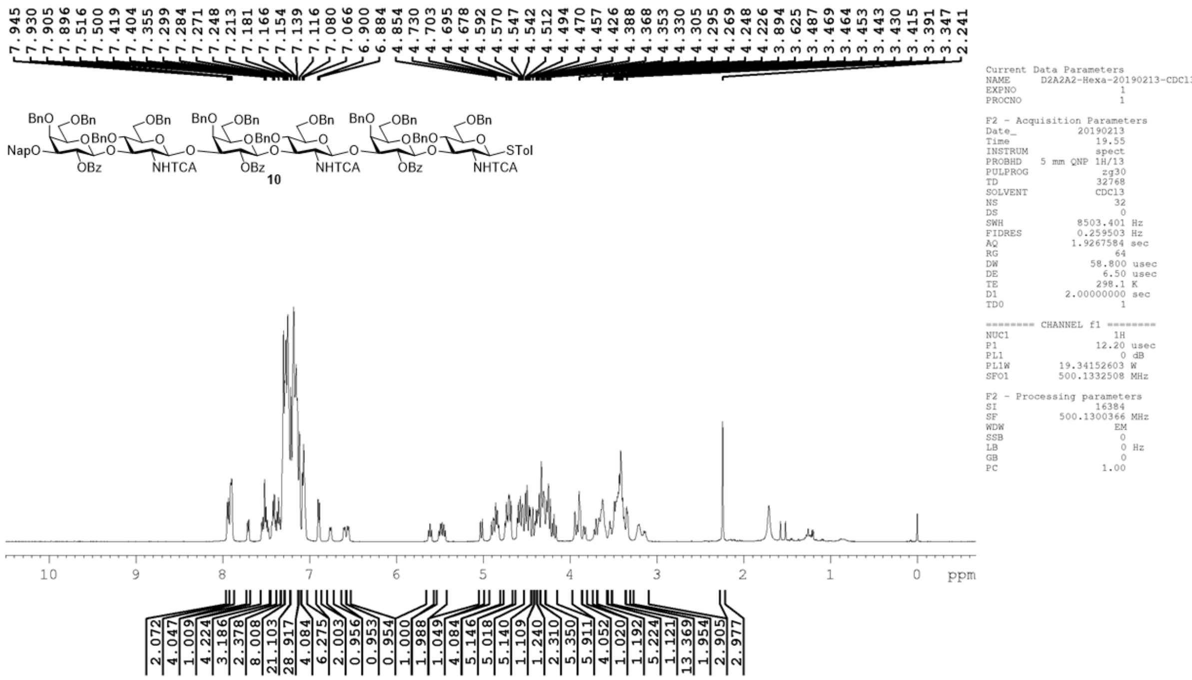
^{13}C NMR spectrum of compound **8a** (125 MHz, $CDCl_3$)



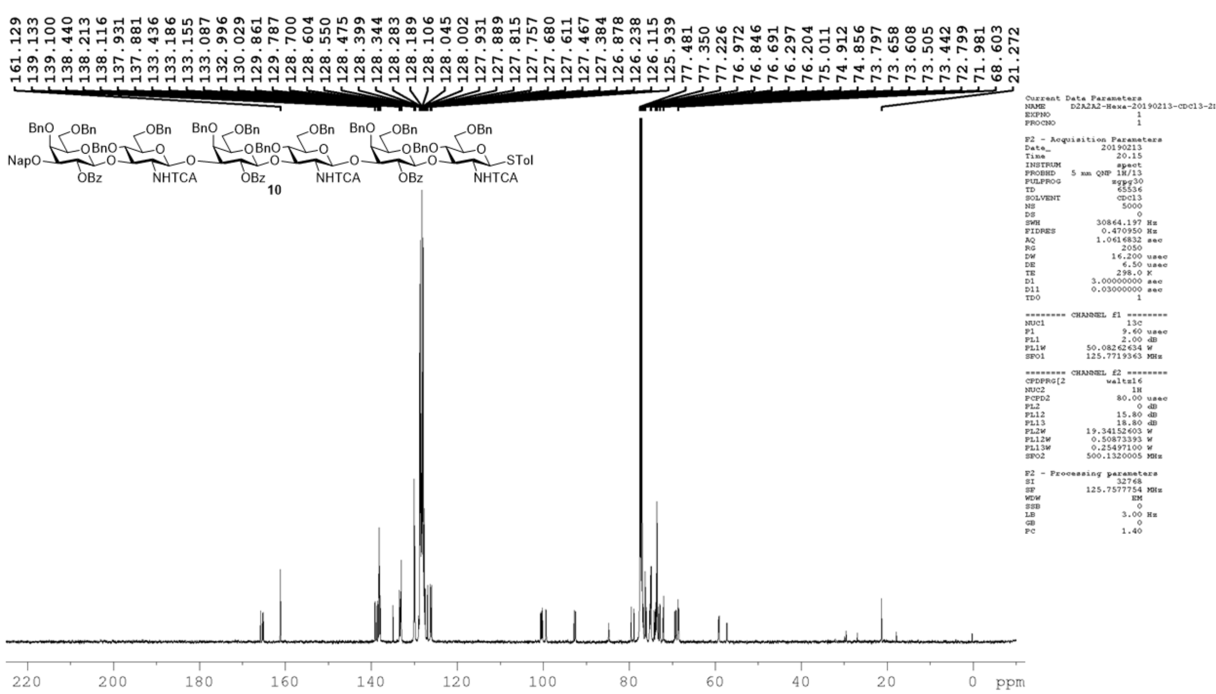
^{1}H NMR spectrum of compound **9** (500 MHz, $CDCl_3$)



