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ORIGINAL ARTICLE

Click inspired synthesis of triazole-linked vanillin glycoconjugates

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Abstract The 1,3-dipolar cycloaddition of deoxy-azido sugars **1** with alkyne derivatives of *p*-vanillin, 3-methoxy-4-(prop-2-ynyloxy)benzaldehyde (**2**) and 2-methoxy-1-(prop-2-ynyloxy)-4-((prop-2-ynyloxy)methyl)benzene) (**4**) to afford regioselective triazole-linked vanillinglycoconjugates **5** and **6** was investigated in the presence of CuI/DIPEA in dichloromethane. All the developed glycoconjugates were characterized on the basis of IR, NMR, and MS.

Keywords Vanillin · Click chemistry · Carbohydrates · Glycoconjugates

Introduction

The coupling of two or more molecular entities with distinct properties to form novel conjugates with combined properties of parent components *via* 'click' chemistry, has emerged as a fast growing technology in recent years [1–3]. Several new conjugates arising through such conjugation have been found to exhibit unusual biological activities as the different molecular segments act cooperatively [4–6].

Glutathione-*S*-transferase(s) (GST) enzyme from *Brugia malayi* has been exploited as a target in lymphatic filariasis therapeutics [7]. The components of the glutathione (GSH) system, mainly GST enzymes, are critical, antioxidant and detoxification compounds responsible for the long-term existence of filarial worms in the mammalian host. Inhibition of parasitic GST affects the survival of the parasites or helps in the enhancement of activity of presently available antifilarial drugs. Hence, they are major chemotherapeutic targets in filarial species. Azeez *et al.,* docked 58 phytochemicals from different plants to GST enzyme of *B. malayi,* and assessed their binding affinity and consequently their inhibitory activity. Among these phytochemicals, the compound *p*-vanillin by virtue of forming greater number of hydrogen bonds and strong hydrogen bonding interactions to GST, was identified as a promising lead to treat lymphatic filariasis [8]. However, the limited solubility of *p*-vanillin in water restricts its pervasive application. Therefore, development of glycohybrids consisting of sugar residues fastened to *p*-vanillin *via* triazole moiety would be crucial as the resulting triazolyl glycoconjugates with fare water solubility in addition to the ability of triazole ring to contribute in numerous noncovalant interactions, including hydrogen bonding dipole-dipole interactions, and π-stacking interactions etc. may have added stimulus in GST inhibitory activity.

Among the reactions comprising the click universe, the perfect example is the Huisgen 1,3-dipolar cycloaddition of terminal alkynes and organic azides to form 1,4-disubstituted-1,2,3-triazoles [9–11]. In addition, because of the important role of carbohydrates in biological systems [12, 13], and their great chemotherapeutic potential [14], a wide variety of glycoconjugates so far have been reported using azide-alkyne cycloaddition approach [15–20]. However, the

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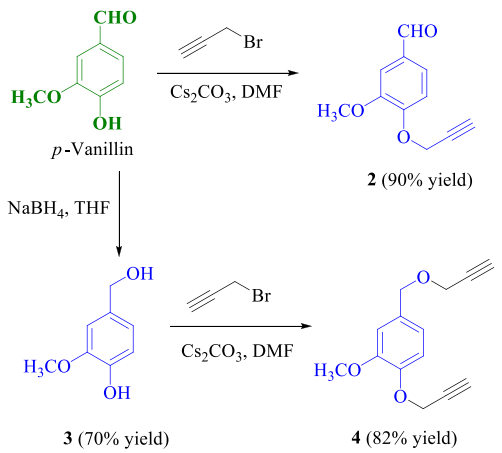
synthesis of *p*-vanillin glycoconjugates *via* 'click' chemistry has not yet realized. Thus, in view of strong binding efficacy of *p*-vanillin to GST of *B. malayi*, and the utility of carbohydrates in numerous chemical, biological, medicinal, and pharmacological investigations, we herein report the high-yielding synthesis of triazole-linked vanillin glycoconjugates **5** and **6** *via* Cu(I) catalyzed click reaction of azido-sugars (**1a-i**) and *p*-vanillin based terminal alkynes **2** and **4**. We also investigated the deprotection of representative compounds, *i.e.* **5a, 6c**, **6f**, and **6i** to afford glycoconjugates **7–10** bearing triazolyl fastend sugar residues attached to vanillin skeleton. To the best of our knowledge no such effort has been made earlier, and all the developed terminal alkynes **2** and **4** in addition to triazolyl glycoconjugates **5–10** are novel.

Result and discussion

The synthetic strategy begins with the cheap and readily available monosaccharides, *i.e.*, D-glucose, D-galactose and D-xylose etc., which after processing to a number of high-yielding steps for protection and modification, afforded deoxy-azido sugars **1a-i** in good yields [21–26].

After the synthesis of azido-sugars **1a-i**, we next attempted the synthesis of *p*-vanillin based terminal alkynes **2 & 4**. The propargylation of *p*-vanillin using Cs_2CO_3 in dry DMF under inert condition furnished 3-methoxy-4-(prop-2-ynyloxy)benzaldehyde **2** in excellent yields. Likewise, terminal alkyne 2-methoxy-1-(prop-2-ynyloxy)-4-((prop-2-ynyloxy)methyl)benzene) **4** was prepared by reduction of *p*-vanillin with $NaBH_4$ in dry THF at room temperature followed by propargylation of resulting 4-(hydroxymethyl)-2-methoxyphenol **3** in presence of Cs_2CO_3 in dry DMF (Scheme 1).

Once the synthesis of terminal alkynes **2** and **4** was accomplished, we further explored their click reaction with deoxy-azido sugars **1(a-i)**. Generally, CuAAC reaction proceeds in many protic and aprotic solvents, including water, and is



Scheme 1 Synthesis of *p*-vanillin based terminal alkynes **2** and **4**

unaffected by most organic and inorganic functional groups [15, 16]. Hence, the CuAAC reaction of terminal alkyne **2** (95 mg, 0.5 mmol) and azido-sugar **1a** (1.2 eqv, 0.6 mmol) was carried out in presence of DIPEA (0.087 ml, 0.5 mmol) and CuI (47 mg, 0.25 mmol) in dry CH_2Cl_2 at room temperature under inert atmosphere for 10 h to afford 1-(5-((4-formyl-2-methoxyphenoxy)methyl)-1*H*-1,2,3-triazol-1-yl)-2,3,4-tri-*O*-acetyl-β-D-xylopyranose **5a** regioselectively in 94 % yields. The regioisomeric nature of compound **5a** was established based on its spectroscopic data. In mass spectrum, compound **5a** displayed a molecular ion peak $[M + H]^+$ at *m/z* 492. The 300 MHz ^1H NMR spectrum of compound **5a** exhibited a total of twenty five proton resonances. A singlet integrated to one proton appeared at δ 9.83 was identified for aldehydic function while a triazolyl proton singlet resonated at δ 7.92. A multiplet integrated to two protons observed between δ 7.43–7.32 in addition to a one proton doublet resonated at δ 7.16 (J = 8.7 Hz) was attributed for unsubstituted positions in phenyl-ring. The anomeric proton of xylose resonated as doublet at δ 5.84 (J = 8.4 Hz) while a multiplet integrated to four protons was attributed to a oxymethylene function and two sugar protons. The proton resonances corresponding to three acetyl functions in compound **5a** were observed as singlets, three proton each appeared at δ 2.07, δ 2.04, and δ 1.83. Finally, single-crystal X-ray analysis unambiguously evidenced the structure of compound **5a** (Fig. 1 & Table 1).

