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Tris(pentafluorophenyl)borane-Catalyzed Stereoselective C-Glycosylation of Indoles with Glycosyl Trichloroacetimidates: Access to 3-Indolyl-C-glycosides

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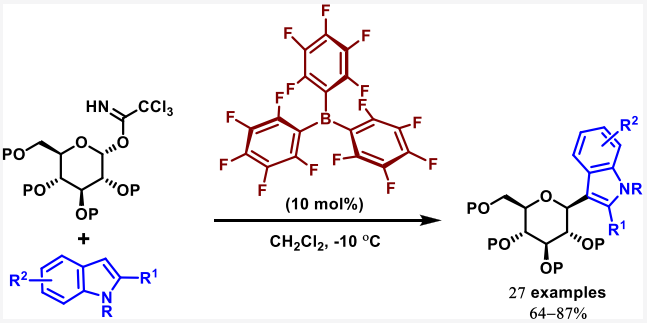
ABSTRACT: An efficient and highly regioselective method for the synthesis of 3-indolyl-C-glycosides has been developed through coupling of glycosyl trichloroacetimidates with a wide range of substituted indoles in the presence of catalytic amounts of $B(C_6F_5)_3$ within a few minutes. This methodology has a wide scope of substrates under mild reaction conditions and provides exclusively β-stereoselective 3-indolyl-C-glycosides in 64−87% yields.



Aryl-C-glycosides are unique structural motifs, signify a metabolically stable[1] class of saccharides or glycoconjugates that extensively arise in biologically relevant natural products and pharmaceutical agents.[2] Conjugation of five-membered nitrogen heterocycles such as indoles to the anomeric carbon of sugars, directly connected through a C−C bond, produces indole-C-glycosides, an important heteroaryl subclass of C-glycoside. Indeed, indole-C-glycosides with framework analogues of the natural N-nucleosides[3] have been the focus of much synthetic as well as biological research owing to the frequent incidence of these structural skeletons in biologically significant proteins[4] and antiviral activities.[5] These particular indole-C-glycosides have distinct motifs, either of natural or synthetic origin, embedded in various biological activities (Figure 1).[6]

Notably, α-C-mannosyltryptophan, as the first naturally occurring C-glycosyl amino acid, was discovered from the Trp7 of ribonuclease II.[4a] In addition, it has been gradually recognized as a well-known post-translational modification (PTM) of proteins, observed in the thrombospondin type-1 repeat (TSR) superfamily, type I cytokine receptor family, and many others.[7] It is worth mentioning that recently synthetic 3-indolyl-C-glycosides have also been approved as sodium-dependent glucose cotransporter 2 (SGLT2) inhibitors[8] for the treatment of type-2 diabetes.

In this context, different synthetic methods have been established to construct these valuable scaffolds. The first most common approach involves the formation of a C-glycosides through sequential addition of a carbanion to gluconolactone[5d,9] or 1,2-anhydro sugars[10] followed by reductive deoxygenation and C-glycosylation of indole derivatives with

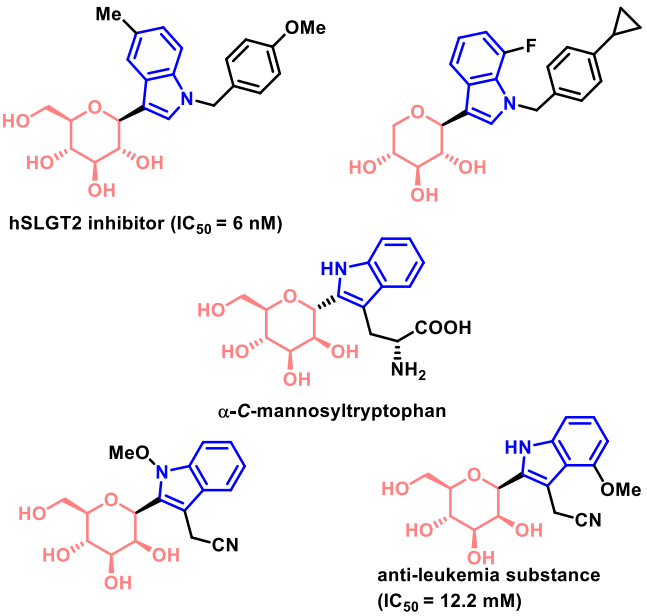


Figure 1. Some examples of bioactive molecules containing indole-C-glycosides.

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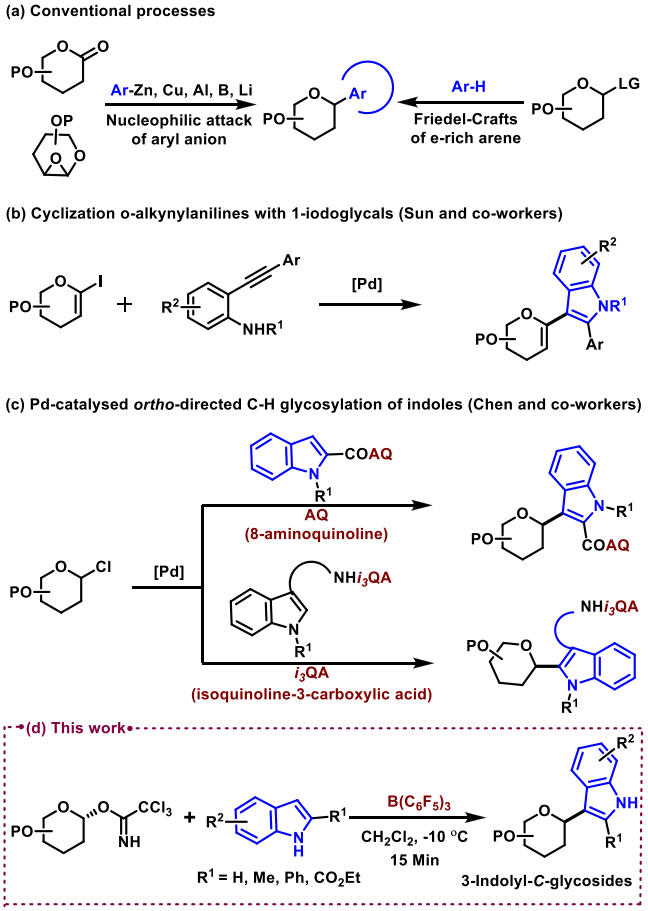
various glycosyl donors[11] using either the heteroaryl compounds in the presence of Lewis acids or the metalated heteroaryl compounds (Scheme 1a).

Scheme 1. Representative Methods for the Synthesis of Aryl-*C*-glycosides and Indole-*C*-glycosides

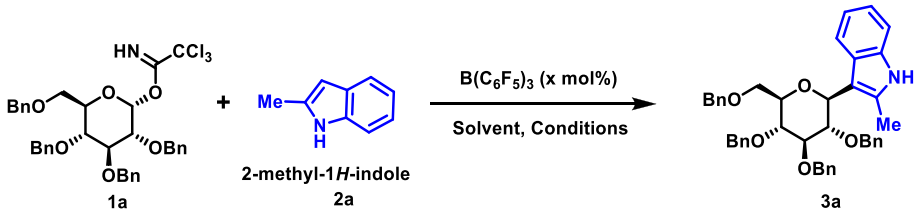


However, these traditional methods suffer from unsatisfactory yields, harsh reaction conditions, or low regio- as well as stereoselectivities. The other approach includes the generation of a nitrogen-containing heterocyclic ring,[12] which allows the reaction of the sugar one carbon unit with the corresponding benzene derivatives. In this regard, a sequential heterocyclization and C-glycosylation sequence of *o*-alkynylanilines with 1-iodoglycals was developed to construct 3-indolyl-*C*-glycosides (Scheme 1b).[12a] Moreover, recently, the formation of indoles glycosides via *ortho*-directed C−H glycosylation promoted by palladium catalyst using glycosyl chloride as a donor was developed by Chen and co-workers (Scheme 1c).[13]

Despite these advances, some of these syntheses are equivocal, as they are performed under a strident environment and often require a multistep reaction sequence with auxiliary and delicate operation conditions. Although significant progress has been made over the past few decades, only one report on the effective synthesis of stereoselective 3-indolyl-*C*-glycosides has been reported until date.[13a] Thus, the study of direct and adequate stereoselective protocols for 3-indolyl-*C*-glycosides is still highly desirable. Keeping these impediments in mind, we have investigated the efficient strategy for directly forming a *C*-glycosidic linkage (direct *C*-glycosylation) via Friedel−Crafts-type glycosylation, like a standard *O*-glycosylation.

Tris(pentafluorophenyl)borane ($B(C_6F_5)_3$ or BCF) catalyst possess relatively less Lewis acidity which may be the reason for optimal temperature for the activation of Schmidt's trichloroacetimidates donors.[14] In spite of a few reported applications of $B(C_6F_5)_3$ in carbohydrate synthesis,[15] its function in *C*-glycosylation reactions for the generation of biologically appealing 3-glycosyl indoles has not yet been reported. In addition, the electron-withdrawing nature as well as the steric bulkiness of the three C_6F_5 groups present around the boron also encouraged us to examine the activation of most used Schmidt's glycosyl donors for stereoselective *C*-glycosylation with BCF. Based on this concept, we report our results for the synthesis of 3-indolyl-*C*-glycosides by $B(C_6F_5)_3$-

Table 1. Optimization of the Reaction Conditions[a]



entry	D/A	catalyst (mol %)	solvent	temp (°C)	time	yield[b] (%)	α/β[c]
1[d]	1.2/1	BCF(10)	CH_2Cl_2	25	15 min	42	β only
2[e]	2.0/1	BCF (10)	CH_2Cl_2	25	45 min	44	β only
3	1.2/1	BCF (10)	CH_2Cl_2	25	15 min	62	β only
4	1.2/1	BCF (20)	CH_2Cl_2	25	45 min	64	β only
5	1.2/1	BCF (10)	CH_2Cl_2	0	15 min	75	β only
6	1.2/1	BCF (10)	CH_2Cl_2	−10	15 min	82	β only
7	1.2/1	BCF (10)	CH_2Cl_2	−20	3 h	66	β only
8	1.2/1	BCF (10)	CH_2Cl_2	−30	6 h	42	β only
9	1.2/1	BCF(10)	THF	−10	3h	20	ND
10	1.2/1	BCF (10)	CH_3CN	−10	3h	<10	ND

[a]The reaction was conducted with **1a** (1.2 equiv), **2a** (1.0 equiv), $B(C_6F_5)_3$ (10 mol %), solvent (4 mL). [b]Isolated yield. [c]α/β ratio was measured using ^{1}H NMR. [d]Molecular sieves were added. [e]Decomposition of the donor was observed.