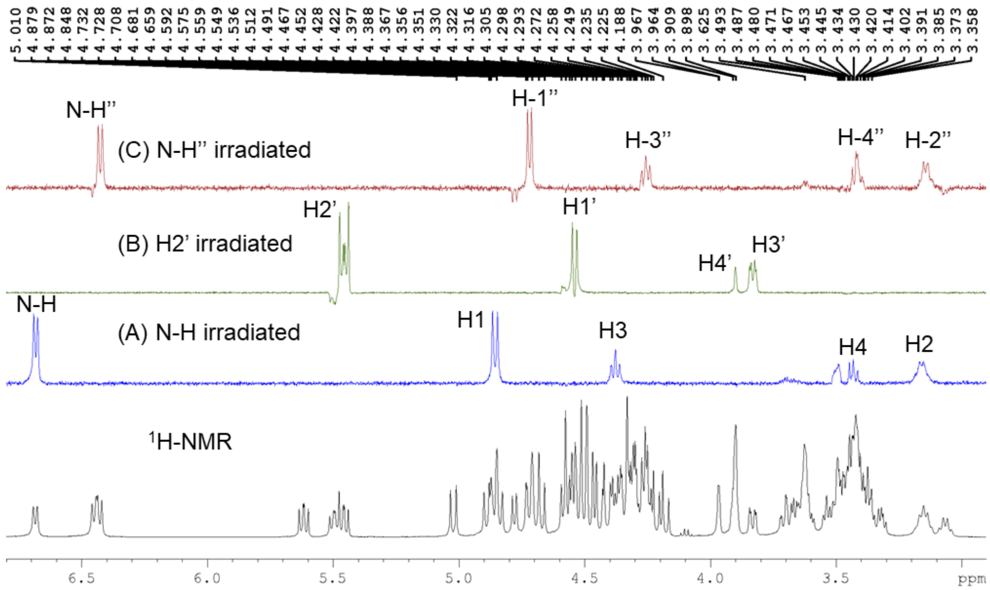
^{13}C NMR spectrum of compound **9** (125 MHz, $CDCl_3$)



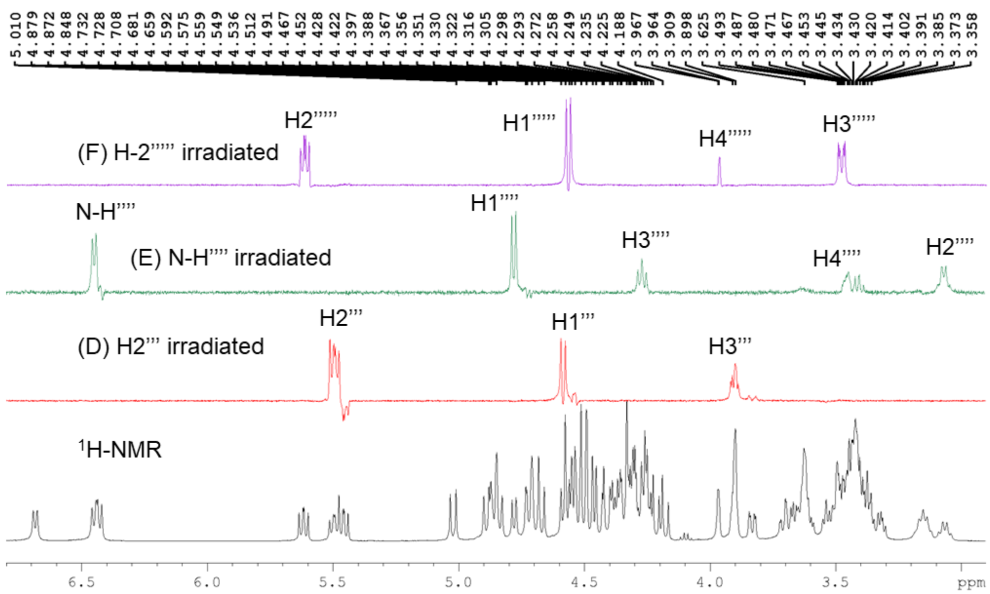
[1]H NMR spectrum of compound **10** (500 MHz, $CDCl_3$)