Once having established the reaction conditions for the regioselective cycloaddition of *p*-vanillin based alkyne **2** and the azido-sugar **1a**, we explored the scope of other sugar azides in such a cycloaddition, and prepared a library of triazole-linked vanillin glycoconjugates **5** in efficient yields (Table 2). We also investigated the reaction under microwave *(MW)* condition, where a significant reduction of reaction time to 10 min was observed.

The structures of all the developed glycoconjugates **5** were elucidated using spectral studies (IR, ^1H, and ^{13}C NMR). Single-crystal X-ray analysis unambiguously evidenced the structure of compound **5b** (Fig. 2).

Further, we extended the work, and successfully prepared a series of *bis*-triazolyl vanillin-glycoconjugates **6** by reaction of alkyne **4** with azido-sugars **1** under optimized reaction condition (Table 3). The structure of all the developed glycoconjugates **6** were deduced from their spectral studies (IR, NMR, and MS).

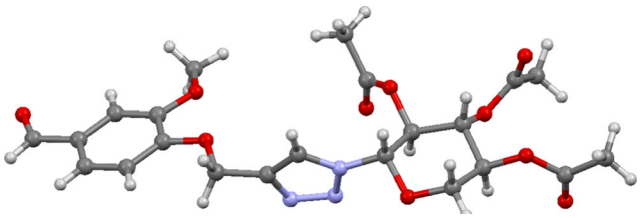


Fig. 1 Molecular structure of **5a**. Thermal ellipsoids of C, N, and O are set at 40 % probability

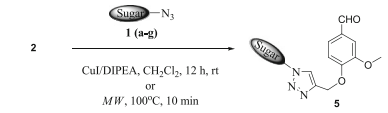
Table 1 Crystallographic refinement data for compound **5a**

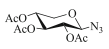
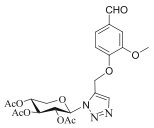
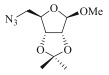
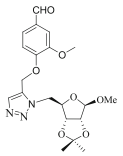
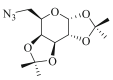
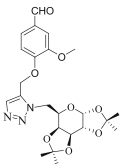
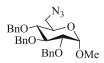
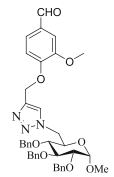
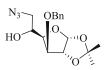
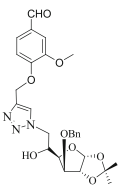
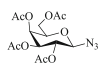
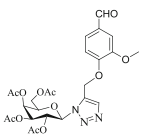
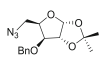
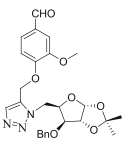
Property	Data
Empirical Formula	C_{22} H_{25} N_3 O_{10}
Formula Weight	491.45
Crystal System	Monoclinic
Space group	P 2_1
a (Å)	12.8377(16)
b (Å)	5.4479(4)
c (Å)	17.5773(15)
α, β, γ (°)	90, 105.297(11), 90
V (Å^3)	1185.8(2)
Z	2
Density (calc)	1.376
F(000)	516
μ (mm^{-1})	0.110
Crystal Size [mm]	0.16 x 0.18 x 0.24
Temperature (K)	293
Radiation / λ	Mo*K*\α / 0.71073
θ Min-Max [°]	3.18, 29.10
h, k, l	-17:10; −6:6; −24:21
Tot.,UniqData, R(int)	5128, 4193, 0.030
Obs. data [I > 2.0 σ(I)]	2183
Nref, Npar	5128, 156
R1, wR2, S	0.0642, 0.1672, 1.041
Max.and Av. Shift/Error	0.00, 0.00
Min. - Max. resd. Dens. [e/ Å^3]	-0.241, 0.198
CCDC	**1,472,356**

Considering the wide application of sugar-containing macrocycles in different fields [15], we extended the synthesis, and successfully developed a macrocycle comprising *bis*-triazolyl vanillin glycoconjugate **6i** (78 % isolated yield) by the reaction of alkyne **4** (1.0 equiv) with *bis* deoxy-azido sugar **1i** (1.2 equiv) in presence of CuI (0.5 equiv) and DIPEA (1.0 equiv) at room temperature for 10 h under optimized reaction conditions. Reaction time was significantly reduced to 10 min, when reaction was carried out under microwave at 100 °C with a stirring rate 200 rpm (Scheme 2).

Finally, for a near future *in vitro* assay against *B. malayi,* we need to remove the various carbohydrate protecting groups from glycoconjugates **(5 & 6)**, therefore, representative compounds **5a**, **6f**, and **6i** were treated with sodium methoxide in anhydrous methanol for 24 h at room temperature to afford corresponding glycoconjugates **7**, **8**, and **9**, respectively (Fig. 3). Likewise, isopropylidene protected glycoconjugate **6c** was deprotected using trifluoroacetic acid-water (3:2 *v*/v) in 2 h to afford corresponding triazolyl glycoconjugate **10**. The structure of deprotected glycoconjugates were deduced from their spectral studies (IR, NMR, and MS).

