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Asymmetric Total Synthesis of Bioactive Natural Lipid Mycalol

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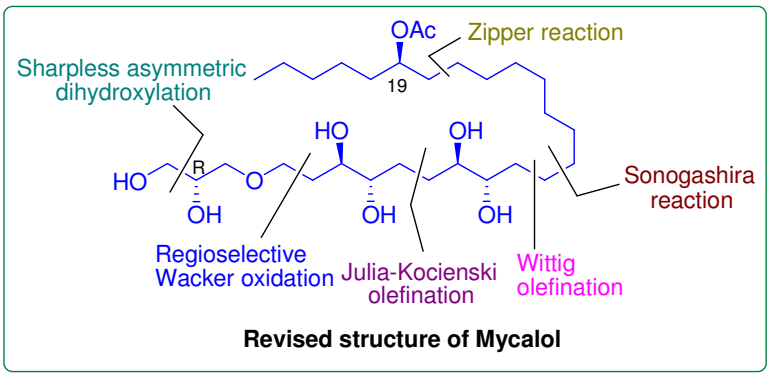


Revised structure of Mycalol

Abstract:

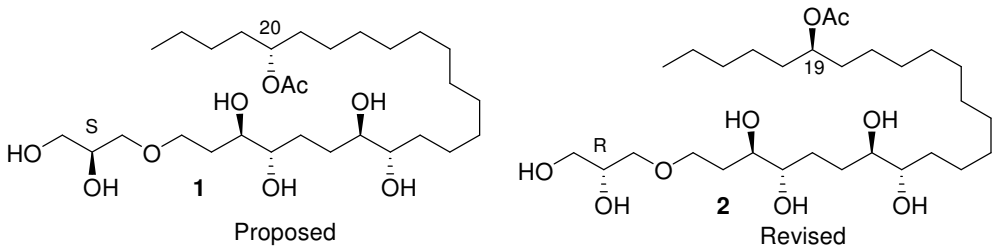
A concise and convergent route for stereoselective total synthesis of promising anticancer natural lipid mycalol has been achieved using cheap and readily available L-arabinose as a chiral pool. The notable features of our synthesis comprised regioselective Wacker oxidation, Sharpless asymmetric dihydroxylation, Julia-Kocienski olefination, Wittig olefination, Zipper reaction and Sonogashira reaction. Comparison of the spectroscopic data on a series of isomers supports the revised structure (*Org. Lett.* **2015**, *17,* 1652) instead of the one originally proposed.

Introduction:

Mycalol is a polyoxygenated monoalkyl glyceryl ether lipid which was first isolated by Fontana and coworkers from chloroform extract of sponge *Mycale (Oxymycale) acerata Kirkpatrick 1907* collected in the coasts of Terra Nova Bay, Antarctica.[1] It exhibits promising and selective cytotoxic activity against human anaplastic thyroid carcinoma (ATC), the most aggressive human thyroid gland malignancy (IC_{50} against different human ATC-derived cell lines: FRO-HMGA1as=7.3 μM, ACT1=4.5 μM, 8505c =3.8 μM). It also shows moderate cytotoxicity to human colon solid tumor cell line (IC_{50}=10.9 μM).[1] The structure of mycalol was determined by a combination of spectroscopic methods (NMR, CD, mass) and by functional group derivatizations. Architecturally mycalol possesses a C-27 linear skeleton embedded with nine oxygenated carbons and one ether linkage. There are seven hydroxy groups present in the molecule among which one remains in its acetylated form [Figure 1, proposed structure (**1**)[1] and revised structure (**2**) [2(*vide infra*), 3]. Statistical data[4] revealed that ATC is responsible up to 40% of all deaths from thyroid cancer and most anxiously, there is not a single clinical lead known to date[1] to combat against this malignancy. The discovery of mycalol may serve a significant role to decipher cancer biology and a lead compound for drug development. Mycalol was isolated in small yields from its natural source. Thus the development of an efficient and scalable synthetic route is highly desirable to render it readily available for thorough biological investigations. As a part of our ongoing program[5] towards synthesis of bioactive natural products, we envisaged the total synthesis of structurally intriguing and biologically potent natural lipid mycalol. Herein, we report a convergent stereoselective total synthesis of mycalol (Figure 1, both proposed and revised structure) which features the regioselective Wacker oxidation,[6] Sharpless asymmetric dihydroxylation,[7] Julia-Kocienski olefination,[8] Wittig olefination,[9] Zipper reaction[10] and

Sonogashira reaction[11] as the key steps. The spectroscopic data on the synthesized proposed structure of mycalol indicate discrepancies suggesting that the proposed structure may be incorrect. To resolve these variation/deviation we have also synthesized a total of twelve analogues of the proposed structure out of which eight diastereomers and four positional isomers. The results indicate that the observed data of mycalol is identical to that of a synthetic analogue which varies in the configuration in the C-2' position (diastereomer) and position of the O-acetyl group (structural isomer). Our synthetic strategy is quite flexible, as demonstrated by the synthesis of a wide range of analogues. Our approach, as described above, uses a different set of key reactions than the recent report by Reddy and coworkers[3] where they have used Sharpless epoxidation, a low yielding cross metathesis and opening of chiral epoxide by alkyl Grignard as the pivotal steps to achieve both the proposed and revised structures of mycalol.

Figure 1: Chemical structure of mycalol.

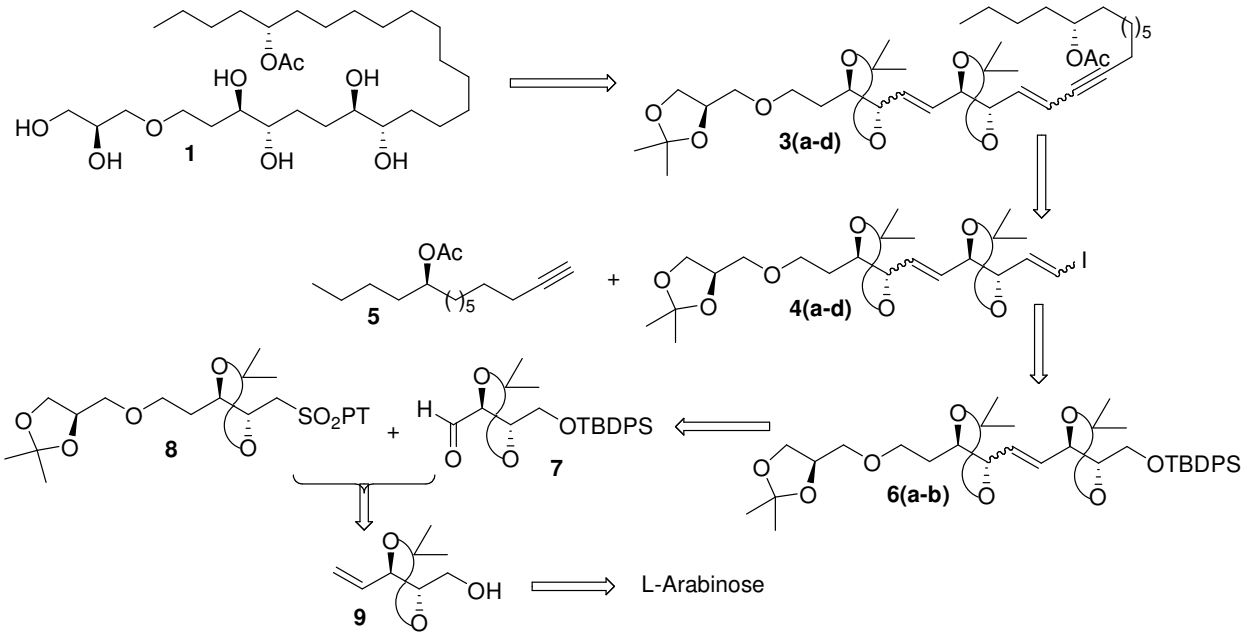


Results and discussion:

Retrosynthetic analysis of proposed structure of mycalol (**1**) is depicted in Scheme 1. It could be synthesized from the advanced stage of intermediates **3(a-d)** by hydrogenation followed by global deprotection of acetonides. Intermediates **3(a-d)** could be constructed further from the vinyl iodides **4(a-d)** and alkyne intermediate **5** using Sonogashira reaction[11] as one of the key coupling steps. Vinyl iodides **4(a-d)** could be accessed from compounds **6(a-b)** using Wittig

olefination[9] as one of the pivotal steps. Next Julia-Kocienski olefination[8] would disconnect compounds **6(a-b)** into two coupling partners **7** and **8** which further could be synthesized from a common precursor **9** derived from the chiral pool L-arabinose.

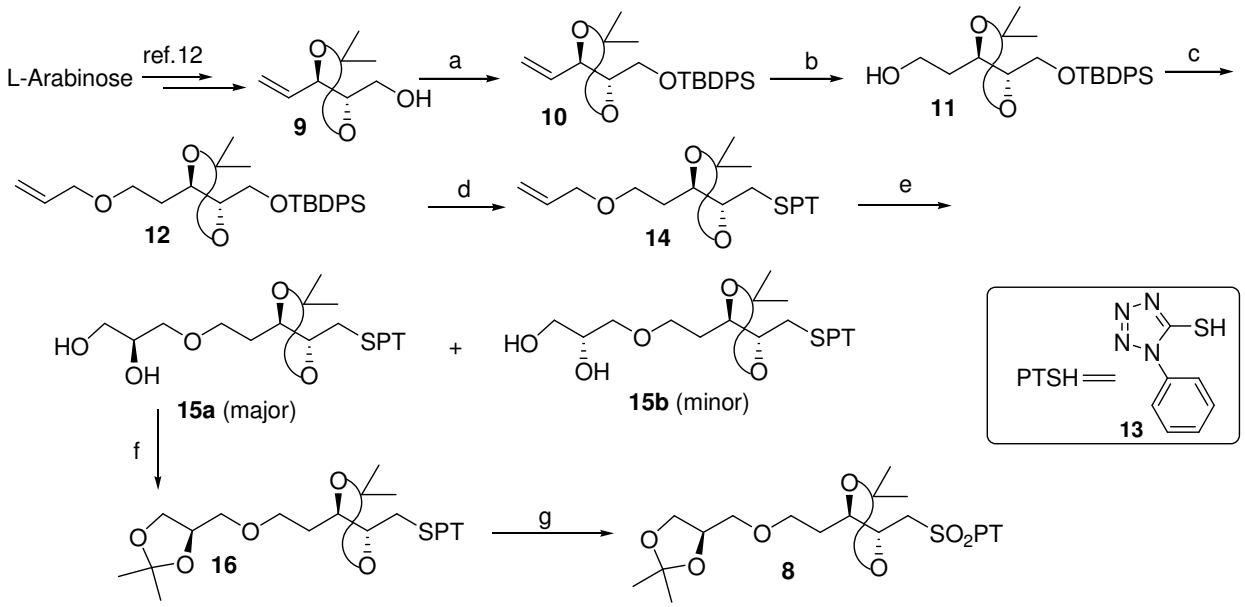
Scheme 1: Retrosynthetic analysis of proposed structure of mycalol (**1**).



Our synthetic endeavor began with preparation of a known precursor **9** from L-arabinose following a reported procedure[12] (Scheme 2). Compound **9** was then protected as TBDPS ether using TBDPSCl in the presence of imidazole to achieve compound **10**. We have tried a number of hydroborylating reagents like 9-BBN, BH_3.THF at this stage in variable conditions to obtain compound **11** but none of these were found to afford the desired compound even in moderate yields. This urged us to adopt a two-step reaction sequence as an alternative. Alkene **10** was first subjected to Wacker oxidation[6] using 10 mol% $PdCl_2$ in the presence of CuCl to produce regioselectively the corresponding aldehyde which concomitantly reduced with $NaBH_4$ to access alcohol **11** with good overall yield (68% over two steps). To construct the glyceryl ether moiety,

alcohol **11** was first subjected to react with allyl bromide in the presence of NaH and catalytic amount of TBAI to afford allyl ether **12** which was further treated with TBAF to deprotect TBDPS ether and subsequently reacted with commercially available 1-Phenyl-1H-tetrazole-5-thiol (PTSH, **13)** in the presence of DIAD/Ph_3P using the Mitsunobu conditions[13] to achieve the synthesis of compound **14** in 86% yield over three steps. The terminal olefin of compound **14** was then dihydroxylated using AD-mix-β in the presence of $MeSO_2NH_2$ following the Sharpless asymmetric dihydroxylation protocol to get diols **15a** and **15b** (*dr*>3.3:1, please see the HPLC analysis in Supporting Information) as major and minor isomers, respectively, with 90% overall yield.[7] Both the diastereomers were separated cautiously using silica gel column chromatography. Our effort to reconfirm the absolute configuration of the newly generated secondary hydroxy center in the major isomer **15a** by the modified Mosher method[14] was not successful at this stage due to the presence of several chemically similar protons in the recorded ^{1}H NMR spectrum. This precluded unambiguous determination of chemical shifts of the protons shielded or deshielded when the diol moiety of compound **15a** was converted to its corresponding (*R*) and (*S*)-Mosher esters, respectively. However from the literature,[7] it can be anticipated that the major compound **15a** is likely to be the appropriate isomer. Next the diol **15a** was treated with 2,2-DMP in the presence of CSA to afford compound **16** (Scheme 2) which was oxidized further using $(NH_4)_6Mo_7O_{24}.4H_2O$ in the presence of 30% H_2O_2[15] to result the sulfone **8** in 85% yield over two steps.

Scheme 2: Synthesis of glyceryl ether unit **8**.

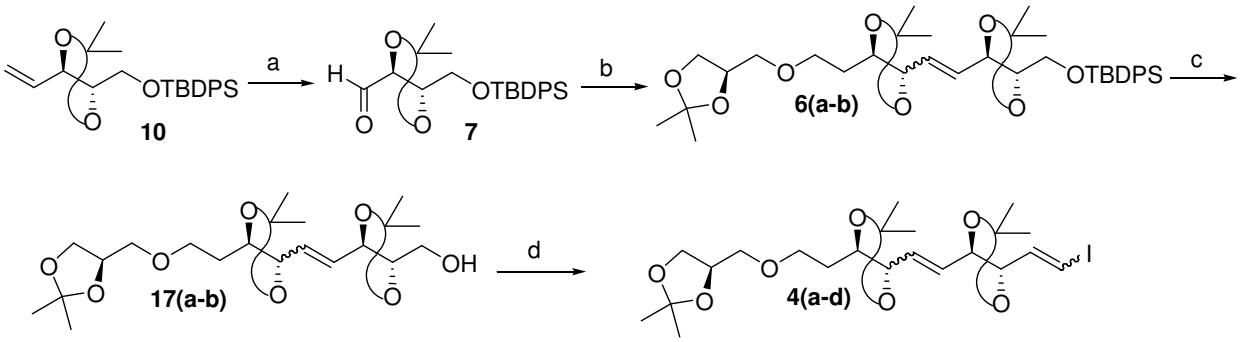


Reagents and conditions: (a) TBDPSCl, imidazole, CH_2Cl_2, 0 °C to rt, 2 h, quantitative; (b) (i) $PdCl_2$, CuCl, DMF:H_2O (7:1), rt, 72 h; (ii) $NaBH_4$, MeOH, 0 °C, 30 min, 68% after two steps; (c) allyl bromide, NaH, TBAI, THF, 0 °C to rt, 2 h, 92%; (d) (i) TBAF, THF, 0 °C to rt, 30 min, 98%; (ii) **13**, DIAD, Ph_3P, THF, 0 °C to rt, 2 h, 88%; (e) AD-mix-β, $MeSO_2NH_2$, ^tBuOH:H_2O (1:1), 0 °C, 36 h, overall 90% (~69% isolable yield based on compound **15a**), (*dr*>3.3:1); (f) 2,2-DMP, CSA, CH_2Cl_2, 0 °C to rt, 1 h, quantitative; (g) $(NH_4)_6Mo_7O_{24}.4H_2O$, 30% aqueous H_2O_2, EtOH, 0 °C to rt, 1.5 h, 85%.

The synthesis of the intermediates **4(a-d)** is summarized in Scheme 3. Alkene **10** was first subjected to oxidative cleavage[16] in the presence of OsO_4, NMO and $NaIO_4$ to produce aldehyde **7** and concomitantly reacted with sulfone **8** (Scheme 2) in the presence of NaHMDS following the Julia-Kocienski olefination protocol[8] to yield an inseparable mixture of alkenes **6(a-b)** which further were reacted with TBAF to produce another inseparable mixture of alcohols **17(a-b)** in good overall yield (59% over three steps). Next the mixture of alcohols **17(a-b)** was

oxidized with IBX[17] to get the corresponding aldehydes which were subjected concomitantly to Wittig olefination[9] reaction in presence of $Ph_3PCH_2I_2$ and NaHMDS to provide the mixture of compounds **4(a-d)** in 73% yield after two steps. We did not attempt to separate this mixture of geometrical isomers **4(a-d)** at this stage because the hydrogenation reaction at the pre-final stage of synthesis would convert them logically to a single saturated compound.

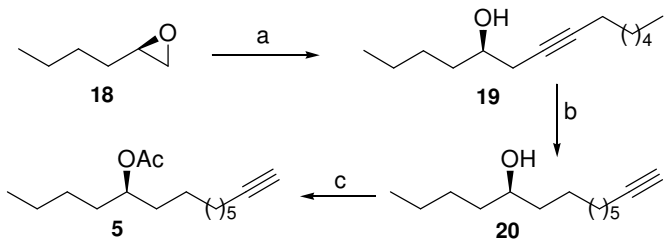
Scheme 3: Synthesis of intermediates **4(a-d)**.



Reagents and conditions: (a) OsO_4, NMO, $NaIO_4$, $NaHCO_3$, ^tBuOH:THF:H_2O(5:5:1), 0 ^oC to rt, 12 h, 90%; (b) **8**, NaHMDS, THF, -78 ^oC to rt, 1.5 h, 68%; (c) TBAF, THF, 0 ^oC to rt, 30 min, 97%; (d) (i) IBX, EtOAc, reflux, 2 h, quantitative; (ii) $Ph_3PCH_2I_2$, NaHMDS, -78 ^oC to rt, 4 h,73% after two steps.

The synthesis of alkyne **5** is summarized in Scheme 4. The known epoxide **18**,[18] prepared from its racemic counterpart using Jacobsen hydrolytic kinetic resolution protocol, was subjected to epoxide ring opening reaction[19] with commercially available octyne in the presence of ^nBuLi and $BF_3.Et_2O$ to afford compound **19** in 83% yield. The internal alkyne in compound **19** was next translocated to its terminal position using Zipper conditions[10] ($KO^tBu/^nBuLi$/1,3-diaminopropane) to achieve the synthesis of alkyne **20** in good yield. The free hydroxy of alkyne **20** was finally protected as acetate with Ac_2O/Py to produce the required alkyne intermediate **5** quantitatively.

Scheme 4: Synthesis of alkyne **5**.

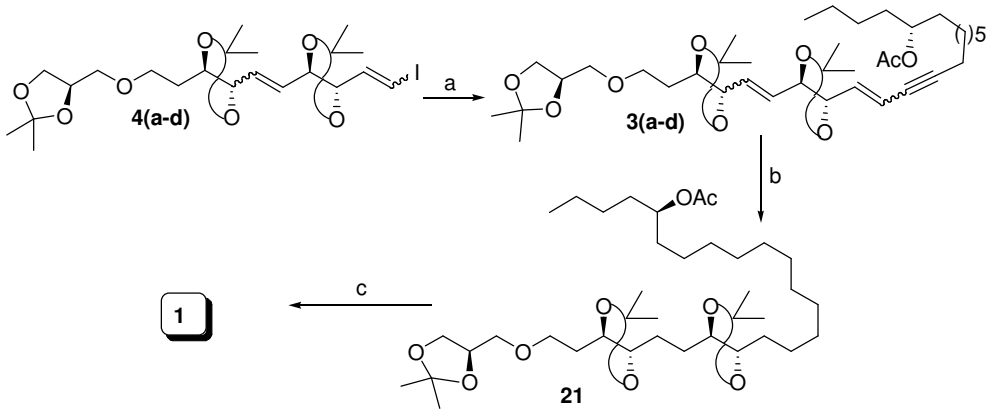


Reagents and conditions: (a) Octyne, ^{n}BuLi, $BF_3.OEt_2$, THF, -78 to 0 ^{o}C, 30 min then -78 ^{o}C, 1.5 h, 83%; (b) KO^{t}Bu, ^{n}BuLi, 1,3-diaminopropane, THF, 0 ^{o}C to rt, 3 h, 73%; (c) Ac_2O, pyridine, 0 ^{o}C to rt, 30 min, quantitative.