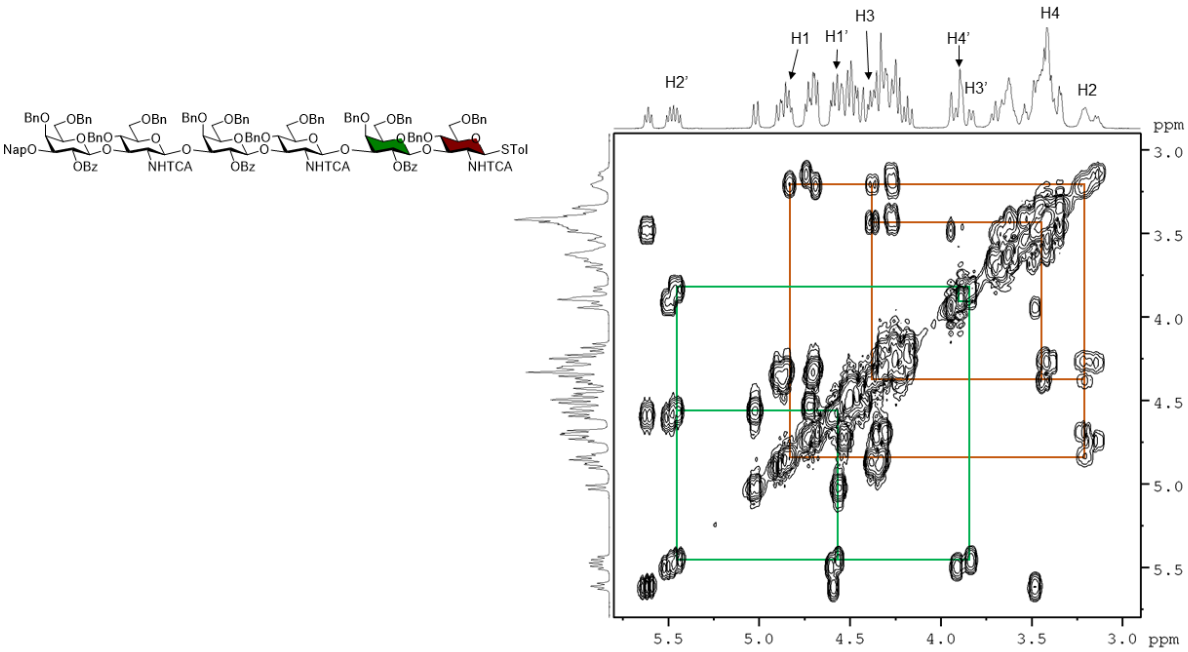
[13]C NMR spectrum of compound **10** (125 MHz, $CDCl_3$)



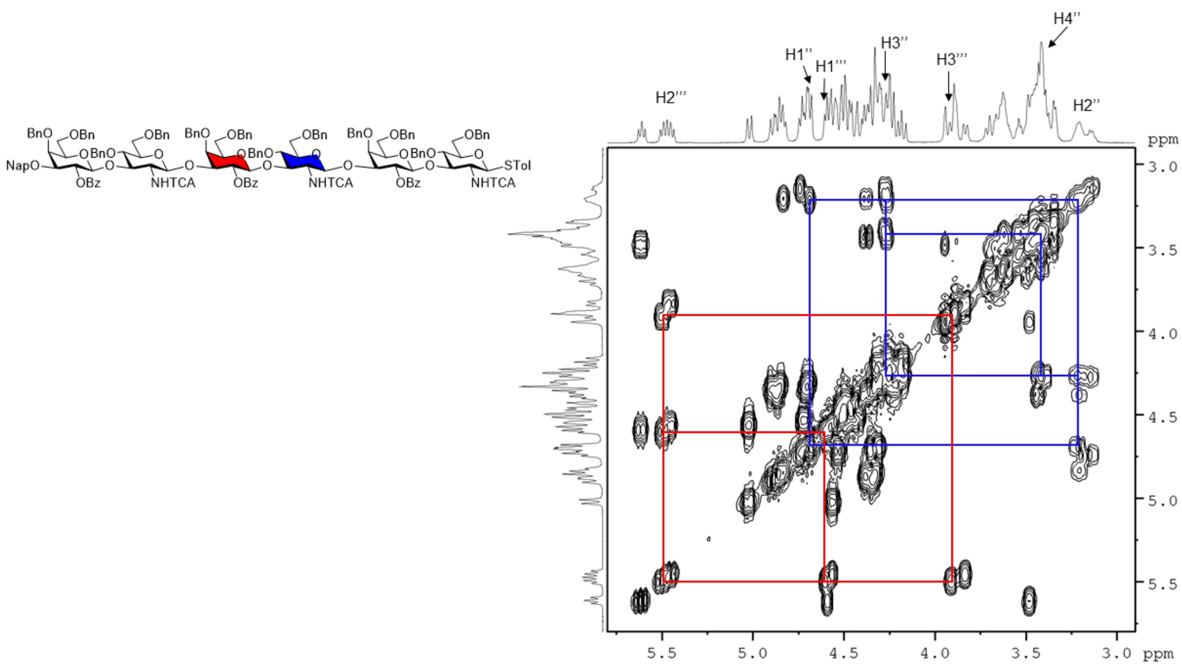
1D-Selective TOCSY NMR spectrum of compound **10** (500 MHz, $CDCl_3$)