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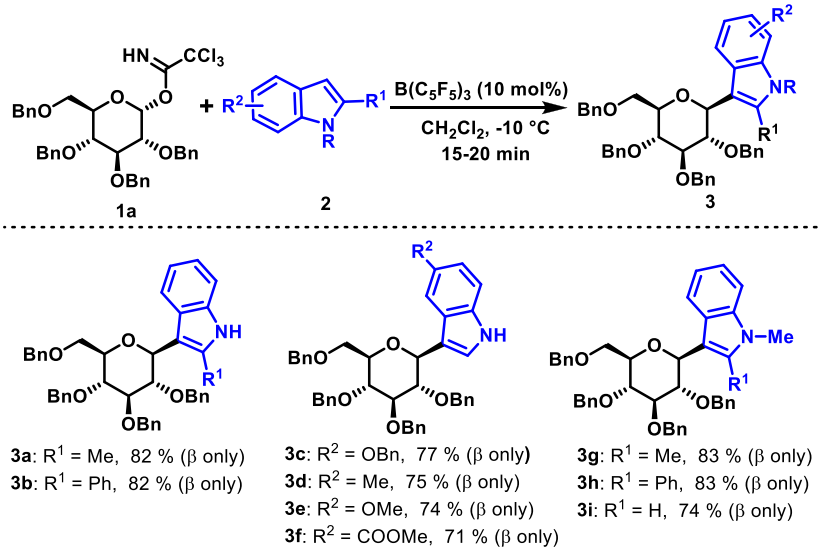
Scheme 2. $B(C_6F_5)_3$-Catalyzed Direct 3-*C*-Indole Glycosylation with Donor 1a[a]



[a]Reaction conditions: **1a** (1.2 equiv), **2** (1.0 equiv), $B(C_6F_5)_3$ (10 mol %), solvent (4 mL). [b]Isolated yield. [c]α/β ratio measured using ^{1}H NMR.

catalyzed with readily accessible glycosyl imidate donors (Scheme 1d).

Our investigation began with the optimization of the reaction conditions with perbenzylated glucose α-imidate (**1a**)[16] and 2-methylindole (**2a**) as the model substrates in dichloromethane (Table 1).

Upon glycosylation of glycosyl donor **1a** with glycosyl acceptor **2a** in 1.2:1 molar ratio in the presence of 10 mol % of $B(C_6F_5)_3$ and a pinch of molecular sieves (4 Å) at room temperature (~25 °C), the desired *C*-glycoside **3a** was isolated in 42% yield within 10 min with exclusively β-selectivity (Table 1, entry 1). However, we have not observed any α-product. The exact structure of **3a** and stereochemistry at the new stereogenic center was unequivocally established by spectroscopic analysis (for details, see the Supporting Information). In the ^{1}H NMR spectra, the indole 3-H signals were absent and the signal of the anomeric proton (at δ 4.54) with the $J_{1,2}$ values (9.3 Hz) established the β-anomeric configuration.

When the reaction was carried out changing the ratio with donor **1a** and acceptor **2a** from a 1.2:1 to 2:1 molar ratio, no improvement of yield was observed even after a long time (entry 2). However, when the glycosylation was carried out in the absence of molecular sieves, surprisingly the reaction also proceeded efficiently to give the desired *C*-glycosides **3a** in 62% yield within 15 min with exclusively β-selectivity (Table 1, entry 3). In fact, similar observations were previously reported in the case of $B(C_6F_5)_3$-catalyzed glycosylation.[14,17] To further increase the yield, we have screened the higher concentration of 20 mol % of $B(C_6F_5)_3$. However, there was no significant change observed in the product yield even after a longer time (entry 4). Thereafter, we performed the glycosylation reaction at different temperatures without using molecular sieves. As a result, the desired glycoside **3a** was obtained in 75% yield with β-selectivity at 0 °C (Table 1, entry 5). However, the glycosylation reaction at −10, −20, and −30 °C showed that the reaction progressed easily at −10 °C to furnish the highest yield **3a** in 82% with exclusively β-selectivity (Table 1, entries 6−8). Moving forward, we performed the reaction in other solvents also, such as acetonitrile and THF at −10 °C (Table 1, entries 9 and 10), but obtained lower yield in both cases, suggesting the dichloromethane was the most suitable solvent for this *C*-glycosylation.

Before evaluating the generality of this new methodology, the standard conditions were applied to the glycosylation of **1a** with 2 unsubstituted 5-(benzyloxy)-1*H*-indole and resulted in the desired product **3c** in 77% yield with good selectivity (Scheme 2).

This suggests that the optimum conditions would be applied to the *C*-glycosylation of the unsubstituted indole substrates also. We then evaluated the synthesis of 3-indolyl-*C*-glycosides with various substituted indoles at different positions using perbenzylated glucose α-imidate (**1a**). However, examination of the obtained results in Scheme 2 showed a favorable trend of C2-substituted indoles producing a slightly higher yield. Unlike C2-unsubstituted indole, this gave a poor yield possible due to the formation of minor C-2 glycosylated product. Notably, the tested substrates bearing either electron-donating groups (Me, OMe, **3d**, **3e**) or an electron-withdrawing group (CO_2Me, **3f**) at the 5-position of the indole ring were well tolerated. However, electron-donating groups (Me, OMe) at the 5-position of indole enhanced the yield to some extent. It appears that the electronic effect of the substituents exerted influences on the yield. In comparison with indoles containing an electron-withdrawing group such as CO_2Me, indoles with an electron-donating group such as Me and OMe exhibited higher reactivity. Besides, there was no evidence for *N*-glycosylated isomer formation in any case. Further, *N*-methylindole systems were also evaluated, and these also provided good yields of the corresponding 3-indolyl-*C*-glycosides (**3g**−**3i**). Obviously, C-glycosylated indoles are particularly prone to this reaction with β-selectivity. In addition, all of the obtained results indicated that BCF may undergo an intramolecular acid−base-type reaction. However, after fast adduct formation with indole this adduct reacted in stereoselective manner with the donor to afford preferentially β-stereoselective glycoside.

To further explore the effect of different commonly used glycosyl imidate donors (**1b**−**k**), such reactions were investigated (Scheme 3).

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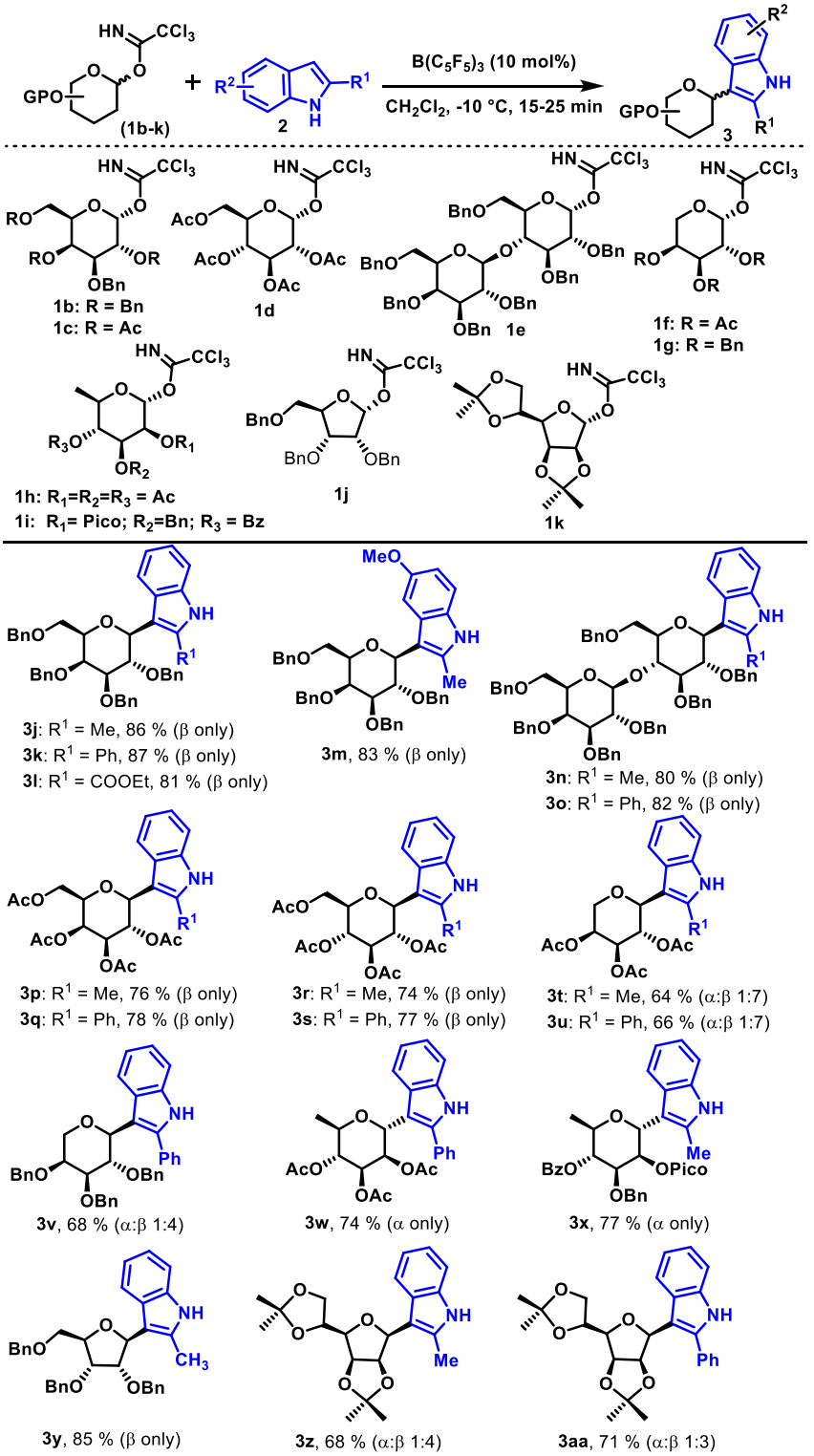
Scheme 3. Substrate Scope for Various Glycosyl Imidates and Substituted Indoles[a]