The final synthetic endeavor for proposed structure of mycalol (**1**) is outlined in Scheme 5. The advanced intermediates **4(a-d)** and alkyne **5** (Scheme 4) were next coupled together in the presence of $Pd[(Ph_3P)_2Cl_2]/CuI/Et_3N$ following Sonogashira reaction conditions[11] to produce the mixture of intermediates **3(a-d)** which finally was hydrogenated using 10% Pd/C to get the single saturated product **21**. We have recorded both the ^{1}H and ^{13}C NMR spectrum of pure compound **21** in different solvents like $CDCl_3$, d_6-benzene and d_5-pyridine and compared with those delineated for the acetonide compound[1] prepared by Fontana *et al*. The ^{1}H NMR spectrum of the synthesized compound **21** recorded either in $CDCl_3$ or in d_6-benzene or in d_5-pyridine although was in agreement with the reported data but there was a significant mismatch in ^{13}C NMR spectrum when compared with the literature values[1]. The signals at δ 31.7 and 25.0 ppm in the ^{13}C NMR of the acetonide derivative of isolated mycalol[1] were missing in the ^{13}C NMR spectrum (recorded in $CDCl_3$) of the synthesized compound **21**. Additionally minor mismatches were observed in the ^{13}C NMR signals of the aliphatic carbon centers bearing a hydroxy group (please see spectra and comparison Table 2 Supporting Information). As there was no specific rotation documented for that acetonide compound, we were unable to compare

its specific rotation with the data recorded {observed $[\alpha]^{27}_D$ = +3.2 (*c* 1.4, $CHCl_3$)} for compound **21**. However, compound **21** was subjected finally to react with AcOH:H_2O (4:1) to afford compound **1** by global deprotection of the acetonides in good overall yield (Scheme 5). The spectral data specifically the ^1H NMR (recorded in d_5-pyridine) and HRMS although were in accordance with the reported values but considerable mismatches (similar to the acetonide derivative) were observed when the ^{13}C NMR (recorded in d_5-pyridine) data was taken into consideration (please see spectra and comparison Table 1 in Supporting Information). This result strongly suggests that the structures proposed for isolated mycalol may not be entirely accurate.

Scheme 5: Synthesis of reported structure of mycalol (**1**).

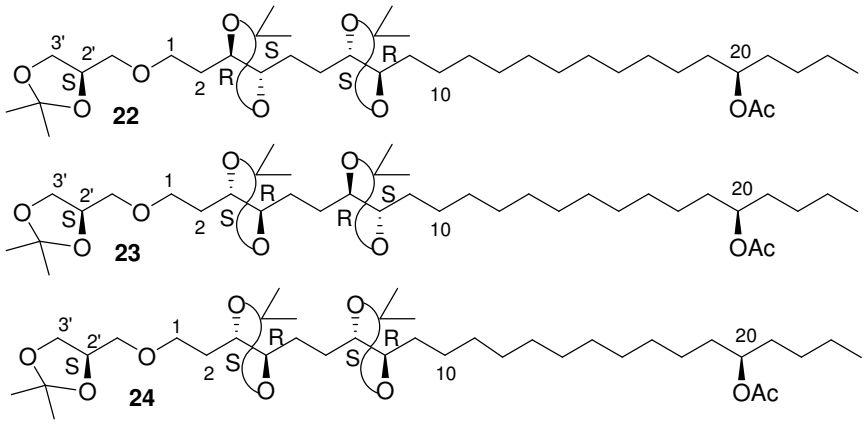


Reagents and conditions: (a) **5**, Pd[$(Ph_3P)_2Cl_2$], CuI, Et_3N, rt, 4 h, 76%; (b) H_2, Pd/C (10%), EtOAc, rt, 12 h, 98%; (c) AcOH:H_2O(4:1), 0 ^oC to rt, 6 h, 97%.

We next have thought for the possibility that the isolated mycalol is a diastereomer of the proposed structure. The configuration of the two vicinal diol units (C-3/C-4 and C-7/C-8, Figure 1, compound **1**) was assigned unambiguously as *erythro* by the isolation group. The ^{13}C NMR study of synthesized acetonide derivative of isolated mycalol exhibited well separated signals (27.1 and 25.9 ppm; 26.8 and 25.4 ppm) characteristic for the methyl acetals of dioxolane rings

of *cis* conformation.[1] Thus the possibility of diastereomers with *threo* vicinal diol moieties has been discarded. The absolute configuration of the two *erythro* diol systems was assigned by the isolation group as *R*, *S*, *R* and *S* for C-3, C-4, C-7 and C-8 centers, respectively, by chiroptical approach using the 1',2'- dibenzoate-3,4-dipivolyl and 1',2'- dibenzoate-7,8-dipivolyl derivatives of mycalol.[1] The preparation, characterization and chiroptical analysis of these compounds were really challenging and could be the potential sources of complication. We thus have planned to construct the possible diastereomers **22**-**24** (Figure 2) where the C-2' center is in *S* configuration. The stereochemistry of well characterized C-20 center did not alter during the course of the synthesis.

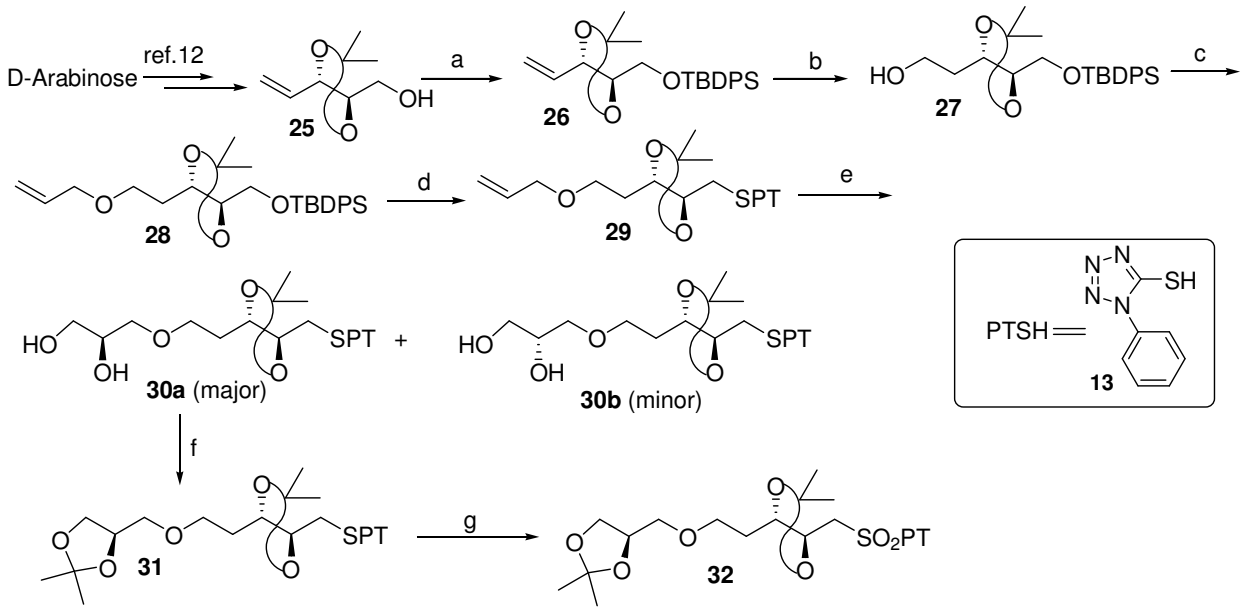
Figure 2: Diastereomers of compound **21** with C-2' center having *S* configuration.



The synthesis of intermediates from D-arabinose is described in Scheme 6. The similar chemistry as developed for the synthesis of compound **21** was adopted. Alkene **25**, prepared from D-arabinose following a reported procedure,[12] was converted to TBDPS ether **26**. It was next subjected to regioselective Wacker oxidation[6] to get the corresponding aldehyde and concomitantly reduced to alcohol **27** using $NaBH_4$. Alcohol **27** was then treated with allyl bromide in the presence of NaH to access olefin ether **28**. Next TBDPS group was deprotected

and the resultant alcohol was reacted subsequently with PTSH (**13**) in Mitsunobu conditions to produce compound **29** which finally was dihydroxylated[7] using AD-mix-β to get compounds **30a** and **30b** (dr>3.3:1) as major and minor isomers, respectively, in good overall yield. The purified major isomer **30a** was then treated with 2,2-DMP to get acetonide **31** (Scheme 6) and finally oxidized[15] with H_2O_2 in the presence of $(NH_4)_6Mo_7O_{24}.4H_2O$ to afford required sulfone **32** in 85% yield over two steps.

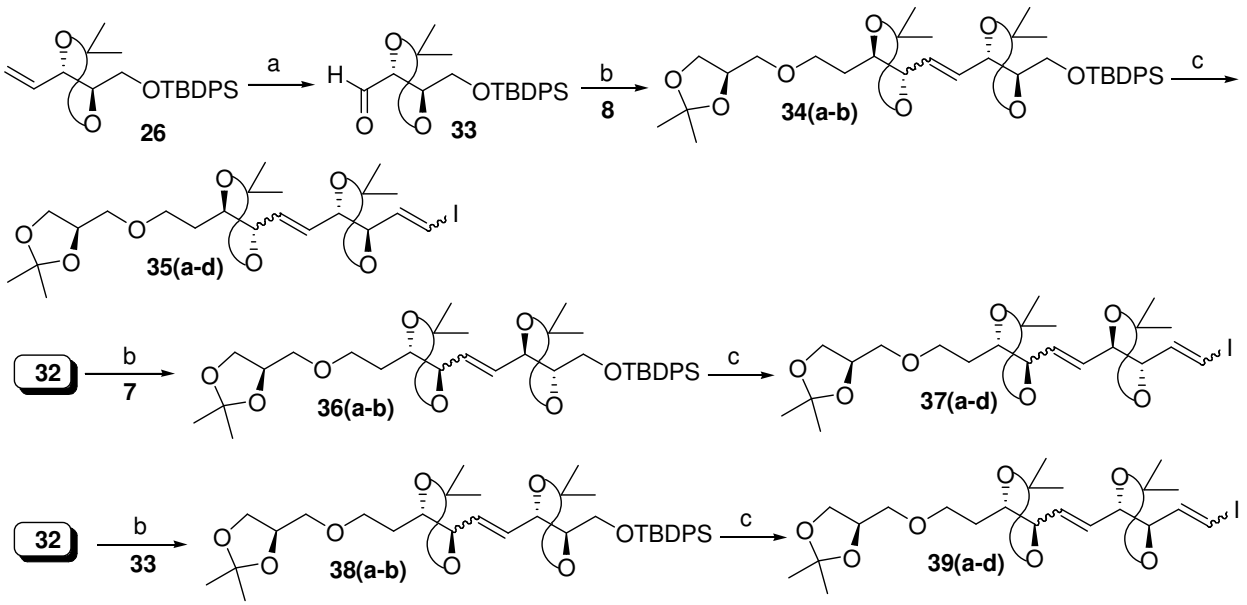
Scheme 6: Synthesis of intermediates from D-arabinose.



Reagents and conditions: (a) TBDPSCl, imidazole, CH_2Cl_2, 0 °C to rt, 2 h, quantitative; (b) (i) $PdCl_2$, CuCl, DMF:H_2O (7:1), rt, 72 h; (ii) $NaBH_4$, MeOH, 0 °C, 30 min, 69% after two steps; (c) allyl bromide, NaH, TBAI, THF, 0 °C to rt, 2 h, 91%; (d) (i) TBAF, THF, 0 °C to rt, 30 min, 97%; (ii) **13**, DIAD, Ph_3P, THF, 0 °C to rt, 2 h, 88%; (e) AD-mix-β, $MeSO_2NH_2$, ^tBuOH:H_2O (1:1), 0 °C, 36 h, overall 90% (~69% isolatable yield based on compound **30a**), (*dr*>3.3:1); (f) 2,2-DMP, CSA, CH_2Cl_2, 0 °C to rt, 1 h, quantitative; (g) $(NH_4)_6Mo_7O_{24}.4H_2O$, 30% aqueous H_2O_2, EtOH, 0 °C to rt, 1.5 h, 85%.

The synthesis of advanced stage of intermediates for compounds **22-24** is summarized in Scheme 7. Alkene **26** was subjected to oxidative cleavage[16] using OsO_4/NMO and $NaIO_4$ to get aldehyde **33** and subsequently reacted with sulfone **8** (prepared from L-arabinose, Scheme 2) in the presence of NaHMDS following the Julia-Kocienski olefination protocol[8] to get an inseparable mixture of compounds **34(a-b)**. The TBDPS group was next deprotected and the mixture of resulting alcohols was oxidized[17] to the corresponding aldehydes with IBX which concomitantly reacted[9] with $Ph_3PCH_2I_2$ in presence of NaHMDS to get a mixture of inseparable compounds **35(a-d)** in good overall yield (67%, in 3 steps). Similarly, sulfone **32** was subjected separately to the Julia-Kocienski olefination[8] with aldehydes **7** (prepared from L-arabinose, Scheme 3) and **33** (prepared from D-arabinose, Scheme 7) to get the mixture of compounds **36(a-b)** and **38(a-b)**, respectively, which finally were transformed to their corresponding vinyl iodides **37(a-d)** and **39(a-d)**, respectively, with good overall yield.

Scheme 7: Synthesis of advanced stage of intermediates for compounds **22**-**24**

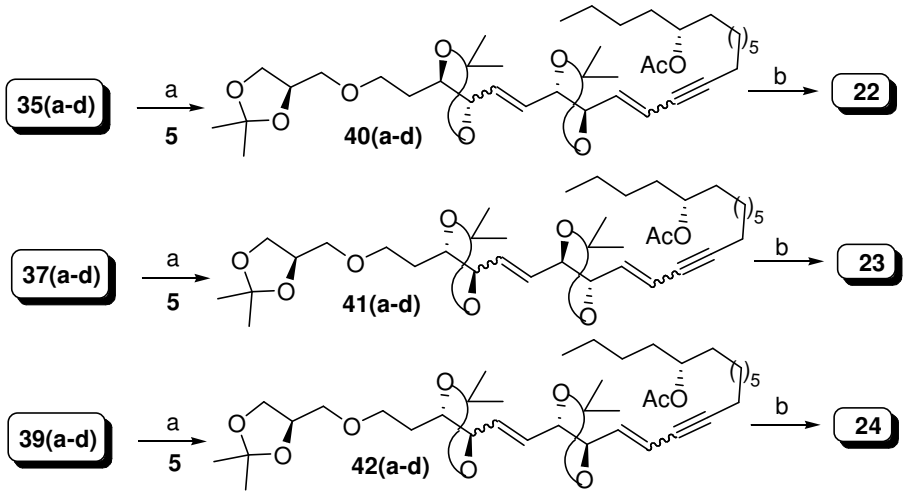


Reagents and conditions: (a) OsO_4, NMO, $NaIO_4$, $NaHCO_3$, ^tBuOH:THF:H_2O(5:5:1), 0 ^oC to rt, 12 h, 90%; (b) **8** or **7** or **33** NaHMDS, THF, -78 ^oC to rt, 1.5 h, 68-71%; (c) (i) TBAF, THF, 0 ^oC

to rt, 30 min, 93-97%; (ii) IBX, EtOAc, reflux, 2 h, quantitative; (iii) $Ph_3PCH_2I_2$, NaHMDS, -78 ^oC to rt, 4 h, 69-72%.

The final endeavor of synthesis of compounds **22-24** is described in Scheme 8. Three sets of vinyl iodides **35(a-d)**, **37(a-d)** and **39(a-d)** in hand were coupled separately with common alkyne **5** following the Sonogashira reaction conditions[11] to afford compounds **40(a-d)**, **41(a-d)** and **42(a-d)**, respectively, which were hydrogenated subsequently to produce the corresponding saturated compounds **22**, **23** and **24**, respectively, in good overall yield (71-73% in two steps). The ^1H NMR spectra of these compounds were in accordance with the reported data of the acetonide compound[1] prepared by Fontana *et al.* But it was quite embarrassing to see that the ^{13}C NMR data of compounds **22**-**24** deviated significantly from the reported values (please see spectra and comparison Table 2 in Supporting Information).

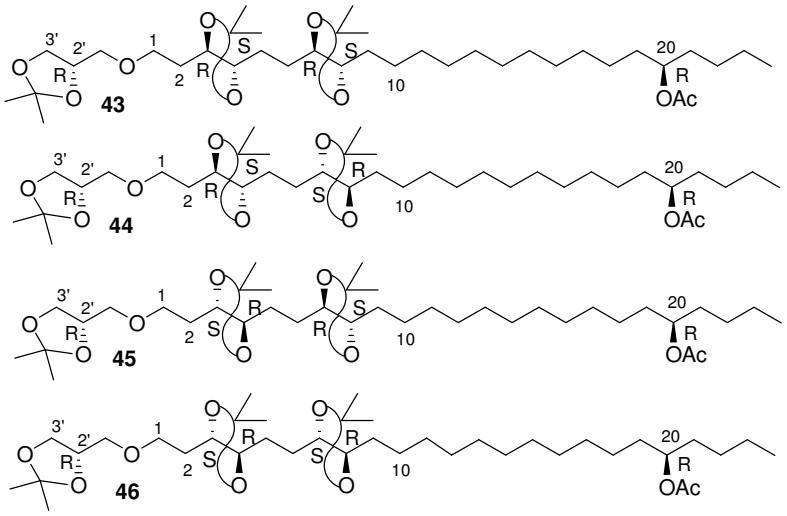
Scheme 8: Synthesis of compounds **22**-**24**



Reagents and conditions: (a) **5**, Pd[$(Ph_3P)_2Cl_2$], CuI, Et_3N, rt, 4 h, 75-76%; (b) H_2, Pd/C (10%), EtOAc, rt, 12 h, 94-97%.

Next, we were keen to see whether the variation of stereochemistry at C-2′ center would provide any insight in to the origin of the aberrant signals in the ^{13}C NMR data. Thus we have synthesized all the four possible diastereomers (**43**-**46**) of compound **21** (Figure 3) where the C-2′ center is in *R* configuration.

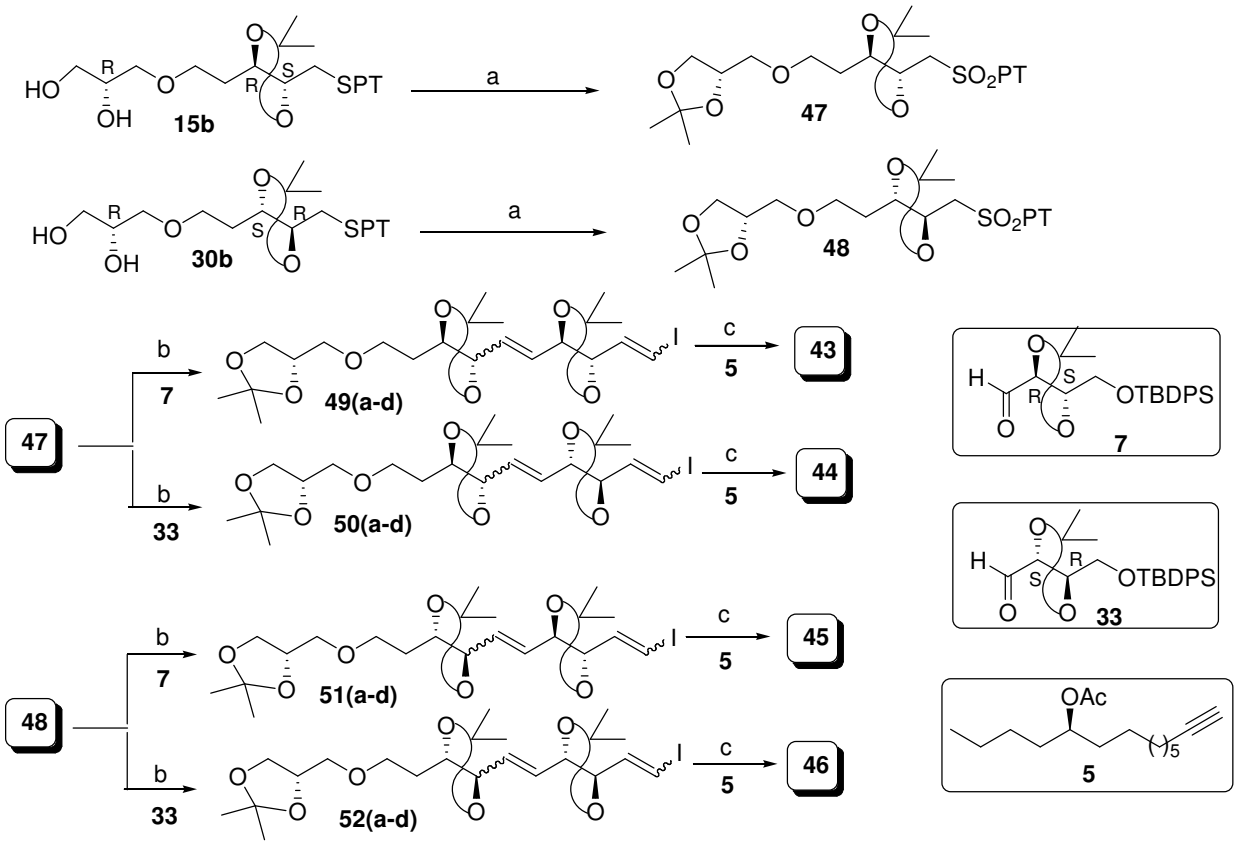
Figure 3: Diastereomers of compound **21** with C-2′ center having *R* configuration.