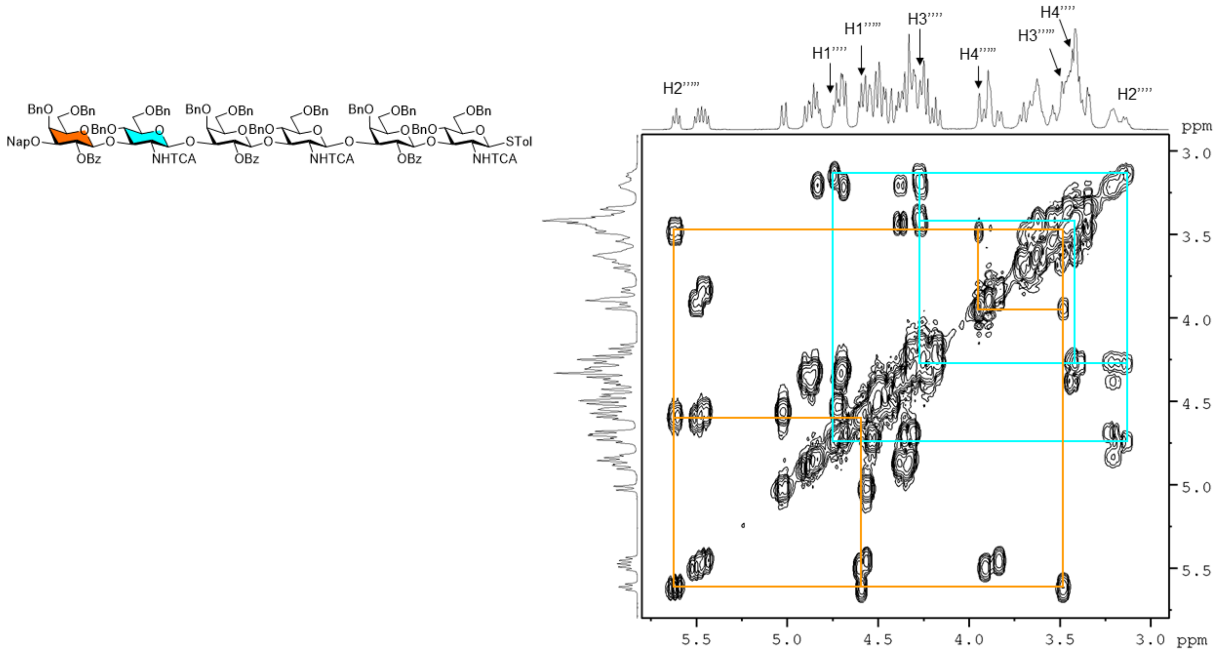
1D-Selective TOCSY NMR spectrum of compound **10** (500 MHz, $CDCl_3$)



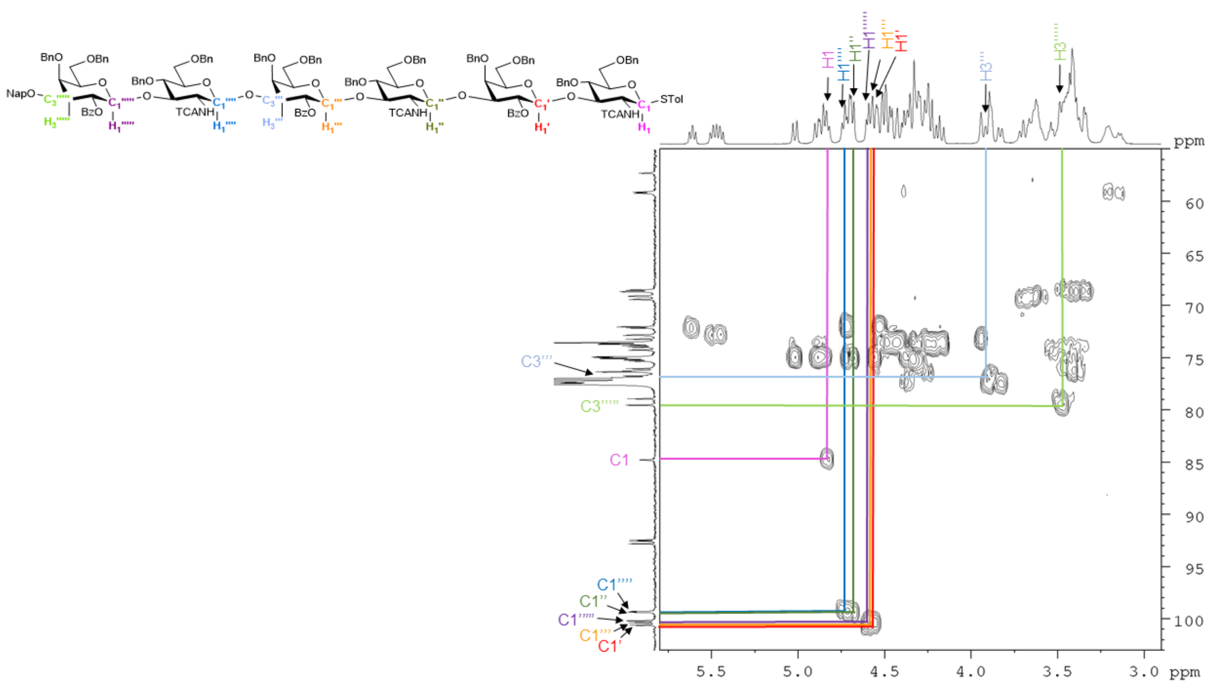
^1H-^1H 2D COSY NMR spectrum of compound **10** (500 MHz, $CDCl_3$)



