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Nedjwa Bennai,[a,b] Nada Ibrahim,[a] Jérôme Marrot,[c] Mohamed Belkadi,[b] Mouad Alami,[a] Emmanuel Magnier,*[c] Elsa Anselmi,[c,d] and Samir Messaoudi[a]*

Dedication ((optional))

[a] N. Bennai, Drs. N. Ibrahim, M. Alami, S. Mesaoudi
Université Paris-Saclay, CNRS, BioCIS, 92290, Châtenay-Malabry, France
E-mail: samir.messaoudi@universite-paris-saclay.fr
[b] N. Bennai, Dr. M. Belkadi
Université des sciences et de la technologie d'Oran-Mohamed-Boudiaf, Algeria
[c] J. Marrot, Drs. E. Magnier, E. Anselmi
Université Paris-Saclay, UVSQ, CNRS, UMR 8180, Institut Lavoisier de Versailles, 78000, Versailles, France 2
[d] Dr. E. Anselmi
Université de Tours, Faculté des Sciences et Techniques, 37200 Tours, France
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Abstract: A general protocol for the synthesis of S-trifluoromethyl S-arylsulfoximine thioglycosides has been reported. This protocol is based on a Pd-catalyzed Migita cross-coupling between *o*-iodo S-trifluoromethyl S-arylsulfoximines and a broad range of 1-thiosugars. This method gives access to a series of functionalized S-trifluoromethyl S-arylsulfoximine thioglycosides in moderate to good yields. Moreover, both diastereoisomers were easily separated by simple crystallization or by HPLC and full characterizations are provided for each pure trifluoromethylsulfoximine.

Introduction

After a long period of latency, the sulfoximines have recently emerged as active pharmaceutical ingredients (APIs) in life and in crop sciences. This very peculiar group slowly evolved from "neglected opportunity in medicinal drug discovery" to an emergent and promising moiety.[1] Some relevant examples are given as follows. BAY 1000394, a potent pan-CDK inhibitor and AZD 6738, an orally bioavailable inhibitor of the serine/threonine protein kinase ataxia telangiectasia mutated (ATM) are currently in phase II of clinical trials (Figure 1).[2] An insecticide including a sulfoximine in its skeleton, the Sulfoxaflor® was launched on the market in 2013.[3] In this context, the presence of fluorine atoms in a molecule dramatically changes its properties and in a vast majority of cases improves its efficiency for bioactive compounds purposes.[4] Despite the importance of this halogen, S-perfluoroalkyl sulfoximines are extremely rare in the chemistry of life sciences whereas they are more and more present in the toolbox of the chemists as reagent in organic chemistry.[5] One can hypothesize that fluorinated sulfoximines could bring original properties for relevant biological targets. A recent example highlighted indeed the interest of S-trifluoromethyl sulfoximine for antidiabetic activity (Figure 1).[6] A library of pyrazines has been tested for antidiabetic properties. The presence of the fluorinated sulfoximine group proved efficient to increase cytosolic glucokinase levels through the binding to glucokinase regulatory protein (GRKP).
In another hand, 1-thioglycosides have emerged as a privileged class of glycosides with a diverse range of potential applications.[7] These glycomimetics are known to be more

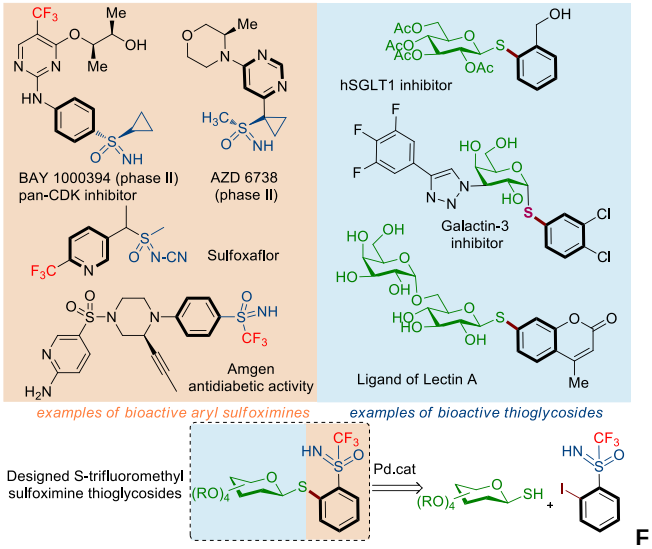


Figure 1. Biologically Active Aryl sulfoximines and Thioglycosides

resistant to glycosidase cleavage under biologically media.[7f,8] Selected examples of bioactive thioglycosides are disclosed in Figure 1 such as hSGLT1 inhibitor, ligand of lectin A as well as Galactin-3 inhibitors. Moreover, thioglycosides are very useful intermediates in carbohydrate chemistry as they are largely used in sequential glycosylation tactics for oligosaccharides synthesis.[9]

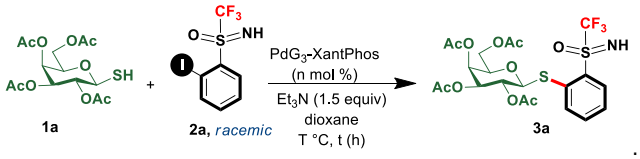
Despite the potential interest of both sulfoximines and thiosugars in medicinal chemistry there is no report, to the best of our knowledge, devoted to synthesis of S-aryl S-trifluoromethylsulfoximine thioglycosides. The combination of both these moieties in a designed single structure may however lead to the creation of unique molecular architectures based glycosides of interest for medicinal chemists. They could furthermore serve as potent drug analogues (Figure 1). This assumption is based on the fact that sulfoximines were proposed as alcohol isosteres.[10] To reach our synthetic goal, we planned an approach merging the knowledge of our both research groups: in the chemistry of S-trifluoromethyl sulfoximine[11] and in the development of strategies devoted to the reactivity of thiosugars under transition metal-catalysis[12] including Pd-catalyzed Migita[13] cross-coupling. The synthesis of *o*-iodo S-aryl S-trifluoromethylsulfoximine and the

subsequent[14] selective functionalization of the *ortho* position, in the presence of the free NH sulfoximine was recently carried out.[15] Another interest of the present study would rely on the chiral pool offered by the thiosugars derivatives. This natural and cheap source of chirality could generate an easy access to pure diastereoisomers of S-trifluoromethyl sulfoximines thioglycosides. This is of particular interest because methods to prepare S-trifluoromethyl sulfoximine diastereoisomers in a pure fashion are rare.[16]

Results and Discussion

To initiate this study, we conducted the coupling of tetra-*O*-acetylated 1-thio-β-D-galactopyranose **1a** with *o*-iodo S-trifluoromethyl S-phenylsulfoximine **2a** as a model study under various reaction conditions. Representative results from this study are summarized in Table 1. The reaction of **1a** (1.2 equiv) with **2a** (1 equiv) was first investigated under our previously reported conditions using 5 mol% of a PdG_3-XantPhos[17] precatalyst in the presence of Et_3N (1.5 equiv) as a base at room temperature for 12 hours (Table 1, entry 1). However, under these conditions, the desired sulfoximine thioglycoside **3a** has never been observed. Increasing the amount of the catalyst from 5 mol% to 20 mol% did not reveal any significant reactivity. This result may be explained by the hindrance effect of the trifluoromethyl arylsulfoximine group which may hamper the oxidative addition of the Pd(0) to the C–I bond. At this stage, we decided to increase the activation energy of this reaction by performing the cross-coupling at 60 °C instead of room temperature. Under these conditions, the desired thioglycoside **3a** was isolated in a good 65% yield as a single β-anomer ($J_{1,2}$ = 9 Hz) in a 1:1 diastereomeric ratio. Pleasingly, the two diastereoisomers showed distinct properties in solution as the pure **3aa**-(*R*) diastereoisomer could be crystallized in Et_2O and easily separated from its **3ab**-(*S*) isomer. Its exact structure was elucidated by X-ray analysis (Scheme 1). Moreover, the **3ab**-(*S*) was obtained as a pure product upon evaporation of the liquid layer.

Table 1. Optimization of the Coupling Reaction of Tetraacetylated β-thiogalactose **1a** with *ortho*-iodo-trifluoromethyl-arylsulfoximines **2a**[a]



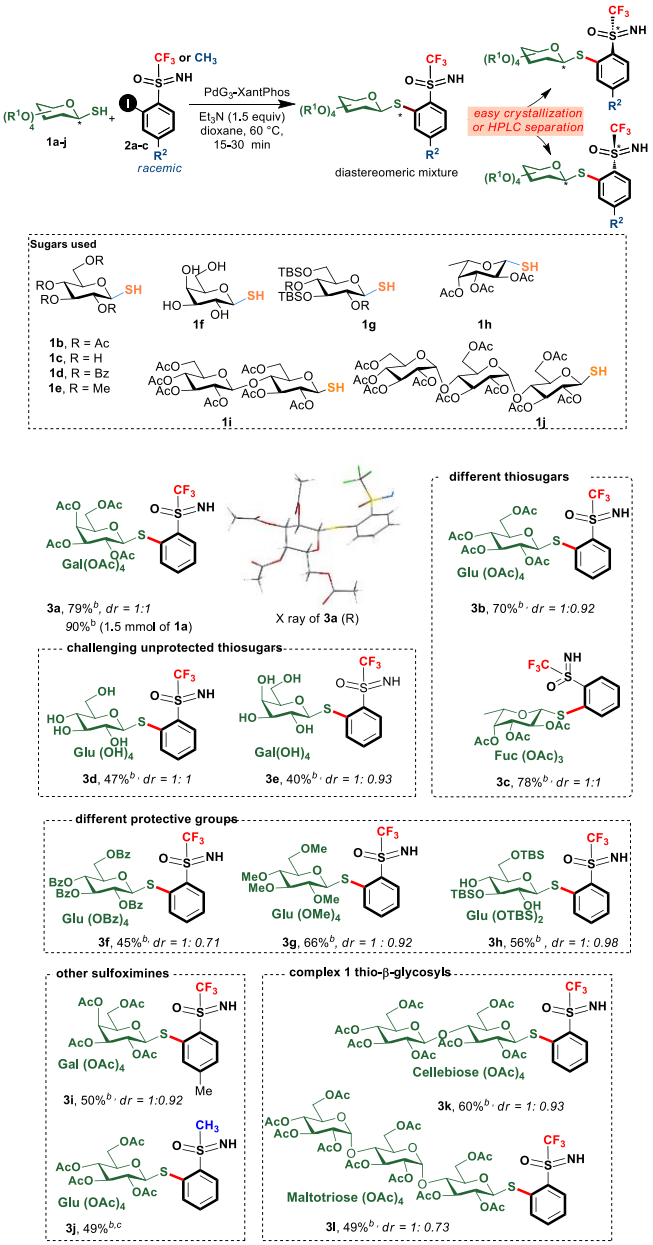
entry	n mol %	T (°C)	T (h)	**4a** (%)[b]
1	5	rt	12	0
2	10	rt	12	0
3	20	rt	12	0
4	10	60	0.5	65
5	10	60	1	63
6	5	60	0.5	64

[a] A sealable tube was charged with thiosugar **1a** (1.2 equiv, 0.2 mmol), *ortho*-iodo-trifluoromethyl-arylsulfoximines **2a** (1 equiv), [Pd precatalyst] (n mol%), Et_3N, (1.5 equiv) in dioxane (1.0 mL). [b] Yield of isolated product.