The synthesis of compounds **43**-**46** is summarized in Scheme 9. The compounds **15b** (Scheme 2) and **30b** (Scheme 6) were transformed separately to their corresponding sulfones **47** and **48**, respectively, following the same chemistry as described for synthesis of compound **8** (Scheme 2). It is noteworthy that both compounds **15b** and **30b** were prepared in bigger scale (3.0 gm, please see experimental section) from the corresponding olefins **14** (Scheme 2) and **29** (Scheme 6), respectively, using AD-mix-α with similar overall yield (~90%) and diastereoselectivity (dr>3.3:1, scheme not shown) as observed in AD-mix-β reaction (Scheme 2 and Scheme 6). Next the sulfone **47** was converted separately to intermediates **49(a-d)** and **50(a-d)** by reacting with the aldehydes **7** and **33**, respectively, following the similar chemistry as developed above. Similarly sulfone **48** transformed to compounds **51(a-d)** and **52(a-d)** using the aldehydes **7** and **33**, respectively. All the four sets of intermediates **49(a-d)**, **50(a-d)**, **51(a-d)** and

52(a-d) were coupled[11] with alkyne **5** separately and hydrogenated subsequently to get saturated compounds **43**, **44**, **45** and **46**, respectively, in good overall yield (73-76% in two steps). Both ^{1}H and ^{13}C NMR for all these compounds were recorded and compared with those reported for the acetonide compound prepared by Fontana *et al*. The ^{1}H NMR data of all compounds **43**-**46** were close to the reported values. It was observed that the ^{13}C NMR signals from the hydroxylated carbon centers of compounds **44**-**46** deviated significantly from the reported values. However the corresponding signals from the synthesized compound **43** were in much better agreement (please see spectra and comparison Table 3 in Supporting Information). This result urged us to consider the possibility of other structural/positional isomers for the proposed structure of mycalol.

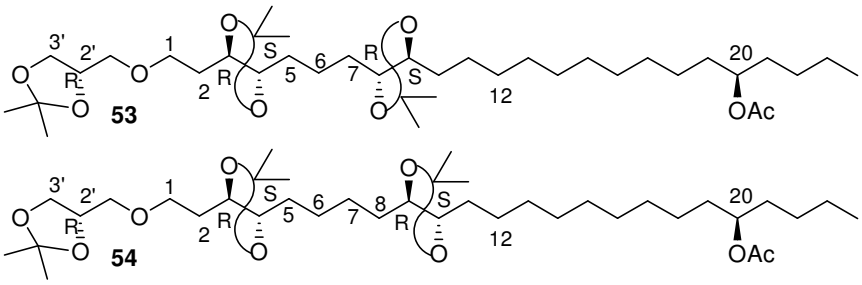
Scheme 9: Synthesis of compounds **43**-**46**



Reagents and conditions: (a) (i) 2,2-DMP, CSA, CH_2Cl_2, 0 °C to rt, 1 h, quantitative; (ii) $(NH_4)_6Mo_7O_{24}.4H_2O$, 30% aqueous H_2O_2, EtOH, 0 °C to rt, 1.5 h, 85%. (b) (i) **7** or **33**, NaHMDS, THF, -78 °C to rt, 1.5 h, 67-69%; (ii) TBAF, THF, 0 °C to rt, 30 min, 96-98%; (iii) IBX, EtOAc, reflux, 2h, quantitative; (iv) $Ph_3PCH_2I_2$, NaHMDS, -78 °C to rt, 4 h, 73-76%; (c) (i) **5**, $Pd[(Ph_3P)_2Cl_2]$, CuI, Et_3N, rt, 4h, 75-79%; (ii) H_2, Pd/C (10%), EtOAc, rt, 12h, 94-98%.

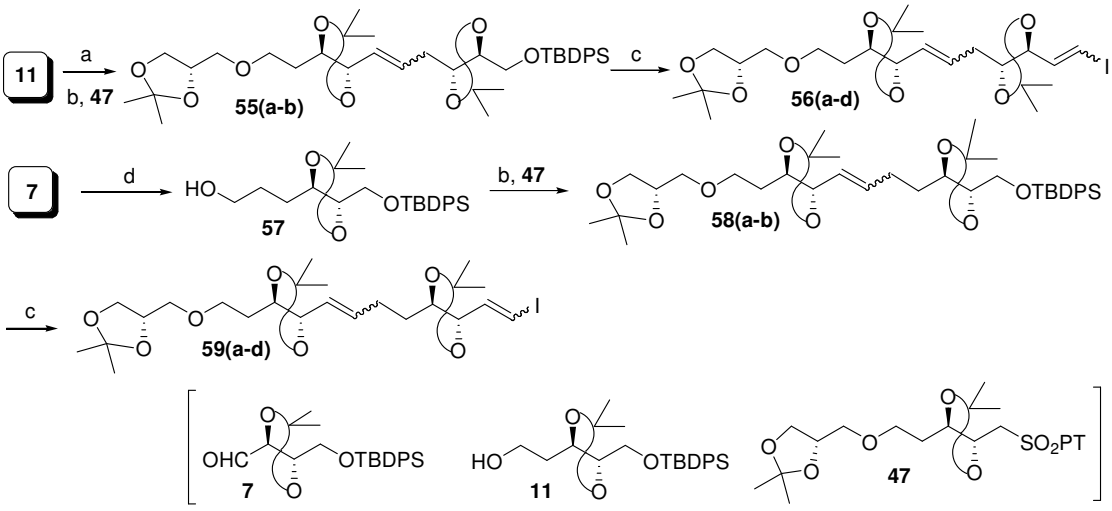
As the ^{13}C NMR data of compound **43** matched better the reported values for mycalol (except the resonances at 31.7 and 25.0 ppm) relative to the other synthesized diastereomers, we have decided to synthesize its structural isomers by varying the position of hydroxy groups. To decide which functional group(s) should be varied two issues were considered. First, the two methylene groups of protons positioned between the *erythro* vicinal diol moieties in the deuterated acetonide derivative of isolated mycalol prepared by Fontana *et al.* have different chemical shifts (δ1.57 and 1.74 ppm)[1] in spite of being in apparently similar chemical environment. Second, the integration of these protons in the presence of number of other closely situated methylene groups of protons was arduous. Both of these above facts tempted us to consider the possibility that there might be more than two methylene groups between the two *erythro* vicinal diol moieties. We have thus designed two compounds **53** and **54**, as shown in Figure 4, where the two *erythro* vicinal diol moieties are separated by three and four methylene groups, respectively. This would generate eventually almost two non identical environments (H_2-5/H_2-7 and H_2-6 for compound **53**; H_2-5/H_2-8 and H_2-6/H_2-7 for compound **54**) for those methylene protons flanked between the two vicinal diol units.

Figure 4: Positional isomers of compound **43**



The synthesis of advanced stage of intermediates for compounds **53** and **54** is outlined in Scheme 10. Alcohol **11** (Scheme 2) was oxidized[17] with IBX to get the corresponding aldehyde and subsequently subjected to Julia-Kocienski olefination[8] with sulfone **47** (Scheme 9) to afford mixture of compounds **55(a-b)** which finally was converted to mixture of compounds **56(a-d)** following the same chemistry as described for compound **21**. For preparation of higher homologue of alcohol **11**, the aldehyde **7** (Scheme 3) was subjected to Wittig olefinations with $Ph_3P{=}CHCO_2Et$[20] to get the corresponding α, β-unsaturated ester which finally was reduced with $LiBH_4$ to yield alcohol **57**. Next this alcohol was transformed to advance stage of intermediates **59(a-d)** through intermediates **58(a-b)** following the identical chemistry as mentioned above.

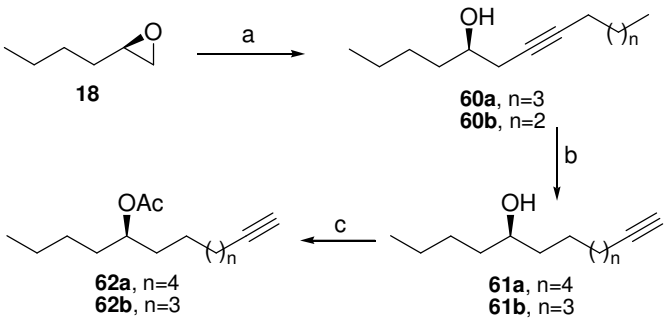
Scheme 10: Synthesis of advanced stage of intermediates for compounds **53**-**54**



Reagents and conditions: (a) IBX, EtOAc, reflux, 2 h, quantitative; (b) **47**, NaHMDS, THF, -78 °C to rt, 1.5 h, 68-69%; (c) (i) TBAF, THF, 0 °C to rt, 30 min, 97-98%; (ii) IBX, EtOAc, reflux, 2 h, quantitative; (iii) $Ph_3PCH_2I_2$, NaHMDS, -78 °C to rt, 4 h, 74-76%; (d) (i) $Ph_3P{=}CHCO_2Et$, CH_2Cl_2, rt, 12 h, 98% (ii) $LiBH_4$, THF, 0 °C to rt, 12 h, 97%.

The synthesis of alkyne fragments for compounds **53** and **54** is depicted in Scheme 11. Following the identical chemistry of alkyne **5** (Scheme 4), we treated epoxide **18** separately with 1-heptyne and 1-hexyne to produce compounds **60a** and **60b**, respectively, which was subjected further to Zipper reaction[10] to access the corresponding alkynes **61a** and **61b**. Finally the free hydroxy groups in both alkynes were protected separately as acetate to yield protected alkynes **62a** and **62b**, respectively.

Scheme 11: Synthesis of alkynes intermediates for compounds **53**-**54**

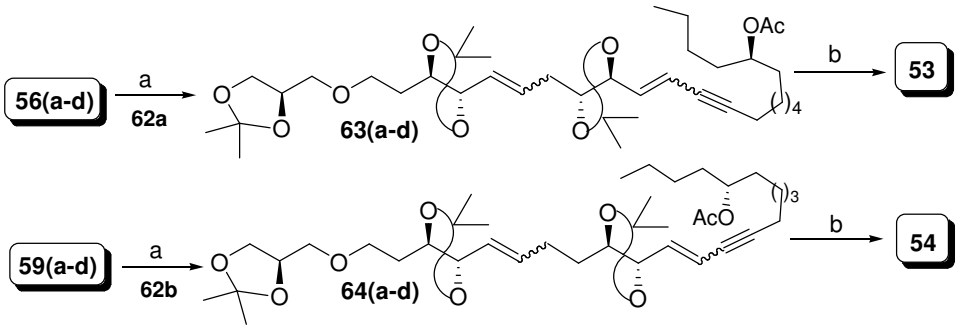


Reagents and conditions: (a) 1-Heptyne or 1-hexyne, ^{n}BuLi, $BF_3.OEt_2$, THF, -78 to 0 °C, 30 min then -78 °C, 1.5 h, 84-86%; (b) KO^{t}Bu, ^{n}BuLi, 1,3-diaminopropane, THF, 0 °C to rt, 3 h, 72-76%; (c) Ac_2O, pyridine, 0 °C to rt, 30 min, 98-99%.

The final endeavor of synthesis of compounds **53** and **54** is described in Scheme 12. Following the same synthetic strategy as developed for compound **21**, the mixture of compounds **56(a-d)** and **59(a-d)** were subjected to the Sonogashira reaction[11] with the alkynes **62a** and **62b**,

respectively, to yield mixture of compounds **63(a-d)** and **64(a-d)**, respectively, which finally were hydrogenate to afford compounds **53** and **54**, respectively. Both the ^{1}H and ^{13}C NMR spectra of compounds **53** and **54** were recorded and compared with those data reported[1] for acetonide compound synthesized by Fontana *et al.* Disappointingly, all the spectra deviated significantly (please see the spectra and comparison Table 4 in Supporting Information) from the reported spectra and no ^{13}C NMR signals at δ 31.7 and 25.0 ppm were observed in both the cases. Thus the possibility of existence of more than two methylene groups between the two *erythro* vicinal diol moieties has been discarded.

Scheme 12: Synthesis of compounds **53**-**54**

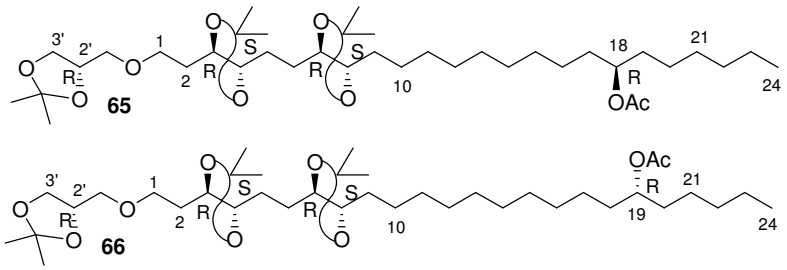


Reagents and conditions: (a) **62a** or **62b**, $Pd[(Ph_3P)_2Cl_2]$, CuI, Et_3N, rt, 4 h, 76-77%; (b) H_2, Pd/C (10%), EtOAc, rt, 12 h, 97-98%.

Finally we considered the possibility that the position of the OAc group in the hydrophobic chain might be different in mycalol from its proposed structure. As it was reported that the terminal methyl group (C-24) has HMBC correlation with C-23, C-22 and C-21 methylene groups of protons, we planned to synthesize isomers where the OAc group is positioned elsewhere in the hydrophobic chain. As the ^{13}C NMR data of compound **43** was more compatible with reported data (except the signals at 31.7 and 25.0 ppm), we have prepared two

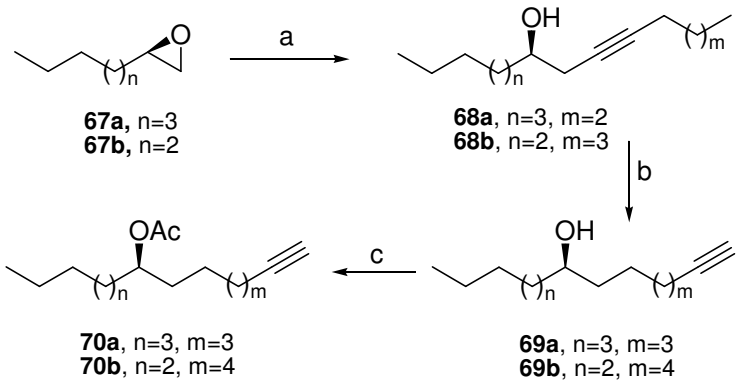
of its structural isomers **65** and **66** (Figure 5) where the OAc group is at C-18 and C-19 position, respectively.

Figure 5: Other positional isomers of compound **43**



The synthesis of alkyne intermediates for compounds **65** and **66** is summarized in Scheme 13. The epoxides **67a** and **67b** prepared from their racemic counterpart using Jacobsen hydrolytic kinetic resolution protocol were subjected to epoxide opening reaction separately with 1-hexyne and1-heptyne, respectively, to afford compounds **68a** and **68b**, respectively. Finally both the alkynes **68a** and **68b** were transformed to other alkynes **70a** and **70b**, respectively, via the intermediate alkynes **69a** and **69b**, respectively, following the same chemistry as followed in synthesis of alkyne **5**.

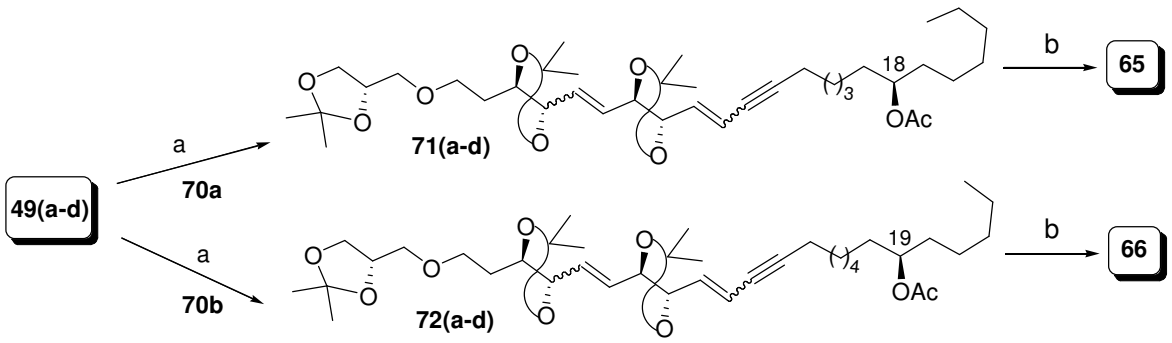
Scheme 13: Synthesis of alkyne intermediates for compounds **65**-**66**



Reagents and conditions: (a) 1-Hexyne or 1-heptyne , ^{n}BuLi, $BF_3.OEt_2$, THF, -78 to 0 ^{o}C, 30 min then -78 ^{o}C, 1.5 h, 83-84%; (b) KO^{t}Bu, ^{n}BuLi, 1,3-diaminopropane, THF, 0 ^{o}C to rt, 3 h, 73-74%; (c) Ac_2O, pyridine, 0 ^{o}C to rt, 30 min, 98-99%.

The final steps of construction of compounds **65** and **66** are outlined in Scheme 14. The mixture of intermediates **49(a-d)** (Scheme 9) was coupled separately with alkynes **70a** and **70b**, respectively following Sonogashira conditions[11] to achieve compounds **71(a-d)** and **72(a-d)**, respectively, in good yield. Both these mixture of products finally hydrogenated to get single saturated compounds **65** and **66**, respectively. The ^{1}H and ^{13}C NMR spectra of both these compounds were recorded and it was observed that the ^{1}H NMR data of both the compounds was compatible with the literature values.[1] Comparison of ^{13}C NMR data of both compounds **65** and **66** with the reported data (please see spectra and comparison Table 5 in Supporting Information) confirmed unambiguously that compound **66** is the actual structure of acetonide derivative of isolated mycalol reported by Fontana *et al*.

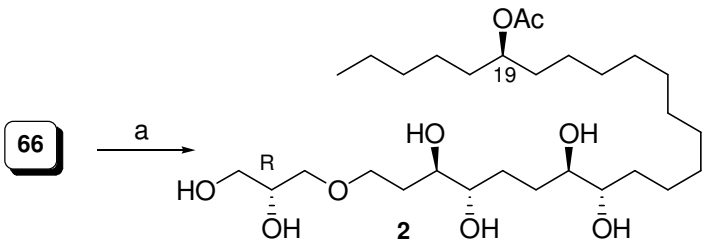
Scheme 14: Synthesis of compounds **65**-**66**



Reagents and conditions: (a) **70a** or **70b**, Pd[$(Ph_3P)_2Cl_2$], CuI, Et_3N, rt, 4 h, 74-76%; (b) H_2, Pd/C (10%), EtOAc, rt, 12 h, 97-98%.

The final endeavor of synthesis mycalol is depicted in Scheme 15. The prefinal compound **66** was finally subjected to AcOH:H_2O (4:1) for global deprotection of the acetonides to achieve the compound **2** in very good yield. The spectral data and specific rotation [reported $[\alpha]^{20}_D$ = +3.45 (*c* 0.1, MeOH); observed $[\alpha]^{22}_D$ = +4.00 (*c* 0.4, MeOH)] of present synthesized compound **2** were in good agreement with those[1] reported for isolated natural product (For comparison of ^{1}H and ^{13}C NMR between isolated mycalol and synthetic mycalol please see Table 6 in supporting Information) which unambiguously confirms the asymmetric total synthesis of isolated mycalol. While we engaged in resolving the differences between the NMR data of mycalol and that of the synthesized compound **1** (i.e. its proposed structure, by synthesizing isomers where both chiral centers and positions of functional groups were systematically varied), Reddy and coworkers[3] used elegant NMR techniques (HMBC at 700 MHz) to resolve the same problem and have arrived at the same conclusion i.e. the proposed structure of mycalol varies from its actual structure in the position of the OAc group and the chirality of the C-2′ center.

Scheme 15: Synthesis of revised structure of mycalol (**2**)



Reagents and conditions: (a) AcOH:H_2O(4:1), 0 °C to rt, 6 h, 98%.

Conclusion:

In summary, we have developed a convergent and flexible synthetic strategy to accomplish the stereoselective total synthesis of biologically promising anticancer natural lipid mycalol from known precursor **9** with good overall yield [(16 linear steps, 10% for proposed structure (**1**) and 11.1% for revised/actual structure (**2**)]. Out of seven hydroxy groups, four have been installed from the chiral pool L-arabinose. The key steps like regioselective Wacker oxidation, Sharpless asymmetric dihydroxylation, Julia-Kocienski olefination, Wittig olefination, Zipper reaction and Sonogashira reaction have been employed logically to construct efficiently the complete architecture of mycalol. In our effort to resolve the differences in the NMR data of the isolate structure and the synthesized proposed structure we have developed convenient synthetic strategies for several configurational and positional isomers for mycalol. The availability of a large number of isomers of the anticancer natural lipid mycalol (analogues) are ideally suited for developing structure activity relationships and their comparative biological activity is currently under investigation.

Experimental section:

***tert*-Butyl(((4*S*,5*R*)-2,2-dimethyl-5-vinyl-1,3-dioxolan-4-yl)methoxy)diphenylsilane (10):** To an ice cold solution of compound **9** (1.98 g, 12.50 mmol) in anhydrous CH_2Cl_2 (30 mL) under argon atmosphere, imidazole (2.5 g, 37.50 mmol) and TBDPSCl (4.0 mL, 16.25 mmol) were added sequentially. The reaction mixture was warmed to ambient temperature and stirred further for 2 h prior to quench it with saturated aqueous NH_4Cl solution (10 mL). The resultant mixture was extracted with CH_2Cl_2 (30 mL), washed with water, brine, dried (Na_2SO_4) and concentrated under reduced pressure. Flash column chromatographic purification (SiO_2, 60-120 mesh, 2%

EtOAc in hexane as eluant) of the resultant crude residue furnished pure TBDPS protected compound **10** (4.95 g, quantitative) as a colorless liquid. R_f=0.6 (5% EtOAc in hexane); $[\alpha]^{27}_D$ = -6.5 (*c* 1.5, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.69-7.65 (m, 4H), 7.43-7.35 (m, 6H), 5.99-5.88 (m, 1H), 5.36 (dt, *J*=16.8, 1.5 Hz, 1H), 5.21 (dq, *J* =10.2, 1.2 Hz, 1H), 4.65 (t, *J* = 6.6, 1H), 4.28 (q, $J_{1,2}$ =6.6 Hz, 1H), 3.73-3.64 (m, 2H), 1.44 (s, 3H), 1.37 (s, 3H), 1.05 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 134.8, 134.8, 132.8, 128.8, 126.8, 117.2, 107.7, 77.9, 77.6, 61.9, 26.9, 25.9, 24.5, 18.4 ppm; IR (neat) ν_{max} 2931, 1215 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{24}H_{32}O_3SiNa$ $[M + Na]^+$ 419.2018, found 419.2016.