[a]Reaction conditions: **1** (1.2 equiv), **2** (1.0 equiv), $B(C_6F_5)_3$ (10 mol %), solvent (4 mL). [b]Isolated yield. [c]α:β ratio measured using ^{1}H NMR.

Initially, the glycosylation was tested with perbenzylated galactose α-imidate (**1b**) with various substituted indoles. Delightfully, the reaction proceeded smoothly and gave the 3-indole *C*-glycosides **3j**−**3m** in 81−87% yield with exclusive β selectivity. Similarly, the glycosylation was again tested with more complex perbenzylated disaccharide α-imidate (**1e**); as a result, the corresponding desired indole *C*-glycosides **3n**−**3o** were produced in good yield. Furthermore, when peracetylated glycosyl imidates **1c** and **1d** were applied for *C*-glycosylation with various indoles derivatives, the corresponding products **3p**, **3q**, **3r**, and **3s** were furnished in moderate to good yields. In addition, *C*-glycosylation was also investigated with the acetyl and benzyl group containing-6-deoxy donors, such as L-arabonopyranose α-imidate (**1f**, **1g**) donors. In general, all of

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the reactions proceeded smoothly to provide the desired products **3t**−**3v** in 64−68% yield, but with lower stereoselectivity (α:β = 1:4−1:7) probably due to their high reactivity by the lack of substitution of carbohydrate ring and conformation.[18] On the other hand, the peracetylated rhamnosyl imidate **1h** gave α-selective glycoside **3w** in 74% yield. Moreover, the reaction between picoloyl-protected rhamnosyl trichloroacetimidate **1i** with substituted indoles proceeded in good yield with α-selective product (Scheme 3). Encouraged by these results, we decided to further expand the scope of this methodology by performing the reaction using glycofuranosyl imidates (**1j**, **1k**) as a donor. Glycosylation of perbenzylated ribofuranosyl imidate **1j** with 2-methylindole (**2a**) proceeded smoothly to give indole *C*-glycosides **3y** in good yields (85%) with good selectivity. Similarly, when the isopropylidene protected mannofuranosyl imidate **1k** was subjected to establish reaction conditions with different substituted indoles to give their corresponding *C*-glycosides **3z** and **3aa** in 68% and 71% yields, respectively, with moderate selectivity (Scheme 3).

However, the exact mechanism is still uncertain. On the basis of the above discussion and previous literature reports,[14,19] we speculate that instead of an S_N1 mechanism the reaction might progress via an S_N2 or acid−base mechanism. In this regard, we performed the ^{1}H NMR experiment with 2-methylindole (acceptor) both in the presence as well as the absence of the promoter BCF (1.0 equiv) at room temperature in $CDCl_3$. We noticed that there are some interaction of the peaks 3-H to the indole in the presence of BCF, thus demonstrating the formation of the acceptor-activator adduct (Figure S1). In addition, the glycosyl imidate donor **1a** did not go through disintegration at −10 °C in the presence of 10 mol % of BCF. Only by raising the temperature did slow decomposition of **1a** take place. In previous reports, similar observations of glycosyl acceptor activation with boron-based catalysts such as BCF,[14] $PhBF_2$,[19a] and other acid−base catalyst gold chlorides were described.[19b] Derived from the experimental data and the literature reports, we anticipated that in place of performing a simple S_N2-type mechanism the BCF may undergo an acid−base-type reaction. Incipiently, the nucleophilic acceptor undergoes complex formation with the catalyst, which promotes the perbenzylated α-glucosyl imidate donor to furnish β-selective glycosides, as shown in Scheme 4.

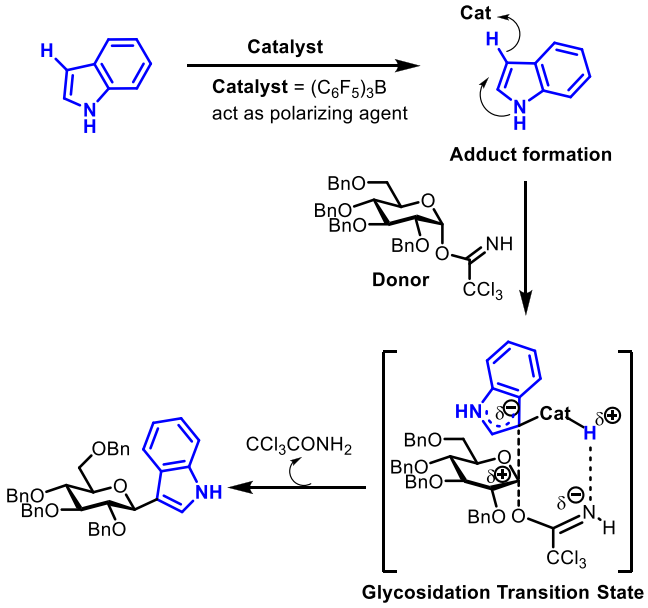
In summary, we have successfully developed the application of tris(pentafluorophenyl)borane as a productive catalyst for stereoselective *C*-glycosylation reactions involving trichloroacetimidate glycosyl donors with indoles. The reaction progresses cleanly in good to excellent yields without the need of molecular sieves and also does not require extremely low temperatures. Furthermore, the conditions are practical and mild, have broad substrate scope, and can be scaled up. Based on these outcomes, we hope that this method will acquire widespread applications in the formation of other heterocycle substrates for biological activities.

EXPERIMENTAL SECTION

General Methods. All reactions were carried out under an argon atmosphere with dry solvents under anhydrous conditions in oven-dried round-bottom flasks unless otherwise noted. Reagents were purchased at the highest commercial quality available and used without further purification unless otherwise stated. Reactions were monitored by thin-layer chromatography (TLC) carried out on 0.25 mm E. Merck silica gel plates (60F-254) using UV light as the visualizing agent also by warming ceric sulfate [2% $Ce(SO_4)_2$ in 5% H_2SO_4 in EtOH]-sprayed plates on a hot plate. Silica gel 230−400 mesh was used for column chromatography. ^{1}H NMR spectra were recorded in $CDCl_3$ on a Bruker AV 400 (400 MHz) spectrometer. $^{13}C\{^1H\}$ NMR spectra were recorded in $CDCl_3$ on a Bruker 400 (100 MHz) and Bruker 300 (75 MHz) spectrometer. Chemical shifts are reported relative to $CDCl_3$ (δ 7.26 ppm) for ^{1}H NMR and $CDCl_3$ (δ 77.0 ppm) for $^{13}C\{^1H\}$ NMR. Coupling constants are given in hertz. Structural assignments were made with additional information from gCOSY, gHSQC, and DEPT-135 experiments. High-resolution mass spectra (HRMS) were recorded as ESI-HRMS on Q-TOF mass spectrometer. Either protonated molecular ions $[M + H]^+$, sodium adducts $[M + Na]^+$, or ammonium adducts $[M + NH_4]^+$ were used for empirical formula confirmation. Commercially available grades of organic solvents are used for column chromatography for purifications. The known compounds **1a**,[16] **1b**,[20a] **1c**,[20b] **1d**,[20b] **1e**,[20c] **1f**,[20d] **1g**,[20e] **1h**,[20f] **1j**,[20g] and **1k**[20h] showed characterization data in full agreement with previously reported data.