It should be noted that the reaction is completely chemoselective and no by-product which could be arisen from the arylation of the nitrogen of the sulfoximine group was observed. Interesting, scale-up experiment (1.5 mmol of **2a**) was also performed with thiosugars **1a**, which led to the formation of thioglycoside **3a** in an excellent 90% yield. Of note, the palladium catalyst is necessary to achieve this transformation since no reaction occurs when the coupling reaction is conducted in the absence of the catalyst.

With these results in hand, we subsequently investigated the substrate scope for this process with diverse mono-, di-, and tri-thiosugars **1b-j** (Scheme 1). Gratifyingly, all the coupling reactions proceeded cleanly and selectively in good yields. This reaction is not limited to only *O*-acetylated 1-thio-β-D-galactose **1a** since different others sugars such as β-D-glucopyranose (**1b**) and β-D-fucose (**1h**) were used successfully providing **3b** and

Scheme 1 Scope of Coupling of various Thiosugars **1a-j** with **2a-c**[a]



[a] Reaction conditions: A sealable tube was charged with thiosugar **1a-j** (1.2 to 2 equiv), iodo-sulfoximine **2a-c** (1 equiv) and XantPhos PdG_3 precatalyst (10 mol %), Et_3N (1.5 equiv) in dioxane. [b] Yield of isolated product. [c] 2 days reaction time

3c in 70% and 78% yields, respectively. Unprotected thiosugars such as **1c** and **1f** can also serve as partners under our reaction conditions leading to the desired arylsulfoximine thioglycosides **3d** and **3e** in moderate yields. In addition, this methodology was not limited to only *O*-acetyl protected thiosugars but other protecting groups are tolerated such as –OBz (**3f**), –OMe (**3g**) and –OTBs (**3h**).

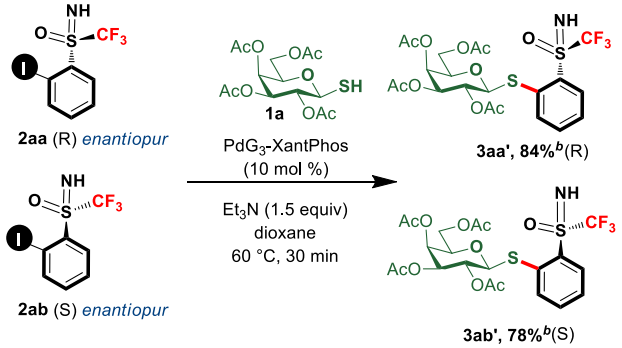
The structural variation of the aromatic partner was then investigated. The introduction of a methyl group on the aromatic ring was not deleterious to the transformation and the resulting compound **3i** was isolated in 50% yield. However, although pure diastereosiomers of **3i** were separated easily through HPLC purification and kept without alteration of the chiral information, epimerization of the chiral sulfoximine was observed in this only case indicating that the methyl group may alter the configurational stability of these diastereosiomers.

The same reaction with a non-fluorinated sulfoximine, a S-methyl analogue of **2a** was rather successful (**3j** isolated in 49% yield) but required an important increase of the reaction time, 2 days versus 30 minutes. This result illustrates the key role of the trifluoromethyl group in the general reactivity of the aromatic ring.

Next, we moved on to investigate the reactivity of complex and biologically relevant saccharide derivatives. Thus, we found that this coupling could be applied to thio-β-D-cellobiose **1i** and thio-β-D-maltotriose **1j** delivering **3k** and **3l** in 60% and 49% yields, respectively.

Finally, we decided to investigate whether the chiral information on enantiopure trifluoromethyl sulfoximines was conserved during the cross-coupling process. In case of success, this may open the door to an efficient way to synthesize highly diastereopure trifluoromethyl sulfoximine thioglycosides. Delightfully, the reaction of enantiopure S-trifluoromethyl S-arylsulfoximines[16] **2aa**(*R*) and **2ab**(*S*) under our optimized condition furnished the expected chiral products **3aa'**(*R*) and **3ab'**(*S*) in 84% and 78% yields, respectively and without any detectable racemization by HPLC analysis or NMR (Scheme 2). To our knowledge, this result represent the first example of functionalization of enantiopure S-trifluoromethyl S-arylsulfoximines under Pd-catalysis, and may open a new way of diversifying the chemical space of S-trifluoromethyl S-arylsulfoximines through this methodology.

Scheme 2. Coupling of Chiral Sulfoximines **2aa** and **2ab** with thiogalactose **1a**[a]



[a]Reaction conditions: A sealable tube was charged with thiosugar **1a** (1.5 equiv, 0.2 mmol), iodo-sulfoximine **2aa** or **2ab** (1 equiv) and XantPhos PdG_3 precatalyst (10 mol %), Et_3N (1.5 equiv) in dioxane. [b] Yield of isolated product.

Conclusion

In summary, we described here general protocol for the synthesis of S-trifluoromethyl S-arylsulfoximine thioglycosides. This protocol is based on a Pd-catalyzed Migita cross-coupling between *o*-iodo S-trifluoromethyl S-arylsulfoximines and a broad range of 1-thiosugars. Interestingly, the sugar part was used as a natural and cheap source of chirality that could generate an easy access to pure diastereomers of S-trifluoromethyl sulfoximines thioglycosides.

Experimental Section

Experimental Details.

General information

Solvents and reagents are obtained from commercial suppliers and were used without further purification. Analytical TLC was performed using Merck silica gel F254 (230-400 mesh) plates and analyzed by UV light or by staining upon heating with vanilin solution (15 g of vanilin in 250 mL ethanol and 2.5 mL of concentrated sulfuric acid). For silica gel chromatography, the flash chromatography technique was used, with Merck silica gel 60 (230-400 mesh) and p.a. grade solvents unless otherwise noted. The ^1H NMR and ^{13}C NMR spectra were recorded in either $CDCl_3$ or CD_3OD on Bruker Avance 300 spectrometers. NMR spectra for 19F (188 MHz) were recorded in either $CDCl_3$ or CD_3OD on Bruker Avance 200 spectrometers. The chemical shifts of ^1H, ^{13}C and ^{19}F are reported in ppm relative to the solvent residual peaks. IR spectra were measured on a Bruker Vector 22 spectrophotometer.Merck silica gel 60 (0.015–0.040 mm) was used for column chromatography. Melting points were recorded on a Büchi B-450 apparatus. High resolution mass spectra (HR-MS) were recorded on a MicroMass LCT Premier Spectrometer spectrometer. Optical rotations were obtained with a PolAAr 32 polarimeter. Thiosugars were synthesized according the literature protocols.[17] 2-iodosulfoximines **2a-c** were prepared as reported.[14] The Xantphos Palladium precatalyst PdG_3 was synthetized according to literature protocol.[18]

General procedure for the coupling of Thiosugars 1a-j with 2-iodosulfoximine 2 a-c

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (10 mol %), ß-thiosugar (1.2 to 2 equiv), 2-iodo-sulfoximine (1 equiv). Then, Dioxane (1 mL) was added and to the solution was added Et_3N (1.5 equiv) dropwise, and the mixture was stirred at 60°C for 30 min. The reaction mixture was cooled to room temperature and passed through celite and rinsed with EtOAc. Then the filtrate was concentrated and the residue was purified by column chromatography on silica gel. The liquid chromatography separation of the diastereoisomers was achieved using an Agilent infinity 1260 (4.6 x 150 mm) 5 µm column.

Compounds characterization

*(2R,3S,4S,5R,6S)-2-(acetoxymethyl)-6-((2-S-(trifluoromethyl)sulfonimidoyl) phenyl)thio)tetrahydro-2H-pyran-3,4,5-triyl triacetate **3a***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (28 mg, 0.03 mmol, 10 mol %), tetraacetylated ß-thiogalactose **1a** (130 mg, 0.36 mmol, 1.2 equiv), 2-iodo-sulfoximine **2a** (100 mg, 0.3 mmol, 1 equiv). Dioxane (1 mL) was added to the mixture and then, Et_3N (61 µL, 0.45 mmol, 1.5 equiv) dropwise. The solution was stirred at 60°C for 30 min. The reaction mixture was cooled to room

temperature and passed through celite and rinsed with EtOAc. This crude was purified by column chromatography on silica gel (Cyclohexane/ EtOAc: 5/5), and **3a** was isolated as a white solid in 65% yield. The ratio of diastereoisomers of compound **3a** was 1:1 measured by NMR.

Protocol for crystallization and separation of (*R*) and (*S*) diastereoisomers for compound 3a:

To a mixture of (*R*) and (*S*) diastereoisomers (100 mg) was added 5 mL of diethyl ether and the solution was stored at 4°C for 24h. A white solid crystal was formed and isolated through simple filtration. The exact structure of the crystal was elucidated by X-ray analysis as the diastereoisomer **3aa-**(*R*). Additionally, the diastereoisomer **3ab**-(*S*) was obtained as a pure product upon evaporation of the liquid layer. This operation was repeated 2 to 3 times until the liquid layer delivered only a pure **3ab**-(*S*).