Table 2 Synthesis of triazole-linked *p*-vanillin glycoconjugates **5** *via* CuAAC reaction



Entry[a]	Sugar azides	Click product[b]	Yield (%)[c]	Yield (%)[d]
1	 **1a**	 **5a**	94	95
2	 **1b**	 **5b**	92	92
3	 **1c**	 **5c**	90	90
4	 **1d**	 **5d**	92	94
5	 **1e**	 **5e**	90	92
6	 **1f**	 **5f**	94	93
7	 **1g**	 **5g**	92	92

[a] Molar ratios: deoxy-azido sugar **1** (1.2 equiv), vanillin alkyne **2** (1.0 equiv), CuI (0.5 equiv) and DIPEA (1.0 equiv)

[b] Vanillin triazolyl glycoconjugates

[c] Isolated yield at rt. (time 10 h)

[d] Isolated yield through reaction under microwave at 100 °C with a stirring rate 200 rpm in 10 min

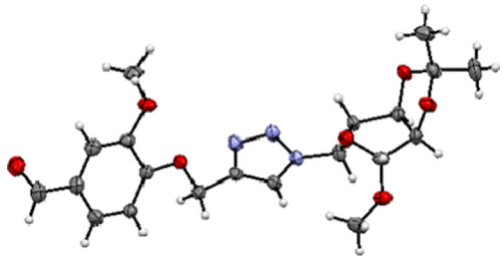


Fig. 2 Molecular structure of **5b**. Thermal ellipsoids of C, N, and O are set at 40 % probability (**CCDC 1022190**)

Conclusion

Diverse deoxy-azido sugars were prepared by nucleophilic substitution from *O*-*p*-toluene sulfonyl glycofurano/pyranoses using sodium azide in anhydrous DMF under inert condition. The deoxy-*azido* sugars were further subjected to CuAAC reaction with *p*--vanillin based terminal alkynes, to afford triazolyl *p*-vanillin-glycoconjugates in excellent yields. The reaction time has been significantly reduced (10 min) under microwave heating.

Experimental

General methods

All of the reactions were executed using anhydrous solvents under an argon atmosphere in 1 h oven-dried glassware at 100 °C. All reagents and solvents were of pure analytical grade. Thin-layer chromatography (TLC) was performed on 60 F254 silica gel, pre-coated on aluminum plates and revealed with either a UV lamp (λ_{max} = 254 nm) or a specific color reagent (iodine vapors) or by spraying with methanol-H_2SO_4 solution and subsequent heating at 60 °C. ^{1}H and ^{13}C NMR spectra were recorded at 300 and 75 MHz, respectively. Chemical shifts given in ppm downfield from internal TMS; *J* values in Hz. Mass spectra were recorded using electrospray ionization mass spectrometry (ESI-MS). Infrared spectra were obtained as Nujol mulls in KBr plates. Elemental analysis was performed using a C, H, N analyzer, and results were found to be within ±0.4 % of the calculated values. Reaction under microwave condition was carried out on Microwave CEM Discover R Lab Mate.

General procedure for synthesis of sugar azides (1)

The compounds **1a-i** were prepared from readily available carbohydrates (D-glucose, D-galactose, D-ribose etc.) using standard protection and modification methodologies [25, 26].

General procedure for synthesis of 3-methoxy-4-(prop-2-ynyloxy) benzaldehyde (2)

To a solution of *p*-vanillin (5.0 g, 32.9 mmol) in DMF (50 mL), caesium carbonate (1.2 equiv., 12.86 g, 39.48 mmol) and propargyl bromide (1.3 equiv., 3.2 mL, 42.8 mmol) were added under inert condition. The reaction mixture was stirred for 12 h at room temperature. After completion of reaction (monitored by TLC), the reaction mixture was *in vacuo* concentrated, extracted with CH_2Cl_2, and washed twice with 10 % Na_2CO_3, water, and brine solution. The organic layer was dried over anhydrous Na_2SO_4. Residue obtained after removal of solvent was purified by flash column chromatography using gradient mixtures of *n*-hexane-ethyl acetate as eluent to afford compound **2**.

3-Methoxy-4-(prop-2-ynyloxy) benzaldehyde (2) White solid; mp = 68-70 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.86 (s, 1H), 7.47–7.43 (m, 3H), 4.86–4.85 (m, 2H), 3.93 (s, 3H), 2.57 (t, J = 1.5 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.5, 152.0, 149.9, 130.8, 126.3, 112.5, 110.2, 56.9, 56.0; MS: *m/z* 191 $[M + H]^+$.

General procedure for synthesis of vanillyl alcohol (3)

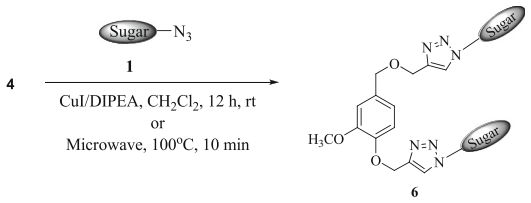
The compound *p*-vanillin was reduced with $NaBH_4$ in dry THF at room temperature to afford compound **3** [27].

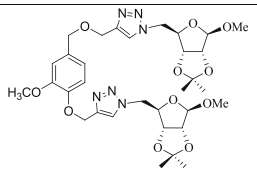
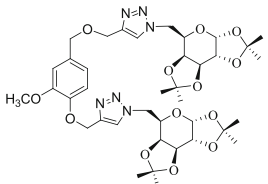
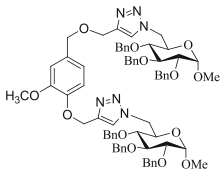
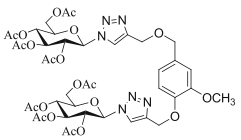
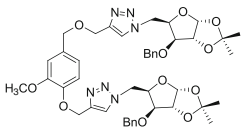
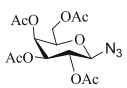
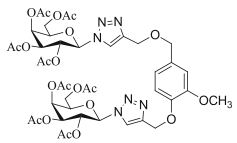
General procedure for synthesis of 2-methoxy-1-(prop-2-ynyloxy)-4-((prop-2-ynyloxy) methyl) benzene (4)

To a solution of vanillyl alcohol **3** (3.2 g, 20.75 mmol) in DMF (30 mL), caesium carbonate (2.4 equiv., 16.23 g, 49.82 mmol) and propargyl bromide (2.6 equiv., 4.8 mL, 53.95 mmol) were added under inert condition. The reaction mixture was stirred for 12 h at room temperature. After completion of reaction (monitored by TLC), reaction mixture was *in vacuo* concentrated, extracted with CH_2Cl_2, and washed twice with 10 % Na_2CO_3, water, and brine solution. The organic layer was dried over anhydrous Na_2SO_4. The residue obtained after removal of the solvent was purified by flash column chromatography using gradient mixtures of *n*-hexane-ethyl acetate as eluent to afford compound **4**.

2-methoxy-1-(prop-2-ynyloxy)-4-((prop-2-ynyloxy)methyl)benzene) (4) Yellow liquid; ^{1}H NMR (300 MHz, $CDCl_3$): δ 7.01–6.87 (m, 3H), 4.75, (s, 2H), 4.55 (s, 2H), 4.16 (s, 2H), 3.88 (s, 3H), 2.49 (s, 1H), 2.47 (s, 1H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 155.0, 149.6, 147.0, 129.0, 121.1, 113.9, 112.1, 78.3, 75.9, 69.7, 56.6, 55.9; MS: *m/z* 231 $[M + H]^+$.