*Experimental Procedures. 3-O-Benzyl-4-O-benzoyl-2-O-(2-pyridinecarbonyl)-α-L-rhamnopyranoside Trichloroacetimidate (**1i**).* *N*-Bromosuccinimide (737 mg, 4.1 mmol) was added at 0 °C to a solution of ethyl 3-*O*-benzyl-4-*O*-benzoyl-2-*O*-(2-pyridinecarbonyl)-1-thio-α-L-rhamnopyranoside (1.0 g, 1.9 mmol) in acetone (9 mL) and water (1 mL), and the mixture was stirred for 30 min. The reaction was quenched by addition of saturated aqueous sodium bicarbonate. The organic solvent was removed in vacuo, and the remaining aqueous solution was extracted with ethyl acetate. After being dried over anhydrous sodium sulfate, the extract was concentrated, and then the residue was dissolved in dry dichloromethane (10 mL) and cooled to 0 °C. Trichloroacetonitrile (0.24 mL, 2.4 mmol) and 1,8-diazabicyclo[5.4.0]undec-7-ene (0.15 mL, 0.9 mmol) were added. The reaction mixture was stirred for 2 h. The solvent was evaporated, and the residue was purified over SiO_2 using hexane−EtOAc (9:1) as eluent to give pure compound **1i** as colorless oil (0.52 g, 85% yield). IR (neat): 3794, 3344, 3017, 2920, 1727, 1672, 1456, 1216, 1164, 765, 669 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.84−8.83 (m, 1 H), 8.76 (s, 1 H), 8.21 (d, J = 7.9 Hz, 1 H), 7.99−7.98 (m, 2 H), 7.92−7.88 (m, 1 H), 7.63−7.59 (m, 1 H), 7.53−7.50 (m, 1 H), 7.49−7.45 (m, 2 H), 7.18−7.08 (m, 5 H), 6.43 (d, J = 1.6 Hz, 1 H), 5.88−5.87 (m, 1 H), 5.53(t, J = 9.9 Hz, 1 H), 4.67 (d, J = 12.5 Hz, 1 H), 4.52 (d, J = 12.5 Hz, 1 H), 4.18−4.12 (m, 2 H), 1.33 (d, J = 6.3 Hz, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 165.8, 163.8, 159.9, 150.5, 147.4, 137.4, 137.1, 133.5, 130.1, 129.7, 128.6, 128.5, 128.1, 127.4,

Scheme 4. Plausible Mechanism



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125.9, 95.1, 73.5, 72.4, 71.6, 69.9, 68.4, 7.9. HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{28}H_{25}Cl_3N_2NaO_7$ 629.0620; Found 629.0615.

General Glycosylation Procedures for the Prepration of 3-Indolyl-C-glycosides (3a−3z, 3aa). To a stirred solution of trichloroacetimidate glycosyl donor **1** (1.2 mmol) in freshly dried DCM (4 mL) was added substituted indole (1.0 mmol) acceptor. The reaction mixture was cooled to −10 °C and allowed to stir for 5 min, to which the activator $B(C_6F_5)_3$ or BCF (0.12 mmol with respect to donor) was added. The reaction was stirred further for 15−20 min at the same temperature, quenched by the addition of triethylamine (0.1 mL), and diluted with 20 mL of DCM. The organic layer was washed with $NaHCO_3$ (aq) and dried over Na_2SO_4. Further, the organic layer was filtered, concentrated, and subjected to column chromatography purification (hexane/ethyl acetate) using silica gel (SiO_2: 100−200) to afford the corresponding C-glycosides (**3a−3z**, **3aa**).

*3-(2,3,4,6-Tetra-O-benzyl-β-D-glucopyranosyl)-2-methyl-1H-indole (**3a**).* Glycosyl trichloroacetimidate donor **1a** (820 mg, 1.2 mmol) and 2-methylindole (**2a**, 131.07 mg, 1.0 mmol) were dissolved in freshly dried DCM (4 mL). The reaction mixture was cooled to −10 °C and allowed to stir for 5 min, to which the activator $B(C_6F_5)_3$ or BCF (61.4 mg, 0.12 mmol with respect to donor) was added. The reaction was stirred further for 15 min at the same temperature, quenched by the addition of triethylamine (0.1 mL), and diluted with 20 mL of DCM. The organic layer was washed with with $NaHCO_3$ (aq), dried (Na_2SO_4), and concentrated. The crude product was purified over SiO_2 using hexane−EtOAc (7:1) as eluent to give pure compound **3a** (535 mg, yield 82%, β only). Colorless jelly. IR (neat): 3466, 3017, 2920, 1727, 1601, 1456, 1216, 1064, 765, 669 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.83 (s, 1 H), 7.77 (d, J = 7.9 Hz, 1 H), 7.35−7.23 (m, 16 H), 7.14−7.09 (m, 4 H), 7.05−7.01 (m, 1 H), 6.84−6.82 (m, 2 H), 4.96 (d, J = 11.0 Hz, 1 H), 4.91(dd, J = 10.8 Hz, 2 H), 4.71 (d, J = 10.8 Hz, 1 H), 4.66 (d, J = 12.3 Hz, 1 H), 4.55−4.52 (m, 2 H), 4.30 (d, J = 10.6 Hz, 1 H), 3.97−3.91 (m, 2 H), 3.87 (dd, J = 3.6, 10.8 Hz, 1 H), 3.84−3.77 (m, 2 H), 3.74 (d, J = 10.5 Hz, 1 H), 3.65−3.61 (m, 1 H), 2.36 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 138.9, 138.6, 138.5, 138.2, 135.5, 133.1, 128.5, 128.4, 128.3, 128.1, 128.0, 127.8, 127.7, 127.6, 127.5, 127.4, 127.3, 121.3, 120.1, 119.7, 110.3, 109.7, 86.8, 82.5, 79.3, 78.5, 75.7, 75.2, 74.6, 73.4, 69.3, 12.3. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{43}H_{44}NO_5$ 654.3214; Found 654.3217.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-glucopyranosyl)-2-phenyl-1H-indole (**3b**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3b** (586 mg, yield 82%, β only); eluent, hexane−EtOAc (8:1). Colorless jelly. IR (neat): 3455, 3017, 2945, 1750, 1612, 1456, 1256, 1086, 765, 668 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 8.13 (s, 1 H), 7.91 (d, J = 7.9 Hz, 1 H,), 7.69 (d, J = 6.6 Hz, 2 H), 7.41−7.33 (m, 5 H), 7.31−7.24 (m, 14 H), 7.22−7.18 (m, 1H), 7.11−7.02 (m, 4 H), 6.82(d, J = 6.9 Hz, 2 H), 4.96−4.86 (m, 3 H), 4.76−4.69 (m, 2 H), 4.62 (d, J = 12.1 Hz, 1 H), 4.46 (d, J = 12.1 Hz, 1 H), 4.31 (d, J = 10.8 Hz, 1 H), 4.19 (t, J = 7.4 Hz, 1 H), 3.99−3.93 (m, 2 H), 3.86−3.72 (m, 3 H), 3.55−3.52 (m, 1 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 138.9, 138.7, 138.5, 138.1, 137.1, 136.1, 132.5, 129.1, 128.8, 128.4, 128.3, 128.1, 127.9, 127.8, 127.7, 127.5, 127.4, 127.3, 122.6, 120.1, 110.9, 110.6, 86.9, 82.2, 79.2, 78.4, 75.7, 75.2, 75.1, 74.6, 73.4, 69.2. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{48}H_{46}NO_5$ 716.3371; Found 716.3377.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-glucopyranosyl)-5-O-benzyl-1H-indole (**3c**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3c** (573 mg, yield 77%, β only); eluent, hexane−EtOAc (8:1). Colorless jelly. IR (neat): 3466, 3017, 2945, 1750, 1601, 1456, 1240, 1064, 765, 668 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 8.01 (s, 1 H), 7.39−7.37 (m, 22 H), 7.25−7.20 (m, 6 H), 7.23−7.10 (m, 4 H), 6.92 (dd, J = 2.4, 8.8 Hz, 1 H), 6.82 (dd, J = 6.8 Hz, 2 H), 4.98−4.91 (m, 5 H), 4.71−4.64 (m, 2 H), 4.54−4.48 (m, 2 H), 4.28 (d, J = 10.7 Hz, 1 H), 3.94−3.86 (m, 1 H), 3.85−3.78 (m, 4 H), 3.74 (d, J = 10.3 Hz, 1 H), 3.65−3.61 (m, 1 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 153.7, 138.8, 138.4, 138.1, 137.7, 131.9, 128.5, 128.4, 128.3, 128.2, 128.1, 128.0, 127.9, 127.8, 127.7, 127.6, 127.5, 126.5, 124.1, 113.9, 113.4, 111.9, 103.9, 86.8, 82.6, 79.3, 78.4, 76.6, 75.7, 75.2, 74.6, 73.5, 70.7, 6934. HRMS (ESI) m/z: $[M + NH_4]^+$ Calcd for $C_{49}H_{51}N_2O_6$ 763.3742; Found 763.3742.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-glucopyranosyl)-5-methyl-1H-indole (**3d**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3d** (490 mg, yield 75%, β only); eluent, hexane−EtOAc (6:1). Colorless jelly. IR (neat): 3455, 3017, 2945, 1765, 1601, 1456,, 1064, 765, 655 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 8.05 (s, 1 H), 7.60 (s, 1 H), 7.36−7.26 (m, 16 H), 7.16−7.12 (m, 4 H), 7.01 (d, J = 8.1 Hz, 1 H), 6.84−6.82 (m, 2 H), 4.98−4.88 (m, 3 H), 4.69 (t, J = 10.8 Hz, 2 H), 4.54−4.51 (m,, 2 H), 4.32 (d, J = 10.4 Hz, 1 H), 3.96−3.86 (m, 3 H), 3.84−3.79 (m, 2 H), 3.78−3.75 (m, 1 H), 3.65−3.62 (m, 1 H), 2.37 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 138.7, 138.5, 138.4, 137.9, 134.9, 129.1, 128.4, 128.3, 128.2, 128.1, 128.0, 127.9, 127.8, 127.6, 127.5, 127.4, 126.3, 124.1, 123.4, 120.3, 120.2, 113.7, 110.9, 86.7, 82.8, 79.3, 78.5, 76.6, 75.7, 75.2, 74.6, 73.4, 69.2, 21.4. HRMS (ESI) m/z: $[M + NH_4]^+$ Calcd for $C_{43}H_{47}N_2O_5$ 671.3479; Found 671.3478.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-glucopyranosyl)-5-methoxy-1H-indole (**3e**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3e** (495 mg, yield 74%, β only); eluent, hexane−EtOAc (6:1). Colorless jelly. IR (neat): 3455, 3017, 2945, 1765, 1601, 1490, 1064, 765, 665 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 8.04 (s, 1 H), 7.32−7.23 (m, 19 H), 7.20−7.14 (m, 3 H), 6.86- 6.83 (m, 2 H), 4.98−4.89 (m, 3 H), 4.73−4.62 (m, 2 H), 4.54−4.49 (m, 2 H), 4.35 (d, J = 10.4 Hz, 1 H), 3.95 (t, J = 8.7 Hz, 1 H), 3.88−3.37 (m, 5 H), 3.64 (s, 3 H), 3.62−3.59 (m, 1 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ154.1, 138.7, 138.4, 138.0, 131.7, 128.5, 128.3, 128.1, 128.0, 127.9, 127.8, 127.7, 127.6, 127.5, 126.6, 123.9, 113.9, 112.9, 112.1, 102.1, 91.3, 86.8, 82.6, 79.2, 78.4, 77.3, 76.6, 75.8, 75.2, 74.7, 73.4, 69.2, 55.7. HRMS (ESI) m/z: $[M + NH_4]^+$ Calcd for $C_{43}H_{47}N_2O_6$ 687.3429; Found 687.3426.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-glucopyranosyl)-5-methylcarboxylate-1H-indole (**3f**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3f** (495 mg, yield 71%, β only); eluent, hexane−EtOAc (8:1). Colorless jelly. IR (neat): 3466, 3017, 2986, 1750, 1601, 1456, 1255, 1064, 765, 635 cm−1; ^1H NMR (400 MHz, $CDCl_3$): δ 8.58 (s, 1 H), 8.52 (s, 1 H), 7.88 (dd, J = 1.6, 8.7 Hz, 1 H), 7.32−7.31 (m, 10 H), 7.25−7.20 (m, 6 H), 7.11−7.04 (m, 4 H), 6.78 (dd, J = 1.3, 7.6 Hz, 2 H), 4.93 (m, 3 H), 4.66 (dd, J = 10.7 Hz, 2 H), 4.54 (dd, J = 12.6 Hz, 2 H), 4.35 (d, J = 10.6 Hz, 1 H), 3.91−3.85 (m, 2 H), 3.84 (s, 3 H), 3.83−3.76 (m, 3 H), 3.69−3.65 (m, 1 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 168.1, 139.1, 138.6, 138.3, 138.2, 137.8, 128.5, 128.4, 128.2, 128.1, 127.9, 127.8, 127.7, 127.6, 127.5, 127.4, 125.7, 124.8, 123.7, 123.2, 121.9, 115.4, 111.2, 86.9, 82.9, 79.4, 78.6, 76.1, 75.8, 75.2, 74.7, 73.5, 69.4, 51.8. HRMS (ESI) m/z: $[M + NH_4]^+$ Calcd for $C_{44}H_{47}N_2O_7$ 715.3378; Found 715.3378.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-glucopyranosyl)-1,2-dimethylindole (**3g**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3g** (554 mg, yield 83%, β only); eluent, hexane−EtOAc (9:1). Brown oil. IR (neat): 3466, 3017, 2920, 1727, 1601, 1456, 1216, 1064, 765, 732, 669 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.79 (d, J = 7.9 Hz, 1 H), 7.35−7.22 (m, 16 H), 7.18−7.08 (m, 4 H), 7.05−7.01 (m, 1 H), 6.76−6.75 (m, 2 H), 4.96 (d, J = 10.9 Hz, 1 H), 4.91(dd, J = 8.3, 10.8 Hz, 2 H), 4.72 (d, J = 10.6 Hz, 1 H), 4.66 (d, J = 12.2 Hz, 1 H), 4.56−4.51 (m, 2 H), 4.32 (d, J = 10.6 Hz, 1 H), 3.98−3.92 (m, 2 H), 3.89 (dd, J = 3.6, 10.9 Hz, 1 H), 3.84−3.76 (m, 2 H), 3.70 (d, J = 10.5 Hz, 1 H), 3.63−3.62 (m, 1 H), 3.61 (s, 3 H), 2.30 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 138.9, 138.7, 138.5, 138.2, 137, 134.9, 128.5, 128.4, 128.3, 128.1, 128.0, 127.8, 127.7, 127.6, 127.4, 127.3, 120.9, 120.1, 119.3, 108.9, 108.7, 869, 82.7, 79.4, 78.5, 76.1, 75.7, 75.2, 74.7, 73.4, 69.3, 29.4, 10.9. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{44}H_{46}NO_5$ 668.3371; Found 668.3369.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-glucopyranosyl)-1-methyl-2-phenylindole (**3h**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3h** (605 mg, yield 83%, β only); eluent, hexane−EtOAc (9:1). Brown oil. IR (neat): 3455, 3017, 2945, 1750, 1612, 1456, 1256, 1086, 906, 832, 765, 668 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.90 (d, J = 7.9 Hz, 1 H,), 7.41−7.39 (m, 5 H), 7.35−7.23 (m, 17 H), 7.14−7.05 (m, 4 H), 6.79 (d, J = 7.2 Hz, 2 H), 4.93−4.83 (m, 3 H), 4.70−4.63 (m, 2 H), 4.47 (d, J = 11.5 Hz, 1 H), 4.42 (d, J =