*(2R,3S,4S,5R,6S)-2-(acetoxymethyl)-6-((2-((R)-S-(trifluoromethyl)sulfonimidoyl)phenyl)thio)tetrahydro-2H-pyran-3,4,5-triyl triacetate **3aa***

R_f (50% EtOAc/Pentane) = 0.57; **$[\alpha]_D^{19}$** = +8.37 (c, 1.66 in $CHCl_3$); **mp**: 50.5 – 54.2 **°C ; IR (neat, cm^{-1})** 1749, 1368, 1213, 1174, 1083, 1058; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.27 (d, *J* = 8.0 Hz, 1H), 7.92 (d, *J* = 8.0 Hz, 1H), 7.65 (t, *J* = 7.7 Hz, 1H), 7.49 (t, *J* = 7.6 Hz, 1H), 5.48 (d, *J* = 3.1 Hz, 1H), 5.41 (t, *J* = 10.0 Hz, 1H), 5.10 (dd, *J* = 9.9, 3.3 Hz, 1H), 4.89 (d, *J* = 9.9 Hz, 1H), 4.23 – 3.99 (m, 3H), 3.95 (bs, NH), 2.18 (s, 3H), 2.05 (s, 6H), 1.99 (s, 3H); **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.36 (C_q), 170.16 (C_q), 170.06 (C_q), 169.39 (C_q), 138.99 (C_q), 135.22 (CH), 133.96 (CH), 132.45 (CH), 131.83 (C_q), 127.52 (CH), 121.16 (q, J_{CF} = 333 Hz, CF_3), 85.60 (CH), 74.81 (CH), 72.08 (CH), 67.34 (CH), 66.67 (CH), 61.84 (CH_2), 20.74 et 20.63 (4xCH_3);**^{19}F NMR (188 MHz, $CDCl_3$) δ** -76.55 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{21}H_{25}F_3NO_{10}S_2$ [M+H] +572.0866; found 572.0866. **Aspect**: White crystal solid.

*(2R,3S,4S,5R,6S)-2-(acetoxymethyl)-6-((2-((S)-S-(trifluoromethyl)sulfonimidoyl)phenyl)thio)tetrahydro-2H-pyran-3,4,5-triyl triacetate **3ab***

R_f (50% EtOAc/Pentane) = 0.5; **$[\alpha]_D^{19}$** = + 83.43 (c, 1.66 in $CHCl_3$); **mp**: 48.1 – 52.3 **°C**; **IR (neat, cm^{-1})** 1760, 1367, 1243, 1085, 1069; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.19 (d, *J* = 8.0 Hz, 1H), 7.87 (d, *J* = 8.0 Hz, 1H), 7.65 (t, *J* = 7.7 Hz, 1H), 7.47 (t, *J* = 7.7 Hz, 1H), 5.48 (d, *J* = 3.2 Hz, 1H), 5.37 (t, *J* = 9.9 Hz, 1H), 5.09 (dd, *J* = 9.9, 3.2 Hz, 1H), 4.81 (d, *J* = 10.1 Hz, 1H), 4.26 – 4.03 (m, 4H), 2.18 (s, 3H), 2.07 (s, 3H), 2.04 (s, 3H), 1.99 (s, 3H),; **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.33 (C_q), 170.24 (C_q), 170.03 (C_q), 169.44 (C_q), 140.70 (C_q), 135.51 (CH), 133.42 (CH), 131.14 (CH), 128.41 (C_q), 127.07 (CH), 121.33 (q, J_{CF} = 334 Hz, CF_3), 86.49 (CH), 74.63 (CH), 71.97 (CH), 67.26 (CH), 66.80 (CH), 61.99 (CH_2), 20.73, 20.62 et 20.53 (4xCH_3); **^{19}F NMR (188 MHz, $CDCl_3$) δ -**76.25 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{21}H_{25}F_3NO_{10}S_2$ [M+H] +572.0866; found 572.0864. **Aspect** : White solid.

*(2R,3R,4S,5R,6S)-2-(acetoxymethyl)-6-((2-(S-(trifluoromethyl)sulfonimidoyl)phenyl)thio)tetrahydro-2H-pyran-3,4,5-triyl triacetate **3b***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (28 mg, 0.03 mmol, 10 mol %), tetraacetylated ß-thioglucose **1b** (130 mg, 0.36 mmol, 1.2 equiv), 2-iodo-sulfoximine **2a** (100 mg, 0.3 mmol, 1 equiv). Dioxane (1mL) was added followed by Et_3N (61 µL, 0.45 mmol, 1.5 equiv) dropwise. The mixture was stirred at 60°C for 30 min.

The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. The crude was purified by column chromatography on silica gel (Cyclohexane/ EtOAc: 5/5), and compound **3b** was isolated as a white solid in 70% yield. The ratio of diastereoisomers of compound **3b** was about 1:0.91 (by NMR).

The chromatographic separation was achieved using an Agilent infinity 1260 (4.6 x 150 mm) 5µm column. The mobile phase was Acetonitrile and H_2O in the ratio of 60:40, v/v in 25min. The column temperature was maintained at 25°C and the eluent was monitored at a wavelength of 280 nm. The injection volume was 10 µL. The typical retention time of diastereoisomers of compound **3b** was about 19.1 min and 20.8 min, respectively.

Diastereoisomer 3ba

R_f (50% EtOAc/Cyclohexane) = 0.37; **$[\alpha]_D^{19}$** = - 58.43 (c, 1.66 in $CHCl_3$); **mp**: 145.2 – 147.5 **°C**; **IR (neat, cm^{-1})** 1752, 1452, 1368, 1252, 1034; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.26 (d, *J* = 7.9 Hz, 1H), 7.84 (d, *J* = 7.8 Hz, 1H), 7.65 (t, *J* = 7.4 Hz, 1H), 7.49 (t, *J* = 7.4 Hz, 1H), 5.28 (t, *J* = 9.1 Hz, 1H), 5.19-5.07 (m, 2H), 4.92 (d, *J* = 10.0 Hz, 1H), 4.80 (bs, NH), 4.25 – 4.15 (m, 2H), 3.89 – 3.76 (m, 1H), 2.08 (s, CH_3), 2.04 (s, CH_3), 2.03 (s, CH_3) and 2.00 (s, CH_3),; **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.52 (C_q), 170.21 (C_q), 169.47 (C_q), 169.33 (C_q), 138.57 (C_q), 135.34 (CH), 133.98 (CH), 132.67 (CH), 132.09 (C_q), 127.72 (CH), 121.13 (q, J_{CF} = 330 Hz, CF_3), 85.13 (CH), 76.05 (CH), 73.96 (CH), 69.68 (CH), 68.33 (CH), 62.36 (CH_2), 20.78 (CH_3), 20.64 (2xCH_3), 20.55 (CH_3); **^{19}F NMR (188 MHz, $CDCl_3$) δ** -76.47 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{21}H_{26}F_3NO_{10}S_2$ [M+2H] +573.0939; found 573.0997. **Aspect**: White solid.

Diastereoisomer 3bb

R_f (50% EtOAc/Cyclohexane) = 0.33; **$[\alpha]_D^{19}$** = - 68.85 (c, 1.66 in $CHCl_3$); **mp**: 179.1 – 181.8 **°C**; **IR (neat, cm^{-1})** 1753, 1453, 1215, 1033, 737 ; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.19 (d, *J* = 7.9 Hz, 1H), 7.84 (d, *J* = 8.0 Hz, 1H), 7.65 (t, *J* = 7.3 Hz, 1H), 7.48 (t, *J* = 6.9 Hz, 1H), 5.28 (t, *J* = 9.2 Hz, 1H), 5.15-5.07 (m, 2H), 4.82 (d, *J* = 10.1 Hz, 1H), 4.22 (m, 2H), 3.92 – 3.83 (m, CH+NH), 2.10 (s, 3H), 2.05 – 2.00 (m, 9H) ; **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.53 (C_q), 170.20 (C_q), 169.47 (C_q), 169.34 (C_q), 140.59 (C_q), 135.56 (CH), 133.41 (CH), 132.71 (C_q), 131.16 (CH), 127.17 (CH), 121.34 (q, J_{CF} = 332 Hz, CF_3), 86.15 (CH), 75.89 (CH), 73.88 (CH), 69.76 (CH), 68.39 (CH), 62.51 (CH_2), 20.81 (CH_3), 20.66 (2xCH_3), 20.46 (CH_3); **^{19}F NMR (188 MHz, $CDCl_3$) δ -**76.14 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{21}H_{26}F_3NO_{10}S_2$ [M+2H] +573.0939; found 573.0997. **Aspect** : White solid.

*(2S,3R,4R,5S,6R)-2-methyl-6-((2-(S-(trifluoromethyl)sulfonimidoyl)phenyl)thio)tetrahydro-2H-pyran-3,4,5-triyl triacetate **3c***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (31 mg, 0.033 mmol, 10 mol %), triacetylated ß-thiofucose **1h** (200 mg, 0.66 mmol, 2.0 equiv), 2-iodo-sulfoximine **2a** (110 mg, 0.33 mmol, 1 equiv). Then, Dioxane (1mL) was added and to the solution was added Et_3N (67 µL, 0.5 mmol, 1.5 equiv) dropwise and the mixture was stirred at 60°C for 30 min.

The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. This crude was purified by column chromatography on silica gel (Cyclohexane/ EtOAc: 6/4), and compound **3c** was isolated as a white solid in 78% yield. The ratio of diastereoisomers of compound **3c** was about 0.93:1 (by NMR).

The chromatographic separation was achieved using a Chiralpak AD-H (250 x 10 mm), hexane / ethanol (50/50) as mobile phase, flow-rate = 5 mL/min, UV detection at 254 nm. Injections: 50 times 80 µL, every 6.2 minutes.