2-((4*R*,5*S*)-5-(((*tert*-Butyldiphenylsilyl)oxy)methyl)-2,2-dimethyl-1,3-dioxolan-4-yl)ethanol (11): To a stirred solution of compound **10** (2 g, 5.04 mmol) in mixture of DMF (35 mL) and water (5 mL) at ambient temperature, $PdCl_2$ (100 mg, 0.1 mmol, 10 mol%) and CuCl (740 mg, 7.47 mmol) were added. The reaction mixture was stirred for 30 min prior to start bubbling oxygen gas though it for 72h at room temperature. The mixture was then filtered using a small pad of celite and washed with EtOAc. The filtrate was washed with water, brine, dried (Na_2SO_4) and concentrated in *vacuo* to afford the corresponding aldehyde as a yellowish liquid which was used directly in the next reaction without further purification and characterization.

The crude aldehyde from the above step was taken in anhydrous MeOH (15 mL) under argon, cooled to 0 °C and $NaBH_4$ (720 mg, 20.0 mmol) was added cautiously into it. The mixture was warmed slowly at room temperature and stirred further for 30 min. The reaction was then quenched with saturated aqueous NH_4Cl solution (5 mL), extracted with EtOAc (3×30 mL), washed with brine, dried over Na_2SO_4 and finally concentrated in *vacuo*. Purification of the resultant crude residue by column chromatography (SiO_2, 60-120 mesh, 20% EtOAc in hexane

as eluant) afforded pure alcohol **11** (1.42 g, 68%) as a colorless oil. R_f =0.4 (20% EtOAc in hexane); $[\alpha]^{30}_D$ = +0.5 (*c* 0.6, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.68-7.61 (m, 4H), 7.47-7.35 (m, 6H), 4.41-4.35 (m, 1H), 4.26-4.19 (m,1H), 3.89-3.82 (m, 2H), 3.76-3.63 (m, 2H), 2.35 (br s, 1H), 1.93-1.86 (m, 2H), 1.37 (s, 3H), 1.33 (s, 3H), 1.05 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 135.7, 133.3, 133.2, 129.9, 127.9, 127.9, 108.3, 77.9, 62.6, 61.6, 31.6, 28.2, 26.9, 25.7, 19.3 ppm; IR (neat) ν_{max} 3446, 2929, 1112 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{24}H_{34}O_4SiNa$ $[M + Na]^+$ 437.2124, found 437.2122.

(((4*S*,5*R*)-5-(2-(Allyloxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)(*tert*-butyl) diphenylsilane (12): To a stirred solution of alcohol **11** (1.5 g, 3.62 mmol) in anhydrous THF (10 mL) at 0 °C under argon, NaH (174 mg, 60% dispersion in mineral oil, 4.34 mmol) was added portion wise. The reaction mixture was warmed to room temperature and stirred for 30 min. The mixture was cooled again to 0 °C and allyl bromide (0.4 mL, 4.34 mmol) followed by TBAI (67 mg, 0.2 mmol) were added into it. The reaction mixture was warmed again to room temperature and stirred further for 1.5 h prior to quench it with saturated aqueous NH_4Cl solution (3 mL). The resulting mixture was extracted with EtOAc (2×30 mL), washed with water, brine, dried over Na_2SO_4 and concentrated in *vacuo*. Purification of the resultant crude residue by flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) provided allyl ether **12** (1.5 g, 92%) as a colorless oil. R_f =0.7 (10% EtOAc in hexane); $[\alpha]^{28}_D$ = +4.3 (*c* 1.45, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.69-7.65 (m, 4H), 7.45-7.34 (m, 6H), 5.96-5.87 (m, 1H), 5.27 (dq, *J* = 17.1, 1.8 Hz, 1H), 5.17 (dq, *J* = 10.2, 1.8 Hz, 1H), 4.38-4.31 (m, 1H), 4.22-4.16 (m, 1H), 3.98 (dt, *J* = 2.7, 1.5 Hz, 2H), 3.77-3.56 (m, 4H), 1.99-1.96 (m, 1H), 1.86-1.81 (m, 1H), 1.37 (s, 3H), 1.33 (s, 3H), 1.05 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ

135.8, 135.7, 135.1, 129.9, 127.8, 116.9, 108.0, 77.9, 74.5, 72.0, 67.6, 62.9, 29.8, 28.3, 27.0, 25.7, 19.3 ppm; IR (neat) ν_{max} 2931, 1587, 1109 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{27}H_{38}O_4SiNa$ $[M + Na]^+$ 477.2437, found 477.2439.

5-((((4*R*,5*R*)-5-(2-(Allyloxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methyl)thio)-2-phenyl-2H-tetrazole (14): To a stirred solution of allyl ether **12** (1.45 g, 3.2 mmol) in anhydrous THF (10 mL) at 0 °C under argon, TBAF (1 M in THF, 4.16 mL, 4.16 mmol) was added. The reaction mixture was warmed to room temperature and stirred for 30 min prior to quench it with saturated aqueous NH_4Cl solution (5 mL). The resultant mixture was extracted with EtOAc (2×30 mL), washed with water, brine, dried (Na_2SO_4), and concentrated under vacuum. Flash column chromatographic purification (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) of the resultant crude residue afforded the corresponding alcohol (995 mg, 98%) as colorless oil. R_f =0.4 (20% EtOAc in hexane); $[\alpha]^{27}_D$ = -3.0 (*c* 1.6, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.95-5.82 (m, 1H), 5.26 (dq, *J* = 16.8, 1.5 Hz, 1H), 5.19 (dq, *J* = 10.5, 1.5 Hz, 1H), 4.33-4.27 (m, 1H), 4.19-4.14 (m, 1H), 3.39 (dt, *J* = 5.7, 1.5 Hz, 2H), 3.79-3.49 (m, 4H), 2.27 (t, *J* = 5.4 Hz, 1H), 1.92-1.81 (m, 2H), 1.44 (s, 3H), 1.35 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 134.6, 117.4, 108.0, 78.1, 74.8, 72.2, 67.5, 61.8, 29.6, 28.3, 25.6 ppm; IR (neat) ν_{max} 3444, 2933 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{11}H_{20}O_4Na$ $[M + Na]^+$ 239.1259, found 239.1256.

To an ice cold solution of above alcohol (650 mg, 3.0 mmol) in anhydrous THF (10 mL) under argon, Ph_3P (870 mg, 3.3 mmol) and 1-phenyl-1*H*-tetrazole-5-thiol (**13**) (590 mg, 3.3 mmol) were added sequentially. After stirring for 30 min at same temperature, DIAD (0.65 mL, 3.3 mmol) was added in drop wise manner. The mixture was warmed slowly to room temperature and stirred for 1.5 h prior to quench it with brine (3 mL). The mixture was extracted

with EtOAc (2×30 mL), washed with brine, dried (Na_2SO_4), and concentrated in *vacuo*. Flash column chromatography (SiO_2, 100-200 mesh, 5% EtOAc in hexane as eluant) of the resultant crude residue afforded pure compound **14** (990 mg, 88%) as a colorless oil. R_f=0.5 (10% EtOAc in hexane); $[\alpha]^{30}_D$ = -31.9 (*c* 0.91, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.62-7.52 (m, 5H), 5.96-5.87 (m, 1H), 5.27 (dq, *J* =16.5, 1.5 Hz, 1H), 5.18 (dq, *J* =10.2, 1.5 Hz, 1H), 4.49-4.37 (m, 2H), 4.01 (dt, *J* = 2.7, 1.5 Hz, 2H), 3.73 (dd, *J* =13.2, 3.0 Hz, 1H), 3.65-3.58 (m, 2H), 3.34 (dd, *J* =12.9, 9.9 Hz, 1H), 1.97-1.88 (m, 2H), 1.45 (s, 3H), 1.35 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.3, 134.8, 133.8, 130.3, 129.5, 123.9, 117.2, 108.8, 75.9, 75.2, 72.2, 67.1, 35.3, 29.9, 28.5, 25.8 ppm; IR (neat) ν_{max} 2927, 1217 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{18}H_{24}N_4O_3SNa$ $[M+Na]^+$ 399.1467, found 399.1465.

5-((((4*R*,5*R*)-5-(2-((2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methyl)thio)-2-phenyl-2H-tetrazole (16): AD mix-β (3.5 g, 1.4 g for 1 mmol of olefin) and $MeSO_2NH_2$ (475 mg, 5.0 mmol) were dissolved in a mixture of ^{t}BuOH (9 mL) and water (10 mL) and stirred for 30 min at room temperature. The reaction mixture was cooled to 0 $^\circ$C and compound **14** (990 mg, 2.5 mmol, dissolved in 1 mL ^{t}BuOH) was added into it. The mixture was stirred vigorously for 36 h at the same temperature and finally quenched with Na_2SO_3 (1.0 g). The resulting mixture was stirred for another 1 h and extracted with EtOAc (3×30 mL). The organic layer was washed with water, brine, dried (Na_2SO_4) and concentrated in *vacuo*. Column chromatographic purification (SiO_2, 230-400 mesh, 50% EtOAc in hexane as eluant) of the resultant crude residue yielded the pure diols **15a** (709 mg, 69%) and **15b** (214 mg, 21%) as colorless oil.

Data for compound 15a: R_f =0.5 (60% EtOAc in hexane); $[\alpha]^{27}_D$ = -10.3 (*c* 1.2, $CHCl_3$); ^1H NMR ($CDCl_3$, 300 MHz) δ 7.60-7.53 (m, 5H), 4.93 (br s, 1H), 4.52-4.49 (m, 1H), 4.39-4.32 (m, 1H), 3.94-3.83 (m, 2H), 3.72-3.61 (m, 4H), 3.56-3.46 (m, 2H), 3.27-3.19 (m, 1H), 2.54 (br s, 1H), 2.04-1.95 (m, 2H), 1.44 (s, 3H), 1.35 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.5, 133.7, 130.4, 130.0, 124.0, 108.6, 76.5, 75.9, 73.2, 70.7, 68.8, 64.2, 35.5, 29.5, 28.5, 25.8 ppm; IR (neat) ν_{max} 3409, 2927, 1218 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{18}H_{26}N_4O_5SNa$ $[M + Na]^+$ 433.1522, found 433.1523.

Data for compound 15b: R_f =0.5 (60% EtOAc in hexane); $[\alpha]^{28}_D$ = +4.9 (*c* 0.6, $CHCl_3$); ^1H NMR ($CDCl_3$, 300 MHz) δ 7.60-7.52 (m, 5H), 4.53-4.45 (m, 1H), 4.38-4.31 (m, 1H), 4.00-3.79 (m, 2H), 3.74-3.58 (m, 4H), 3.55-3.47 (m, 2H), 3.27-3.19 (m, 1H), 2.00-1.92 (m, 2H), 1.43 (s, 3H), 1.33 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.5, 133.6, 130.4, 129.9, 124.0, 108.6, 76.5, 75.9, 73.1, 70.7, 68.8, 64.1, 35.5, 29.5, 28.5, 25.7 ppm. IR (neat) ν_{max} 3421, 2920, 1216 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{18}H_{26}N_4O_5SNa$ $[M + Na]^+$ 433.1522, found 433.1519.

To an ice cold solution of the diol **15a** (700 mg, 1.7 mmol) in anhydrous CH_2Cl_2 (10 mL) under argon, 2,2-DMP (0.63 mL, 5.1 mmol) and CSA (20 mg, 0.08 mmol) were added sequentially. The reaction mixture was stirred for 1 h at room temperature prior to quench it with Et_3N (1 mL). The mixture was concentrated and purified by flash column chromatography to get (SiO_2, 60-120 mesh, 10% EtOAc in hexane as elutant) compound **16** (762 mg, quantitative) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); $[\alpha]^{27}_D$ = -44.9 (*c* 0.8, $CHCl_3$); ^1H NMR ($CDCl_3$, 300 MHz) δ 7.62-7.53 (m, 5H), 4.47-4.43 (m, 1H), 4.40-4.36 (m, 1H), 4.31-4.26 (m, 1H), 4.08-4.03 (m, 1H), 3.75-3.57 (m, 4H), 3.56-3.44 (m, 2H), 3.31 (dd, *J* = 12.9, 10.2 Hz, 1H), 1.95-1.87 (m, 2H), 1.44 (s, 3H), 1.42 (s, 3H), 1.35 (s, 3H), 1.34 (s, 3H); ^{13}C NMR ($CDCl_3$, 300 MHz) δ 154.3, 133.8, 130.3, 129.9, 123.9, 109.6, 108.8, 75.9, 75.1, 74.8, 72.4, 68.5, 66.9, 35.3, 29.8,

28.5, 26.9, 25.8, 25.5; IR (neat) ν_{max} 2931, 1218 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{30}N_4O_5SNa$ $[M + Na]^+$ 473.1835, found 473.1837.

5-((((4*R*,5*R*)-5-(2-(((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methyl)sulfonyl)-2-phenyl-2H-tetrazole (8): To an ice cold solution of compounds **16** (750 mg, 1.7 mmol) in EtOH (5 mL), $(NH_4)_6Mo_7O_{24}.4H_2O$ (105 mg, 0.09 mmol) and 30% H_2O_2 (3 mL) were added sequentially. The reaction mixture was warmed slowly to room temperature and stirred further for 1.5 h. The mixture was extracted with EtOAc (2×30 mL), washed with water, brine, dried over Na_2SO_4, and concentrated in *vacuo*. Flash column chromatography (SiO_2, 100-200 mesh, 20% EtOAc in hexane as eluant) of the resultant crude residue provided sulfone **8** (694 mg, 85%) as colorless oil. R_f = 0.3 (30% EtOAc in hexane); $[\alpha]^{27}_D$ = -66.3 (*c* 0.52, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.65-7.54 (m, 5H), 4.69-4.60 (m, 1H), 4.33 (q, $J_{1,2}$ = 6.6 Hz, 1H), 4.28-4.18 (m, 1H), 4.04-3.98 (m, 1H), 3.86-3.83 (m, 2H), 3.70-3.57 (m, 2H), 3.55-3.39 (m, 3H), 1.87-1.81 (m, 2H), 1.40 (s, 3H), 1.32 (s, 3H), 1.26 (s, 3H), 1.21 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.4, 133.4, 131.5, 129.5, 126.0, 109.7, 109.4, 75.9, 74.6, 72.7, 72.7, 68.3, 66.8, 58.5, 29.8, 27.7, 26.9, 25.6, 25.4 ppm; IR (neat) ν_{max} 2926, 1219 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{30}N_4O_7SK$ $[M + K]^+$ 521.1472, found 521.1474.

(4*S*,5*S*)-5-(((*tert*-Butyldiphenylsilyl)oxy)methyl)-2,2-dimethyl-1,3-dioxolane-4-carbaldehyde (7): To an ice cold solution of compound **10** (815 mg, 2.05 mmol) in a mixture of THF (3 mL), ^{t}BuOH (3 mL), and water (0.6 mL), OsO_4 (5% solution in ^{t}BuOH, 100 μL) and NMO (481 mg, 4.1 mmol) was added and stirred for 30 min at the same temperature. $NaHCO_3$ (515 mg, 6.15 mmol) followed by $NaIO_4$ (875 mg, 4.1 mmol) was added into it. The reaction

mixture was warmed slowly to room temperature and stirred further for 11.5 h. The reaction mixture was then passed through a small pad of celite and washed with EtOAc. The filtrate was washed with water, brine, dried (Na_2SO_4) and concentrated in *vacuo* to give crude aldehyde **7** (740 mg, 90%) as a colorless liquid which was taken directly in next reaction without further purification and characterization.

***tert*-Butyl(((4*S*,5*R*)-5-(2-((*R*)-5-(2-(((*R*)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)vinyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)diphenylsilane [6(a-b)]:** Sulfone **8** (750 mg, 1.55 mmol) was dissolved in anhydrous THF (7 mL) under argon atmosphere and cooled to -78 ^oC. NaHMDS (1 M in THF, 1.6 mL, 1.6 mmol) was added and stirred for 5 min. A solution of aldehyde **7** (740 mg, 1.85 mmol, dissolved in 4 mL THF) obtained from before step was cannulated into the reaction mixture and stirred for 30 min at the same temperature. The reaction mixture was warmed slowly to room temperature and stirring was continued for 1 h prior to quench it with saturated aqueous NH_4Cl solution (3 mL). The mixture was extracted with EtOAc (2×30 mL), washed with water, brine, dried over Na_2SO_4, and finally concentrated in *vacuo*. Purification by flash column chromatography (SiO_2, 230-400 mesh, 10% EtOAc in hexane as eluant) of the resultant crude residue provided an inseparable mixture of compounds **6**(**a**-**b**) (690 mg, 68%) as colorless liquid. R_f = 0.5 (20% EtOAc in hexane); ^1H NMR ($CDCl_3$, 300 MHz) δ 7.69-7.66 (m, 4H), 7.44-7.34 (m, 6H), 5.76 (q, $J_{1,2}$ = 8.4 Hz, 1H), 5.60-5.54 (m, 1H), 4.99 (t, J = 6.9 Hz, 1H), 4.91 (t, J = 7.5 Hz, 1H), 4.24-4.16 (m, 3H), 4.03-3.98 (m, 1H), 3.72-3.65 (m, 2H), 3.59-3.45 (m, 4H), 3.41-3.34 (m, 1H), 1.61-1.52 (m, 2H), 1.48-1.42 (m, 6H), 1.40 (s, 3H), 1.35-1.34 (m, 9H), 1.04 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 135.8 (135.8), 133.6 (133.5),

129.8, 129.6, 129.0, 127.8, 109.5, 108.9, 108.6, 79.2, 75.4 (75.3), 74.9 (74.8), 74.2, 73.4, 72.3 (72.2), 68.6 (68.6), 67.1, 63.5, 31.1, 29.8, 28.5, 27.9, 27.0 (26.9), 25.9, 25.6 (25.5), 19.4 ppm; IR (neat) ν_{max} 2931, 1215 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{37}H_{54}O_8SiNa$ $[M + Na]^+$ 677.3486, found 677.3488.

((4*S*,5*R*)-5-(2-((*R*)-5-(2-(((*R*)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)vinyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methanol [17(a-b)]: The inseparable mixture of compounds **6**(**a**-**b**) (450 mg, 0.68 mmol) was dissolved in anhydrous THF (4 mL) under argon and cooled to 0 °C. Then TBAF (1 M in THF, 0.9 mL, 0.9 mmol) was added. The reaction was warmed to room temperature and stirred further for 30 min prior to quench it with saturated aqueous NH_4Cl solution (3 mL). The resulting mixture was extracted with EtOAc (2×25 mL), washed with water, brine, dried (Na_2SO_4), and concentrated in *vacuo*. Flash column chromatographic purification (SiO_2, 60-120 mesh, 30% EtOAc in hexane as eluant) of the resultant crude residue gave mixture of alcohols **17**(**a-b**) (280 mg, 97%) as colorless oil. R_f = 0.4 (40% EtOAc in hexane); ^1H NMR ($CDCl_3$, 300 MHz) δ 5.72-5.61 (m, 2H), 5.06-5.00 (m, 1H), 4.95-4.91 (m, 1H), 4.30-4.18 (m, 3H), 4.07-4.02 (m, 1H), 3.76-3.69 (m, 1H), 3.67-3.52 (m, 4H), 3.51-3.41 (m, 2H), 2.29 (br s, 1H), 1.71-1.64 (m, 2H), 1.51 (s, 3H), 1.47 (s, 3H), 1.42 (s, 3H), 1.38 (s, 3H), 1.36 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 129.8 (129.7), 128.9 (128.9), 109.7, 109.1, 108.8, 78.9 (78.8), 75.5, 74.9 (74.8), 74.3, 73.4, 72.4 (72.0), 68.4, 66.8, 61.9, 31.3, 28.4, 28.1, 26.9 (26.9), 25.8, 25.5 (25.4) ppm; IR (neat) ν_{max} 3473, 2985, 1217 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{36}O_8Na$ $[M + Na]^+$ 439.2308, found 439.2306.

(*R*)-4-(2-(((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-5-(2-((4*R*,5*S*)-5-(2-iodovinyl)-2,2-dimethyl-1,3-dioxolan-4-yl)vinyl)-2,2-dimethyl-1,3-dioxolane [4(a-d)]: To a stirred solution of alcohols **17**(**a**-**b**) (110 mg, 0.26 mmol) in EtOAc (3 mL) under argon, IBX (110 mg, 0.4 mmol) was added and reflux for 2 h. The reaction mixture was then cooled to room temperature and filtered through a small pad of celite and washed with EtOAc. The filtrate was concentrated in *vacuo* to afford the corresponding aldehyde as a yellowish liquid which was used directly in the next reaction without further characterization.