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9.6 Hz, 1 H), 4.36 (d, J = 11.8 Hz, 1 H), 4.13 (t, J = 8.4 Hz, 1 H), 3.95−3.90 (m, 2 H), 3.86−3.69 (m, 3 H), 3.58 (s, 1 H), 3.49−3.46 (m, 1 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ140.1, 138.9, 138.8, 138.6, 138.3, 137.7, 131.2, 131.1, 128.4, 128.3, 128.2, 127.9, 127.8, 127.6, 127.5, 127.4, 127.3, 126.3, 122.1, 120.9, 119.9, 110.6, 109.6, 86.9, 82.3, 79.2, 78.5, 75.8, 75.7, 75.6, 75.1, 74.6, 73.4, 69.3, 30.9. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{49}H_{48}NO_5$ 730.3527; Found 730.3530.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-glucopyranosyl)-1-methylindole (**3i**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3i** (483 mg, yield 74%, β only); eluent, hexane−EtOAc (9:1). Brown oil. IR (neat): 3466, 3017, 2920, 1727, 1601, 1456, 1216, 1064, 765, 669 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.82 (d, J = 7.8 Hz, 1 H), 7.35−7.21 (m, 17 H), 7.14−7.08 (m, 4 H), 7.06−7.05 (m, 1 H), 6.79−6.77 (m, 2 H), 4.96 (d, J = 10.9 Hz, 1 H), 4.90 (dd, J = 8.3, 10.9 Hz, 2 H), 4.69 (d, J = 10.6 Hz, 1 H), 4.64 (d, J = 12.1 Hz, 1 H), 4.54−4.51 (m, 2 H), 4.34 (d, J = 10.4 Hz, 1 H), 3.92−3.76 (m, 6 H), 3.73 (s, 3 H), 3.64−3.61 (m, 1 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ138.8, 138.5, 138.4, 138.1, 137.4, 128.5, 128.4, 128.3, 128.2, 128.1, 127.9, 127.8, 127.7, 127.6, 127.5, 127.4, 126.7, 121.9, 120.7, 119.4, 112.7, 109.4, 86.9, 83.1, 79.4, 78.5, 76.4, 75.7, 75.2, 74.7, 73.4, 69.3, 32.8. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{43}H_{44}NO_5$ 654.3214; Found 654.3215.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-galactopyranosyl)-2-methyl-1H-indole (**3j**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3j** (561 mg, yield 86%, β only); eluent, hexane−EtOAc (6:1). Colorless jelly. IR (neat): 3455, 3115, 2940, 1765, 1636, 1456,, 1064, 765, 665 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.88 (d, J = 7.9 Hz, 1 H), 7.74 (brs, 1 H), 7.46−7.44 (m, 2 H), 7.39−7.35 (m, 4 H), 7.33−7.21 (m, 10 H), 7.13−7.06 (m, 4 H), 6.97−6.94 (m, 1 H), 6.86−6.84 (m, 2 H), 5.13 (d, J = 11.5 Hz, 1 H), 4.79 (ABq, J = 12.0 Hz, 2 H), 4.67 (d,, J = 11.4 Hz, 1 H), 4.52 (d, J = 9.4 Hz, 1 H), 4.44 (ABq, J = 12.0 Hz, 2 H), 4.41−4.36 (m, 2 H), 4.15 (d, J = 2.3 Hz, 1 H), 3.79−3.70 (m, 4 H), 3.65−3.61 (m, 1 H), 2.34 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 139.4, 138.9, 138.5, 138.1, 137.4, 135.5, 132.9, 128.4, 128.3, 128.2, 128.1, 127.9, 127.7, 127.5, 127.4, 127.3, 127.2, 121.3, 121.2, 120.5, 119.6, 110.5, 110.1, 84.4, 79.4, 76.6, 75.6, 75.1, 74.5, 74.4, 73.5, 72.5, 68.8, 12.2. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{43}H_{44}NO_5$ 654.3214; Found 654.3212.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-galactopyranosyl)-2-phenyl-1H-indole (**3k**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3k** (622 mg, yield 87%, β only); eluent, hexane−EtOAc (7:1). Colorless jelly. IR (neat): 3455, 3017, 2955, 1765, 1640, 1456, 1256, 1086, 740, 665 cm. ^1H NMR (400 MHz, $CDCl_3$): δ 8.05 (d, J = 7.9 Hz, 1 H,), 8.03 (brs, 1 H), 7.65−7.63 (m, 2 H), 7.47−7.45 (m, 2 H), 7.38−7.23 (m, 17 H), 7.15−7.12 (m, 1 H), 7.07−6.95 (m, 4 H), 6.85−6.83 (m, 2 H), 5.13 (d, J = 11.2 Hz, 1 H), 4.82−4.73 (m, 2 H), 4.74−4.65 (m, 3 H), 4.44−4.36 (m, 3 H), 4.16 (brs, 1 H), 3.98 (d, J = 10.8 Hz, 1 H), 3.73−3.66 (m, 3 H), 3.57−3.55 (m, 1 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 139.5, 138.9, 138.4, 138.1, 136.7, 136.2, 132.6, 129.1, 128.7, 128.5, 128.4, 128.3, 128.2, 128.1, 127.9, 127.8, 127.6, 127.5, 127.4, 127.3, 127.2, 122.5, 120.1, 111.3, 110.8, 84.6, 79.1, 76.4, 75.3, 75.1, 74.7, 74.4, 73.5, 72.5, 68.8. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{48}H_{46}NO_5$ 716.3371; Found 716.3366.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-galactopyranosyl)-2-ethylcarboxylate-1H-indole (**3l**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3l** (575 mg, yield 81%, β only); eluent, hexane−EtOAc (7:1). Colorless jelly. IR (neat): 3465, 3017, 2945, 1795, 1601, 1490, 1286, 1085, 765, 665 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 8.74 (s, 1 H), 8.14 (d, J = 8.2 Hz, 1 H), 7.46−7.44 (m, 2 H), 7.39−7.36 (m, 4 H), 7.33−7.25 (m, 11 H), 7.09−7.07 (m, 3 H), 6.96 (t, J = 7.5 Hz, 1 H), 6.85−6.84 (m, 2 H), 5.46 (d, J = 9.3 Hz, 1 H), 5.14 (d, J = 11.4 Hz, 1 H), 4.80 (d, J = 11.9 Hz, 2 H), 4.68 (d, J = 11.3 Hz, 1 H), 4.47 (dd, J = 11.9 Hz, 2 H), 4.41 (d, J = 10.8 Hz, 1 H), 4.38−4.29 (m, 3 H), 4.18 (d, J = 2.2 Hz, 1 H), 3.83−3.72 (m, 4 H), 3.63 (dd, J = 5.1, 8.6 Hz, 1 H), 1.33 (t, J = 7.1 Hz, 1 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 161.8, 139.4, 138.8, 138.5, 137.9, 135.9, 128.4, 128.3, 128.2, 127.9, 127.8, 127.7, 127.6, 127.5, 127.4, 127.3, 127.1, 125.6, 124.2, 123.9, 121.1, 120.5, 111.5, 84.3, 79.5, 74.7, 74.6, 74.5, 73.5, 72.5, 68.7, 60.9, 14.4. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{45}H_{46}NO_7$ 712.3269; Found 712.3270.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-galactopyranosyl)-2-methyl-5-methoxy-1H-indole (**3m**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3m** (566 mg, yield 83%, β only); eluent, hexane−EtOAc (6:1). Colorless jelly. IR (neat): 3465, 3017, 2945, 1785, 1601, 1490, 1085, 765, 675 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.63 (s, 1 H), 7.40−7.37 (m, 3 H), 7.32−7.24 (m, 14 H), 7.14−7.06 (m, 3 H), 6.89−6.88 (m, 1 H), 6.69−6.67 (m, 1 H), 5.08 (d, J = 10.8 Hz, 1 H), 4.82 (brs, 2 H), 4.63 (d, J = 10.7 Hz, 1 H), 4.49−4.46 (m, 3 H), 4.39−4.34 (m, 2 H), 4.17 (brs, 1 H), 3.83−3.72 (m, 4 H), 3.65−3.64 (m, 1 H), 3.35 (brs, 3 H), 2.31 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 153.9, 139.3, 138.9, 138.5, 137.9, 133.5, 130.4, 128.5, 128.4, 128.2, 128.1, 128.0, 127.8, 127.5, 127.3, 111.5, 110.8, 110.2, 101.8, 84.3, 78.8, 76.4, 75.7, 75.2, 74.9, 74.8, 74.7, 73.6, 72.6, 68.7, 55.2, 12.2. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{44}H_{46}NO_6$ 684.3320; Found 684.3318.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-galactopyranosyl)-(1→4)-2,3,6-tri-O-benzyl-β-D-glucopyranoside-2-methyl-1H-indole (**3n**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3n** (868 mg, yield 80%, β only); eluent, hexane−EtOAc (4:1). Colorless jelly. IR (neat): 3465, 3017, 2945, 1795, 1601, 1490, 1157, 1250, 1286, 1085, 765, 665 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.79 (s, 1 H), 7.71 (d, J = 7.8 Hz, 1 H), 7.35−7.27 (m, 28 H), 7.24−7.07 (m, 7 H), 6.98 (t, J = 7.5 Hz, 1 H), 6.82 (d, J = 6.1 Hz, 2 H), 5.14 (d, J = 10.8 Hz, 1 H), 4.99 (d, J = 11.6 Hz, 1 H), 4.84 (quart, 3 H), 4.73 (brs, 3 H), 4.63−4.61 (m, 2 H), 4.57 (d, J = 11.2 Hz, 1 H), 4.50 (d, J = 9.7 Hz, 1 H), 4.41−4.37 (m, 3 H), 4.27- 4.25 (m, 2 H), 3.99 (dd, J = 3.5, 11.3 Hz, 1 H), 3.95 (d, J = 2.8 Hz, 1 H), 3.88−3.83 (m, 2 H), 3.75−3.69 (m, 3 H), 3.59−3.41 (m, 5 H), 2.33 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 138.8, 138.7, 138.5, 138.2, 135.5, 133.1, 128.4, 128.2, 128.1, 128.0, 127.9, 127.7, 127.6, 127.5, 127.4, 127.3, 127.2, 127.1, 121.2, 120.2, 119.6, 110.2, 109.8, 102.8, 85.1, 82.7, 81.9, 80.2, 79.8, 75.8, 75.5, 75.4, 74.9, 74.8, 73.9, 73.5, 73.1, 72.7, 68.5, 68.2, 12.3. HRMS (ESI) m/z: $[M + NH_4]^+$ Calcd for $C_{70}H_{75}N_2O_{10}$ 1103.5416; Found 1103.5359.