Diastereoisomer 3ca

R_f (50% EtOAc/Cyclohexane) = 0.47; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.25 (d, *J* = 8.0 Hz, 1H), 7.94 (d, *J* = 8.0 Hz, 1H), 7.65 (t, *J* = 7.7 Hz, 1H), 7.47 (t, *J* = 7.7 Hz, 1H), 5.39 (t, *J* = 10.0 Hz, 1H), 5.31 (m, 1H), 5.09 (dd, *J* = 9.9, 3.2 Hz, 1H), 4.85 (d, *J* = 10.1 Hz, 1H), 3.91 (q, *J* = 6.3 Hz, 1H), 2.25 (s, 3H), 2.04 (s, 3H), 1.98 (s, 3H), 1.26 (d, *J* = 6.5 Hz, 3H); **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.57 (C_q), 170.17 (C_q), 169.48 (C_q), 139.25 (C_q), 135.27 (CH), 133.93 (CH), 132.35 (CH), 131.72 (C_q), 127.38 (CH), 121.20 (q, J_{CF} = 332 Hz, CF_3), 85.36 (CH), 73.58 (CH), 72.57 (CH), 70.39 (CH), 66.66 (CH), 20.90 (CH_3), 20.80 (CH_3), 20.72 (CH_3), 16.61 (CH_3); **HRMS(ESI)**: m/z calcd for $C_{19}H_{23}F_3NO_8S_2$ [M+H] +514.0812; found 514.0811. **Aspect** : amorphous.

Diastereoisomer 3cb

R_f (50% EtOAc/Cyclohexane) = 0.40; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.20 (d, *J* = 8.0 Hz, 1H), 7.86 (d, *J* = 8.0 Hz, 1H), 7.67 (t, *J* = 7.7 Hz, 1H), 7.47 (t, *J* = 7.7 Hz, 1H), 5.39 – 5.32 (m, 2H), 5.09 (dd, *J* = 9.9, 3.2 Hz, 1H), 4.79 (d, *J* = 10.1 Hz, 1H), 4.23 (bs, NH), 3.93 (q, *J* = 6.5 Hz, 1H), 2.20 (s, 3H), 2.03 (s, 3H), 1.99 (s, 3H), 1.28 (d, *J* = 6.5 Hz, 3H); **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.69 (C_q), 170.17 (C_q), 169.54 (C_q), 140.64 (C_q), 135.60 (CH), 133.44 (CH), 131.37 (CH), 127.11 (CH), 121.36 (q, J_{CF} = 332 Hz, CF_3), 86.45 (CH), 73.35 (CH), 72.44 (CH), 70.28 (CH), 66.89 (CH), 20.80 (CH_3), 20.72 (CH_3), 20.64 (CH_3), 16.64 (CH_3), (one carbon (Cq) is missing); **HRMS(ESI)**: m/z calcd for $C_{19}H_{23}F_3NO_8S_2$ [M+H] +514.0812; found 514.0811. **Aspect** : amorphous.

*imino(trifluoromethyl)(2-(((2S,3R,4S,5S,6R)-3,4,5-trihydroxy-6-(hydroxymethyl)tetrahydro-2H-pyran-2-yl)thio)phenyl)-l6-sulfanone **3d***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (32 mg, 0.034 mmol, 10 mol %), ß-thioglucose **1c** (80 mg, 0.41 mmol, 1.2 equiv), 2-iodo-sulfoximine **2a** (114 mg, 0.34 mmol, 1 equiv). Then, a mixture of dioxane/H_2O (1mL/0.5mL) was added and to the solution was added Et_3N (69 µL, 0.51 mmol, 1.5 equiv) dropwise. The mixture was stirred at 60°C for 30 min.

The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. This crude was purified by column chromatography on silica gel (DCM/ MeOH 8/2), and the desired product **3d** was isolated as a yellow oil in 47% yield. The ratio of diastereoisomers of compound **3d** was about 0.97:1 (by NMR).

The chromatographic separation was achieved using a Agilent infinity 1260 (4.6 x 150 mm) 5µm column. The mobile phase was Methanol and H_2O + 0.1DEA (Grad MeOH 30 to 80%) in 15 min. The column temperature was maintained at 25°C and the eluent was monitored at a wavelength of 254 nm. The injection volume was 10 µL. The typical retention time of diastereoisomers of compound **3d** was about 9.5 min and 11.5 min, respectively.

Diastereoisomer 3da

R_f (20% MeOH/DCM) = 0.6; **$[\alpha]_D^{19}$ = -** 37.53 (c, 1.66 in $CHCl_3$); **IR (neat, cm^{-1})** 1634, 1452, 1279, 1042, 991 ; **^{1}H NMR (300 MHz, CD_3OD) δ** 8.18 (d, *J* = 7.7 Hz, 1H), 8.04 (d, 8.1 Hz, 1H), 7.75 (t, *J* = 7.5 Hz, 1H), 7.52 (t, *J* = 7.7 Hz, 1H), 4.76 (d, *J* = 9.6 Hz, 1H), 3.95 (d, *J* = 11.9 Hz, 1H), 3.78 – 3.59 (m, 1H), 3.53 – 3.38 (m, 4H); this sample was contaminated by an amount of diethylamine used during the HPLC purification: pics at 3.36 (q) and 1.31 (t), **^{13}C NMR (75 MHz, CD_3OD) δ** 142.53 (C_q), 136.61 (CH), 134.53 (CH), 132.11 (CH), 131.64 (C_q), 127.28 (CH), 88.20 (CH), 80.84 (CH), 76.37 (CH), 70.86 (CH), 70.45 (CH), 62.74 (CH_2), (one carbon (-CF_3) is missing); **^{19}F NMR (188 MHz, CD_3OD) δ -**78.58 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{13}H_{17}F_3NO_6S_2$ [M+H] +404.0444; found 404.0460. **Aspect** : Colorless oil.

Diastereoisomer 3db

R_f (20% MeOH/DCM) = 0.5 ; **$[\alpha]_D^{19}$** = - 2.11 (c, 1.66 in $CHCl_3$); **IR (neat, cm^{-1})** 1634, 1453, 1280, 1105, 1016 ; **^{1}H NMR (300 MHz, CD_3OD) δ** 8.23 (d, *J* = 7.8 Hz, 1H), 7.97 (d, 8.1 Hz, 1H), 7.77 (t, *J* = 7.7 Hz, 1H), 7.52 (t, *J* = 7.5 Hz, 1H), 4.90 (s, 1H), 3.50(d, *J* = 11.8 Hz, 1H), 3.43 (dd, *J* = 12.1, 5.8 Hz, 1H), 3.56 – 3.37 (m, 4H); this sample was contaminated by a small amount of diethylamine used during the HPLC purification: pics at 2.97 (q) and 1.29 (t),; **^{13}C NMR (75 MHz, CD_3OD) δ** 142.47 (C_q), 136.62 (CH), 134.12 (CH), 132.83 (CH), 131.98 (C_q), 122.69 (q, J_{CF} = 333 Hz, CF_3), 88.88 (CH), 80.78 (CH), 76.25 (CH), 70.66 (CH), 70.42 (CH), 62.79 (CH_2) ; **^{19}F NMR (188 MHz, CD_3OD) δ -**78.12 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{13}H_{17}F_3NO_6S_2$ [M+H] +404.0444; found 404.0460. **Aspect** : Colorless oil.

*(2R,3R,4S,5R,6S)-2-(hydroxymethyl)-6-((2-(-imino(l1-oxidanyl)(trifluoromethyl)-l5-sulfanyl)phenyl)thio)tetrahydro-2H-pyran-3,4,5-triol **3e***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (61 mg, 0.064 mmol, 10 mol %), ß-thiogalactose **1f** (150 mg, 0.768 mmol, 1.2 equiv), 2-iodo-sulfoximine **2a** (213 mg, 0.64 mmol, 1 equiv). Then, dioxane/H_2O (1mL/0.5mL) was added before adding Et_3N (130 µL, 0.95 mmol, 1.5 equiv) dropwise. The mixture was stirred at 60°C for 30 min.

The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. This crude was purified by column chromatography on silica gel (DCM/ MeOH: 9/1), and the desired product **3e** was isolated as a yellow oil in 40% yield. The ratio of diastereoisomers of compound **3e** was about 1:0.93 (by NMR).

The chromatographic separation was achieved using a Agilent infinity 1260 (4.6 x 150 mm) 5µm column. The mobile phase was Methanol and H_2O + 0.1AcF (Grad MeOH 25 to 40%) in 15min. The column temperature was maintained at 25°C and the eluent was monitored at a wavelength of 254 nm. The injection volume was 10 µL. The typical retention time of diastereoisomers of compound **3e** was about 8.9 min and 9.8 min, respectively.

Diastereoisomer 3ea

R_f (10% MeOH/DCM) = 0.03 ; **$[\alpha]_D^{19}$** = + 12.53 (c, 1.66 in $CHCl_3$); **IR (neat, cm^{-1})** 1648, 1632, 1279, 1196, 1060 ; **^{1}H NMR (300 MHz, CD_3OD) δ** 8.24 (d, *J* = 8.1 Hz, 1H), 8.03 (d, *J* = 7.9 Hz, 1H), 7.77 (t, *J* = 7.1 Hz, 1H), 7.53 (t, *J* = 7.4 Hz, 1H), 4.83 (m, 1H), 3.99 (d, *J* = 3.0 Hz, 1H), 3.88-3.73 (m, 4H), 3.62 (dd, *J* = 9.1, 3.2 Hz, 1H); **^{13}C NMR (75 MHz, CD_3OD) δ** 142.53 (C_q), 136.61 (CH), 134.53 (CH), 132.11 (CH), 131.64 (C_q), 127.28 (CH), 88.20 (CH), 80.84 (CH), 76.37 (CH), 70.86 (CH), 70.45 (CH), 62.74 (CH_2) (one carbon (-CF_3) is missing); **^{19}F NMR (188 MHz, CD_3OD) δ -**78.59 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{13}H_{17}F_3NO_6S_2$ [M+H] +404.0444; found 404.0454. **Aspect** : Yellow oil.