Table 3 Synthesis of vanillin glycoconjugates **6** *via* CuAAC reaction



Entry[a]	Sugar azides	Click product[b]	Yield (%)[c]	Yield (%)[d]
1	**1b**	 **6b**	90	92
2	**1c**	 **6c**	91	90
3	**1d**	 **6d**	90	90
4	**1f**	 **6f**	89	90
5	**1g**	 **6g**	85	87
6	 **1h**	 **6h**	88	88

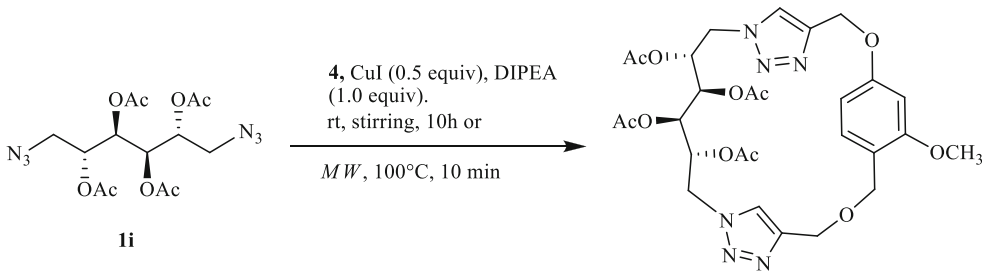
[a] Molar ratios: deoxy-azido sugar **1** (2.4 equiv), vanillin alkyne **4** (1.0 equiv), CuI (0.5 equiv) and DIPEA (1.0 equiv)

[b] Triazolyl vanillin-glycoconjugates

[c] Isolated yield at rt. (time 10 h)

[d] Isolated yield through reaction under microwave at 100 °C with a stirring rate 200 rpm in 10 min

Scheme 2 Click inspired synthesis of vanillin containing glycomacrocycle



1i

6i
Y1: 78% (reaction at rt, 10h)
Y2: 80% (*MW*, 100°C, 10 min)

General procedure for synthesis of triazolyl glycoconjugates 5

A solution of **2** (95.1 mg, 0.5 mmol) and azido-sugars **1a** (1.2 eqv, 0.6 mmol) in presence of DIPEA (0.087 ml, 0.5 mmol) and CuI (47.6 mg, 0.25 mmol) in dry CH_2Cl_2 were stirred at room temperature under inert atmosphere for 10 h. After completion of reactions (monitored by TLC), the reaction mixtures were *in vacuo* concentrated to obtain crude residues, which were further purified by silica gel (100–200 mesh) column chromatography to afford compounds **5a**.

An equimolar mixture of azido-sugars **1a** (1.2 eqv, 0.6 mmol) and compound **2** (95.1 mg, 0.5 mmol) in anhydrous toluene (10 ml) in presence of DIPEA (0.087 ml, 0.5 mmol) and CuI (47.6 mg, 0.25 mmol) were heated at 100 °C for 10 min in a microwave reactor (Microwave CEM Discover R Lab Mate). After completion (monitored by TLC), the reaction mixtures were *in vacuo* concentrated, extracted with CH_2Cl_2, washed with water, and dried over anhydrous Na_2SO_4 followed by *in vacuo* concentration. Purification using flash column chromatography afforded triazolyl *O*-vanillin glycoconjugate **5a**.

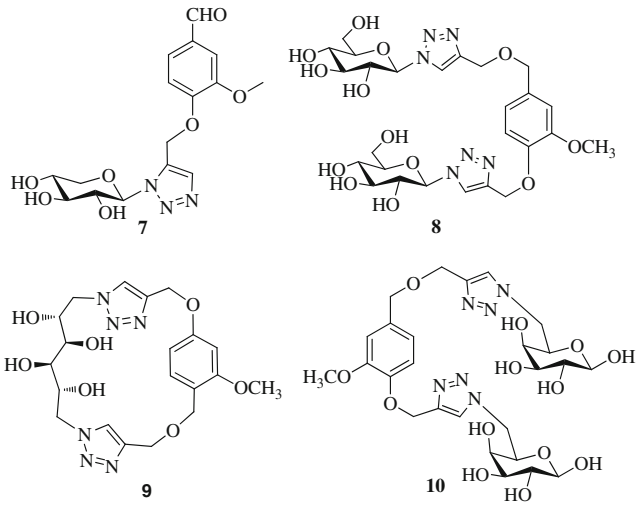


Fig. 3 Structure of deprotected glycoconjugates **7–10**

1-(5-((4-formyl-2-methoxyphenoxy)methyl)-1H-1,2,3-triazol-1-yl)-2,3,4-tri-O-acetyl-β-D-xylopyranose (5a) Yellowish solid (231 mg, yield 94 %); mp = 140-142 °C; IR (KBr) ν_{max}: 3210, 3132, 2937, 2870, 1668, 1591, 1511, 1461, 1428, 1301, 1265, 1154, 730, 629 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 9.83 (s, 1H), 7.92 (s, 1H), 7.43–7.32 (m, 2H), 7.16 (d, J = 8.7, 1H), 5.84 (d, J = 8.4, 1H), 5.46–5.37 (m, 4H), 5.19–5.14 (m, 1H), 4.31–4.26 (m, 1H), 3.92 (s, 3H), 3.65–3.58 (m, 1H), 2.07 (s, 3H), 2.04 (s, 3H), 1.83 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 190.7, 169.6, 169.5, 168.7, 152.6, 149.8, 130.4, 126.3, 121.5, 112.5, 109.2, 86.1, 71.7, 70.2, 68.1, 65.3, 62.4, 55.8, 29.4, 20.4, 20.3, 19.9; MS: *m/z* 492 $[M + H]^+$; Anal. Calcd for $C_{22}H_{25}N_3O_{10}$: C, 53.77; H, 5.13; N, 8.55. Found: C, 54.16; H, 4.8; N, 8.8.

1-(5-((4-formyl-2-methoxyphenoxy)methyl)-1H-1,2,3-triazol-1-yl)-methyl-5-deoxy-2,3-O-isopropylidene-β-D-ribofuranoside (5b) Yellow liquid (193 mg, yield 92 %); IR (KBr) ν_{max}: 3205, 3135, 2937, 2860, 1670, 1590, 1510, 1465, 1425, 1255, 1148, 730, 626 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 9.84 (s, 1H), 7.79 (s, 1H), 7.44–7.41 (m, 2H), 7.28–7.22 (m, 1H), 5.38 (s, 2H), 5.00–4.41 (m, 6H), 3.92 (s, 3H), 3.36 (s, 3H), 1.45 (s, 3H), 1.30 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 190.8, 152.9, 149.8, 143.3, 130.4, 126.6, 123.5, 112.8, 112.4, 110.0, 109.9, 109.0, 84.9, 81.6, 62.7, 55.9, 55.5, 53.1, 26.2, 24.7; MS: *m/z* 420 $[M + H]^+$; Anal. Calcd for $C_{20}H_{25}N_3O_7$: C, 57.27; H, 6.01; N, 10.02. Found: C, 57.56; H, 6.28; N, 10.35.