*3-(2,3,4,6-Tetra-O-benzyl-β-D-galactopyranosyl)-(1→4)-2,3,6-tri-O-benzyl-β-D-glucopyranoside-2-phenyl-1H-indole (**3o**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3o** (940 mg, yield 82%, β only); eluent, hexane−EtOAc (4:1). Colorless jelly. IR (neat): 3465, 3017, 2945, 1795, 1601, 1490, 1157, 1250, 1286, 1085, 800, 770, 740, 665 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 8.09 (s, 1 H), 7.83 (d, J = 8.1 Hz, 1 H), 7.68 (d, J = 7.3 Hz, 2 H), 7.35−7.21 (m, 34 H), 7.12−7.09 (m, 2 H), 7.05- 7.01 (m, 3 H), 6.83 (d, J = 7.1 Hz, 2 H), 5.14 (d, J = 10.4 Hz, 1 H), 4.99 (d, J = 11.4 Hz, 1 H), 4.83−4.78 (m, 2 H), 4.72 (t, J = 10.8 Hz, 4 H), 4.62−4.56 (m, 3 H), 4.44−4.26 (m, 5 H), 4.14 (t, J = 9.7 Hz, 1 H), 3.99−3.94 (m, 3 H), 3.82−3.79 (m, 1H), 3.72 (t, J = 8.9 Hz, 1 H), 3.65−3.58 (m, 2 H), 3.48−3.42 (m, 4 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 139.2, 138.9, 138.7, 138.4, 138.3, 137.1, 129.1, 128.8, 128.5, 128.4, 128.3, 128.2, 128.1, 128.0, 127.9, 127.9, 127.8, 127.7, 127.5, 127.4, 127.4, 127.3, 127.2, 127.0, 122.5, 120.1, 110.8, 102.8, 85.2, 82.6, 80.3, 79.7, 76.7, 75.6, 75.4, 74.9, 74.8, 73.9, 73.5, 73.1, 73.1, 72.8, 68.2. HRMS (ESI) m/z: $[M + NH_4]^+$ Calcd for $C_{75}H_{77}N_2O_{10}$ 1165.5573; Found 1165.5510.

*3-(2,3,4,6-Tetra-O-acetyl-β-D-galactopyranosyl)-2-methyl-1H-indole (**3p**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3p** (350 mg, yield 76%, β only); eluent, hexane−EtOAc (5:1). Colorless jelly. IR (neat): 33375, 3017, 1795, 1490, 1372, 1250, 1085, 924, 770, 665 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.94 (s, 1 H), 7.66 (dd, J = 2.4, 6.3 Hz, 1 H), 7.23−7.21 (m,1 H), 7.11−7.05 (m, 2 H), 5.63 (t, J = 9.9 Hz, 1 H), 5.57 (dd, J = 0.8, 3.3 Hz, 1 H), 5.23 (dd, J = 3.3, 10.2 Hz, 1 H), 4.73 (d, J = 9.8 Hz, 1 H), 4.23 (dd, J = 6.9, 11.1 Hz, 1 H), 4.15 (dd, J = 6.4, 11.3 Hz, 1 H), 4.09−4.06 (m, 1 H), 2.47 (s, 3 H), 2.26 (s, 3 H), 2.03 (s, 3 H), 1.99 (s, 3 H), 1.65 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 170.5, 170.4, 170.3, 169.1, 135.1, 133.5, 127.3, 121.4, 119.8, 118.5, 110.4, 107.3, 74.6, 74.4, 72.5, 69.5, 68.1, 61.8, 20.8, 20.7, 20.6, 20.4, 12.2. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{23}H_{28}NO_9$ 462.1759; Found 462.1759.