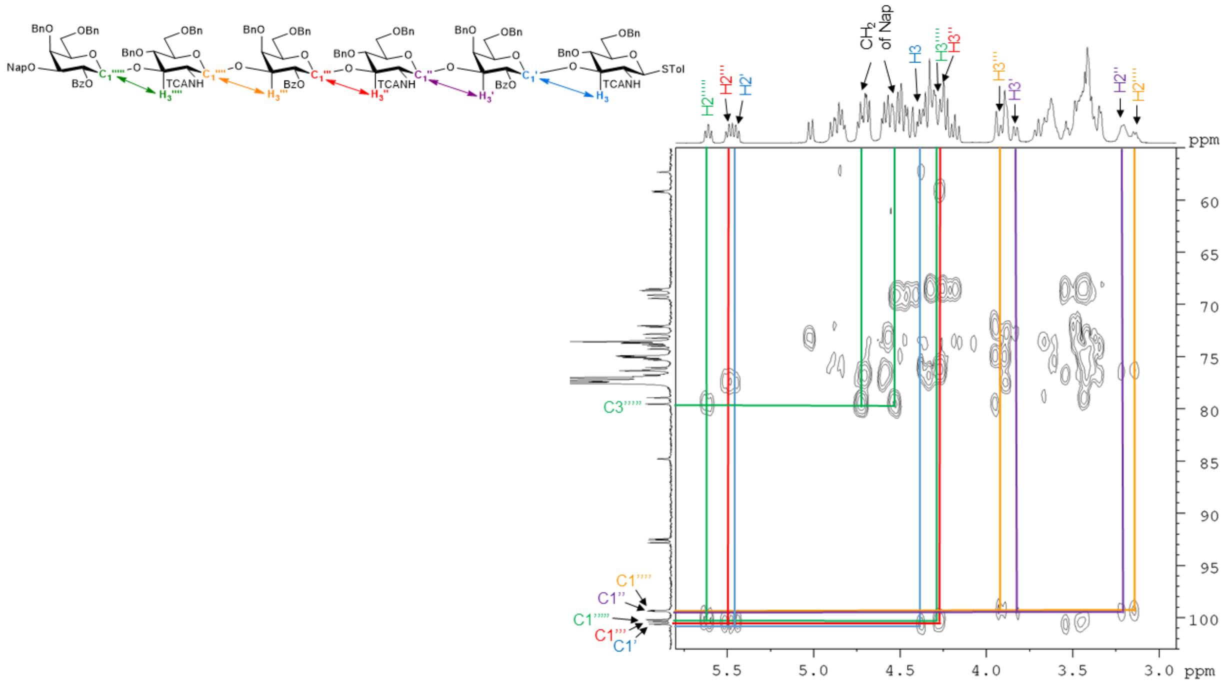
^1H-^1H 2D COSY NMR spectrum of compound **10** (500 MHz, $CDCl_3$)



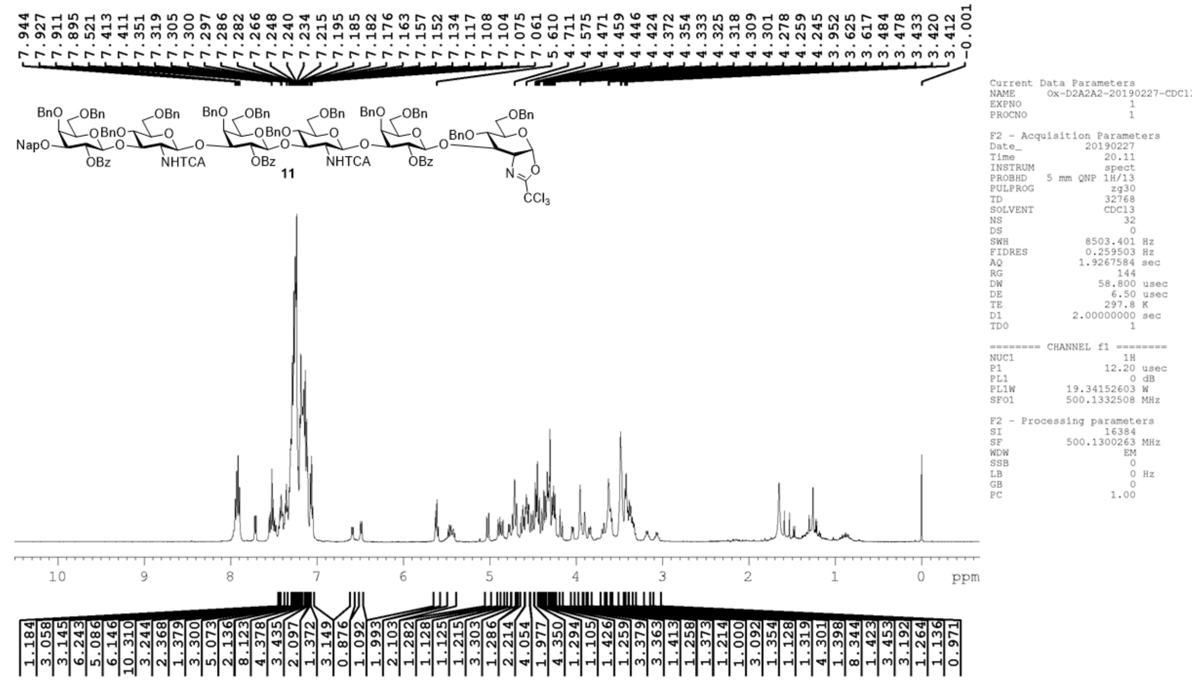
^{1}H-^{1}H 2D COSY NMR spectrum of compound **10** (500 MHz, $CDCl_3$)