To a suspension of $Ph_3PCH_2I_2$ [(iodomethyl)triphenylphosphonium iodide] (420 mg, 0.8 mmol) in anhydrous THF (5 mL) at 0 °C under argon atmosphere, NaHMDS (1M in THF, 0.8 ml, 0.8 mmol) was added drop wise and stirred for 30 min at same temperature. The resulting dark red solution was cooled to −78°C and the aldehyde from above step (dissolved in anhydrous 3 ml THF) was cannulated into it. After 30 min of stirring at −78 °C, the reaction mixture was warmed to room temperature and stirred further for 3 h. The reaction mixture was quenched with saturated aqueous NH_4Cl solution (3 mL) and extracted with EtOAc (2×25 mL), washed with water, brine, dried (Na_2SO_4), and concentrated in *vacuo*. Flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) of the resultant crude residue afforded an inseparable mixture of vinyl iodides **4**(**a**-**d**) (100 mg, 73%) as colorless liquid. R_f = 0.5 (10% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 6.51-6.47 (m, 1H), 6.29-6.24 (m, 1H), 5.64-5.53 (m, 2H), 5.07 (t, J = 6.9 Hz, 1H), 4.94-4.83 (m, 2H), 4.29-4.22 (m, 2H), 4.05 (q, $J_{1,2}$ = 6.3 Hz, 1H), 3.73-3.68 (m, 1H), 3.61-3.50 (m, 3H), 3.46-3.42 (m, 1H), 1.68-1.61 (m, 2H), 1.51 (s, 3H), 1.46 (s, 3H), 1.42-1.41 (m, 6H), 1.36 (s, 6H), ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 137.4, 137.3, 129.9, 129.1 (129.1), 109.8, 109.6 (109.5), 108.8, 85.8 (85.7), 81.4 (81.4), 75.7 (75.6), 74.9 (74.8), 73.9 (73.8), 72.3 (72.2), 68.8

(68.7), 67.0, 31.3, 29.8, 28.5, 28.2, 26.9, 25.9, 25.7, 25.6 ppm; IR (neat) ν_{max} 2924, 1217 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{22}H_{35}IO_7Na$ $[M + Na]^+$ 561.1325, found 561.1323.

(*R*)-Tetradec-7-yn-5-ol (19): To a solution 1-octyne (0.75 mL, 5.0 mmol) in anhydrous THF (10 mL) at -78 °C under argon, ^{n}BuLi (3 mL, 4.8 mmol, 1.6 M in hexane) was added. The resulting mixture was stirred for 30 min at this temperature and then warmed slowly to 0 °C and stirred further for 1 h at the same temperature. The reaction was again cooled to -78 °C and a solution of epoxide **18** (450 mg, 4.5 mmol, dissolved in 5 mL anhydrous THF) followed by $BF_3.Et_2O$ (freshly distilled, 0.6 mL, 4.8 mmol) were added into it. The reaction was quenched by saturated aqueous NH_4Cl solution (5 mL) and extracted with Et_2O (3×10 mL), washed with water, brine, dried (Na_2SO_4) and concentrated under vacuum. Flash column chromatographic purification (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) of the resultant crude residue provided pure alcohol **19** (785 mg, 83%) as a colorless liquid. R_f = 0.7 (10% EtOAc in hexane); $[\alpha]^{28}_D$ = -4.2 (*c* 1.38, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 500 MHz) δ 3.67-3.66 (m, 1H), 2.41-2.36 (m, 1H), 2.28-2.23 (m, 1H), 2.17-2.14 (m, 2H), 1.99 (s,1H), 1.52-1.41 (m, 4H), 1.39-1.23 (m, 10H), 0.91-0.87 (m, 6H); ^{13}C NMR ($CDCl_3$, 125 MHz) δ 83.4, 76.2, 70.4, 36.1, 31.5, 29.1, 28.7, 27.9, 27.9, 22.8, 22.7, 18.9, 14.1, 14.1 ppm; IR (neat) ν_{max} 3373, 2929 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{14}H_{27}O$ $[M+H]^+$ 211.2062, found 211.2054.

(*R*)-Tetradec-13-yn-5-ol (20): To a stirred solution of 1,3-diaminopropane (0.88 mL, 10.7 mmol) in anhydrous THF (7 mL) at 0 °C under argon, ^{n}BuLi (5.34 mL, 8.56 mmol, 1.6 M in hexane) was added. The resulting mixture was stirred for 30 min at same temperature prior to addition of ^{t}BuOK (960 mg, 8.56 mmol) in portion wise manner. The resulting yellow solution

was then warmed to room temperature and stirred for 30 min. The reaction mixture was cooled again to 0 °C and the alcohol **19** (450 mg, 2.14 mmol, dissolved in 3 mL anhydrous THF) was cannulated into it. The resulting red-brown color solution was slowly warmed to room temperature and stirred further for 2.5 h. The reaction was quenched with saturated aqueous NH_4Cl solution (5 mL). The mixture was extracted with EtOAc (30 mL), washed with 5% HCl, saturated aqueous $NaHCO_3$ solution, water, brine, dried (Na_2SO_4) and concentrated in vacuo. Purification by column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) of the resultant crude residue afforded alcohol **20** (330 mg, 73% yield) as a colorless liquid. R_f = 0.7 (10% EtOAc in hexane); $[\alpha]^{27}_D$ = -2.2 (*c* 1.6, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.59-3.58 (m, 1H), 2.21-2.15 (m, 2H), 1.94 (t, *J* = 2.4 Hz, 1H), 1.55-1.26 (m, 18H), 0.91 (t, *J* = 1.8 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 84.8, 72.1, 68.2, 37.5, 37.3, 29.7, 29.2, 28.8, 28.6, 27.9, 25.7, 22.9, 18.5, 14.2 ppm; IR (neat) ν_{max} 3311, 2929, 2117 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{14}H_{27}O$ $[M+H]^+$ 211.2062, found 211.2031.

(*R*)-Tetradec-13-yn-5-yl acetate (5): To a solution of alcohol **20** (250 mg, 1.18 mmol) in anhydrous pyridine (2 mL) at 0 °C under argon, Ac_2O (0.22 mL, 2.36 mmol) was added. The reaction mixture was warmed slowly to room temperature and stirred further for 30 min. Pyridine was removed under reduced pressure. Purification by flash column chromatography (SiO_2, 60-120 mesh, 2% EtOAc in hexane as eluant) of the resultant crude residue afforded alkyne **5** as a colorless liquid (300 mg, quantitative). R_f = 0.9 (5% EtOAc in hexane); $[\alpha]^{28}_D$ = +2.2 (*c* 1.95, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 500 MHz) δ 4.87-4.82 (m, 1H), 2.18-2.15 (m, 2H), 2.02 (s, 3H), 1.92 (t, *J* = 2.5 Hz, 1H), 1.53-1.48 (m, 6H), 1.38-1.23 (m, 12H), 0.88 (t, *J* = 7.0 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 84.8, 74.5, 68.2, 34.2, 33.9, 29.5, 29.1, 28.8, 28.5, 27.6,

25.4, 22.7, 21.4, 18.5, 14.1 ppm; IR (neat) ν_{max} 3309, 2935, 2117, 1733 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{16}H_{28}O_2Na$ $[M+Na]^+$ 275.1987, found 275.1989.

16-((4*S*,5*R*)-5-(2-((*R*)-5-(2-(((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)vinyl)-2,2-dimethyl-1,3-dioxolan-4-yl)hexadec-15-en-13-yn-5-yl acetate [3(a-d)]: To a freshly dried and degassed Et_3N (1 mL) solution of vinyl iodides **4**(**a-d**) (50 mg, 0.09 mmol) and alkyne **5** (28 mg, 0.11 mmol) under argon at ambient temperature, CuI (4 mg, 0.02 mmol) and $Pd(PPh_3)_2Cl_2$ (7 mg, 0.01 mmol) were added successively. The resulting orange color suspension was stirred further for 4 h at same temperature. Et_3N was removed under *vacuo* and the resultant crude residue was purified by column chromatography (SiO_2, 100-200 mesh, 10% EtOAc in hexane as eluant) to afford compounds **3**(**a-d**) as colorless liquid (45 mg, 76%). R_f = 0.3 (20% EtOAc in hexane); ^1H NMR ($CDCl_3$, 300 MHz) δ 5.78-5.72 (m, 1H), 5.64-5.56 (m, 3H), 5.15 (q, $J_{1,2}$ = 6.6 Hz, 1H), 5.02 (t, J = 6.3 Hz, 1H), 4.91-4.81 (m, 2H), 4.29-4.18 (m, 2H), 4.05 (q, $J_{1,2}$ = 6.3 Hz, 1H), 3.75-3.69 (m, 1H), 3.63-3.49 (m, 3H), 3.45-3.40 (m, 1H), 2.35-2.29 (m, 2H), 2.03 (s, 3H), 1.67-1.61 (m, 2H), 1.54-1.46 (m, 10H), 1.41-1.34 (m, 14H), 1.28-1.22 (m, 12H), 0.88 (t, J = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 136.7, 130.1, 129.2, 113.8, 109.5, 109.4, 108.6, 75.8, 75.7, 74.8, 74.8, 74.5, 73.8, 72.3, 67.1, 34.3, 33.9, 31.2, 29.8, 29.6, 29.2, 29.1, 28.9, 28.5, 28.3, 27.6, 26.9, 25.9, 25.7, 25.5, 25.5, 22.7, 21.4, 19.7, 14.1 ppm; IR (neat) ν_{max} 2929, 2217, 1732 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{62}O_9Na$ $[M+Na]^+$ 685.4292, found 685.4290.

16-((4*S*,5*R*)-5-(2-((4*S*,5*R*)-5-(2-(((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)hexadecan-5-yl-acetate

(21): To a stirred solution of compounds **3**(**a-d**) (25 mg, 0.037 mmol) in EtOAc (1 mL) was added 10% Pd/C (4 mg) using hydrogen-balloon at room temperature and stirred for 12 h. The reaction mixture was filtered using a short pad of celite and washed with EtOAc. The organic layers were concentrated in vacuum and purified by flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) to get pure saturated compound **21** (24 mg, 98 %) as a colorless liquid. R_f = 0.35 (20% EtOAc in hexane); $[\alpha]^{27}_D$ = +3.2 (*c* 1.4, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.89-4.81 (m, 1H), 4.30-4.18 (m, 2H), 4.13-4.02 (m, 3H), 3.75-3.41 (m, 6H), 2.03 (s, 3H), 1.78-1.69 (m, 2H), 1.67-1.63 (m, 4H), 1.54-1.49 (m, 6H), 1.42 (s, 8H), 1.37-1.25 (m, 32H), 0.88 (t, *J* = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 Hz) δ 171.1, 109.6, 107.8, 107.5, 78.5, 78.4, 78.2, 74.9, 74.9, 74.6, 72.3, 68.8, 67.0, 34.3, 33.9, 30.3, 29.8, 29.7, 29.1, 28.7, 27.6, 27.3, 26.9, 26.5, 26.1, 261, 25.5, 25.5, 22.7, 21.4, 14.1 ppm; IR (neat) ν_{max} 2927, 1731 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{70}O_9Na$ $[M+Na]^+$ 693.4918, found 693.4915.

(5*R*,17*S*,18*R*,21*S*,22*R*)-24-((*S*)-2,3-Dihydroxypropoxy)-17,18,21,22-tetrahydroxytetracosan-5-yl acetate (1). The compound **21** (10 mg, 0.015 mmol) was dissolved in of AcOH:H_2O (4:1, 0.5 mL) mixture at 0 °C. The reaction mixture was warmed to room temperature and stirred further for 6 h. The mixture of AcOH and H_2O was removed under vacuum and purified by flash column chromatography (SiO_2, 60-120 mesh, 5% MeOH in CH_2Cl_2 as eluant) to afford pure compound **1** (8 mg, 97%) as a colorless liquid. R_f = 0.5 (10% MeOH in CH_2Cl_2); $[\alpha]^{21}_D$ = +2.8 (*c* 0.44, MeOH); ^{1}H NMR (C_5D_5N, 300 MHz) δ 5.13-5.05 (m, 1H, merged in water peak, confirmed by HSQC NMR study), 4.40-4.33 (m, 1H), 4.23-4.17 (m, 1H), 4.15-4.04 (m, 3H), 4.02-3.98 (m, 3H), 3.95-3.83 (m, 3H), 2.59 (br d, *J* = 9.3 Hz, 2H), 2.43-2.29 (m, 2H), 2.18-2.09 (m, 5H), 2.02-1.95 (m, 1H), 1.88-1.85 (m, 2H), 1.61-1.53 (m, 5H), 1.32-1.22 (m, 20H), 0.83 (t, *J*

= 6.6 Hz, 3H); ^{13}C NMR (C_5D_5N, 100 MHz) δ 170.7, 75.9, 75.3, 74.3, 73.7, 72.9, 71.9, 69.7, 64.7, 34.5, 34.2, 33.6, 30.6, 30.4, 30.3, 30.1, 29.9, 29.9, 29.9, 29.8, 27.8, 26.8, 25.7, 22.8, 21.1,14.1; IR (neat) ν_{max} 3365, 2925, 1737 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{29}H_{58}O_9Na$ $[M+Na]^+$ 573.3979, found 573.3975.

***tert*-Butyl(((4*R*,5*S*)-2,2-dimethyl-5-vinyl-1,3-dioxolan-4-yl)methoxy)diphenylsilane (26).** Following the same synthetic procedure of compound **10**, alcohol **25** (4.0 g, 25.25 mmol) was converted to compound **26** using TBDPSCl (8.0 mL, 32.50 mmol) and imidazole (5.0 g, 75.0 mmol) in CH_2Cl_2 (60 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 2% EtOAc in hexane as eluant) afforded compound **26** (9.95 g, quantitative) as colorless oil. R_f = 0.6 (5% EtOAc in hexane); $[\alpha]^{25}_D$ = 8.2 (*c* 1.1, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.69-7.67 (m, 4H), 7.46-7.35 (m, 6H), 6.00-5.88 (m, 1H), 5.39-5.20 (m, 2H), 4.66 (t, *J* = 6.6, 1H), 4.29 (q, $J_{1,2}$ =6.3 Hz, 1H), 3.74-3.63 (m, 2H), 1.45 (s, 3H), 1.38 (s, 3H), 1.06 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 134.8, 134.8, 133.6 (133.5), 129.8, 127.8, 118.1, 108.7, 78.9, 78.6, 63.0, 27.9, 26.9, 25.5, 19.3 ppm; IR (neat) ν_{max} 2931, 1217 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{24}H_{32}O_3SiNa$ $[M + Na]^+$ 419.2018, found 419.2014.

2-((4*S*,5*R*)-5-(((tert-Butyldiphenylsilyl)oxy)methyl)-2,2-dimethyl-1,3-dioxolan-4-yl)ethanol (27). Following the same synthetic procedure of compound **11**, compound **26** (2.0 g, 5.04 mmol) was converted to compound **27** using $PdCl_2$ (100 mg, 0.1 mmol), CuCl (740 mg, 7.47 mmol) in DMF:H_2O (7:1, 40 mL) followed by treatment of resultant aldehyde with $NaBH_4$ (720 mg, 20.0 mmol) in MeOH (15 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 20% EtOAc in hexane as eluant) afforded compound **27** (1.45 g, 69%) as colorless oil. R_f = 0.4 (20% EtOAc in hexane); $[\alpha]^{27}_D$ = -2.3 (*c* 1.3, $CHCl_3$); ^{1}H NMR ($CDCl_3$,

300 MHz) δ 7.68-7.65 (m, 4H), 7.46-7.36 (m, 6H), 4.41-4.36 (m, 1H), 4.26-4.21 (m,1H), 3.85-3.80 (m, 2H), 3.79-3.64 (m, 2H), 2.40 (br s, 1H), 1.93-1.87 (m, 2H), 1.37 (s, 3H), 1.34 (s, 3H), 1.06 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 135.7, 133.3, 133.2, 130.1, 129.9, 127.9, 127.9, 108.3, 77.8, 77.0, 62.6, 31.6, 28.2, 26.9, 25.6, 19.3 ppm; IR (neat) ν_{max} 3445, 2930, 1113 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{24}H_{34}O_4SiNa$ $[M + Na]^+$ 437.2124, found 437.2120.

(((4*R*,5*S*)-5-(2-(Allyloxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)(tert-butyl)diphenylsilane (28). Following the same synthetic procedure of compound **12**, compound **27** (1.5 g, 3.62 mmol) was converted to compound **28** using allyl bromide (0.4 mL, 4.34 mmol), NaH (174 mg, 4.34 mmol, 60% absorbed in oil) and TBAI (67 mg, 0.2 mmol) in THF (10 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compound **28** (1.48 g, 91%) as colorless oil. R_f = 0.7 (10% EtOAc in hexane); $[\alpha]^{26}_D$ = -2.0 (*c* 1.5, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.68-7.66 (m, 4H), 7.45-7.36 (m, 6H), 5.95-5.87 (m, 1H), 5.27 (dd, *J* = 12.9, 1.2 Hz, 1H), 5.17 (dd, *J* = 7.8, 0.6 Hz, 1H), 4.37-4.32 (m, 1H), 4.22-4.17 (m, 1H), 3.97 (t, *J* = 4.2 Hz, 2H), 3.77-3.54 (m, 4H), 2.01-1.97 (m, 1H), 1.85-1.79 (m, 1H), 1.37 (s, 3H), 1.33 (s, 3H), 1.06 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 135.8, 135.7, 135.1, 129.8, 127.8, 116.8, 108.0, 77.9, 74.5, 72.0, 67.6, 62.9, 29.8, 28.3, 27.2, 25.7, 19.3 ppm; IR (neat) ν_{max} 2930, 1587, 1110 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{27}H_{38}O_4SiNa$ $[M + Na]^+$ 477.2437, found 477.2436.

5-((((4*S*,5*S*)-5-(2-(Allyloxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methyl)thio)-1-phenyl-1H-tetrazole (29). Following the same synthetic procedure of compound **14**, compound **28** (1.5 g, 3.3 mmol) was converted to corresponding TBDPS deprotected alcohol using TBAF (1M in

THF, 4.0 mL, 3.95 mmol) in THF (10 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded corresponding alcohol (692 mg, 97%) as colorless oil. R_f = 0.4 (20% EtOAc in hexane); $[\alpha]^{28}_D$ = +1.9 (*c* 1.1, $CHCl_3$); ^{1}NMR ($CDCl_3$, 300 MHz) δ 5.92-5.79 (m, 1H), 5.26 (dq, *J* = 16.8, 1.5 Hz, 1H), 5.19 (dq, *J* = 10.5, 1.5 Hz, 1H), 4.29-4.23 (m, 1H), 4.17-4.11 (m, 1H), 3.94 (dt, *J* = 5.1, 1.5 Hz, 2H), 3.64-3.49 (m, 4H), 1.85-1.78 (m, 2H), 1.41 (s, 3H), 1.32 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 134.6, 117.2, 107.9, 78.0, 74.6, 72.1, 67.4, 61.6, 29.5,28.2, 25.6 ppm; IR (neat) ν_{max} 3443, 2930 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{11}H_{20}O_4Na$ $[M + Na]^+$ 239.1259, found 239.1258.

The above alcohol (650 mg, 3.0 mmol) was converted to compound **29** using compound **13** (641 mg, 3.6 mmol), DIAD (0.7 mL, 3.6 mmol,) and Ph_3P (944 mg, 3.6 mmol) in THF (15 mL). Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 5% EtOAc in hexane as eluant) afforded compound **29** (1.04 g, 88%) as colorless oil. R_f = 0.5 (10% EtOAc in hexane); $[\alpha]^{25}_D$ = +27.2 (*c* 1.3, $CHCl_3$); ^{1}NMR ($CDCl_3$, 300 MHz) δ 7.59-7.54 (m, 5H), 5.96-5.85 (m, 1H), 5.27 (dq, *J* =16.5, 1.5 Hz, 1H), 5.18 (dd, *J* =10.2, 1.5 Hz, 1H), 4.50-4.36 (m, 2H), 4.01 (dt, *J* = 2.7, 1.5 Hz, 2H), 3.73 (dd, *J* =13.2, 3.0 Hz, 1H), 3.66-3.55 (m, 2H), 3.33 (dd, *J* =12.9, 9.9 Hz, 1H), 1.97-1.88 (m, 2H), 1.45 (s, 3H), 1.35 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.4, 134.8, 130.3, 129.9, 123.9, 117.2, 108.8, 75.9, 75.3, 72.2, 67.1, 35.3, 29.9, 28.5, 25.8 ppm; IR (neat) ν_{max} 2928, 1215 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{18}H_{24}N_4O_3SNa$ $[M+Na]^+$ 399.1467, found 399.1466.

5-((((4*S*,5*S*)-5-(2-(((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methyl)thio)-2-phenyl-2H-tetrazole (31): Following the same synthetic procedure of compound **15a** and **15b**, compound **29** (1.0 g, 2.55 mmol) was converted to

compounds **30a** and **30b** using AD-mix-β (3.6 g, 1.4 g for 1 mmol of olefin) $MeSO_2NH_2$ (485 mg, 5.1 mmol) in $^tBuOH:H_2O$ (1:1, 20 mL). Purification of crude mixture using flash column chromatography (SiO_2, 230-400 mesh, 50% EtOAc in hexane as eluant) afforded compounds **30a** (723 mg, 69%) and **30b** (219 mg, 21%) as colorless oil.