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*3-(2,3,4,6-Tetra-O-acetyl-β-D-galactopyranosyl)- 2-phenyl-1H-indole (**3q**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3q** (407 mg, yield 78%, β only); eluent, hexane−EtOAc (5:1). Colorless jelly. IR (neat): 33375, 3022, 1746, 1452, 1372, 1220, 1051, 924, 766, 669 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 8.23 (s, 1 H), 7.93 (d, *J* = 7.5 Hz, 1 H), 7.63−7.61 (m, 2 H), 7.52−7.42 (m, 3 H), 7.32 (dd, *J* = 1.6, 7.2 Hz, 1 H), 7.22−7.14 (m, 2 H), 5.89 (t, *J* = 9.7 Hz, 1 H), 5.54 (d, *J* = 3.5 Hz, 1 H), 5.20 (dd, *J* = 3.3, 10.1 Hz, 1 H), 4.87 (d, *J* = 9.9 Hz, 1 H), 4.19 (dd, *J* = 7.2, 11.3 Hz, 1 H), 4.11 (dd, *J* = 6.2, 11.3 Hz, 1 H), 4.03−3.99 (m, 1 H), 2.28 (s, 3 H), 1.99 (s, 3 H), 1.98 (s, 3 H), 1.69 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 170.5, 170.4, 170.3, 168.6, 137.3, 135.9, 132.3, 128.9, 128.7, 128.5, 127.2, 122.8, 120.4, 111.1, 108.1, 74.7, 74.2, 72.7, 68.9, 68.1, 61.8, 20.8, 20.7, 20.6, 20.5. HRMS (ESI) *m*/*z*: $[M + H]^+$ Calcd for $C_{28}H_{30}NO_9$ 524.1915; Found 524.1910.

*3-(2,3,4,6-Tetra-O-acetyl-β-D-glucopyranosyl)-2-methyl-1H-indole (**3r**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3r** (341 mg, yield 74%, β only); eluent, hexane−EtOAc (4:1). Colorless jelly. IR (neat): 33375, 3022, 1750, 1746, 1452, 1372, 1220, 1051, 924, 766, 669 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.91 (s, 1 H), 7.62−7.61 (m, 1 H), 7.22−7.21 (m, 1 H), 7.09−7.07 (m, 2 H), 5.39−5.32 (m, 3 H), 4.78−4.77 (m, 1 H), 4.29−4.20 (m, 2 H), 3.87−3.85 (m, 1 H), 2.46 (s, 3 H), 2.09 (s, 3 H), 2.08 (s, 3 H), 2.00 (s, 3 H), 1.64 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 170.8, 170.5, 169.6, 168.9, 135.1, 133.4, 127.2, 121.5, 119.9, 118.6, 110.3, 106.8, 76.1, 74.5, 74.4, 72.1, 68.7, 62.4, 20.8, 20.7, 20.3, 12.4. HRMS (ESI) *m*/*z*: $[M + H]^+$ Calcd for $C_{23}H_{28}NO_9$ 462.1759; Found 462.1755.

*3-(2,3,4,6-Tetra-O-acetyl-β-D-glucopyranosyl)-2-phenyl-1H-indole (**3s**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3s** (402 mg, yield 77%, β only); eluent, hexane−EtOAc (4:1). Colorless jelly. IR (neat): 33375, 3022, 1746, 1452, 1372, 1220, 1051, 924, 766, 669 cm^{-1};. ^1H NMR (400 MHz, $CDCl_3$): δ 8.25 (s, 1 H), 7.85 (d, *J* = 7.4 Hz, 1 H), 7.62−7.49 (m, 2 H), 7.52−7.43 (m, 3 H), 7.32−7.29 (m, 1 H), 7.22−7.14 (m, 2 H), 5.73−5.68 (m, 1 H), 5.37−5.31 (m, 2 H), 4.88 (d, *J* = 9.9 Hz, 1 H), 4.23 (dd, *J* = 4.3, 12.2 Hz, 1 H), 4.16 (dd, *J* = 2.4, 12.3 Hz, 1 H), 3.81−3.77 (m, 1 H), 2.07 (s, 3 H0, 2.05 (S, 3 H), 1.99 (S, 3 H), 1.69 (S, 3 H); $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 170.8, 170.6, 169.6, 168.6, 137.6, 135.9, 132.2, 129.1, 128.7, 128.6, 126.8, 122.9, 120.5, 111.1, 107.5, 75.7, 74.9, 74.4, 71.3, 68.7, 62.4, 20.8, 20.7, 20.6, 20.4. HRMS (ESI) *m*/*z*: $[M + H]^+$ Calcd for $C_{28}H_{30}NO_9$ 524.1915; Found 524.1902.

*3-(2,3,4-Tri-O-acetyl-α/β-L-arabinopyranosyl)-2-methyl-1H-indole (**3t**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3t** (248 mg, yield 64%, α:β = 1:7); eluent, hexane−EtOAc (6:1). Colorless jelly. IR (neat): 3340, 1746, 1452, 1372, 1220, 1051, 924, 766, 665 cm^{-1}. ^1H NMR (400 MHz, CDCl3): δ 7.93 (s, 1 H), 7.72- 7.67 (m, 1 H), 7.22−7.19 (m, 1H), 7.10−7.05 (m, 2 H), 5.68 (t, *J* = 9.8 Hz, 1 H), 5.43- 5.40 (m, 1 H), 5.23 (dd, *J* = 3.4, 10.1 Hz, 1H), 4.62 (d, *J* = 9.7 Hz, 1 H), 4.17 (dd, *J* = 2.2, 13.2 Hz, 1 H), 3.8 (d, J = 13.2 Hz, 1 H), 2.46 (s, 3 H), 2.27 (s, 3 H), 2.01 (s, 3 H), 1.65 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 170.5, 170.4, 169.1, 135.1, 133.5, 127.3, 121.5, 121.4, 119.8, 118.9, 118.6, 110.5, 110.3, 107.5, 75.1, 72.2, 69.7, 69.4, 68.2, 21.2, 20.8, 20.4, 12.1. HRMS (ESI) *m*/*z*: $[M + H]^+$ Calcd for $C_{20}H_{24}NO_7$ 390.1547; Found 390.1550.

*3-(2,3,4-Tri-O-acetyl-α/β-L-arabinopyranosyl)-2-phenyl-1H-indole (**3u**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3u** (297 mg, yield 66%, α:β = 1:6); eluent, hexane−EtOAc (6:1). Colorless jelly. IR (neat): 3340, 1746, 1452, 1372, 1220, 1051, 924, 766, 669 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 8.20 (s, 1 H), 7.96 (d, *J* = 7.3 Hz, 1 H), 7.60−7.41 (m, 5 H), 7.33−7.28 (m, 1 H), 7.22- 7.14 (m, 2 H), 5.97 (t, *J* = 9.7 Hz, 1 H), 5.41-5.37 (m, 1 H), 5.20 (dd, *J* = 3.4, 10.1 Hz, 1H), 4.08 (dd, *J* = 2.4, 13.2 Hz, 1 H), 3.7 (d, *J* = 13.2 Hz, 1 H), 2.30 (s, 3 H), 2.01 (s, 3 H), 1.71 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 170.5, 170.4, 168.7, 137.3, 136.2, 135.9, 132.3, 131.9, 128.9, 128.8, 128.6, 128.4,, 122.7, 120.4, 120.1, 111.1, 108.3, 75.1, 72.4, 69.4, 69.2, 67.9, 63.7, 21.2, 20.9, 20.8, 20.5. HRMS (ESI) *m*/*z*: $[M + H]^+$ Calcd for $C_{25}H_{26}NO_7$ 452.1704; Found 452.1704.

*3-(2,3,4-Tri-O-benzyl-α/β-L-arabinopyranosyl)-2-phenyl-1H-indole (**3v**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3v** (404 mg, yield 68%,α:β = 1:4); eluent, hexane−EtOAc (7:1). Colorless jelly. IR (neat): 3465, 2945, 1795, 1601, 1490, 1286, 1085, 765, 665 cm^{-1}. ^1H NMR (400 MHz, CDCl3): δ 8.13 (s, 1 H), 7.96 (d, *J* = 7.9 Hz, 1 H), 7.60−7.57 (m, 1H), 7.44−7.41 (m, 1 H), 7.35- 7.29 (m, 9 H), 7.28−7.23 (m, 5 H), 7.14−7.10 (m, 2 H), 7.04−7.02 (m, 2 H), 5.30 (d, *J* = 8.1 Hz, 1 H), 4.75 (dd, *J* = 4.8, 8.1 Hz, 1 H), 4.64- 4.59 (m, 2 H), 4.53−4.52 (m, 2 H), 4.45 (dd, *J* = 5.1, 9.8 Hz, 1 H), 4.34 (brs, 1 H), 4.31 (t, *J* = 4.7 Hz, 1H), 4.18−4.08 (m, 1 H), 3.63 (d, *J* = 5.2 Hz, 2 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 138.5, 138.3, 138.2, 137.9, 137.5, 136.4, 132.2, 128.9, 128.8, 128.7, 128.4, 128.3, 128.2, 128.1, 128.0, 127.9, 127.8, 127.7, 127.6, 127.5, 127.4, 127.1, 123.5, 122.6, 122.4, 120.9, 120.2, 119.8, 110.9, 110.7, 88.2, 86.4, 86.2, 85.3, 81.5, 80.8, 78.2, 73.4, 73.3, 72.5, 72.2, 72.1, 71.9, 70.5. HRMS (ESI) *m*/*z*: $[M + H]^+$ Calcd for $C_{40}H_{38}NO_4$ 596.2795; Found 596.2797.