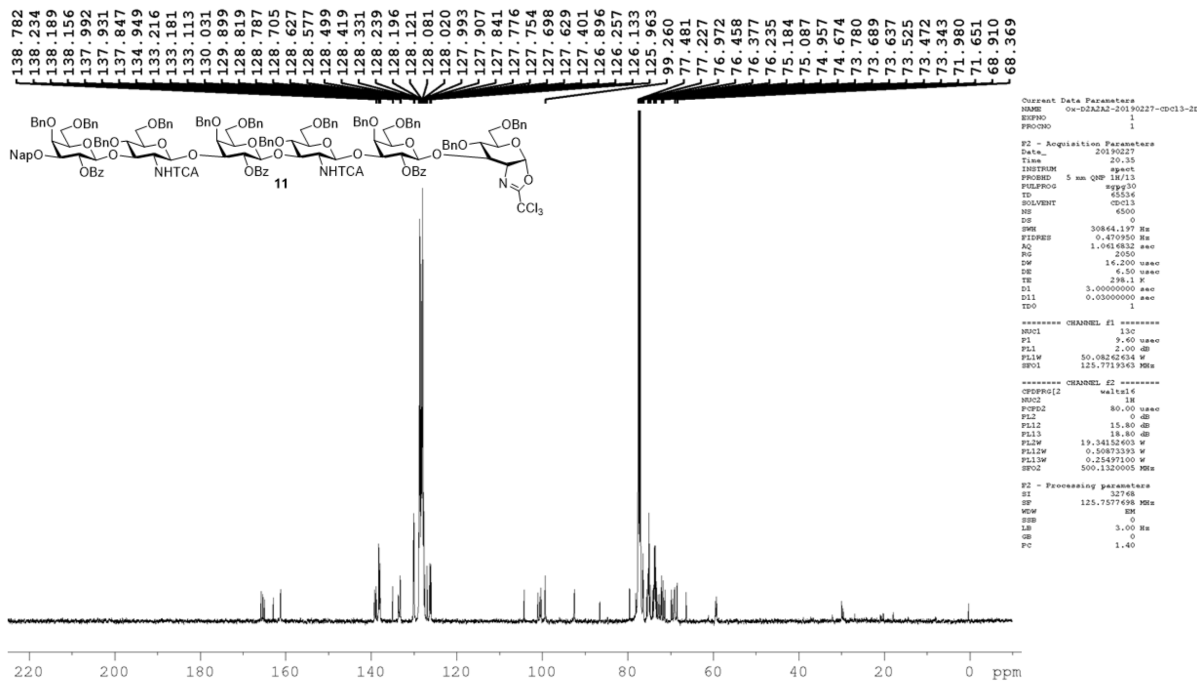
^{1}H-^{13}C 2D HMQC NMR spectrum of compound **10** (500/125 MHz, $CDCl_3$) showing the selective correlations to identify the C1 of Gal and GlcNTCA residues.



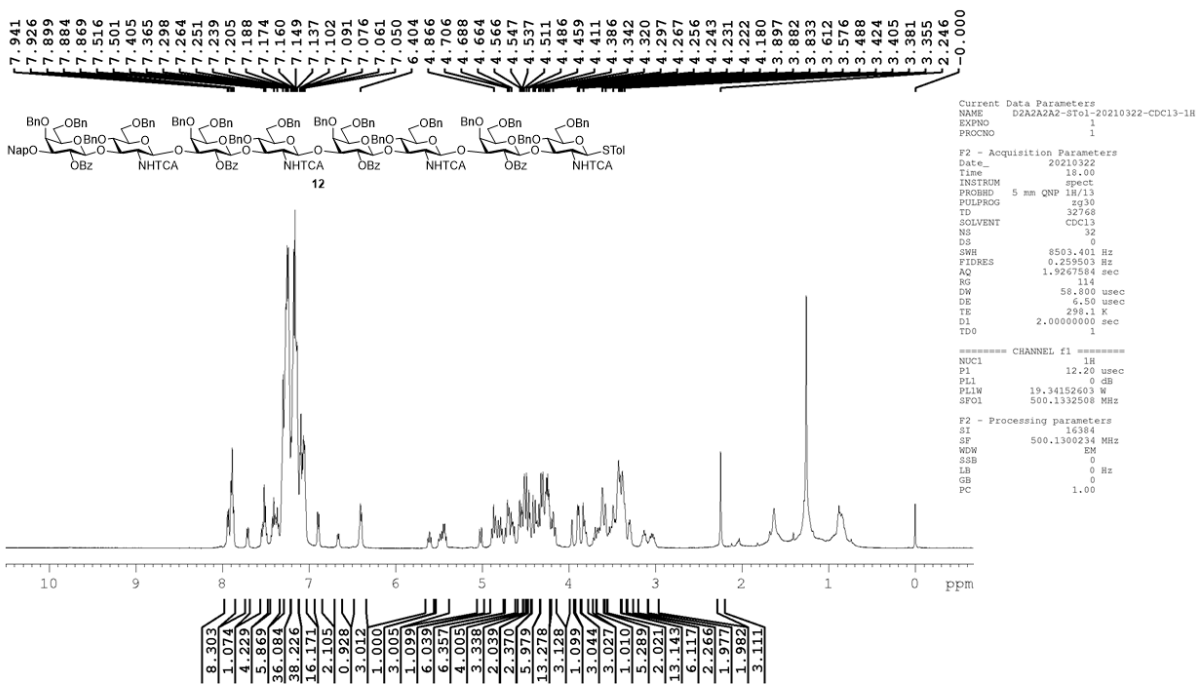
^{1}H-^{13}C 2D HMBC NMR spectrum of compound **10** (500/125 MHz, CDCl$_3$) showing the selective correlations to identify the β 1-3 linkages.