Diastereoisomer 3eb

R_f (10% MeOH/DCM) = 0 ; **$[\alpha]_D^{19}$** = + 47.95 (c, 1.66 in $CHCl_3$); **IR (neat, cm^{-1})** 1634, 1625, 1182, 1052; **^{1}H NMR (300 MHz, CD_3OD) δ** 8.22 (d, *J* = 7.9 Hz, 1H), 8.12 (d, *J* = 8.1 Hz, 1H), 7.79 (t, *J* = 7.7 Hz, 1H), 7.55 (t, *J* = 7.7 Hz, 1H), 4.77 (d, *J* = 9.6 Hz, 1H), 4.00 (d, *J* = 2.9 Hz, 1H), 3.90 – 3.71 (m, 4H), 3.62 (dd, *J* = 9.1, 3.1 Hz, 1H); **^{13}C NMR (75 MHz, CD_3OD) δ** 142.47 (C_q), 136.62 (CH), 134.12 (CH), 132.83 (CH), 131.98 (C_q), 127.40 (CH), 122.69 (q, J_{CF} = 333 Hz, CF_3), 88.88 (CH), 80.78 (CH), 76.25 (CH), 70.66 (CH), 70.42 (CH), 62.79 (CH_2) ; **^{19}F NMR (188 MHz, CD_3OD) δ -**78.12 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{13}H_{17}F_3NO_6S_2$ [M+H] +404.0444; found 404.0454. **Aspect** : Yellow oil.

*(2R,3R,4S,5R,6S)-2-((benzoyloxy)methyl)-6-((2-(S-(trifluoromethyl)sulfonimidoyl)phenyl)thio)tetrahydro-2H-pyran-3,4,5-triyl tribenzoate **3f***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (52 mg, 0.054 mmol, 10 mol %), tetrabenzoylated ß-thioglucose **1d** (400 mg, 0.653 mmol, 1.2 equiv), 2-iodo-sulfoximine **2a** (182 mg, 0.54 mmol, 1 equiv). After, dioxane (1mL) was added before adding Et_3N (110 µL, 0.815 mmol, 1.5 equiv) dropwise. Then, the mixture was stirred at 60°C for 30 min.

The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. This crude was purified by column chromatography on silica gel (Cyclohexane/ EtOAc: 5/5), and compound **3f** was isolated as a yellow oil in 45% yield. The ratio of diastereoisomers of compound **3f** was about 0.71:1 (by NMR).

The chromatographic separation was achieved using a Agilent infinity 1260 (4.6 x 150 mm) 5µm column. The mobile phase was Acetonitrile and H_2O + 0.1AcF in the ratio of 35:65, v/v in 40min. The column temperature was maintained at 25°C and the eluent was monitored at a wavelength of 254 nm. The injection volume was 10 µL. The typical retention time of diastereoisomers of compound **3f** was about 22.0 min and 22.9 min, respectively.

Diastereoisomer 3fa

R_f (50% EtOAc/Cyclohexane) = 0.74; **$[\alpha]_D^{19}$** = + 47.95 (c, 1.66 in $CHCl_3$); **IR (neat, cm^{-1})** 1728, 1451, 1258, 1067, 1025, 800, 706 ; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.18 (d, *J* = 7.9 Hz, 1H), 8.01 (d, *J* = 7.3 Hz, 2H), 7.94-7.88 (m, 6H), 7.81 (d, *J* = 7.4 Hz, 2H), 7.62-7.28 (m, 13H + pic of $CHCl_3$), 5.99 (t, *J* = 9.4 Hz, 1H), 5.69-5.60 (m, 2H), 5.27 (d, *J* = 10.0 Hz, 1H), 4.66 (dd, *J* = 12.3, 2.8 Hz, 1H), 4.51 (dd, *J* = 12.1, 6.6 Hz, 1H), 4.30 – 4.22 (m, *J* = 7.0 Hz, 1H), 3.72 (bs, NH) ; **^{13}C NMR (75 MHz, $CDCl_3$) δ** 165.89 (C_q), 165.52 (C_q), 165.23 (C_q), 139.25 (C_q), 135.28 (CH), 133.76 (CH), 133.47 (3xCH), 130.05 (CH), 129.93 (2xCH), 128.83 (6xCH), 128.63 (3xC_q), 128.49 (4xCH), 127.72 (5xCH), 85.74 (CH), 74.11 (CH), 70.48 (CH), 69.63 (CH), 63.48 (CH_2), some carbons are missing; **^{19}F NMR (188 MHz, $CDCl_3$) δ** -76.26 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{41}H_{33}F_3NO_{10}S_2$ [M+H] +820.1492; found 820.1474. **Aspect** : Yellow oil.

Diastereoisomer 3fb

R_f (50% EtOAc/Cyclohexane) = 0.7; **$[\alpha]_D^{19}$** = + 35.48 (c, 1.66 in $CHCl_3$); **mp**: 125.4 – 128.3 **°C**; **IR (neat, cm^{-1})** 1721, 1244, 1177, 1063, 736, 705 ; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.08 (t, J = 8.5 Hz, 4H), 7.92 (m, 6H), 7.82 (d, *J* = 7.3 Hz, 2H), 7.60-7.18 (m, 12H + pic of $CHCl_3$), 6.00 (t, *J* = 9.4 Hz, 1H), 5.74 - 5.62 (m, 2H), 5.15 (d, *J* = 10.0 Hz, 1H), 4.73 (d, *J* = 8.3 Hz, 1H), 4.58 – 4.50 (m, 1H), 4.37-4.32 (m, 1H), 4.02 (bs, NH) ; **^{13}C NMR (75 MHz, $CDCl_3$) δ** 166.09 (C_q), 165.85 (C_q), 165.43 (C_q), 165.24 (C_q), 140.69 (C_q), 135.51 (CH), 133.75 (CH), 133.49 (2xCH), 131.28 (CH), 130.04 (2xCH), 129.90 (6xCH), 128.99 (C_q), 128.79 (C_q), 128.64 (4xCH), 128.47 (3xCH), 128.36 (2xCH), 126.98 (CH), 120.97 (q, J_{CF} = 331 Hz, CF_3), 86.64 (CH), 76.59 (CH), 74.04 (CH), 70.42 (CH), 69.66 (CH), 63.67 (CH_2); **^{19}F NMR (188 MHz, $CDCl_3$) δ** -76.22 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{41}H_{33}F_3NO_{10}S_2$ [M+H] +820.1492; found 820.1474. **Aspect** : Yellow solid.

*(l1-oxidanyl)(trifluoromethyl)(2-(((2S,3R,4S,5R,6R)-3,4,5-trimethoxy-6-(methoxymethyl)tetrahydro-2H-pyran-2-yl)thio)phenyl)-l5-sulfanimine **3g***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (31 mg, 0.032 mmol, 10 mol %), tetramethoxylated ß-thioglucose **1e** (160 mg, 0.634 mmol, 2.0 equiv), 2-iodo-sulfoximine **2a** (106 mg, 0.32 mmol, 1 equiv). After, Dioxane (1mL) was added before adding Et_3N (64 µL, 0.48 mmol, 1.5 equiv) dropwise. Then, the mixture was stirred at 60°C for 30 min.

The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. This crude was purified by column chromatography on silica gel (Cyclohexane/ EtOAc: 5/5), and compound **3g** was isolated as a yellow oil in 66% yield. The ratio diastereoisomers of compound **3g** was about 1:0.92 (by NMR).

The chromatographic separation was achieved using a Agilent infinity 1260 (4.6 x 150 mm) 5µm column. The mobile phase was Methanol and H_2O + 0.1AcF in the ratio of 45:55, v/v in 40min. The column temperature was maintained at 25°C and the eluent was monitored at a wavelength of 254 nm. The injection volume was 10 µL. The typical retention time of diastereoisomers of compound **3g** was about 10.8 min and 11.5 min, respectively.

Diastereoisomer 3ga

R_f (50% EtOAc/Cyclohexane) = 0.5; **$[\alpha]_D^{19}$** = + 91.8 (c, 1.66 in $CHCl_3$); **IR (neat, cm^{-1})** 1756, 1452, 1177, 1093, 1030, 820, 736 ; **^{1}H NMR (300 MHz, CD_3OD) δ** 8.21 (d, *J* = 8.0 Hz, 1H), 7.98 (d, *J* = 8.1 Hz, 1H), 7.79 (t, *J* = 7.7 Hz, 1H), 7.55 (t, *J* = 7.7 Hz, 1H), 4.78 (d, *J* = 9.9 Hz, 1H), 3.73 (s, 4H), 3.67 (s, 3H), 3.61 (s, 3H), 3.6 – 3.55 (m, 1H), 3.46 (s, 3H), 3.41-3.38 (m, 1H), 3.38 – 3.34 (m, 1H), 3.26 - 3.14 (m, 2H); **^{13}C NMR (75 MHz, $CDCl_3$) δ** 141.18 (C_q), 135.62 (CH), 133.15 (CH), 131.79 (CH), 131.46 (C_q), 126.77 (CH), 121.37 (q, J_{CF} = 332 Hz, CF_3), 88.75 (CH), 87.79 (CH), 82.87 (CH), 79.41 (CH), 78.98 (CH), 71.60 (CH_2), 61.18 (CH_3), 61.11 (CH_3), 60.68 (CH_3), 59.56 (CH_3); **^{19}F NMR (188 MHz, $CDCl_3$) δ** -76.52 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{17}H_{25}F_3NO_{16}S_2$ [M+H] +460.1069; found 460.1068. **Aspect** : Colorless oil.

Diastereoisomer 3gb

R_f (50% EtOAc/Cyclohexane) = 0.48; **$[\alpha]_D^{19}$** = - 2.11 (c, 1.66 in $CHCl_3$); **IR (neat, cm^{-1})** 1453, 1289, 1177, 1089, 1014, 797; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.19 (d, *J* = 8.1 Hz, 1H), 8.04 (d, *J* = 8.2 Hz, 1H), 7.62 (t, *J* = 7.7 Hz, 1H), 7.40 (t, *J* = 7.7 Hz, 1H), 5.80 (d, *J* = 5.5 Hz, 1H), 4.10 - 4.04 (m, 2H), 3.65 (s, 3H), 3.60 (dd, *J* = 9.0 Hz, *J* = 3.6 Hz, 1H), 3.55 (s, 3H), 3.46 – 3.39 (m, 8H), 3.33 – 3.27 (m, 1H) ; **^{13}C NMR (75 MHz, $CDCl_3$) δ** 142.10 (C_q), 135.48 (CH), 133.59 (CH), 131.15 (CH), 130.51 (C_q), 126.06 (CH), 85.61 (CH), 83.80 (CH), 81.58 (CH), 78.94 (CH), 71.55 (CH), 70.96 (CH_2), 61.17 (CH_3), 60.60 (CH_3), 59.29 (CH_3), 57.89 (CH_3) (one carbon (-CF_3) is missing); **^{19}F NMR (188 MHz, $CDCl_3$) δ** – 76.16 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{17}H_{25}F_3NO_{16}S_2$ [M+H] +460.1069; found 460.1068. **Aspect** : Colorless oil.