Data for compound 30a: R_f = 0.5 (60% EtOAc in hexane); $[\alpha]^{27}_D$ = +3.2 (*c* 0.9, $CHCl_3$); ^1H NMR ($CDCl_3$, 300 MHz) δ 7.60-7.54 (m, 5H), 4.55-4.67 (m, 1H), 4.39-4.32 (m, 1H), 3.96-3.81 (m, 2H), 3.72-3.64 (m, 4H), 3.57-3.54 (m, 2H), 3.23-3.17 (m, 1H), 2.00-1.98 (m, 2H), 1.44 (S, 3H), 1.35 (S, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.4, 133.7, 130.4, 129.9, 124.0, 108.6, 76.5, 75.7, 73.1, 70.8, 68.8, 64.2, 35.5, 29.4, 28.5, 25.8 ppm. IR (neat) ν_{max} 3413, 2928, 1213 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{18}H_{26}N_4O_5SNa$ $[M + Na]^+$ 433.1522, found 433.1515.

Data for compound 30b: R_f = 0.5 (60% EtOAc in hexane); $[\alpha]^{29}_D$ = -15.6 (*c* 1.5, $CHCl_3$); ^1H NMR ($CDCl_3$, 300 MHz) δ 7.61-7.54 (m, 5H), 4.55-4.47 (m, 1H), 4.39-4.32 (m, 2H), 3.70-3.63 (m, 4H), 3.57-3.54 (m, 2H), 3.27-3.17 (m, 1H), 2.01-1.92 (m, 2H), 1.44 (s, 3H), 1.35 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.4, 133.7, 130.4, 129.9, 124.0, 108.6, 76.5, 75.9, 73.2, 70.6, 68.8, 64.2, 35.5, 29.5, 28.5, 25.8 ppm. IR (neat) ν_{max} 3410, 2926, 1209 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{18}H_{26}N_4O_5SNa$ $[M + Na]^+$ 433.1522, found 433.1521.

Following the same synthetic procedure of compound **16**, compound **30a** (700 mg, 1.7 mmol) was converted to compound **31** using 2,2-DMP (0.63 mL, 5.1 mmol) and CSA (20 mg, 0.09 mmol) in CH_2Cl_2 (7 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded compound **31** (762 mg, quantitative) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); $[\alpha]^{28}_D$ = +43.2 (*c* 7.8, $CHCl_3$); ^1H NMR ($CDCl_3$, 300 MHz) δ 7.58-7.49 (m, 1H), 4.46-4.39 (m, 1H), 4.36-4.29 (m, 1H), 4.27-4.23 (m, 1H), 4.05-3.99 (m, 1H), 3.72-3.64 (m, 4H), 3.63-3.41 (m, 2H), 3.29 (dd, *J* = 12.9, 10.2 Hz,

1H), 1.94-1.83 (m, 2H), 1.41 (s, 3H), 1.38 (s, 3H), 1.31-1.30 (m, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.2, 133.6, 130.2, 129.8, 123.8, 109.4, 108.6, 75.8, 75.1, 74.7, 72.2, 68.4, 66.8, 35.1, 29.6, 28.3, 26.8, 25.7, 25.4 ppm. IR (neat) ν_{max} 2932, 1218 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{30}N_4O_5SNa$ $[M + Na]^+$ 473.1835, found 473.1840.

5-((((4*S*,5*S*)-5-(2-(((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methyl)sulfonyl)-2-phenyl-2H-tetrazole (32): Following the same synthetic procedure of sulfone **8**, compound **31** (500 mg, 1.1 mmol) was converted to sulfone **32** using $(NH_4)_6Mo_7O_{24}.4H_2O$ (69 mg, 0.05 mmol), 30% aqueous H_2O_2 (3 mL), in EtOH (5 mL). Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 20% EtOAc in hexane as eluant) afforded sulfone **32** (449 mg, 85%) as colorless oil. R_f = 0.3 (30% EtOAc in hexane); $[\alpha]^{28}_D$ = -2.4 (*c* 1.4, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.61-7.55 (m, 5H), 4.66-4.57 (m, 1H), 4.31 (q, *J* = 6.6 Hz, 1H), 4.24-4.16 (m, 1H), 4.02-3.96 (m, 1H), 3.84-3.81 (m, 2H), 3.68-3.58 (m, 2H), 3.55-3.47 (m, 1H), 3.45-3.39 (m, 2H), 1.85-1.79 (m, 2H), 1.37 (s, 3H), 1.28 (s, 3H), 1.24 (s, 3H), 1.19 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.2, 133.3, 131.4, 129.4, 125.9, 109.5, 109.3, 75.9, 72.6, 72.4, 68.3, 66.7, 58.4, 29.7, 27.6, 26.9, 25.6, 25.3 ppm. IR (neat) ν_{max} 2926, 1210 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{30}N_4O_7SNa$ $[M + Na]^+$ 505.1733, found 505.1712.

***tert*-Butyl(((*R*)-5-(2-((4*S*,5*R*)-5-(2-(((*R*)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)vinyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)diphenylsilane [34(a-b)]:** Following the same synthetic procedure of aldehyde **7**, compound **26** (396 mg, 1.0 mmol) was converted to aldehyde **33** (362 mg) using OsO_4 (5% solution in ^{t}BuOH, 50 µL),

NMO (234 mg, 1.8 mmol), $NaIO_4$ (464 mg, 1.8 mmol), $NaHCO_3$ (252 mg, 2.7 mmol) in ^tBuOH:THF:H_2O (5:5:1, 3.5 mL). The aldehyde was filter through silica gel column and taken for next reaction without further characterization.

Following the same synthetic procedure of compounds **6(a-b)**, aldehyde **33** (362 mg, 0.92 mmol) and sulfone **8** (375 mg, 0.77 mmol) reacted together in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (4 mL) to get compounds **34(a-b)**. Purification of crude mixture using flash column chromatography (SiO_2, 230-400 mesh, 10% EtOAc in hexane as eluant) afforded compounds **34(a-b)** (350 mg, 69%) as colorless oil. R_f = 0.5 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.68-7.65 (m, 4H), 7.42-7.37 (m, 6H), 5.94-5.87 (m, 1H), 5.78-5.71 (m, 1H), 4.68 (t, *J* = 6.3 Hz, 1H), 4.53 (t, *J* = 6.6 Hz, 1H), 4.27-4.21 (m, 3H), 4.06-4.01 (m, 1H), 3.73-3.66 (m, 2H), 3.64-3.58 (m, 1H), 3.54-3.47 (m, 3H), 3.42-3.37 (m, 1H), 1.65-1.63 (m, 2H), 1.44-1.42 (m, 9H), 1.36-1.33 (m, 9H), 1.04 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 135.8, 133.5 (133.4), 129.9 (129.8), 129.3, 129.0, 127.8, 109.6, 108.8, 108.4, 78.6, 78.4, 75.2, 75.1, 74.8, 72.3, 68.6, 67.0, 63.2, 31.2, 28.4, 27.8, 26.9, 25.8, 25.5 (25.5), 19.3 ppm; IR (neat) ν_{max} 2928, 1208 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{37}H_{54}O_8SiNa$ $[M + Na]^+$ 677.3486, found 677.3496.

(4*R*,5*S*)-4-(2-(((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-5-(2-((R)-5-(2-iodovinyl)-2,2-dimethyl-1,3-dioxolan-4-yl)vinyl)-2,2-dimethyl-1,3-dioxolane [35(a-d)]: Following the same synthetic procedure of compounds **17(a-b)**, the mixture of compounds **34(a-b)** (225 mg, 0.34 mmol) was converted to the corresponding alcohols using TBAF (1 M in THF, 0.5 mL. 0.5 mmol) in THF (2 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 30% EtOAc in hexane as eluant) afforded the corresponding alcohols (140 mg, 97%) as colorless oil. R_f = 0.4 (40% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.75-5.73

(m, 2H), 4.67-4.63 (m, 1H), 4.56-4.52 (m, 1H), 4.29-4.19 (m, 3H), 4.05-4.00 (m, 1H), 3.71-3.66 (m, 1H), 3.62-3.38 (m, 6H), 2.26 (s, 1H), 1.68 (q, $J_{1,2}$ = 6.0 Hz, 2H), 1.47 (s, 3H), 1.44 (s, 3H), 1.39 (s, 3H), 1.36-1.33 (m, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 130.3 (130.2), 128.6 (128.5), 109.6 (109.5), 108.9, 108.4, 78.4, 75.3 (75.2), 74.8 (74.7), 72.2, 68.6, 66.8 (66.7), 62.1, 30.9, 29.8, 28.3, 27.9, 26.8, 25.7, 25.5 (25.4) ppm; IR (neat) ν_{max} 3476, 2970, 1219 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{36}O_8Na$ $[M + Na]^+$ 439.2308, found 439.2300.

Following the same synthetic procedure of compounds **4(a-d)**, the alcohols from the above step (100 mg, 0.23 mmol) was transformed to the corresponding aldehydes using IBX (110 mg, 0.4 mmol) in EtOAc (3 mL) which further were reacted with $Ph_3PCH_2I_2$ (420 mg, 0.8 mmol) in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (5 mL) to get compounds **35(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compounds **35(a-d)** (95 mg, 69%) as colorless oil. R_f = 0.5 (10% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 6.46 (dd, *J* = 7.8, 1.2 Hz, 1H), 6.29 (t, *J* = 7.5 Hz, 1H), 5.77-5.69 (m, 1H), 5.66-5.56 (m, 1H), 4.89-4.85 (m, 1H), 4.79-4.75 (m, 1H), 4.54-4.49 (m, 1H), 4.31-4.24 (m, 2H), 4.05 (dd, *J* = 8.4, 6.3 Hz, 1H), 3.75-3.68 (m, 1H), 3.63-3.49 (m, 3H), 3.47-3.40 (m, 1H), 1.70-1.66 (m, 2H), 1.51 (s, 3H), 1.46 (s, 3H), 1.42-1.38 (m, 6H), 1.36-1.35 (m, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 138.1, 130.1, 129.0, 109.6, 108.5, 84.9, 81.2, 78.5, 77.9, 75.2, 74.9, 72.3, 68.6, 66.9, 31.0, 28.4, 28.0, 26.9, 25.8, 25.6, 25.5 ppm; IR (neat) ν_{max} 2924, 1219 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{22}H_{35}IO_7Na$ $[M + Na]^+$ 561.1325, found 561.1309.

***tert*-Butyl(((*S*)-5-(2-((4*R*,5*S*)-5-(2-(((*R*)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)vinyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)diphenylsilane**

36(a-b). Following the same synthetic procedure of compounds **6(a-b)**, aldehyde **7** (362 mg, 0.92 mmol) and sulfone **32** (375 mg, 0.77 mmol) reacted together in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (4 mL) to get compounds **36(a-b)**. Purification of crude mixture using flash column chromatography (SiO_2, 230-400 mesh, 10% EtOAc in hexane as eluant) afforded compounds **36(a-b)** (350 mg, 68%) as colorless oil. R_f = 0.5 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.69-7.66 (m, 4H), 7.44-7.34 (m, 6H), 5.77 (dd, *J* = 11.5, 8.4 Hz, 1H), 5.61-5.54 (m, 1H), 4.99 (t, *J* = 6.9 Hz, 1H), 4.26-4.17 (m, 3H), 4.04-3.98 (m, 1H), 3.73-3.66 (m, 2H), 3.60-3.45 (m, 4H), 3.41-3.37 (m, 1H), 1.61-1.56 (m, 2H), 1.46-1.45 (m, 6H), 1.41 (s, 3H), 1.36-1.34 (m, 9H), 1.05 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 135.7 (135.7), 133.4 (133.4), 129.8, 129.5, 128.9, 127.8, 109.5, 108.9, 108.5, 79.1, 75.3 (75.2), 74.8 (74.7), 74.1, 73.8, 72.2 (72.1), 68.5 (68.5), 66.9, 63.4, 31.0, 28.5, 27.8, 26.9 (26.9), 25.8, 25.5, 19.3 ppm; IR (neat) ν_{max} 2935, 1219 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{37}H_{54}O_8SiNa$ $[M + Na]^+$ 677.3486, found 677.3478

(4*S*,5*R*)-4-(2-(((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-5-(2-((S)-5-(2-iodovinyl)-2,2-dimethyl-1,3-dioxolan-4-yl)vinyl)-2,2-dimethyl-1,3-dioxolane [37(a-d)]: Following the same synthetic procedure of compounds **17(a-b)**, the mixture of compounds **36(a-b)** (250 mg, 0.34 mmol) was converted to the corresponding alcohols using TBAF (1 M in THF, 0.5 mL. 0.5 mmol) in THF (3 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 30% EtOAc in hexane as eluant) afforded the corresponding alcohols (135 mg, 93 %) as colorless oil. R_f = 0.4 (40% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.77-5.76 (m, 2H), 4.69-4.66 (m, 1H), 4.58-4.54 (m, 1H), 4.31-4.22 (m, 3H), 4.07-4.02 (m, 1H), 3.73-3.68 (m, 1H), 3.65-3.41 (m, 6H), 3.41 (q, *J* = 6.3 Hz, 2H), 1.29 (s, 3H), 1.46 (s, 3H), 1.42 (s, 3H),

1.38 (s, 3H), 1.36 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 130.4, 128.5, 109.7, 109.0, 108.5, 78.5, 78.5, 78.4, 75.3, 74.9, 72.3 (72.2), 68.7, 66.9 (66.8), 62.1, 30.9, 29.8, 28.3, 27.9, 26.9, 25.8, 25.5 (25.4) ppm; IR (neat) ν_{max} 3468, 2977, 1205 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{36}O_8Na$ $[M + Na]^+$ 439.2308, found 439.2301.

Following the same synthetic procedure of compounds **4(a-d)**, the alcohols from the above step (100 mg, 0.23 mmol) was transformed to the corresponding aldehydes using IBX (110 mg, 0.4 mmol) in EtOAc (3 mL) which further was reacted with $Ph_3PCH_2I_2$ (420 mg, 0.8 mmol) in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (5 mL) to get compounds **37(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compounds **37(a-d)** (100 mg, 72%) as colorless oil. R_f = 0.5 (10% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 6.29 (t, *J* = 7.5 Hz, 2H), 5.77-5.57 (m, 3H), 4.90-4.85 (m, 1H), 4.79-4.72 (m, 1H), 4.59-4.49 (m, 1H), 4.33-4.24 (m, 2H), 4.07-4.03 (m, 1H), 3.75-3.69 (m, 1H), 3.67-3.47 (m, 3H), 3.45-3.42 (m, 1H), 1.72-1.64 (m, 2H), 1.51-1.49 (m, 3H), 1.46 (s, 3H), 1.42-1.41 (m, 6H), 1.36-1.35 (m, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 138.1, 130.1, 129.0, 109.8, 109.6, 108.5, 84.3, 81.3, 78.6, 78.0, 75.2, 74.9, 74.8, 72.3, 68.7, 67.0 (67.9), 31.1, 29.8, 28.5 (28.4), 28.0, 26.9, 25.9 (25.8), 25.6 ppm; IR (neat) ν_{max} 2930, 1210 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{22}H_{35}IO_7Na$ $[M + Na]^+$ 561.1325, found 561.1323.

***tert*-Butyl(((*R*)-5-(2-((4*R*,5*S*)-5-(2-(((*R*)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)vinyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)diphenylsilane [38(a-b)]:** Following the same synthetic procedure of compounds **6(a-b)**, aldehyde **33** (370 mg,

0.92 mmol) and sulfone **32** (375 mg, 0.77 mmol) reacted together in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (4 mL) to get compounds **38(a-b)**. Purification of crude mixture using flash column chromatography (SiO_2, 230-400 mesh, 10% EtOAc in hexane as eluant) afforded compounds **38(a-b)** (360 mg, 73%) as colorless oil. R_f = 0.5 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.69-7.66 (m, 4H), 7.42-7.35 (m, 6H), 5.77 (q, $J_{1,2}$ = 8.7 Hz, 1H), 5.58 (q, $J_{1,2}$ = 10.9 Hz, 1H), 4.99 (t, J = 7.5 Hz, 1H), 4.91(t, J = 7.5 Hz, 1H), 4.26-4.15 (m, 3H), 4.05-3.98 (m, 1H), 3.75-3.66 (m, 2H), 3.62-3.45 (m, 4H), 3.99-3.36 (m, 1H), 1.62-1.59 (m, 2H), 1.46-1.45 (m, 6H), 1.40 (s, 3H), 1.36-1.34 (m, 9H), 1.05 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 135.7 (135.7), 133.4 (133.4), 129.8 , 129.5, 128.9, 127.8, 109.4, 108.8, 108.5, 79.1, 75.3, 74.7, 74.1, 73.3, 72.1, 68.5, 66.9, 63.4, 31.0, 28.5, 27.8, 26.9, 26.9, 25.8, 25.5, 25.5, 19.3 ppm; IR (neat) ν_{max} 2934, 1218 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{37}H_{54}O_8SiNa$ $[M + Na]^+$ 677.3486, found 677.3464.

(4*S*,5*R*)-4-(2-(((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-5-(2-((R)-5-(2-iodovinyl)-2,2-dimethyl-1,3-dioxolan-4-yl)vinyl)-2,2-dimethyl-1,3-dioxolane [39(a-d)]: Following same synthetic procedure of compounds **17(a-b)**, the mixture of compounds **38(a-b)** (250 mg, 0.34 mmol) was converted to the corresponding alcohols using TBAF (1 M in THF, 0.5 mL. 0.5 mmol) in THF (2 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 30% EtOAc in hexane as eluant) afforded the corresponding alcohols (144 mg, 96%) as colorless oil. R_f = 0.4 (40% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.70-5.59 (m, 2H), 5.04-4.99 (m, 1H), 4.91 (t, J = 6.9 Hz, 1H), 4.25-4.17 (m, 3H), 4.06-4.00 (m, 1H), 3.74-3.65 (m, 1H), 3.59-3.54 (m, 4H), 3.51-3.41 (m, 2H), 2.58 (s, 1H), 1.69-1.62 (m, 2H), 1.49 (s, 3H), 1.46 (s, 3H), 1.41 (s, 3H), 1.37-1.34 (m, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed

minor diastereomeric peaks are given in parentheses) δ 129.7, 128.9, 109.6, 109.1, 108.7, 78.8, 75.5, 74.9 (74.7), 74.2, 73.4, 71.9, 68.4, 66.9, 61.9, 31.2, 29.8, 28.4, 28.0, 26.9 (26.8), 25.7, 25.4 (25.4) ppm; IR (neat) ν_{max} 3460, 2988, 1217 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{36}O_8Na$ $[M + Na]^+$ 439.2308, found 439.2322.

Following the same synthetic procedure of compounds **4(a-d)**, the alcohols from the above step (100 mg, 0.23 mmol) was transformed to the corresponding aldehydes using IBX (110 mg, 0.4 mmol) in EtOAc (3 mL) which further was reacted with $Ph_3PCH_2I_2$ (420 mg, 0.8 mmol) in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (5 mL) to get compounds **39(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compounds **39(a-d)** (98 mg, 71%) as colorless oil. R_f = 0.5 (10% EtOAc in hexane); ^1H NMR ($CDCl_3$, 300 MHz) δ 6.51-6.47 (m, 1H), 6.29-6.24 (m, 1H), 5.64-5.53 (m, 2H), 5.07 (t, *J* = 6.9 Hz, 1H), 4.94-4.83 (m, 2H), 4.07-4.02 (m, 1H), 3.75-3.68 (m, 1H), 3.60-3.50 (m, 3H), 3.46-3.41 (m, 1H),1.64 (q, *J* = 6.9 Hz, 2H), 1.51 (s, 3H), 1.46 (s, 3H), 1.42-1.41 (m, 6H), 1.36 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 137.4, 129.9, 129.1, 109.8, 108.7, 85.7, 81.4, 75.7, 74.9 (74.8), 73.9, 73.7, 72.1, 68.8, 67.0, 31.3, 28.4, 29.8, 28.5, 26.9, 25.9, 25.7 (25.5) ppm; IR (neat) ν_{max} 2928, 1212 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{22}H_{35}IO_7Na$ $[M + Na]^+$ 561.1325, found 561.1335.

(*R*)-16-((4*R*,5*S*)-5-(2-((4*S*,5*R*)-5-(2-(((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)hexadecan-5-yl acetate (22) : Following the same synthetic procedure of compounds **3(a-d)**, the compounds **35(a-d)** (50 mg, 0.09 mmol) and alkyne **5** (28 mg, 0.11 mmol) were coupled using $Pd(Ph_3P)_2Cl_2$ (7 mg, 0.01

mmol) and CuI (4 mg, 0.02 mmol) in Et_3N (1 mL) to get compounds **40(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 10% EtOAc in hexane as eluant) afforded compounds **40(a-d)** (44 mg, 75%) as colorless liquid. R_f = 0.3 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.78-5.59 (m, 4H), 5.19-5.14 (m, 1H), 4.87-4.83 (m, 1H), 4.71 (t, *J* = 6.0 Hz, 1H), 4.52 (t, *J* = 6.6 Hz, 1H), 4.29-4.23 (m, 2H), 4.05 (dd, *J* = 8.2, 6.6 Hz, 1H), 3.75-3.68 (m, 1H), 3.60-3.49 (m, 3H), 3.46-3.41 (m, 1H), 2.34-2.29 (m, 2H), 2.03 (s, 3H), 1.68-1.66 (m, 4H), 1.51-1.46 (m, 9H), 1.42-1.39 (m, 6H), 1.36-1.34 (m, 6H), 1.28-1.25 (m, 11H), .088 (t, *J* = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 171.1, 137.3, 135.4, 129.7, 129.5, 113.4, 109.6 (109.2), 108.4, 78.6 (78.5), 75.2 (75.2), 74.9, 74.8, 74.5, 72.3, 68.6, 66.9, 34.3, 33.9, 30.9, 29.8, 29.6, 29.2, 29.0, 28.8, 28.4, 28.2, 27.6, 26.9, 25.8, 25.7, 25.5, 25.5, 22.7, 21.4, 19.7, 14.1 ppm; IR (neat) ν_{max} 2927, 2223, 1730 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{62}O_9Na$ $[M+Na]^+$ 685.4292, found 685.4289.