1-(5-((4-formyl-2-methoxyphenoxy)methyl)-1H-1,2,3-triazol-1-yl)-6-deoxy-1,2:3,4-di-O-isopropylidene-α-D-galactopyranose (5c) Yellow liquid (214 mg, yield 90 %); IR (KBr) ν_{max}: 3190, 3129, 2932, 2865, 1667, 1592, 1515, 1468, 1427, 1268, 1153, 735, 628 cm^{-1};^1H NMR (300 MHz, $CDCl_3$): δ 9.83 (s, 1H), 7.84 (s, 1H), 7.43–7.40 (m, 2H), 7.23–7.20 (m, 1H), 5.49–5.29 (m, 3H), 4.63–4.61 (m, 2H), 4.48–4.32 (m, 2H), 4.19–4.17 (m, 2H), 3.91 (s, 3H), 1.47 (s, 3H), 1.35 (s, 6H), 1.28 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 190.8, 153.0, 149.9, 142.7, 130.4, 126.6, 124.4, 112.6, 109.8, 108.9, 96.2, 70.9, 70.5, 70.1, 66.9, 62.6, 55.8, 50.4, 25.8, 24.7,

24.2; MS: *m/z* 475 $[M + H]^+$; Anal. Calcd for $C_{23}H_{29}N_3O_8$: C, 58.10; H, 6.15; N, 8.84. Found: C, 57.73; H, 5.85; N, 8.53.

1-(5-((4-formyl-2-methoxyphenoxy)methyl)-1H-1,2,3-triazol-1-yl)-methyl-2,3,4-tri-O-benzyl-6-deoxy-α-D-glucopyranose (5d) Yellowish solid (313 mg, yield 92 %); mp = 90-92 °C; IR (KBr) ν_{max} 3215, 3137, 2936, 2870, 1670, 1590, 1520, 1463, 1440, 1275, 1160, 728, 636 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 9.81 (s, 1H), 7.70 (s, 1H), 7.40–7.18 (m, 18H), 5.37–5.28 (m, 2H), 4.98–4.48 (m, 9H), 4.01–3.90 (m, 5H), 3.39–3.37 (m, 1H), 3.16–3.07 (m, 4H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 190.8, 152.9, 149.8, 143.1, 138.3, 137.8 (2), 130.5, 128.4 (2), 128.1, 127.9, 127.7, 126.6, 124.5, 112.5, 109.1, 98.0, 97.9, 81.8, 81.7, 79.8, 75.7, 74.9, 73.4, 73.2, 68.9, 62.8, 62.7, 56.0, 55.9, 55.1, 50.7, 29.6; MS: *m/z* 680 $[M + H]^+$; Anal. Calcd for $C_{39}H_{41}N_3O_8$: C, 68.91; H, 6.08; N, 6.18. Found: C, 69.22; H, 5.81; N, 5.79.

1-(5-((4-formyl-2-methoxyphenoxy)methyl)-1H-1,2,3-triazol-1-yl)-3-O-benzyl-6-deoxy-1,2-O-isopropylidene-α-D-glucofuranose (5e) Yellowish solid (236 mg, yield 90 %); mp = 52-54 °C; IR (KBr) ν_{max}: 3205, 3135, 2931, 2876, 1665, 1600, 1522, 1460, 1430, 1263, 1157, 733, 628 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 9.82 (s, 1H), 7.78 (s, 1H), 7.42–7.18 (m, 8H), 5.93 (d, *J* = 3.3, 1H), 5.31 (s, 2H), 4.75–4.51 (m, 4H), 4.39–4.35 (m, 2H), 4.08 (s, 1H), 3.93–3.89 (m, 4H), 1.41 (s, 3H), 1.31 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 190.9, 152.9, 149.7, 142.6, 137.0, 130.4, 128.5, 128.1, 127.7, 126.6, 125.0, 112.3, 111.9, 109.1, 105.2, 105.0, 82.0, 81.0, 80.1, 72.1, 67.4, 62.5, 55.8, 55.7, 53.9, 26.6, 26.1; MS: *m/z* 526 $[M + H]^+$; Anal. Calcd for $C_{27}H_{31}N_3O_8$: C, 61.70; H, 5.95; N, 8.00. Found: C, 62.04; H, 6.34; N, 8.31.

1-(5-((4-formyl-2-methoxyphenoxy)methyl)-1H-1,2,3-triazol-1-yl)-2,3,4,6-tetra-O-acetyl-β-D-galactopyranose (5f) Yellow liquid (262 mg, yield 93 %); IR (KBr) ν_{max}: 3210, 3140, 2930, 2868, 1666, 1597, 1517, 1461, 1444, 1262, 1153, 729, 632 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 9.85 (s, 1H), 7.98 (s, 1H), 7.45–7.42 (m, 2H), 7.19–7.16 (m, 1H), 5.88 (d, *J* = 9.3, 1H), 5.54 (t, *J* = 9.6, 2H), 5.38 (s, 2H), 5.30–5.24 (m, 1H), 4.25–4.14 (m, 3H), 3.94 (s, 3H), 2.21 (s, 3H), 2.04 (s, 3H), 2.00 (s, 3H), 1.84 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 190.8, 170.2, 169.8, 169.6, 168.9, 152.8, 149.9, 143.8, 130.6, 126.4, 121.7, 112.6, 109.3, 86.2, 86.1, 73.9, 70.6, 67.7, 66.8, 66.7, 62.8, 62.6, 62.5, 61.1, 56.0, 55.9, 20.5, 20.3, 20.1; MS: *m/z* 564 $[M + H]^+$; Anal. Calcd for $C_{25}H_{29}N_3O_{12}$: C, 53.29; H, 5.19; N, 7.46. Found: C, 53.49; H, 5.51; N, 7.83.