*(2-(((2S,3R,4S,5R,6R)-4-((tert-butyldimethylsilyl)oxy)-6-(((tert-butyldimethylsilyl)oxy)methyl)-3,5-dihydroxytetrahydro-2H-pyran-2-yl)thio)phenyl)(imino)(trifluoromethyl)-l6-sulfanone **3h***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (7 mg, 0.0075 mmol, 10 mol %), 2,4- tert-butyldimethylsilyl ß-thioglucose **1g** (64 mg, 0.1516 mmol, 2.0 equiv), 2-iodo-sulfoximine **2a** (25 mg, 0.075 mmol, 1 equiv). After, dioxane (1mL) was added before adding Et_3N (15 µL, 0.112 mmol, 1.5 equiv) dropwise. Then, the mixture was stirred at 60°C for 30 min.

The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. This crude was purified by column chromatography on silica gel (DCM/ MeOH: 2/8), and compound **3h** was isolated as a yellow oil in 56% yield. The ratio of diastereoisomers of compound **3h** was about 1:0.98 (by NMR).

The diastereoisomers were separated directly by column chromatography on silica gel (DCM/MeOH : 2/8).

Diastereoisomer 3ha

R_f (20% MeOH/DCM) = 0.53 ; **$[\alpha]_D^{19}$** = - 41.74 (c, 1.66 in $CHCl_3$); **IR (neat, cm^{-1})** 1250, 1076, 1005, 835, 811, 737 ; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.29 (d, *J* = 8.2 Hz, 1H), 7.95 (d, *J* = 8.0 Hz, 1H), 7.63 (t, *J* = 7.6 Hz, 1H), 7.48 (t, *J* = 7.7 Hz, 1H), 4.62 (d, *J* = 9.6 Hz, 1H), 4.17 – 4.08

(m, 2H), 3.94 (dd, *J* = 11.2, 2.6 Hz, 1H), 3.85 (dd, *J* = 10.7, 4.7 Hz, 1H), 3.55 – 3.40 (m, 3H), 2.92 (d, *J* = 2.4 Hz, 1H), 2.51 (s, 1H), 0.90 (s, 18H), 0.14 (s, 3H), 0.07 (s, 9H); **^{13}C NMR (75 MHz, $CDCl_3$) δ**135.46 (CH), 135.35 (CH), 133.25 (CH), 127.99 (CH), 88.41 (CH), 79.83 (CH), 79.52 (CH), 72.40 (CH), 71.59 (CH), 63.71 (CH_2), 29.85 (2xC_q), 26.13 (3xCH_3), 26.08 (3xCH_3), 1.17 (CH_3), -4.00(CH_3), -4.61 (CH_3), -5.2 (CH_3), 2 Cq_{arom} + CF_3 carbons are missing; **^{19}F NMR (188 MHz, $CDCl_3$) δ -**76.61 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{25}H_{45}F_3NO_6S_2Si_2$ [M+H] +632.2173; found 632.2181. **Aspect** : Yellow oil.

Diastereoisomer 3hb

R_f (20% MeOH/DCM) = 0.45 ; **$[\alpha]_D^{19}$** = - 56.32 (c, 1.66 in $CHCl_3$); **IR (neat, cm^{-1})** 1258, 1043, 1017, 835, 780, 737 ; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.25 (d, *J* = 8.0 Hz, 1H), 8.07 (d, *J* = 7.7 Hz, 1H), 7.64 (t, *J* = 7.6 Hz, 1H), 7.52 (t, *J* = 7.6 Hz, 1H), 4.54 (d, *J* = 9.6 Hz, 1H), 4.17-4.07 (m, 2H), 3.96 (dd, *J* = 10.8, 2.1 Hz, 1H), 3.87 (dd, *J* = 10.8, 4.2 Hz, 1H), 3.72 – 3.67 (m, 1H), 3.57-3.40 (3, 2H), 3.25 (dt, *J* = 9.9, 2.1 Hz, 1H), 2.48 (s, 1H), 0.93 (s, 9H), 0.89 (s, 9H), 0.18 – 0.05 (m, 12H); **^{13}C NMR (75 MHz, $CDCl_3$) δ** 137.90 (Cq), 135.47 (CH), 135.34 (CH), 133.24 (CH), 132.3 (Cq), 127.99 (CH), 88.41 (CH), 79.83 (CH), 79.52 (CH), 72.39 (CH), 71.59 (CH), 63.71 (CH_2), 29.86 (2xC_q), 26.13 (3xCH_3), 26.08 (3xCH_3), 1.17 (CH_3), -4.00 (CH_3), -4.61 (CH_3), -5.19 (CH_3), 1 Cq (-CF_3) carbons are missing; **^{19}F NMR (188 MHz, $CDCl_3$) δ** -76.18 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{25}H_{45}F_3NO_6S_2Si_2$ [M+H] +632.2173; found 632.2181. **Aspect** : Yellow oil.

*(2R,3S,4S,5R,6S)-2-(acetoxymethyl)-6-((5-methyl-2-(S-(trifluoromethyl)sulfonimidoyl)phenyl)thio)tetrahydro-2H-pyran-3,4,5-triyl triacetate **3i***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (23 mg, 0.024 mmol, 10 mol %), tetraacetylated ß-thiogalactose **1a** (125 mg, 0.343 mmol, 1.5 equiv), 2-iodo,4-methyl-sulfoximine **2b** (80 mg, 0.24 mmol, 1 equiv). After, Et_3N (48 µL, 0.36 mmol, 1.5 equiv) was added drop by drop. Then, Dioxane (1mL) was added and the mixture was stirred at 60°C for 30 min.

The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. This coupling product was purified by column chromatography on silica gel (Pentane/ EtOAc: 6/4), and was isolated as a white solid in 50% yield. The ratio of diastereoisomers of compound **3i** was about 1:1 (by NMR).

The chromatographic separation was achieved using a Chromatographic conditions: Lux-Cellulose-1 (250 x 10 mm), hexane / ethanol (70/30) as mobile phase, flow-rate = 5 mL/min, UV detection at 254 nm. Injections: 60 times 50 µL, every 4 minutes.

After the separation of the two diastereoisomers, we observed unfortunately epimerization during the storage. Herein we provided only NMR data of a mixture.

^{1}H NMR (300 MHz, $CDCl_3$) (mixture of $diastereoisomer_{major}$ + $diastereoisomer_{minor}$) **δ** 8.13 (d, *J* = 8.2 Hz, $1H_{major}$), 8.06 (d, *J* = 9.0 Hz, $1H_{minor}$), 7.69 (s, $1H_{major}$), 7.65 (s, $1H_{minor}$),7.27 (d, *J* = 8.2 Hz, $1H_{major+ minor}$+ pic of $CHCl_3$), 5.47 (d, *J* = 2.4 Hz, $1H_{major+ minor}$), 5.37 (td, *J* = 10.0, 7.1 Hz, $1H_{major+ minor}$), 5.10 (dd, *J* = 9.9, 3.3 Hz, $1H_{major+ minor}$), 4.89 (d, *J* = 10.1 Hz, $1H_{major}$), 4.83 (d, *J* = 10.1 Hz, $1H_{minor}$), 4.19-3.90 (m, $3H_{major+ minor}$, $NH_{major+ minor}$), 2.47 (s, $3H_{major+ minor}$), 2.18 (s, $3H_{major+ minor}$), 2.05 (s, $6H_{major+ minor}$), 1.98 (s, $3H_{major+ minor}$); **^{13}C NMR (75 MHz, $CDCl_3$)** (mixture of $diastereoisomer_{major}$ + $diastereoisomer_{minor}$) **δ** 170.42 (C_q), 170.22 (C_q), 170.07 (C_q), 169.42 (C_q), 147.03 (C_q), 146.79 (C_q), 138.54 (C_q), 134.05 (CH_{major}), 133.56 (CH_{minor}), 133.32 (CH_{major}), 132.06 (CH_{minor}), 128.41 (CH_{major}), 127.98 (CH_{minor}), 86.71 (CH_{minor}), 85.88 (CH_{major}), 74.89 (CH), 74.71 (CH), 72.09 (CH), 72.01 (CH), 67.47 (CH), 66.82 (CH), 66.72 (CH), 62.34 (CH_{2minor}), 62.10 (CH_{2major}), 21.98 (CH_3) 20.78 (2xCH_3), 20.66 (2xCH_3), 1 Cq (-CF_3) carbons are missing; **HRMS(ESI)**: m/z calcd for $C_{22}H_{27}F_3NO_{10}S_2$ [M+H] +586.1023; found 586.1102. **Aspect** : White solid.

*(2R,3R,4S,5R,6S)-2-(acetoxymethyl)-6-((2-(S-methylsulfonimidoyl)phenyl)thio)tetrahydro-2H-pyran-3,4,5-triyl triacetate **3j***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (34 mg, 0.036 mmol, 10 mol %), tetraacetylated ß-thioglucose **1b** (156 mg, 0.43 mmol, 1.2 equiv), S-Methyl-2-iodo-sulfoximine **2c** (100 mg, 0.36 mmol, 1 equiv). After, Et_3N (73 µL, 0.54 mmol, 1.5 equiv) was added drop by drop. Then, Dioxane (1mL) was added and the mixture was stirred at 60°C for 2 days. The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. This coupling product was purified by column chromatography on silica gel ((EtOAc: 100%), and was isolated as a white solid in 49% yield as a mixture of two diastereoisomers. Both diastereoisomers **3ja** and **3jb** were separated through a preparative TLC (Cyclohexane/ EtOAc : 5/5).