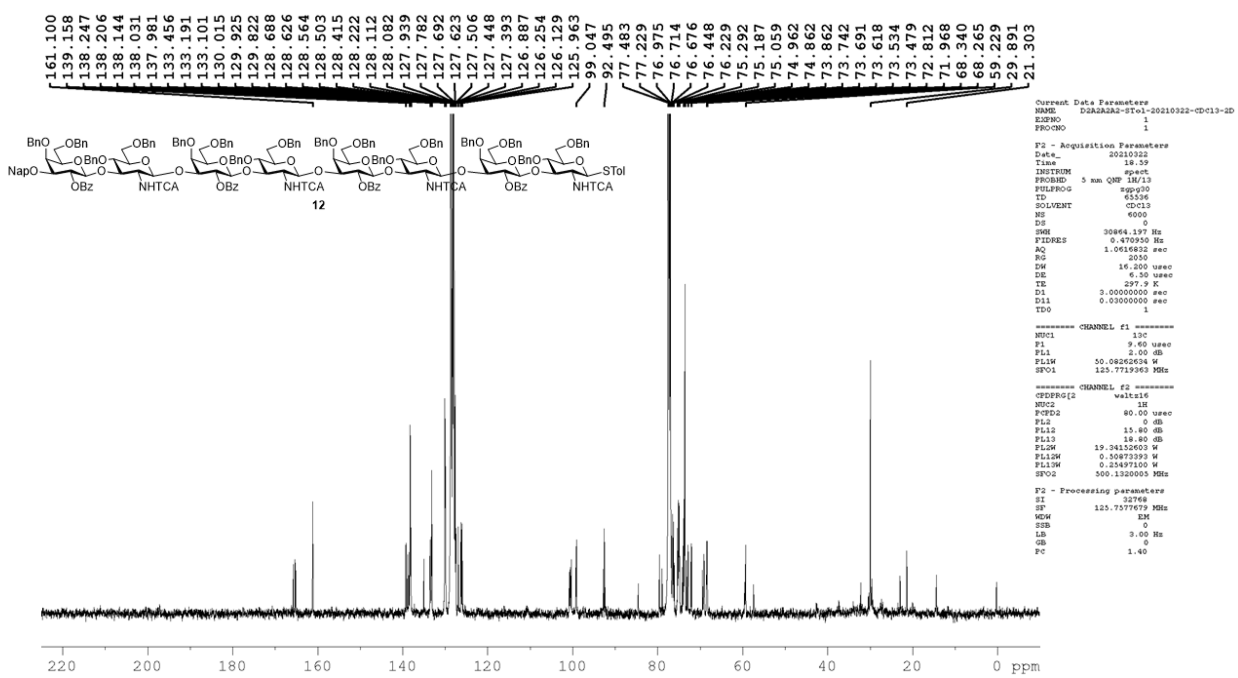
^{1}H NMR spectrum of compound **11** (500 MHz, $CDCl_3$)



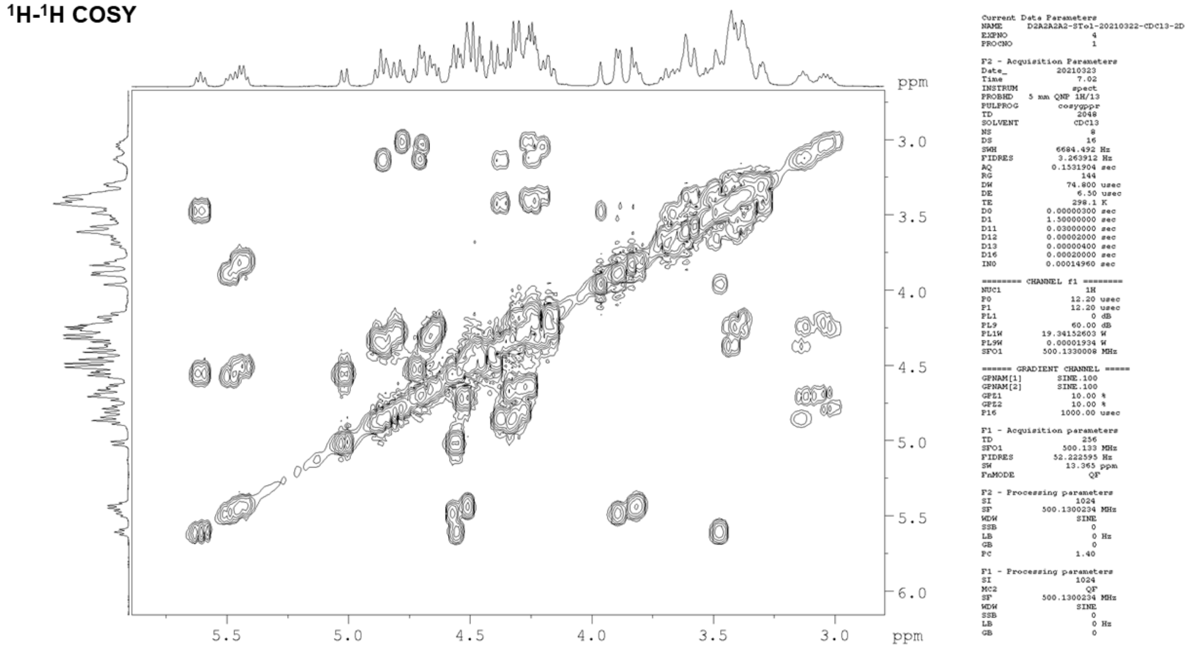
^{13}C NMR spectrum of compound **11** (125 MHz, $CDCl_3$)