1-(5-((4-formyl-2-methoxyphenoxy)methyl)-1H-1,2,3-triazol-1-yl)-3-O-benzyl-1,2-O-isopropylidine-α-D-xylofuranose (5 g) Yellow liquid (228 mg, yield 92 %); IR (KBr) ν_{max}: 3217, 3135, 2927, 2856, 1660, 1591, 1519, 1457, 1453, 1261, 1167, 728, 631 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 9.82 (s, 1H), 7.73 (s, 1H), 7.42–7.20 (m, 8H), 5.97–5.96 (m, 1H), 5.32 (s, 2H), 4.72–4.63 (m, 3H), 4.54–4.43 (m, 3H), 3.98–3.97 (m, 1H), 3.87 (s, 3H), 1.42 (s, 6H), 1.30 (m, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 190.6, 152.8, 149.6, 142.8, 136.5, 130.2, 128.4, 128.0, 127.7, 126.4, 124.2, 112.3, 111.8, 109.0, 104.9, 81.6, 81.3, 78.4, 77.4, 71.7, 62.4, 55.6, 49.1, 26.4, 25.9; MS: *m/z* 496 $[M + H]^+$; Anal. Calcd for $C_{26}H_{29}N_3O_7$: C, 63.02; H, 5.90; N, 8.48. Found: C, 63.35; H, 6.16; N, 8.29.

General procedure for synthesis of triazolyl glycoconjugates 6

A solution of compound **4** (58 mg, 0.25 mmol) and *azido*-sugars **1b** (2.4 eqv, 0.6 mmol) in presence of DIPEA (0.087 ml, 0.5 mmol) and CuI (47.6 mg, 0.25 mmol) in dry CH_2Cl_2 were stirred at room temperature under inert atmosphere for 10 h. After completion of reactions (monitored by TLC), the reaction mixtures were *in vacuo* concentrated to obtain crude residues which were further purified by silica gel (100–200 mesh) column chromatography to afford compounds **6b**.

An equimolar mixture of *azido*-sugars **1b** (1.2 eqv, 0.3 mmol) and compound **4** (29 mg, 0.125 mmol) in anhydrous toluene (10 ml) in presence of DIPEA (0.044 ml, 0.25 mmol) and CuI (24 mg, 0.125 mmol) were heated at 100 °C for 10 min in a microwave (*MW*) reactor (Microwave CEM Discover R Lab Mate). After completion (monitored by TLC), the reaction mixtures were *in vacuo* concentrated, extracted with CH_2Cl_2, washed with water, and dried over anhydrous Na_2SO_4 followed by *in vacuo* concentration. Purification using flash column chromatography afforded triazolyl glycoconjugates **6b**.

1-(4-((2-methoxy-4-((methyl-5-deoxy-2,3-O-isopropylidene-β-D-ribofuranosyl)-1H-1,2,3-triazol-4-yl)methoxy)methyl)phenoxy)methyl)-1H-1,2,3-triazol-1-yl)-methyl-5′-deoxy-2′,3′-O-isopropylidene-β-D-ribofuranose (6b) Yellow liquid (155 mg, yield 90 %); IR (KBr) ν_{max}: 3138, 2955, 2937, 2910, 2874, 2637, 1613, 1443, 1422, 1378, 1212, 1174, 1111, 934, 829, 757, 710, 606 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 7.74 (s, 1H), 7.67 (s, 1H), 7.00–6.83 (m, 3H), 5.29–5.27 (m, 2H), 5.01–5.00 (m, 2H), 4.754.41 (m, 12H), 3.85 (s, 3H), 3.37 (s, 3H), 3.35 (s, 3H), 1.49 (s, 3H), 1.30 (s, 6H), 1.26 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 149.5, 147.0, 145.1, 144.2, 131.3, 123.2, 123.1, 122.8, 120.3, 113.9, 112.7, 111.6, 109.9, 85.0, 84.9, 84.8, 81.6, 72.1, 63.1, 63.0, 55.7, 55.3, 52.9, 31.7, 29.1, 26.1 (2), 24.7 (2); MS: *m/z* 689 $[M + H]^+$; Anal. Calcd for $C_{32}H_{44}N_6O_{11}$: C, 55.80; H, 6.44; N, 12.20. Found: C, 56.13; H, 6.13; N, 12.39.

1-(4-((2-methoxy-4-((6-deoxy-1,2:3,4-di-O-isopropylidene-α-D-galactopyranosyl)-1H-1,2,3-triazol-4-yl)methoxy)methyl)phenoxy)methyl)-1H-1,2,3-triazol-1-yl)-6′-deoxy-1′,2′:3′,4′-di-O-isopropylidene-α-D-galactopyranose (6c) Yellow liquid (182 mg, yield 91 %); IR (KBr) ν_{max}: 3135, 2957, 2942, 2915, 2867, 2640, 1605, 1450, 1423, 1370, 1215, 1178, 1110, 932, 831, 755, 716, 610 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 7.79 (s, 1H), 7.73 (s, 1H), 7.00–6.92 (s, 2H), 6.85–6.82 (d, J = 8.4 Hz, 1H), 5.51 (t, J = 4.8, 2H), 5.27 (s, 2H), 4.66–4.58 (m, 6H), 4.49–4.40 (m, 4H), 4.32 (m, 2H), 4.21–4.15 (m, 4H), 3.86 (s, 3H), 1.48 (s, 6H), 1.38 (s, 3H), 1.37 (s, 3H), 1.34 (s, 3H), 1.28 (s, 6H), 1.25 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 149.61, 147.2, 144.6, 143.8, 131.3, 124.1, 124.1, 123.8, 123.8, 120.4, 114.1, 111.7, 109.7, 109.7, 108.9, 96.1, 71.9, 71.0, 70.9, 70.6, 70.2, 67.1, 67.0, 63.2, 55.8, 50.3, 29.5 (2), 25.8, 24.7, 24.3; MS: *m/z* 801 $[M + H]^+$; Anal. Calcd for $C_{38}H_{52}N_6O_{13}$: C, 56.99; H, 6.54; N, 10.49. Found: C, 56.69; H, 6.33; N, 10.75.

1-(4-((2-methoxy-4-((methyl-2,3,4-tri-O-benzyl-6-deoxy-α-D-glucopyranosyl)-1H-1,2,3-triazol-4-yl)methoxy)methyl)phenoxy)methyl)-1H-1,2,3-triazol-1-yl)-methyl-2′,3′,4′-tri-O-benzyl-6′-deoxy-α-D-glucopyranose (6d) Yellowish solid (272 mg, yield 90 %); mp = 65-67 °C; IR (KBr) ν_{max}: 3131, 2960, 2940, 2920, 2865, 2647, 1610, 1455, 1427, 1378, 1220, 1176, 1148, 938, 840, 756, 720, 618 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 7.67 (s, 1H), 7.57 (s, 1H), 7.32–7.30 (m, 15H), 6.97–6.81 (m, 3H), 5.26 (m, 4H), 4.99–4.87 (m, 4H), 4.81–4.68 (m, 6H), 4.62–4.47 (m, 14H), 3.98 (m, 2H), 3.83 (s, 3H), 3.42–3.39 (m, 2H), 3.18 (s, 3H), 3.09 (s, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): δ 149.4, 147.0, 144.8, 144.0, 138.2, 137.7, 131.2, 128.3, 128.2, 128.0, 127.8, 127.7, 127.5, 124.1, 123.9, 120.2, 113.7, 111.5, 97.8 (2), 81.6, 79.7, 75.5, 74.7, 73.2, 71.9, 68.9, 63.1, 63.0, 55.7, 55.1, 55.0, 50.5, 50.4. MS: *m/z* 1209 $[M + H]^+$; Anal. Calcd for $C_{70}H_{76}N_6O_{13}$: C, 69.52; H, 6.33; N, 6.95. Found: C, 69.81; H, 5.95; N, 7.27.