Diastereoisomer 3ja (amorphous)

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.14 (d, *J* = 7.8 Hz, 1H), 7.78 (d, *J* = 7.8 Hz, 1H), 7.56 (t, *J* = 7.5 Hz, 1H), 7.46 (t, *J* = 7.5 Hz, 1H), 5.27 (t, *J* = 8,7 Hz, 1H), 5,19 – 5.06 (m, 2H), 4.96 (d, *J* = 10.0 Hz, 1H), 4.21 – 4.07 (m, 2H), 3.78 – 3.72 (m, 1H), 3.34 (s, 3H), 2.85 (bs, NH), 2.06 – 2.01 (m, 12H); **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.52 (C_q), 170.28 (C_q), 169.48 (C_q), 169.23 (C_q), 143.42 (C_q), 134.10 (C_q), 133.56 (CH), 133.17 (CH), 130.08 (CH), 128.01 (CH), 85.95 (CH), 76.09 (CH), 73.93 (CH), 70.21 (CH), 68.20 (CH), 62.11 (CH_2), 43.20 (CH_3), 20.83 (CH_3), 20.80 (CH_3), 20.70 (2xCH_3); **HRMS(ESI)**: m/z calcd for $C_{21}H_{28}F_3NO_{10}S_2$ [M+H] +518.1151; found 518.1155.

Compound 3jb (amorphous)

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.14 (d, *J* = 7.8 Hz, 1H), 7.77 (d, *J* = 7.8 Hz, 1H), 7.55 (t, *J* = 7.5 Hz, 1H), 7.45 (t, *J* = 7.5 Hz, 1H), 5.27 (t, *J* = 9.4, 1H), 5.19 – 5.07 (m, 2H), 4.92 (d, *J* = 9.9 Hz, 1H), 4.24 – 4.08 (m, 2H), 3.79 – 3.75 (m, 1H), 3.30 (s, 3H), 2.51(bs, NH), 2.08 – 2.00 (m, 12H); **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.53 (C_q) 170.24 (C_q), 169.49 (C_q), 169.20 (C_q), 143.29 (C_q), 134.84 (C_q), 133.57 (CH), 132.55 (CH), 130.06 (CH), 127.87 (CH), 86.22 (CH), 76.01 (CH), 73.92 (CH), 70.33 (CH), 68.26 (CH), 62.27 (CH_2), 42.93 (CH_3), 20.83 (CH_3), 20.78 (CH_3), 20.71 (2xCH_3); **HRMS(ESI)**: m/z calcd for $C_{21}H_{28}F_3NO_{10}S_2$ [M+H] +518.1151; found 518.1155.

*(2R,3R,4S,5R,6S)-2-(acetoxymethyl)-6-(((2R,3R,4S,5R,6S)-4,5-diacetoxy-2-(acetoxymethyl)-6-((2-(S-(trifluoromethyl)sulfonimidoyl)phenyl)thio)tetrahydro-2H-pyran-3-yl)oxy)tetrahydro-2H-pyran-3,4,5-triyl triacetate **3k***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (29 mg, 0.03 mmol, 10 mol %), peracetylated ß-thiocellobiose **1i** (233 mg, 0.36 mmol, 1.2 equiv), 2-iodo-sulfoximine **2a** (100 mg, 0.3 mmol, 1 equiv). After, dioxane (1mL) was added followed by adding Et_3N (61 µL, 0.45 mmol, 1.5 equiv) dropwise. Then, the mixture was stirred at 60°C for 30 min.

The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. This crude was purified by column chromatography on silica gel (Cyclohexane/ EtOAc : 6/4), and compound **3k** was isolated as a white solid in 60% yield. The ratio of diastereoisomers of compound **3k** was about 1:0.93 respectively (by NMR).

The chromatographic separation was achieved using a Agilent infinity 1260 (4.6 x 150 mm) 5µm column. The mobile phase was Methanol and

H_2O+ 0.1AcF in the ratio of 55:45, v/v in 30min. The column temperature was maintained at 25°C and the eluent was monitored at a wavelength of 254 nm. The injection volume was 10 µL. The typical retention time of diastereoisomers of compound **3k** was about 16.9 min and 20.9 min, respectively.

Diastereoisomer 3ka

R_f (40% EtOAc/Cyclohexane) = 0.5; **$[\alpha]_D^{19}$** = - 39.64 (c, 1.66 in $CHCl_3$); **mp**: 226.1 – 228.5**°C**; **IR (neat, cm^{-1})** 1756, 1452, 1259, 1035, 767 ; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.26 (d, *J* = 7.8 Hz, 1H), 7.80 (d, *J* = 7.9 Hz, 1H), 7.64 (t, *J* = 7.7 Hz, 1H), 7.48 (t, *J* = 7.7 Hz, 1H), 5.24 (t, *J* = 8.9 Hz, 1H), 5.17 – 5.03 (m, 3H), 4.96 – 4.85 (m, 2H), 4.53 (d, *J* = 8.2 Hz, 2H), 4.36 (dd, *J* = 10.4, 4.3 Hz, 1H), 4.18 – 4.03 (m, 2H), 3.95 (bs, NH), 3.81 (t, *J* = 9.0 Hz, 1H), 3.75 – 3.62 (m, 2H), 2.17-1.98 (m, 21H), **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.58 (C_q), 170.31 (C_q), 170.23 (C_q), 169.83 (C_q), 169.56 (C_q), 169.42 (C_q), 169.16 (C_q), 138.94 (C_q), 135.34 (CH), 134.00 (CH), 132.40 (CH), 132.02 (C_q), 127.62 (CH), 100.95 (CH), 85.09 (CH), 76.98 (CH), 76.45 (CH), 73.72 (CH), 73.06 (CH), 72.24 (CH), 71.83 (CH), 70.08 (CH), 67.97 (CH), 62.27 (CH_2), 61.74 (CH_2), 20.89 (CH_3), 20.78 (CH_3), 20.66 (5xCH_3) (one carbon (-CF_3) is missing); **^{19}F NMR (188 MHz, $CDCl_3$) δ -**76.42 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{33}H_{41}F_3NO_{18}S_2$ [M+H] +860.1711; found 860.1697. **Aspect** : White solid.

Diastereoisomer 3kb

R_f (40% EtOAc/Cyclohexane) = 0.45; **$[\alpha]_D^{19}$** = - 50.06 (c, 1.66 in $CHCl_3$); **mp**: 227.2 – 229.8 **°C**; **IR (neat, cm^{-1})** 1746, 1453, 1291, 1032, 795 ; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.18 (d, *J* = 7.8 Hz, 1H), 7.82 (d, *J* = 7.9 Hz, 1H), 7.64 (t, *J* = 7.4 Hz, 1H), 7.47 (t, *J* = 7.6 Hz, 1H), 5.32 – 5.18 (m, 1H), 5.18 – 5.01 (m, 3H), 4.93 (t, *J* = 8.5 Hz, 1H), 4.78 (d, *J* = 10.1 Hz, 1H), 4.55 (t, *J* = 8.1 Hz, 2H), 4.36 (dd, *J* = 12.5, 4.2 Hz, 1H), 4.18 – 3.98 (m, 3H), 3.88 – 3.74 (m, 2H), 3.72 – 3.62 (m, 1H), 2.13-1.97 (m, 21H); **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.57 (C_q), 170.25 (C_q), 169.79 (C_q), 169.56 (C_q), 169.43 (2xC_q), 169.18 (C_q), 140.72 (C_q), 135.57 (CH), 133.41 (CH), 131.07 (CH), 127.14 (CH), 125.95 (C_q), 101.00 (CH), 86.08 (CH), 76.83 (CH), 76.53 (CH), 73.64 (CH), 73.09 (CH), 72.26 (CH), 71.85 (CH), 70.08 (CH), 67.97 (CH), 62.41 (CH_2), 61.75 (CH_2), 20.92 (CH_3), 20.79 (CH_3), 20.67 (4xCH_3), 20.51 (CH_3) (one carbon (-CF_3) is missing); **^{19}F NMR (188 MHz, $CDCl_3$) δ -**76.12 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{33}H_{41}F_3NO_{18}S_2$ [M+H] +860.1711; found 860.1697. **Aspect** : White solid.

*(2R,3R,4S,5R,6R)-2-(acetoxymethyl)-6-(((2R,3R,4S,5R,6R)-4,5-diacetoxy-2-(acetoxymethyl)-6-(((2R,3R,4S,5R,6S)-4,5-diacetoxy-2-(acetoxymethyl)-6-((2-(S-(trifluoromethyl)sulfonimidoyl)phenyl)thio)tetrahydro-2H-pyran-3-yl)oxy)tetrahydro-2H-pyran-3-yl)oxy)tetrahydro-2H-pyran-3,4,5-triyl triacetate **3l***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (8 mg, 0.008 mmol, 10 mol %), peracetylated ß-thiomaltotriose **1j** (150 mg, 0.16 mmol, 2 equiv), 2-iodo-sulfoximine **2a** (26 mg, 0.08 mmol, 1 equiv). After, dioxane (1mL) was added followed by adding of Et_3N (16 µL, 0.12 mmol, 1.5 equiv) dropwise. Then, the mixture was stirred at 60°C for 30 min.

The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. This crude was purified by column chromatography on silica gel (DCM/ MeOH : 95/5), and compound **3l** was isolated as a colorless oil in 49% yield. The ratio of diastereoisomers of compound **3l** was about 1:0.73 (by NMR).

The chromatographic separation was achieved using an Agilent infinity 1260 (4.6 x 150 mm) 5µm column. The mobile phase was Acetonitrile and H_2O+ 0.1AcF in the ratio of 50:50, v/v in 25min. The column temperature was maintained at 25°C and the eluent was monitored at a wavelength of 254 nm. The injection volume was 10 µL. The typical retention time of diastereoisomers of compound **3l** was about 19.8 min and 21.2 min, respectively.