Following the same synthetic procedure of compound **21**, compounds **40(a-d)** (25 mg, 0.037 mmol) were hydrogenated to get compound **22** using 10 mol% Pd/C (4 mg) in EtOAc (1 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded compound **22** (23 mg, 94%) as colorless oil. R_f = 0.35 (20% EtOAc in hexane); $[\alpha]^{27}_D$ = +7.8 (*c* 1.5, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.89-4.81 (m, 1H), 4.28-4.18 (m, 2H), 4.11-4.03 (m, 4H), 3.75-3.69 (m, 1H), 3.66-3.51 (m, 3H), 3.48-3.41 (m, 1H), 2.03 (s, 3H), 1.78-1.72 (m, 4H), 1.52-1.48 (m, 6H), 1.42 (s, 9H), 1.36-1.33 (m, 10H), 1.29-1.25 (m, 23H), 0.88 (t, *J* = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 109.6, 107.8, 107.6, 78.2, 74.9, 74.8, 72.3, 68.9, 66.9, 34.3, 33.9, 32.1, 30.2, 29.8, 29.8, 29.7, 28.7, 27.6, 26.9,

26.6, 26.5, 26.2, 26.1, 25.6, 25.5, 22.8, 21.4, 14.1 ppm; IR (neat) ν_{max} 2927, 1728 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{70}O_9Na$ $[M+Na]^+$ 693.4918, found 693.4911.

(*R*)-16-((4*S*,5*R*)-5-(2-((4*R*,5*S*)-5-(2-(((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)hexadecan-5-yl acetate (23): Following the same synthetic procedure of compounds **3(a-d)**, compounds **37(a-d)** (50 mg, 0.09 mmol) and alkyne **5** (28 mg, 0.11 mmol) was coupled together using $Pd(Ph_3P)_2Cl_2$ (7 mg, 0.01 mmol) and CuI (4 mg, 0.02 mmol) in Et_3N (1 mL) to get compounds **41(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 10% EtOAc in hexane as eluant) afforded compounds **41(a-d)** (45 mg, 76%) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); ^1H NMR ($CDCl_3$, 300 MHz) δ 5.86-5.57 (m, 4H), 5.19-5.14 (m, 1H), 4.89-4.81 (m, 1H), 4.71 (t, *J* = 5.7 Hz, 1H), 4.55-4.50 (m, 1H), 4.31-4.21 (m, 2H), 4.07-4.02 (m, 1H), 3.75-3.68 (m, 1H), 3.65-3.49 (m, 3H), 3.46-3.39 (m, 1H), 2.34-2.24 (m, 2H), 2.03 (s, 3H), 1.70-1.64 (m, 2H), 1.58-1.46 (m, 15H), 1.42-1.25 (m, 33H), 0.89 (t, *J* = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 171.1, 137.3, 129.8, 129.4, 113.4, 109.6, 109.2, 108.4, 97.2, 78.7, 78.6, 78.5 (78.4), 77.6, 75.2, 74.9 (74.7), 74.5, 72.3, 68.7 (68.6), 67.0 (66.9), 34.3, 33.9, 30.9, 29.8, 29.6, 29.2, 29.0, 28.8, 28.4, 28.2, 27.6, 26.9, 25.8 (25.7), 25.6, 25.4, 22.7, 21.4, 19.7, 14.1 ppm; IR (neat) ν_{max} 2931, 2220, 1735 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{62}O_9Na$ $[M+Na]^+$ 685.4292, found 685.4301.

Following the same synthetic procedure of compound **21**, compounds **41(a-d)** (25 mg, 0.037mmol) was hydrogenated to get compound **23** using 10 mol% Pd/C (4 mg) in EtOAc (1 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded compound **23** (23.4 mg, 96%) as colorless oil. R_f =

0.35 (20% EtOAc in hexane); $[\alpha]^{28}_{D}$ = +0.9 (*c* 0.7, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.89-4.81 (m, 1H), 4.30-4.18 (m, 2H), 4.13-4.02 (m, 4H), 3.75-3.69 (m, 1H), 3.65-3.51 (m, 3H), 3.47-3.41 (m, 1H), 2.03 (s, 3H), 1.78-1.63 (m, 6H), 1.54-1.47 (m, 6H), 1.42 (s, 8H), 1.37-1.25 (m, 32H), 0.88 (t, *J* = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 109.6, 107.8, 107.6, 78.2, 77.6, 74.9, 74.8, 74.6, 72.3, 68.9, 66.9, 34.3, 33.9, 30.2, 29.8, 29.8, 29.7, 29.5, 28.7, 28.7, 27.6, 26.6, 26.2, 26.1, 25.6, 25.5, 22.8, 21.4, 14.1 ppm; IR (neat) ν_{max} 2928, 1730 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{70}O_9Na$ $[M+Na]^+$ 693.4918, found 693.4935.

(*R*)-16-((4*R*,5*S*)-5-(2-((4*R*,5*S*)-5-(2-(((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)hexadecan-5-yl acetate (24): Following the same synthetic procedure of compounds **3(a-d)**, compounds **39(a-d)** (50 mg, 0.09 mmol) and alkyne **5** (28 mg, 0.11 mmol) were coupled using $Pd(Ph_3P)_2Cl_2$ (7 mg, 0.01 mmol) and CuI (4 mg, 0.02 mmol) in Et_3N (1 mL) to get compounds **42(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 10% EtOAc in hexane as eluant) afforded compounds **42(a-d)** (44 mg, 75%) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.78-5.72 (m, 1H), 5.64-5.53 (m, 3H), 5.18-5.13 (m, 1H), 5.04-4.99 (m, 1H), 4.90-4.83 (m, 2H), 4.27-4.14 (m, 2H), 4.07-4.02 (m, 1H), 3.75-3.69 (m, 1H), 3.61-3.49 (m, 3H), 3.45-3.38 (m, 1H), 2.82 (dt, *J* = 1.8 Hz, 2H), 2.03 (s, 3H), 1.67-1.61 (m, 2H), 1.51-1.45 (m, 12H), 1.42-1.39 (m, 7H), 1.35-1.34 (m, 7H), 1.28-1.25 (m, 12H), .088 (t, *J* = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 171.1, 136.7, 130.0, 139.1, 113.8, 109.5, 109.3, 108.6, 97.2, 76.4, 75.7, 74.8 (74.7), 74.5, 73.7, 72.2 (72.1), 68.9, 67.0, 34.3, 33.9, 31.2, 29.6, 29.2, 29.1, 28.8, 28.5, 28.3,

27.6, 26.9, 25.9, 25.6, 25.5, 22.7, 21.4, 19.7, 14.1 ppm; IR (neat) ν_{max} 2931, 2219, 1733 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{62}O_9Na$ $[M+Na]^+$ 685.4292, found 685.4289.

Following the same synthetic procedure of compound **21**, compounds **42(a-d)** (25 mg, 0.037 mmol) was hydrogenated to get compound **24** using 10 mol% Pd/C (4 mg) in EtOAc (1 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded compound **24** (23.8 mg, 97%) as colorless oil. R_f = 0.35 (20% EtOAc in hexane); $[\alpha]^{26}_D$ = -3.9 (*c* 1.0, $CHCl_3$); ^1H NMR ($CDCl_3$, 300 MHz) δ 7.89-4.83 (m, 1H), 4.28-4.15 (m, 2H), 4.07-4.03 (m, 4H), 3.76-3.69 (m, 1H), 3.65-3.51 (m, 3H), 3.48-3.41 (m, 1H), 2.03 (s, 3H), 1.78-1.70 (m, 6H), 1.66-1.59 (m, 6H), 1.52-1.49 (m, 9H), 1.36-1.35 (m, 10H), 1.33-1.28 (m, 21H), 0.89 (t, *J* = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 109.5, 107.8, 107.5, 78.5, 78.4, 78.2, 74.9, 74.6, 72.1, 68.8, 67.0, 34.3, 33.9, 30.3, 29.8, 29.8, 29.7, 29.7, 28.8, 28.7, 27.6, 27.3, 26.9, 26.5, 26.1, 25.6, 25.5, 22.8, 22.4, 14.1 ppm; IR (neat) ν_{max} 2925, 1727 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{70}O_9Na$ $[M+Na]^+$ 693.4918, found 693.4923.

5-((((4*R*,5*R*)-5-(2-(((*S*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methyl)sulfonyl)-2-phenyl-2H-tetrazole (47): Following the same procedure described above for AD-mix-*β* reaction, compound **14** (3.0 g, 7.6 mmol) was transformed to **15a** as minor and **15b** as major isomers using AD-mix-*α* (10.7 g, 1.4 g for 1 mmol of olefin) and $MeSO_2NH_2$ (1.45 mg, 15.2 mmol) in ^tBuOH:H_2O (1:1, 60 mL) with diastereoselectivity (**15a**:**15b**~1: 3.3) and overall yield (90%). Purification of crude mixture using flash column chromatography (SiO_2, 230-400 mesh, 50% EtOAc in hexane as eluant) afforded pure compound **15a** (653 mg, 21%) and **15b** (2.15 g, 69%) as colorless oil.

Following the same synthetic procedure of compound **16**, compound **15b** (2.0 g, 4.9 mmol) was converted to corresponding acetonide using 2,2-DMP (1.2 ml, 9.8 mmol) and CSA (57 mg, 0.25 mmol) in CH_2Cl_2 (20 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded corresponding acetonide (2.2 g, quantitative) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); $[\alpha]^{27}_D$ = +73.0 (*c* 1.35, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.60-7.53 (m, 5H), 4.49-4.43 (m, 1H), 4.39-4.33 (m, 1H), 4.31-4.24 (m, 1H), 3.75-3.63 (m, 4H), 3.57-3.48 (m, 2H), 3.35-3.28 (m, 1H), 1.99-1.85 (m, 2H), 1.44-1.41 (m, 6H), 1.35-1.34 (m, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.3, 133.8, 130.3, 129.9, 123.9, 109.6, 108.8, 75.9, 75.2, 74.8, 72.3, 68.5, 66.9, 35.3, 29.7, 28.5, 26.9, 25.8, 25.5 ppm. IR (neat) ν_{max} 2930, 1213 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{30}N_4O_5SNa$ $[M + Na]^+$ 473.1835, found 473.1837.

Following the same synthetic procedure of compound **8**, the acetonide (2.0 g, 4.5 mmol) from above step was converted to compound **47** using $(NH_4)_6Mo_7O_{24}.4H_2O$ (278 mg, 0.22 mmol), 30% aqueous H_2O_2 (12 mL), in EtOH (20 mL). Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 20% EtOAc in hexane as eluant) afforded compound **47** (1.8 g, 85%) as colorless oil. R_f = 0.3 (30% EtOAc in hexane); $[\alpha]^{28}_D$ = +23.7 (*c* 0.9, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.60-7.53 (m, 5H), 4.65-4.56 (m, 1H), 4.30 (q, *J* = 6.6 Hz, 1H), 4.23-4.15 (m, 1H), 4.01-3.95 (m, 2H), 3.82-3.79 (m, 2H), 3.68-3.59 (m, 2H), 3.58-3.46 (m, 1H), 3.44-3.39 (m, 2H), 1.83-1.78 (m, 2H), 1.38-1.36 (m, 3H), 1.29-1.27 (m, 3H), 1.23 (s, 3H), 1.18-1.17 (m, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.1, 133.3, 131.4, 129.4, 125.9, 109.5, 109.3, 75.8, 72.5, 72.4, 68.2, 66.7, 58.4, 29.6, 27.6, 26.8, 25.5, 25.3 ppm. IR (neat) ν_{max} 2923, 1216 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{30}N_4O_7SNa$ $[M + Na]^+$ 505.1733, found 505.1730.

5-((((4*S*,5*S*)-5-(2-(((*S*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)methyl)sulfonyl)-2-phenyl-2H-tetrazole (48) : Following the same procedure described above for AD-mix-β reaction, compound **29** (1.0 g, 2.55 mmol) was transformed to **30a** as minor and **30b** as major isomers using AD-mix-α (3.6 g, 1.4 g for 1 mmol of olefin) and $MeSO_2NH_2$ (476 mg, 5.0 mmol) in ^tBuOH:H_2O (1:1, 20 mL) with good diastereoselectivity (**30a**:**30b**~1: 3.3) and overall yield (90%). Purification of crude mixture using flash column chromatography (SiO_2, 230-400 mesh, 50% EtOAc in hexane as eluant) afforded pure compound **30a** (220 mg, 21%) and **30b** (723 mg, 69%) as colorless oil.

Following the same synthetic procedure of compound **16**, compound **30b** (700 mg, 1.7 mmol) was converted to corresponding acetonide using 2,2-DMP (0.42 mL, 3.4 mmol) and CSA (20 mg, 0.085 mmol) in CH_2Cl_2 (7 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded corresponding acetonide (761 mg, quantitative) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); $[\alpha]^{27}_D$ = -44.9 (*c* 0.9, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.59-7.50 (m, 5H), 4.48-4.41 (m, 1H), 4.38-4.22 (m, 2H), 4.06-4.01 (m, 1H), 3.73-3.61 (m, 4H), 3.60-3.43 (m, 2H), 3.29 (dd, *J* = 12.9, 10.2 Hz, 1H), 1.95-1.81 (m, 2H), 1.42-1.39 (m, 6H), 1.33-1.32 (m, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.2, 133.7, 130.2, 129.9, 123.9, 109.5, 108.7, 75.9, 75.1, 74.7, 68.5, 66.8, 35.2, 29.7, 28.4, 26.9, 25.7, 25.5 ppm. IR (neat) ν_{max} 2933, 1217 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{30}N_4O_5SNa$ $[M + Na]^+$ 473.1835, found 473.1833.

Following the same synthetic procedure of compound **8**, the acetonide (600 mg, 1.3 mmol) from above step was converted to compound **48** using $(NH_4)_6Mo_7O_{24}.4H_2O$ (83 mg, 0.06 mmol), 30% aqueous H_2O_2 (3 mL), in EtOH (5 mL). Purification of crude mixture using flash

column chromatography (SiO_2, 100-200 mesh, 20% EtOAc in hexane as eluant) afforded compound **48** (530 mg, 85%) as colorless oil. R_f = 0.3 (30% EtOAc in hexane); $[\alpha]^{28}_D$ = -23.2 (*c* 1.7, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.62-7.55 (m, 5H), 4.68-4.59 (m, 1H), 4.32 (q, *J* = 6.6 Hz, 1H), 4.25-4.18 (m, 1H), 4.03-3.97 (m, 1H), 3.85-3.82 (m, 2H), 3.69-3.32 (m, 2H), 3.60-3.49 (m, 1H), 3.47-3.38 (m, 2H), 1.86-1.79 (m, 2H), 1.39 (s, 3H), 1.31-1.29 (m, 3H), 1.25 (s, 3H), 1.21-1.19 (m, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.2, 133.4, 131.4, 129.4, 125.9, 109.6, 109.4, 75.8, 74.6, 72.7, 72.6, 68.2, 66.8, 58.5, 29.7, 27.6, 26.9, 25.6, 25.3 ppm. IR (neat) ν_{max} 2930, 1217 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{30}N_4O_7SNa$ $[M + Na]^+$ 505.1733, found 505.1739.

(5*S*)-17-((4*S*,5*R*)-5-(2-((4*S*,5*R*)-5-(2-(((*S*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)-4-methylheptadecan-5-yl acetate (43): Following the same synthetic procedure of compounds **6(a-b)**, aldehyde **7** (370 mg, 0.92 mmol) and sulfone **47** (375 mg, 0.77 mmol) reacted together in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (4 mL) to get the corresponding Julia-Kocienski products. Purification of crude mixture using flash column chromatography (SiO_2, 230-400 mesh, 10% EtOAc in hexane as eluant) afforded corresponding compounds (342 mg, 67%) as colorless oil. R_f = 0.5 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.69-7.66 (m, 4H), 7.42-7.37 (m, 6H), 5.77 (dd, *J* = 11.4, 8.4 Hz, 1H), 5.61-5.55 (m, 1H), 5.00 (t, *J* = 7.5 Hz, 1H), 4.92 (t, *J* = 7.2 Hz, 1H), 4.25-4.18 (m, 3H), 4.04-3.99 (m, 1H), 3.73-3.66 (m, 2H), 3.60-3.46 (m, 4H), 3.42-3.35 (m, 1H), 1.62-1.56 (m, 2H), 1.47-1.45 (m, 6H), 1.41 (s, 3H), 1.36-1.34 (m, 9H), 1.05 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 135.8 (135.7), 133.4 (133.4), 129.8, 129.0, 127.8, 109.5, 108.9, 108.5, 79.1, 75.3 (75.2), 74.8

(74.7), 74.1, 73.3, 72.2 (72.1), 68.5, 66.9, 31.0, 28.5, 27.8, 26.9 (26.9), 25.8, 25.5 (25.5), 19.3 ppm; IR (neat) ν_{max} 2932, 1219 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{37}H_{54}O_8SiNa$ $[M + Na]^+$ 677.3486, found 677.3487.

Following the same synthetic procedure of compounds **17(a-b)**, compounds (225 mg, 0.34 mmol) from above step were converted to their corresponding alcohols using TBAF (1 M in THF, 0.5 mL. 0.5 mmol) in THF (2 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 30% EtOAc in hexane as eluant) afforded the corresponding alcohols (142 mg, 98%) as colorless oil. R_f = 0.4 (40% EtOAc in hexane); ^1H NMR ($CDCl_3$, 300 MHz) δ 5.71-5.59 (m, 1H), 5.05-4.99 (m, 1H), 4.92 (t, *J* = 6.6, Hz, 1H), 4.26-4.17 (m, 3H), 4.06-4.00 (m, 1H), 3.74-3.67 (m, 1H), 3.59-3.51 (m, 4H), 3.49-3.41 (m, 2H), 1.69-1.65 (m, 2H), 1.49 (s, 3H), 1.46 (s, 3H), 1.41 (s, 3H), 1.37 (s, 3H), 1.34 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 129.7, 128.9, 109.6, 109.1, 108.7, 78.8, 75.5, 74.9 (74.7), 74.2, 73.4, 71.9, 68.4, 66.7, 61.9, 31.2, 29.8, 28.4, 28.0, 26.9 (26.8), 25.8, 25.4, (25.4) ppm; IR (neat) ν_{max} 3467, 2987, 1210 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{36}O_8Na$ $[M + Na]^+$ 439.2308, found 439.2307.

Following the same synthetic procedure of compounds **4(a-d)**, the corresponding alcohols from the above step (110 mg, 0.26 mmol) were transformed to their corresponding aldehydes using IBX (110 mg, 0.4 mmol) in EtOAc (3 mL) which further was reacted with $Ph_3PCH_2I_2$ (420 mg, 0.8 mmol) in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (5 mL) to get compounds **49(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compounds **49(a-d)** (99 mg, 73%) as colorless oil. R_f = 0.5 (10% EtOAc in hexane); ^1H NMR ($CDCl_3$, 300 MHz) δ 6.51-6.47 (m, 1H), 6.30-6.24 (m, 1H), 5.64-5.33 (m, 2H), 5.09-5.05 (m, 1H), 4.94-4.83 (m,

2H), 4.28-4.19 (m, 2H), 4.05 (dd, *J* = 8.2, 6.6 Hz, 1H), 3.76-3.71 (m, 1H), 3.61-3.50 (m, 3H), 3.46-3.41 (m, 1H), 1.68-1.61 (m, 2H), 1.51 (s, 3H), 1.46 (s, 3H), 1.42-1.41 (m, 6H), 1.36 (m, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 136.4, 128.9, 128.1, 108.8, 108.6 (108.5), 107.8, 84.7, 80.7, 74.7, 73.8, 72.9, 72.8, 71.1, 67.8, 66.0, 30.3, 28.8, 27.5, 27.2, 25.9, 24.8, 24.7 (24.5) ppm; IR (neat) ν_{max} 2932, 1215 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{22}H_{35}IO_7Na$ $[M + Na]^+$ 561.1325, found 561.1331.