1-(4-((2-methoxy-4-((2,3,4,6-tetra-O-acetyl-β-D-glucoopyranosyl)-1H-1,2,3-triazol-4-yl)methoxy)methyl)phenoxy)methyl)-1H-1,2,3-triazol-1-yl)-2′,3′,4′,6′-tetra-O-acetyl-β-D-glucoopyranosyl (6f) Yellowish solid (217 mg, yield 89 %); mp = 138-140 °C; IR (KBr) ν_{max}: 3140, 2951, 2938, 2926, 2861, 2650, 1613, 1447, 1421, 1371, 1210, 1180, 928, 831, 750, 610 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 7.94 (s, 1H), 7.87 (s, 1H), 6.96–6.87 (m, 3H), 5.95 (m, 2H), 5.47 (m, 4H), 5.26 (m, 4H), 4.67 (s, 2H), 4.49 (s, 2H), 4.27–4.07 (m, 6H), 3.87 (s, 3H), 2.06–2.03 (m, 18H), 1.86–1.83 (m, 6H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 170.25, 169.6, 169.1, 168.6, 149.5, 147.0, 145.6, 144.7, 131.3, 121.3, 120.9, 120.3, 114.1, 111.7, 85.3, 74.7, 72.4, 71.9, 70.1, 67.5, 62.8, 61.3, 55.6, 20.3, 20.2, 19.8; MS: *m/z* 977 $[M + H]^+$; Anal. Calcd for $C_{42}H_{52}N_6O_{21}$: C, 51.64; H, 5.37; N, 8.60. Found: C, 51.26; H, 5.6; N, 8.91.

1-(4-((2-methoxy-4-((3-O-benzyl-1,2-O-isopropylidine-α-D-xylofuranose)-1H-1,2,3-triazol-4-yl)methoxy)methyl)phenoxy)methyl)-1H-1,2,3-triazol-1-yl)-3′-O-benzyl-1′,2′-O-isopropylidine-α-D-xylofuranosyl (6 g) Yellowish solid (179 mg, yield 85 %); mp = 48-50 °C; IR (KBr) ν_{max}: 3136, 2957, 2931, 2929, 2878, 2633, 1621, 1443, 1418, 1377, 1212, 1175, 932, 827, 754, 608 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 7.66 (s, 1H), 7.58 (s, 1H), 7.33–7.32 (m, 10H), 7.00–6.83 (m, 3H), 5.97–5.94 (m, 2H), 5.27–5.24 (m, 3H), 4.74–4.42 (m, 15H), 3.99 (m, 2H), 3.84 (s, 3H), 1.42 (s, 6H), 1.30 (m, 6H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 149.6, 147.1, 144.9, 144.0, 136.7, 131.3, 128.5, 128.1, 127.8, 124.0, 123.6, 123.6, 120.4, 114.1, 111.9, 111.6, 105.1, 81.8, 81.4, 78.7, 78.6, 72.2, 71.8, 63.2, 63.1, 55.7, 49.1, 49.0, 26.6, 26.0; MS: *m/z* 841 $[M + H]^+$; Anal. Calcd for $C_{44}H_{52}N_6O_{11}$: C, 62.84; H, 6.23; N, 9.99. Found: C, 62.47; H, 6.44; N, 9.8.

1-(4-((2-methoxy-4-((2,3,4,6-tetra-O-acetyl-β-D-galactopyranosyl)-1H-1,2,3-triazol-4-yl)methoxy)methyl)phenoxy)methyl)-1H-1,2,3-triazol-1-yl)-2′,3′,4′,6′-tetra-O-acetyl-D-galactopyranosyl (6 h) Yellowish solid (215 mg, yield 88 %); mp = 48-50 °C; IR (KBr) ν_{max}: 3137, 2954, 2940, 2918, 2870, 2637, 1612, 1443, 1421, 1377, 1221, 1182, 929, 830, 751, 610 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 7.94 (s, 1H), 7.86 (s, 1H), 7.02–6.87 (m, 3H), 5.85–5.82 (m, 2H), 5.58–5.54 (m, 4H), 5.27–5.23 (m, 4H), 4.76–4.68 (m, 2H), 4.57–4.52 (m, 4H), 4.21–4.15 (m, 4H), 3.89 (s, 3H), 2.22 (s, 6H), 2.04–2.00 (s, 12H), 1.89 (s, 3H), 1.86 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 170.2, 169.9, 169.7, 168.9, 158.9, 149.7, 147.2, 145.8, 144.8, 131.6, 131.0, 121.4, 121.0, 120.7, 120.3, 114.2, 111.8, 86.1, 79.5, 75.7, 74.6, 73.9, 72.2, 71.3, 70.7, 67.8, 67.7, 66.8, 63.1, 61.1, 56.8, 56.7, 55.8, 20.5, 20.4 (2), 20.1; MS: *m/z* 977 $[M + H]^+$; Anal. Calcd for $C_{42}H_{52}N_6O_{21}$: C, 51.64; H, 5.37; N, 8.60. Found: C, 51.91; H, 5.71; N, 8.83.

General procedure for synthesis of triazolyl glycoconjugate 6i

A solution of compouind **4** (115 mg, 0.5 mmol) and *azido*-sugars **1i** (1.2 eqv, 0.6 mmol) in presence of DIPEA (0.087 ml, 0.5 mmol) and CuI (47.6 mg, 0.25 mmol) in dry CH_2Cl_2 were stirred at room temperature under inert atmosphere for 10 h. After completion of reactions (monitored by TLC), the reaction mixtures were *in vacuo* concentrated to obtain crude residues which were further purified by silica gel (100–200 mesh) column chromatography to afford compounds **6i**.