Diastereoisomer 3la

R_f (10% MeOH/DCM) = 0.6; **$[\alpha]_D^{19}$** = - 6.26 (c, 1.66 in $CHCl_3$); **IR (neat, cm^{-1})** 1756, 1452, 1238, 1025, 767 ; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.27 (d, *J* = 7.3 Hz, 1H), 7.84 (d, *J* = 8.1 Hz, 1H), 7.68 (t, *J* = 7.3 Hz, 1H), 7.49 (t, *J* = 7.8 Hz, 1H), 5.44 – 5.29 (m, 4H), 5.27 (d, *J* = 4.0 Hz, 1H), 5.06 (t, *J* = 9.0 Hz, 1H), 5.03 – 4.95 (m, 2H), 4.86 (dd, *J* = 10.5, 3.9 Hz, 1H), 4.75 (dd, *J* = 10.3, 3.9 Hz, 1H), 4.53 – 4.42 (m, 2H), 4.32 (dd, *J* = 12.2, 4.9 Hz, 1H), 4.22 (td, *J* = 12.8, 3.6 Hz, 2H), 4.10 – 3.87 (m, 6H), 3.87 – 3.77 (m, 1H), 2.15 (s, 6H), 2.09 (s, 3H), 2.07 – 1.92 (m, 21H) ; **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.68 (3xC_q), 170.48 (C_q), 170.39 (C_q), 170.14 (C_q), 169.99 (C_q), 169.81 (C_q), 169.67 (C_q), 169.54 (C_q), 138.86 (C_q), 135.48 (CH), 134.00 (CH), 132.39 (CH), 131.92 (C_q), 127.64 (CH), 96.11 (CH), 95.89 (CH), 84.78 (CH), 76.26 (2xCH), 74.04 (CH), 72.82 (CH), 71.87 (CH), 70.64 (CH), 70.57 (CH), 70.25 (CH), 69.57 (CH), 69.27 (CH), 68.74 (CH), 68.14 (CH), 63.30 (CH_2), 62.59 (CH_2), 61.61 (CH_2), 20.99 (CH_3), 20.93 (2xCH_3), 20.79 (CH_3), 20.71 (5xCH_3), 20.61 (CH_3), (one carbon (-CF_3) is missing); **^{19}F NMR (188 MHz, $CDCl_3$) δ -**76.46 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{45}H_{57}F_3NO_{26}S_2$ [M+H] +1148.2556; found 1148.2462. **Aspect** : Colorless oil.

Diastereoisomer 3lb

R_f (10% MeOH/DCM) = 0.51; **$[\alpha]_D^{19}$** = +56.32 (c, 1.66 in $CHCl_3$); **IR (neat, cm^{-1})** 1739, 1368, 1212, 1027, 735; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.18 (d, *J* = 8.0 Hz, 1H), 7.86 (d, *J* = 7.8 Hz, 1H), 7.68 (t, *J* = 7.2 Hz, 1H), 7.48 (t, *J* = 7.5 Hz, 1H), 5.43 – 5.24 (m, 5H), 5.06 (t, *J* = 9.9 Hz, 1H), 4.98 (t, *J* = 9.0 Hz, 1H), 4.90 – 4.82 (m, 2H), 4.75 (dd, *J* = 8.4, 4.0 Hz, 1H), 4.54 – 4.42 (m, 2H), 4.35 (dd, *J* = 9.0, 5.2 Hz, 1H), 4.23 (td, *J* = 12.0, 3.6 Hz, 2H), 4.12 –3.83 (m, 7H), 2.17 (s, 3H), 2.16 (s, 3H), 2.09 (s, 3H), 2.05 – 1.98 (m, 21H) ; **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.50 (3xC_q), 170.32 (C_q), 170.23 (C_q), 169.92 (C_q), 169.82 (C_q), 169.65 (C_q), 169.47 (C_q), 169.37 (C_q), 140.54 (C_q), 135.55 (CH), 133.22 (CH), 130.82 (CH), 126.94 (CH), 122.88 (C_q), 95.93 (CH), 95.73 (CH), 85.58 (CH), 76.07 (CH), 75.92 (CH), 73.92 (CH), 72.71 (CH), 71.70 (CH), 70.41 (CH), 70.08 (2xCH), 69.41 (CH), 69.11 (CH), 68.58 (CH), 67.97 (CH), 63.29 (CH_2), 62.47 (CH_2), 61.44 (CH_2), 20.81-20.32 (10xCH_3), (one carbon Cq is missing); **^{19}F NMR (188 MHz, $CDCl_3$) δ -**76.11 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{45}H_{57}F_3NO_{26}S_2$ [M+H] +1148.2556; found 1148.2462. **Aspect** : Colorless oil.

Coupling of enantiopure sulfoximines 2aa, 2ab

*(2R,3S,4S,5R,6S)-2-(acetoxymethyl)-6-((2-((S)-imino(l1-oxidanyl)(trifluoromethyl)-l5-sulfanyl)phenyl)thio)tetrahydro-2H-pyran-3,4,5-triyl triacetate **3aa´***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (9 mg, 0.009 mmol, 10 mol %), tetraacetylated ß-thiogalactose **1a** (49 mg, 0.13 mmol, 1.5 equiv), (R)-(+)-2-iodo-sulfoximine **2aa** (30 mg, 0.09 mmol, 1 equiv). Then, Dioxane (1mL) was added and to the solution was added Et_3N (19 µL, 0.13 mmol, 1.5 equiv) dropwise and the mixture was stirred at 60°C for 30 min.

The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. This coupling product was purified by column chromatography on silica gel (Pentane/ EtOAc: 5/5), and **3aa'**was isolated as a white solid in 78% yield.

R_f (50% EtOAc/Pentane) = 0.57; **$[\alpha]_D^{19}$** = +8.37 (c, 1.66 in $CHCl_3$); **mp**: 50.3 – 54.0 **°C ; IR (neat, cm^{-1})** 1749, 1368, 1213, 1174, 1083, 1058 ; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.25 (d, *J* = 8.0 Hz, 1H), 7.91 (d, *J* = 8.0 Hz, 1H), 7.64 (t, *J* = 7.7 Hz, 1H), 7.48 (t, *J* = 7.7 Hz, 1H), 5.46 (d, *J* = 3.2 Hz, 1H), 5.39 (t, *J* = 9.9 Hz, 1H), 5.09 (dd, *J* = 9.9, 3.2 Hz, 1H), 4.89 (d, *J* =

10.1 Hz, 1H), 4.18 – 4.15 (m, 2H), 4.04 – 3.97 (m, 2H), 2.17 (s, 3H), 2.03 (s, 6H), 1.97 (s, 3H); **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.36 (C_q), 170.16 (C_q), 160.06 (C_q), 169.39 (C_q), 138.99 (C_q), 135.22 (CH), 133.96 (CH), 132.45 (CH), 131.83 (C_q), 127.52 (CH), 121.16 (CF_3, q, J_{CF} = 333 Hz), 85.60 (CH), 74.81 (CH), 72.08 (CH), 67.34 (CH), 66.67 (CH), 61.84 (CH_2), 20.74 (2xCH_3), 20.63 (2xCH_3); **^{19}F NMR (188 MHz, $CDCl_3$) δ** -76.55 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{21}H_{25}F_3NO_{10}S_2$ [M+H] +572.0866; found 1148.0864. **Aspect** : White solid.

*(2R,3S,4S,5R,6S)-2-(acetoxymethyl)-6-((2-((R)-imino(l1-oxidanyl)(trifluoromethyl)-l5-sulfanyl)phenyl)thio)tetrahydro-2H-pyran-3,4,5-triyl triacetate **3ab´***

A sealable tube purged with argon equipped with a cap was charged with PdG_3-Xantphos (9 mg, 0.009 mmol, 10 mol %), tetraacetylated ß-thiogalactose **1a** (49 mg, 0.13 mmol, 1.5 equiv), (S)-(-)-2-iodo-sulfoximine **2ab** (30 mg, 0.09 mmol, 1 equiv). Then, Dioxane (1mL) was added and to the solution was added Et_3N (19 µL, 0.13 mmol, 1.5 equiv) dropwise and the mixture was stirred at 60°C for 30 min.

The reaction mixture was cooled to room temperature and passed through a plug of celite and rinsed with EtOAc. This coupling product was purified by column chromatography on silica gel (Pentane/ EtOAc: 5/5), and **3ab'** was isolated as a white solid in 84% yield.

R_f (50% EtOAc/Pentane) = 0.5; **$[\alpha]_D^{19}$** = + 83.43 (c, 1.66 in $CHCl_3$); **mp**: 48.0 – 52.0 **°C**; **IR (neat, cm^{-1})** 1760, 1367, 1243, 1085, 1069 ; **^{1}H NMR (300 MHz, $CDCl_3$) δ** 8.17 (d, *J* = 7.9 Hz, 1H), 7.83 (d, *J* = 8.0 Hz, 1H), 7.63 (t, *J* = 7.7 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 1H), 5.46 (d, *J* = 3.2 Hz, 1H), 5.35 (t, *J* = 10.0 Hz, 1H), 5.08 (dd, *J* = 9.9, 3.2 Hz, 1H), 4.80 (d, *J* = 10.1 Hz, 1H), 4.21 – 4.07 (m, 3H), 4.07 – 4.02 (m, 1H), 2.16 (s, 3H), 2.05 (s, 3H), 2.01 (s, 3H), 1.97 (s, 3H); **^{13}C NMR (75 MHz, $CDCl_3$) δ** 170.33 (C_q), 170.24 (C_q), 170.03 (C_q), 169.44 (C_q), 140.70 (C_q), 135.51 (CH), 133.42 (CH), 131.14 (CH), 127.98 (C_q), 127.07 (CH), 121.33 (q, J_{CF} = 334 Hz, CF_3), 86.49 (CH), 74.63 (CH), 71.97 (CH), 67.26 (CH), 66.80 (CH), 61.99 (CH_2), 20.73 (2xCH_3), 20.62 (CH_3), 20.53 (CH_3); **^{19}F NMR (188 MHz, $CDCl_3$) δ** -76.25 (CF_3); **HRMS(ESI)**: m/z calcd for $C_{21}H_{25}F_3NO_{10}S_2$ [M+H] +572.0866; found 1148.0866. **Aspect** : White solid.

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