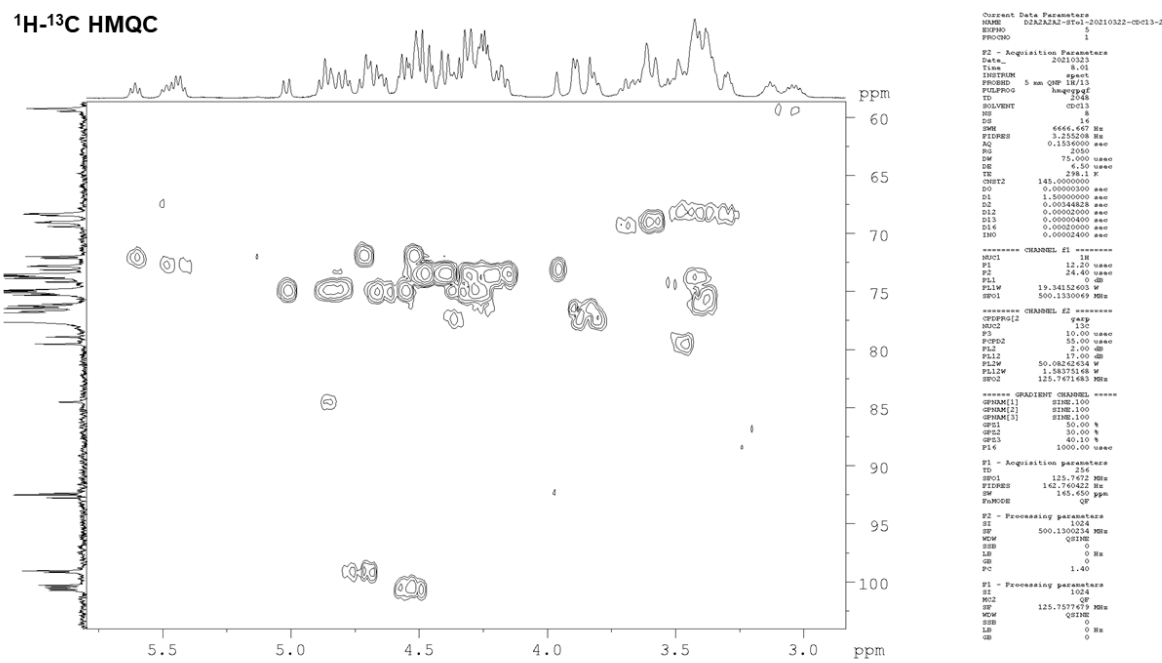
^{1}H NMR spectrum of compound **12** (500 MHz, $CDCl_3$)



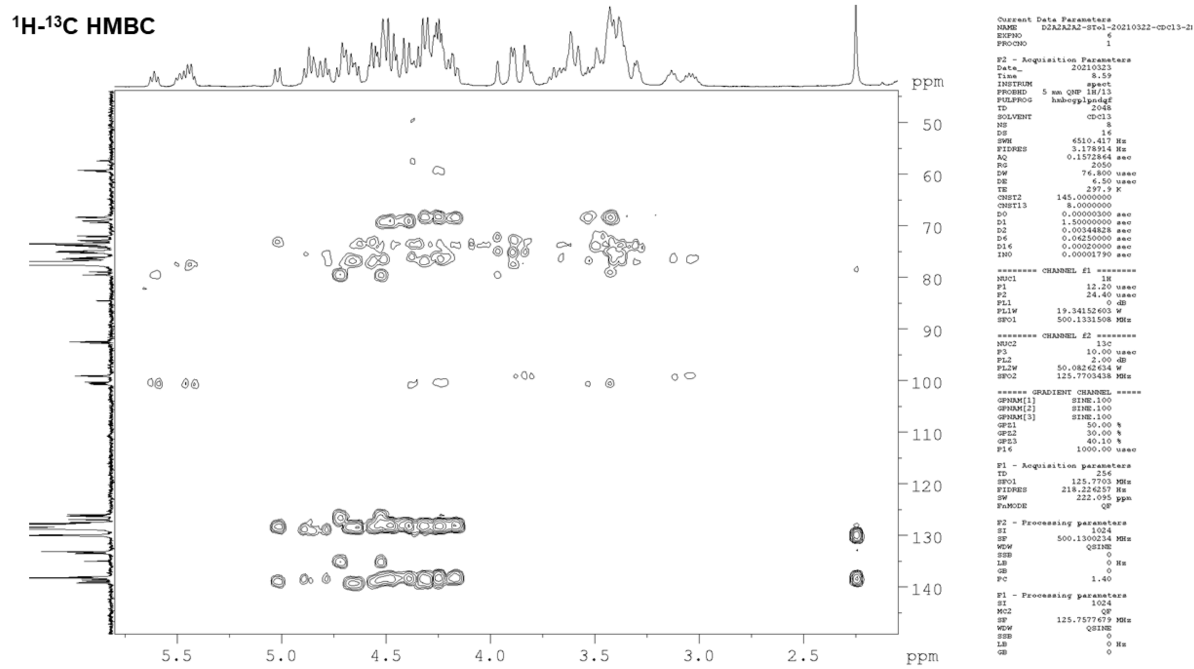
^{13}C NMR spectrum of compound **12** (125 MHz, $CDCl_3$)



^{1}H-^{1}H 2D COSY NMR spectrum of compound **12** (500 MHz, $CDCl_3$)



^{1}H-^{13}C 2D HMQC NMR spectrum of compound **12** (500/125 MHz, $CDCl_3$)



^{1}H-^{13}C 2D HMBC NMR spectrum of compound **12** (500/125 MHz, $CDCl_3$)