Bis-triazolyl-tetra-O-acetyl-D-mannitol macrocycle (6i) Yellowish liquid (262 mg, yield 78 %); IR (KBr) ν_{max}: 3216,

3139, 2936, 2857, 1667, 1590, 1524, 1470, 1440, 1262, 1145, 730, 636 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 7.62–7.59 (m, 2H), 6.79–6.72 (m, 3H), 5.27–5.14 (m, 6H), 4.54 (m, 3H), 4.36 (s, 2H), 3.73 (s, 3H), 3.64–3.61 (m, 2H), 3.07–3.04 (m, 1H), 2.05–1.83 (m, 12H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 169.5, 169.4, 169.3, 169.1, 149.3, 146.8, 144.3, 131.2, 123.6, 123.3, 120.3, 113.7, 111.6, 71.8, 68.2, 67.7, 62.8, 55.6, 54.1, 49.8, 20.5, 20.4, 20.3, 20.1; MS: *m/z* 631 $[M + H]^+$; Anal. Calcd for $C_{42}H_{52}N_6O_{21}$: C, 53.33; H, 5.43; N, 13.33. Found: C, 52.72; H, 5.64; N, 13.04.

General procedure for deprotection of acetyl-protected triazolyl glycoconjugates

Acetyl protected triazolyl glycoconjugates were deprotected by reaction with sodium methoxide in anhydrous methanol for 24 h using the protocol described by Agoston *et al.* [28].

1-(5-((4-formyl-2-methoxyphenoxy)methyl)-1H-1,2,3-triazol-1-yl)-β-D-xylopyranose (7) White solide; mp = 136-138 °C; IR (KBr) ν_{max}: 3274, 2918, 2854, 2355, 1661, 1585, 1510, 1410, 1268, 1133, 1046, 1005, 820, 721 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 9.85 (s, 1H), 8.48 (s, 1H), 7.59–7.56 (m, 1H), 7.42–7.40 (m, 2H), 5.53–5.37 (m, 3H), 5.27–5.21 (m, 3H), 3.85–3.75 (m, 4H), 3.48–3.47 (s, 1H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 191.4, 152.7, 149.2, 141.8, 129.8, 125.8, 124.3, 112.4, 109.5, 88.1, 77.0, 71.9, 69.0, 68.3, 61.5, 55.4; MS: *m/z* 366 $[M + H]^+$; Anal. Calcd for $C_{42}H_{52}N_6O_{21}$: C, 52.60; H, 5.57; N, 11.50. Found: C, 52.99; H, 5.64; N, 11.31.

1-(4-((2-methoxy-4-((β-D-glucoopyranosyl)-1H-1,2,3-triazol-4-yl)methoxy)methyl)phenoxy)methyl)-1H-1,2,3-triazol-1-yl)-β-D-glucopyranose (8) Viscous liquid; IR (KBr) ν_{max}: 3152, 2930, 2851, 2348, 1520, 1504, 1424, 1254, 1120, 1038, 960, 826, 728 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 8.45 (s, 1H), 8.34 (s, 1H), 7.15–7.13 (m, 1H), 6.94–6.88 (m, 2H), 5.57–5.51 (m, 2H), 5.10 (s, 2H), 4.55 (s, 2H), 4.47 (s, 2H), 3.81–3.67 (m, 12H), 3.46–3.39 (m, 6H), 3.26–3.22 (m, 2H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 149.2, 147.3, 144.2, 142.9, 131.4, 124.5, 123.7, 120.5, 113.3, 112.1, 87.9, 80.4 (2), 77.3, 72.5, 72.4, 71.6, 69.9, 62.9, 61.8, 61.1, 55.8; MS: *m/z* 641 $[M + H]^+$; Anal. Calcd for $C_{42}H_{52}N_6O_{21}$: C, 48.75; H, 5.66; N, 13.12. Found: C, 48.48; H, 5.99; N, 12.78.

Bis-triazolyl-D-mannitol macrocycle (9) Viscous liquid; IR (KBr) ν_{max}: 3222, 3136, 2940, 2842, 1570, 1506, 1461, 1438, 1252, 1149, 735, 638 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 8.14 (s, 1H), 7.88 (s, 1H), 7.10 (m, 1H), 6.89–6.81 (m, 2H), 5.08–5.05 (m, 3H), 4.95–4.91 (m, 2H), 4.73–4.70 (m, 4H), 4.49–4.48 (m, 2H), 4.31–4.29 (m, 3H), 3.83–3.81 (m, 3H), 3.72–3.70 (m, 4H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 160.5, 158.9, 148.8, 146.8, 142.1, 131.1, 125.5, 119.9, 113.1, 111.5, 73.4, 70.069.2, 61.6, 57.2, 55.3, 54.9, 53.0, 48.6, 45.8, 41.3; MS: *m/z* 463 $[M + H]^+$; Anal. Calcd for $C_{42}H_{52}N_6O_{21}$: C, 51.94; H, 5.67; N, 18.17. Found: C, 52.27; H, 6.04; N, 18.56.

General procedure for deprotection of isopropylidene protected triazolyl glycoconjugates

Isopropylidene protected triazolyl glycoconjugate **6c** was deprotected by reaction with trifluoroacetic acid in water for 2 h to afford compound **10** using the protocol described by Prasad *et al.* [29].

1-(4-((2-methoxy-4-((D-galactopyranosyl)-1H-1,2,3-triazol-4-yl)methoxy)methyl)phenoxy)methyl)-1H-1,2,3-triazol-1-yl)-α-D-galactopyranose (10) Viscous liquid; IR (KBr) ν_{max}: 3141, 2953, 2948, 2916, 2853, 2648, 1611, 1443, 1430, 1356, 1221, 1182, 1105, 938, 827, 757, 719, 618 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 8.18 (s, 1H), 8.17 (s, 1H), 7.11–7.05 (m, 1H), 6.92–6.90 (m, 1H), 6.84–6.80 (m, 1H), 5.07–5.04 (m, 4H), 4.90–4.90 (m, 1H), 4.52–4.47 (m, 2H), 4.41 (s, 2H), 4.31–4.26 (m, 2H), 4.21–4.19 (m, 1H), 3.91–3.89 (m, 1H), 3.73–3.71 (m, 3H), 3.63–3.60 (m, 2H), 3.38–3.31 (m, 5H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 148.7, 146.1, 142.3, 135.3, 119.9, 118.4, 113.2, 110.5, 97.1, 92.5, 73.4, 72.8, 71.4, 69.5, 68.8, 68.2, 62.6, 61.5, 57.1, 55.2, 51.0, 48.5; MS: *m/z* 641 $[M + H]^+$; Anal. Calcd for $C_{38}H_{52}N_6O_{13}$: C, 48.75; H, 5.66; N, 13.12. Found: C, 49.01; H, 5.29; N, 13.51.

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Compliance with ethical standards

Conflicts of interest The authors declare that they have no conflicts of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

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