*3-(2,3,4-Tri-O-acetyl-α-L-rhamnopyranosyl)-2-phenyl-1H-indole (**3w**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3w** (344 mg, yield 74%, α only); eluent, hexane−EtOAc (4:1). Colorless jelly. IR (neat): 3340, 1746, 1452, 1372, 1220, 1051, 924, 766, 669 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 8.20 (s, 1 H), 8.05 (dd, *J* = 1.2, 7.3 Hz, 1 H), 7.49−7.39 (m, 5 H), 7.27−7.26 (m, 1 H), 7.17−7.09 (m, 2 H), 5.57 (dd, *J* = 1.3, 3.3 Hz, 1 H), 5.29−5.19 (m, 2 H), 4.99 (brs, 1 H), 3.62−3.55 (m, 1 H), 2.06 (s, 3 H), 1.98 (s, 3 H), 1.90 (s, 3 H), 1.30 (d, *J* = 6.2 Hz, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 170.4, 170.2, 135.9, 135.3, 132.3, 128.9, 128.8, 128.5, 127.5, 122.9, 122.5, 119.8, 110.7, 109.1, 74.7, 74.5, 72.9, 72.2, 71.2, 20.9, 20.8, 20.7, 17.9. HRMS (ESI) *m*/*z*: $[M + H]^+$ Calcd for $C_{26}H_{28}NO_7$ 466.1860; Found 466.1861.

*3-(3-O-Benzyl-4-O-benzoyl-2-O-(2-pyridinecarbonyl)-α-L-rhamnopyranoside)-2-methyl-1H-indole (**3x**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3x** (443 mg, yield 77%, α only); eluent, hexane−EtOAc (7:1). Colorless jelly. IR (neat): 3390, 3018, 2924, 2403, 1724, 1590, 1456, 1357, 1268, 1217, 1178, 1084, 1026, 764, 668, 623 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 8.48 (dd, *J* = 0.8, 4.7 Hz, 1 H), 8.09 (d, *J* = 8.0 Hz, 1 H), 8.05 (s, 1 H), 8.01 (dd, *J* = 1.4, 8.6 Hz, 1 H), 7.94 (d, *J* = 7.8 Hz, 1 H), 7.72 (td, 1 H, *J* = 1.7, 7.6 Hz), 7.61−7.57 (m, 1 H), 7.48−7.44 (m, 2 H), 7.18−7.09 (m, 7 H), 7.09−6.97 (m, 2 H), 5.50−5.45 (m, 2 H), 4.73 (d, *J* = 12.4 Hz, 1 H), 4.56 (dd, *J* = 2.3, 4.0 Hz,1 H), 4.51 (d, *J* = 12.4 Hz, 1 H), 3.91 (dd, *J* = 4.1, 9.6 Hz, 1 H), 3.62−3.55 (m, 1 H), 2.51 (s, 3 H), 1.18 (d, *J* = 6.3 Hz, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 165.7, 160.3, 148.6, 137.5, 136.5, 134.9, 133.9, 133.2, 129.9, 129.8, 128.4, 128.2, 127.8, 127.7, 127.1, 122.9, 120.9, 120.7, 120.5, 119.8, 111.8, 110.1, 97.2, 76.6, 75.7, 72.9, 71.1, 69.8, 17.6, 13.5. HRMS (ESI) *m*/*z*: $[M + H]^+$ Calcd for $C_{35}H_{33}N_2O_6$ 577.2333; Found 577.2332.

*3-(2,3, 5-Tri-O-benzyl-β-D-ribofuranose)-2-methyl-1H-indole (**3y**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3y** (453 mg, yield 85%, β only); eluent, hexane−EtOAc (7:1). Colorless jelly. IR (neat): 3466, 3017, 2923, 1617, 1457, 1216, 1079, 762, 700, 669 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.78 (s, 1 H), 7.63 (d, *J* = 7.8 Hz, 1 H), 7.48 (dd, *J* = 1.5, 8.2 Hz, 2 H), 7.36−7.21 (m, 9 H), 7.15−6.99 (m, 5 H), 6.86−6.82 (m, 2 H), 5.00 (d, *J* = 9.7 Hz, 1 H), 4.94 (dd, *J* = 12.1 Hz, 2 H), 4.60 (q, *J* = 12.1 Hz, 2 H), 4.29−4.27 (m, 1 H), 4.06 (d, *J* = 11.8 Hz, 1 H), 3.99−3.77 (m, 2 H), 3.93 (d, *J* = 11.9 Hz, 1 H), 3.76 (d, *J* = 2.4, 9.8 Hz, 1 H), 3.73−3.69 (m, 1 H), 2.34 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 139.6, 138.5, 138.4, 135.5, 133.6, 128.5, 128.3, 128.1, 127.9, 127.8, 127.7, 127.4, 127.3, 127.2, 121.1, 119.8, 119.4, 110.3, 109.6, 78.8, 76.3, 75.2, 74.1, 71.8, 71.4, 71.1, 64.6, 12.2. HRMS (ESI) *m*/*z*: $[M + H]^+$ Calcd for $C_{35}H_{36}NO_4$ 534.2639; Found 534.2636.

*3-(2,3,5,6-Di-O-isopropylidene-α/β-D-manofuranose)-2-methyl-1H-indole (**3z**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3z** (253 mg, yield 68%, α:β = 1:4); eluent, hexane−EtOAc (5:1). Colorless jelly. IR (neat): 3421, 3320, 2930, 1612, 1511, 1456, 1379, 1251, 1084, 762, 700, 669 cm^{-1}; ^1H NMR

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(400 MHz, $CDCl_3$): δ 7.49 (d, J = 7.8 Hz, 1 H), 713- 7.07 (m, 3 H), 6.27 (brs, 1 H), 6.01 (d, J = 1.8 Hz, 1 H), 5.47 (dd, J = 1.9, 5.8 Hz, 1 H), 5.22−5.20 (m, 1 H), 4.48- 4.43 (m, 1 H), 4.35 (dd, J = 3.8, 7.5 Hz, 1 H), 4.08- 4.04 (m, 1 H), 3.97 (dd, J = 4.5, 8.7 Hz, 1 H), 2.46 (s, 3 H), 1.62 (s, 3 H), 1.41 (s, 6 H), 1.37 (s, 3 H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 137.2, 135.7, 135.2, 133.4, 130.3, 129.3, 121.3, 120.3, 120.2, 119.7, 119.2, 119.1, 117.5, 113.7, 112.9, 109.7, 109.4, 108.2, 102.8, 99.8, 91.5, 86.7, 84.8, 84.3, 83.1, 81.4, 80.4, 80.3, 74.2, 73.5, 66.7, 65.6, 26.9, 26.7, 26.6, 26.5, 26.0, 25.3, 25.2, 24.8, 24.6, 13.7, 13.6. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{28}NO_5$ 374.1962; Found 374.1974.

*3-(2,3,5,6-Di-O-isopropylidene-α/β-D-manofuranose)-2-phenyl-1H-indole (**3aa**).* Synthesized according to the general procedure on a 1 mmol scale to afford **3aa** (308 mg, yield 71%, α:β = 1:3); eluent, hexane−EtOAc (4:1). Colorless jelly. IR (neat): 3421, 3320, 2930, 1612, 1511, 1456, 1379, 1251, 1084, 762, 700, 669 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.75 (d, J = 7.6 Hz, 1 H), 7.57−7.54 (m, 2 H), 7.46−7.38 (m, 3 H), 7.22- 7.05 (m, 3 H), 6.55 (brs, 1 H), 6.03 (d, J = 2.3 Hz, 1 H), 5.45 (dd, J = 2.4, 5.7 Hz, 1 H), 5.14 (dd, J = 3.4, 5.6 Hz, 1 H), 4.50−4.39 (m, 1 H), 4.07 (dd, J = 5.6, 8.9 Hz, 1 H), 3.90 (dd, J = 3.8, 8.5 Hz, 1 H), 1.47 (s, 3 H), 1.44 (s, 3 H), 1.37 (s, 6 H); $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 142.3, 138.8, 135.3, 134.2, 132.5, 132.4, 130.1, 129.3, 128.8, 128.5, 128.3, 127.8, 125.7, 122.3, 121.2, 120.7, 120.1, 119.9, 118.9, 113.7, 113.1, 110.6, 109.4, 108.4, 104.3, 99.5, 91.6, 86.9, 84.8, 83.8, 82.9, 81.4, 80.7, 80.3, 74.3, 73.6, 66.8, 65.8, 27.0, 26.6, 26.5, 26.1, 25.6, 25.3, 24.9, 24.5. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{26}H_{30}NO_5$ 436.2118; Found 436.2112.

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge at https://pubs.acs.org/doi/10.1021/acs.joc.1c00698.

Copies of ^1H NMR spectra of 2-methylindole in the presence of and absence of $B(C_6F_5)_3$ and 1H, $^{13}C\{^1H\}$, and HRMS spectra of **1i**, glycoside **3a−3z** and **3aa** (PDF)

FAIR data, including the primary NMR FID files, for compounds **1i**, **3a−3z**, and **3aa** (ZIP)

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Notes

The authors declare no competing financial interest.

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