Following the same synthetic procedure of compounds **3(a-d)**, the compounds **49(a-d)** (25 mg, 0.045 mmol) and alkyne **5** (14 mg, 0.55 mmol) were coupled using $Pd(Ph_3P)_2Cl_2$ (4 mg, 0.05 mmol) and CuI (2 mg, 0.01 mmol) in Et_3N (1 mL) to get corresponding Sonograsia coupled products. Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 10% EtOAc in hexane as eluant) afforded the corresponding compounds (23 mg, 78%) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.78-5.72 (m, 1H), 5.64-5.56 (m, 3H), 5.15 (dd, *J* = 8.7, 6.6 Hz, 1H), 5.04-5.00 (m, 1H), 4.91-4.83 (m, 2H), 4.27-4.14 (m, 2H), 4.05 (dd, *J* = 7.6, 6.6 Hz, 1H), 3.75-3.70 (m, 1H), 3.60-3.49 (m, 1H), 3.45-3.39 (m, 1H), 2.32 (td, *J* = 7.0, 1.8 Hz, 2H), 2.03 (s, 3H), 1.68-1.61 (m, 2H), 1.55-1.49 (m, 8H), 1.46 (s, 3H), 1.41-1.39 (m, 8H), 1.35-1.34 (m, 7H), 1.29-1.25 (m, 12H), 0.88 (t, *J* = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 171.1, 136.7, 130.1, 129.2, 113.8 (113.8), 109.5 (103.4), 108.6, 97.2, 75.8, 74.8 (74.8), 74.5, 73.8, 72.1, 68.9, 67.0, 34.3, 33.9, 31.2, 29.6, 29.2, 29.1, 28.9, 28.5, 28.3, 27.6, 26.9, 25.9, 25.7, 25.5 (25.5), 22.7, 21.4, 19.7, 14.1 ppm; IR (neat) ν_{max} 2932, 2219, 1729 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{62}O_9Na$ $[M+Na]^+$ 685.4292, found 685.4307.

Following the same synthetic procedure of compound **21**, the compounds (25 mg, 0.034 mmol) from above step was hydrogenated to get compound **43** using 10 mol% Pd/C (4 mg) in

EtOAc (1 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded compound **43** (24 mg, 98%) as colorless oil. R_f = 0.35 (20% EtOAc in hexane); $[\alpha]^{27}_D$ = +15.9 (*c* 1.3, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.89-4.81 (m, 1H), 4.28-4.18 (m, 2H), 4.07-4.03 (m, 4H), 3.75-3.69 (m, 1H), 3.65-3.51 (m, 3H), 3.48-3.43 (m, 1H), 2.03 (s, 3H), 1.82-1.59 (m, 5H), 1.52-1.48 (m, 6H), 1.45-1.42 (m, 9H), 1.36-1.33 (m, 10H), 1.29-1.25 (m, 22H), 0.88 (t, *J* = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 109.5, 107.8, 107.6, 78.5, 78.3, 78.2, 74.8, 74.6, 74.5, 72.1, 68.8, 67.0, 34.3, 33.9, 29.8, 29.7, 29.7, 29.5, 28.7, 27.6, 26.9, 26.5, 26.1, 25.5, 22.8, 21.4, 14.1 ppm; IR (neat) ν_{max} 2926, 1728 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{70}O_9Na$ $[M+Na]^+$ 693.4918, found 693.4917.

(*R*)-16-((4*R*,5*S*)-5-(2-((4*S*,5*R*)-5-(2-(((*S*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)hexadecan-5-yl acetate (44): Following the same synthetic procedure of compounds **6(a-b)**, aldehyde **33** (370 mg, 0.92 mmol) and sulfone **47** (375 mg, 0.77 mmol) reacted together in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (7 mL) to get the mixture of corresponding Julia-Kocienski coupled products. Purification of crude mixture using flash column chromatography (SiO_2, 230-400 mesh, 10% EtOAc in hexane as eluant) afforded corresponding Julia-Kocienski compounds (348 mg, 69%) as colorless oil. R_f = 0.5 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.69-7.66 (m, 4H), 7.42-7.37 (m, 6H), 5.80-5.74 (m, 1H), 5.59 (t, *J* = 8.7 Hz, 1H), 5.03-4.89 (m, 2H), 4.27-4.18 (m, 3H), 4.04-3.99 (m, 1H), 3.73-3.66 (m, 2H), 3.60-3.46 (m, 4H), 3.42-3.37 (m, 1H), 1.64-1.55 (m, 2H), 1.47-1.45 (m, 3H), 1.36-1.34 (m, 6H), 1.26 (s, 6H), 1.05 (m, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 135.8 (135.7), 133.5 (133.4), 129.8, 129.6 (129.5), 129.0, 127.8, 109.5, 108.9, 108.6, 97.2, 75.4 (75.3),

74.8 (74.7), 74.2, 73.3, 72.1, 68.6, 67.0, 63.4, 31.0, 28.5, 27.8, 26.9 (26.9), 25.8, 25.5 (25.5), 19.3 ppm; IR (neat) ν_{max} 2929, 1216 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{37}H_{54}O_8SiNa$ $[M + Na]^+$ 677.3486, found 677.3489.

Following the same synthetic procedure of compounds **17(a-b)**, the mixture of compounds (225 mg, 0.34 mmol) from above step were converted to their corresponding alcohols using TBAF (1 M in THF, 0.5 mL. 0.5 mmol) in THF (2 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 30% EtOAc in hexane as eluant) afforded the corresponding alcohols (140 mg, 97%) as colorless oil. R_f = 0.4 (40% EtOAc in hexane); ^1H NMR ($CDCl_3$, 300 MHz) δ 5.72-5.60 (m, 1H), 5.06-5.00 (m, 1H), 4.93 (t, *J* = 6.9 Hz, 1H), 4.30-4.18 (m, 3H), 4.07-4.01 (m, 1H), 3.75-3.69 (m, 1H), 3.60-3.54 (m, 4H), 3.50-3.42 (m, 2H), 1.70-1.64 (m, 2H), 1.50 (s, 3H), 1.47 (s, 3H), 1.42 (s, 3H), 1.38 (s, 3H), 1.35 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 129.8 (129.7), 128.9 (128.9) 109.6, 109.1, 108.7, 78.8, 75.6 (75.5), 74.3 (74.3), 73.5, 72.0, 68.4, 66.8, 61.9, 31.3, 29.8, 28.4, 28.1, 26.9 (26.9), 25.8, 25.5 (25.4) ppm; IR (neat) ν_{max} 3469, 2977, 1210 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{36}O_8Na$ $[M + Na]^+$ 439.2308, found 439.2310.

Following the same procedure of synthesis of compounds **4(a-d)**, the corresponding alcohols from the above step (100 mg, 0.23 mmol) were transformed to the corresponding aldehydes using IBX (110 mg, 0.4 mmol) in EtOAc (2 mL) which further was reacted with $Ph_3PCH_2I_2$ (420 mg, 0.8 mmol) in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (5 mL) to get mixture of compounds **50(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compounds **50(a-d)** (95 mg, 69%) as colorless oil. R_f = 0.5 (10% EtOAc in hexane); ^1H NMR ($CDCl_3$, 300 MHz) δ 6.51-6.47 (m, 1H), 6.29-6.24 (m, 1H), 5.64-5.53 (m, 2H), 5.09-5.05 (m,

1H), 4.94-4.83 (m, 2H), 4.30-4.19 (m, 2H), 4.07-4.02 (m, 1H), 3.75-3.68 (m, 1H), 3.63-3.53 (m, 3H), 3.52-3.39 (m, 1H), 1.64 (q, J = 6.9 Hz, 2H), 1.51 (s, 3H), 1.46 (s, 3H), 1.42-1.41 (m, 6H), 1.36 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 137.4, 129.3, 129.1, 109.9, 109.8, 108.8, 85.7, 81.4, 75.7 (75.6), 74.9 (74.8), 73.9 (73.8), 72.4, 72.2, 68.8, 67.0, 31.3, 29.8, 28.5, 28.2, 26.9, 25.9 (25.8), 25.7 (25.5) ppm; IR (neat) v_{max} 2928, 1216 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{22}H_{35}IO_7Na$ $[M + Na]^+$ 561.1325, found 561.1317.

Following the same synthetic procedure of compounds **3(a-d)**, the compounds **50(a-d)** (50 mg, 0.09 mmol) and alkyne **5** (28 mg, 0.11 mmol) were coupled using $Pd(Ph_3P)_2Cl_2$ (7 mg, 0.01 mmol) and CuI (4 mg, 0.02 mmol) in Et_3N (1 mL) to get mixture of corresponding Sonograsia products. Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 10% EtOAc in hexane as eluant) afforded the corresponding compounds (44.4 mg, 75%) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.78-5.59 (m, 4H), 5.17 (t, J = 7.2 Hz, 1H), 4.85 (t, J = 6.0 Hz, 1H), 4.71 (t, J = 6.0 Hz, 1H), 4.53 (t, J = 6.3 Hz, 1H), 4.29-4.24 (m, 2H), 4.07-4.02 (m, 1H), 3.75-3.70 (m, 1H), 3.58-3.49 (m, 3H), 3.46-3.41 (m, 1H), 2.34-2.29 (m, 2H), 2.04 (s, 3H), 1.68 (q, J = 6.3 Hz, 2H), 1.51-1.46 (m, 10H), 1.42-1.40 (m, 6H), 1.36-1.35 (m, 6H), 1.29-1.25 (m, 14H), 0.89 (t, J = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 171.1, 137.4 (137.3), 113.5, 109.6 (109.5), 109.2, 108.4, 78.7, 78.5, 75.3, 74.8, 74.5, 72.1, 68.8, 66.9, 34.3, 33.9, 30.9, 29.8, 29.6, 29.2, 29.0, 28.8, 28.4, 28.2, 27.6, 25.8, 25.7, 25.6 (25.5), 22.7, 21.4, 14.4 ppm; IR (neat) v_{max} 2924, 2216, 1734 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{62}O_9Na$ $[M+Na]^+$ 685.4292, found 685.4297.

Following the same synthetic procedure of compound **21**, the compounds (25 mg, 0.037 mmol) from above step was hydrogenated to get compound **44** using 10 mol% Pd/C (4 mg) in EtOAc (1 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded compound **44** (23.8 mg, 97%) as colorless oil. R_f = 0.35 (20% EtOAc in hexane); $[\alpha]^{26}_D$ = -0.6 (*c* 1.5, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.90-4.82 (m, 1H), 4.30-4.16 (m, 2H), 4.11-4.03 (m, 4H), 3.75-3.65 (m, 1H), 3.63-3.59 (m, 2H), 3.57-3.51 (m, 1H), 3.48-3.41 (m, 1H), 2.04 (s, 3H), 1.79-1.68 (m, 4H), 1.54-1.48 (m, 6H), 1.42 (s, 8H), 1.37-1.36 (m, 4H), 1.33-1.25 (m, 30H), 0.89 (t, *J* = 6.0 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 109.5, 107.8, 107.6, 78.2, 75.0, 74.8, 74.6, 72.1, 68.9, 66.9, 34.3, 33.9, 32.1, 30.2, 29.9, 29.8, 29.7, 29.5, 28.7, 27.6, 26.9, 26.6, 26.5, 26.1, 25.6, 25.5, 22.8, 21.4, 14.1 ppm; IR (neat) ν_{max} 2933, 1736 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{70}O_9Na$ $[M+Na]^+$ 693.4918, found 693.4922.

(*R*)-16-((4*S*,5*R*)-5-(2-((4*R*,5*S*)-5-(2-(((*S*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)hexadecan-5-yl acetate (45): Following the same synthetic procedure of compounds **6(a-b)**, aldehyde **7** (370 mg, 0.92 mmol) and sulfone **48** (375 mg, 0.77 mmol) reacted together in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (4 mL) to get the mixture of corresponding Julia-Kocienski products. Purification of crude mixture using flash column chromatography (SiO_2, 230-400 mesh, 10% EtOAc in hexane as eluant) afforded the corresponding compounds (349 mg, 69%) as colorless oil. R_f = 0.5 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.69-7.66 (m, 4H), 7.41-7.37 (m, 6H), 5.79-5.72 (m, 1H), 5.60-5.54 (m, 1H), 5.02-4.96 (m, 1H), 4.91 (t, *J* = 7.2 Hz, 1H), 4.29-4.15 (m, 3H), 4.03-4.98 (m, 1H), 3.72-3.65 (m, 2H), 3.62-3.45 (m, 4H), 3.41-3.34 (m,

1H), 1.59-1.53 (m, 2H), 1.46-1.44 (m, 3H), 1.40 (s, 3H), 1.35-1.34 (m, 6H), 1.04 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 135.7 (135.7), 133.4 (133.4), 129.8, 129.5 (129.5), 128.9, 127.8, 109.5, 108.9, 108.5, 79.1, 75.3 (75.2), 74.9 (74.7), 74.1, 73.3, 72.2 (72.1), 68.5 (68.5), 66.9, 63.4, 31.0, 28.5, 27.8, 26.9 (26.9), 25.8, 25.5, 19.3 ppm; IR (neat) ν_{max} 2930, 1215 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{37}H_{54}O_8SiNa$ $[M + Na]^+$ 677.3486, found 677.3483.

Following the same synthetic procedure of compounds **17(a-b)**, the compounds (225 mg, 0.34 mmol) from above step were converted to the corresponding alcohols using TBAF (1 M in THF, 0.5 mL. 0.5 mmol) in THF (2 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 30% EtOAc in hexane as eluant) afforded the corresponding alcohols (140 mg, 97%) as colorless oil. R_f = 0.4 (40% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.71-5.59 (m, 2H), 5.02 (t, *J* = 6.6 Hz, 1H), 4.92 (t, *J* = 6.6 Hz, 1H), 4.25-4.17 (m, 3H), 4.05-4.00 (m, 1H), 3.75-3.68 (m, 1H), 3.64-3.55 (m, 4H), 3.49-3.41 (m, 2H), 1.69-1.65 (m, 2H), 1.49-1.46 (m, 6H), 1.41-1.34 (m, 12H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 129.7, 128.9, 109.7 (109.6), 109.1, 108.8 (108.7), 78.9, 75.6 (75.5), 74.7, 74.2 (74.2), 73.4, 71.9, 68.4, 66.7, 61.9, 32.2, 29.8, 28.9, 28.0, 26.8, 25.8, 25.4 ppm; IR (neat) ν_{max} 3472, 2987, 1217 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{36}O_8Na$ $[M + Na]^+$ 439.2308, found 439.2305.

Following the same synthetic procedure of compounds **4(a-d)**, the alcohols from the above step (110 mg, 0.23 mmol) were transformed to the corresponding aldehydes using IBX (110 mg, 0.4 mmol) in EtOAc (3 mL) which further were reacted with $Ph_3PCH_2I_2$ (420 mg, 0.8 mmol) in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (5 mL) to get mixture of compounds **51(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2,

60-120 mesh, 5% EtOAc in hexane as eluant) afforded compounds **51(a-d)** (103 mg, 75%) as colorless oil. R_f = 0.5 (10% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 6.41-6.37 (m,1H), 6.20-6.14 (m, 1H), 5.54-5.43 (m, 2H), 5.01-4.95 (m, 1H), 4.84-4.73 (m, 2H), 4.20-4.09 (m, 2H), 3.98-3.93 (m, 1H), 3.66-3.58 (m, 1H), 3.51-3.40 (m, 3H), 3.36-3.29 (m, 1H), 1.55 (q, *J* = 6.6 Hz, 2H), 1.41 (s, 3H), 1.36 (s, 3H), 1.32-1.31 (m, 6H), 1.26 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 137.4, 129.9, 129.1, 109.8, 109.5, 108.8, 85.7, 81.4, 75.7 (75.6), 74.9 (74.8), 73.9 (73.8), 72.1, 68.8 (68.7), 67.0, 31.3, 29.8, 28.5, 28.2, 26.9, 25.9, 25.7 (25.5) ppm; IR (neat) ν_{max} 2925, 1216 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{22}H_{35}IO_7Na$ $[M + Na]^+$ 561.1325, found 561.1323.

Following the same synthetic procedure of compounds **3(a-d)**, compounds **51(a-d)** (50 mg, 0.09 mmol) and alkyne **5** (28 mg, 0.11 mmol) were coupled using $Pd(Ph_3P)_2Cl_2$ (7 mg, 0.01 mmol) and CuI (4 mg, 0.02 mmol) in Et_3N (1 mL) to get mixture of corresponding Sonograsia products. Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 10% EtOAc in hexane as eluant) afforded the corresponding compounds (47 mg, 79%) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.80-5.72 (m, 1H), 5.18-5.13 (m, 1H), 5.05-5.00 (m, 1H), 4.95-4.81 (m, 2H), 4.29-4.14 (m, 2H), 4.07-4.02 (m, 1H), 3.75-3.69 (m, 1H), 3.64-3.44 (m, 3H), 3.45-3.38 (m, 1H), 2.34-2.29 (m, 2H), 2.03 (s, 3H), 1.68-1.61 (m, 2H), 1.55-1.46 (m, 10H), 1.41-1.40 (m, 6H), 1.36-1.34 (m, 6H), 1.29-1.25 (m, 14H), 0.89 (t, *J* = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 171.1, 136.7, 130.1, 129.2, 113.8, 109.5, 109.4, 108.6, 97.2, 75.8, 74.8, 73.8, 72.1, 68.9, 67.1, 34.3, 33.9, 31.2, 29.8, 29.6, 29.2, 29.1, 28.9, 28.5, 28.3, 27.6, 26.9, 25.7, 25.5 (25.5), 22.7, 21.4, 19.7, 14.1 ppm; IR (neat) ν_{max} 2929, 2215, 1732 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{62}O_9Na$ $[M+Na]^+$ 685.4292, found 685.4288.

Following the same synthetic procedure of compound **21**, compounds (25 mg, 0.037 mmol) from above step were hydrogenated to get compound **45** using 10 mol% Pd/C (5 mg) in EtOAc (1 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded compound **45** (23 mg, 94%) as colorless oil. R_f = 0.35 (20% EtOAc in hexane); $[\alpha]^{30}_D$ = +1.5 (*c* 0.9, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.89-4.81 (m, 1H), 4.29-4.15 (m, 2H), 4.07-4.03 (m, 4H), 3.76-3.69 (m, 1H), 3.63-3.48 (m, 3H), 3.48-3.41 (m, 1H), 2.03 (s, 3H), 1.78-1.63 (m, 5H), 1.52-1.42 (m, 15H), 1.36-1.25 (m, 32H), 0.88 (t, *J* = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 109.5, 107.8, 107.5, 78.5, 78.4, 78.2, 75.0, 74.8, 74.6, 72.1, 68.9, 67.0, 34.3, 33.9, 30.3, 29.8, 29.8, 28.7, 27.6, 27.3, 27.2, 26.9, 26.1, 25.6, 25.5, 22.8, 21.4, 14.1 ppm; IR (neat) ν_{max} 2930, 1731 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{70}O_9Na$ $[M+Na]^+$ 693.4918, found 693.4917.

(*R*)-16-((4*R*,5*S*)-5-(2-((4*R*,5*S*)-5-(2-(((*S*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)hexadecan-5-yl acetate (46): Following the same synthetic procedure of compounds **6(a-b)**, aldehyde **33** (370 mg, 0.92 mmol) and sulfone **48** (375 mg, 0.77 mmol) reacted together in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (7 mL) to get the mixture of corresponding Julia-Kocienski products. Purification of crude mixture using flash column chromatography (SiO_2, 230-400 mesh, 10% EtOAc in hexane as eluant) afforded corresponding compounds (346 mg, 68%) as colorless oil. R_f = 0.5 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 400 MHz) δ 7.68-7.66 (m, 4H), 7.44-7.35 (m, 6H), 5.78-5.73 (m, 1H) 5.59-5.54 (m, 1H), 4.99 (t, *J* = 5.7 Hz, 1H), 4.91(t, *J* = 6.3 Hz, 1H), 4.25-4.17 (m, 3H), 4.03-3.99 (m, 1H), 3.71-3.66 (m, 2H), 3.59-3.46 (m, 4H), 3.40-3.35 (m, 1H), 1.64-1.57 (m, 2H), 1.46-1.45 (m, 6H), 1.41-1.40 (m, 6H), 1.36-1.34 (m, 6H), 1.05 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 135.8

(135.8), 133.5, 129.8, 129.6, 129.0, 127.8, 109.6, 108.9, 108.6, 79.2, 75.3, 74.9, 74.2, 73.4, 72.2, 68.6, 67.0, 63.5, 31.1, 28.5, 27.9, 27.0, 25.9, 25.5, 19.4 ppm; IR (neat) ν_{max} 2937, 1218 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{37}H_{54}O_8SiNa$ $[M + Na]^+$ 677.3486, found 677.3484.

Following the same synthetic procedure of compounds **17(a-b)**, compounds (225 mg, 0.34 mmol) from above step were converted to the corresponding alcohols using TBAF (1 M in THF, 0.5 mL. 0.5 mmol) in THF (2 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 30% EtOAc in hexane as eluant) afforded the corresponding alcohols (137 mg, 96%) as colorless oil. R_f = 0.4 (40% EtOAc in hexane); ^1H NMR ($CDCl_3$, 300 MHz) δ 5.70-5.59 (m, 2H), 5.03-4.98 (m, 1H), 4.91(t, *J* = 6.9 Hz, 1H), 4.29-4.17 (m, 3H), 4.06-4.01 (m, 1H), 3.74-3.65 (m, 1H), 3.59-3.51 (m, 4H), 3.49-3.39 (m, 2H), 2.33 (s, 1H), 1.68-1.62 (m, 2H), 1.49 (s, 3H), 1.45 (s, 3H), 1.41 (s, 3H), 1.37 (s, 3H), 1.34 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 129.8 (129.7), 128.9 (128.9), 109.7, 109.1, 108.7, 78.8 (78.8), 75.5 (75.5), 74.9 (74.7), 74.2 (74.2), 73.4, 72.4, 68.4, 66.7, 61.9, 31.3, 29.8, 28.4, 28.0, 26.9 (26.8), 25.7, 25.4 (25.4) ppm; IR (neat) ν_{max} 3470, 2987, 1213 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{21}H_{36}O_8Na$ $[M + Na]^+$ 439.2308, found 439.2315.

Following the same synthetic procedure of compounds **4(a-d)**, the alcohols from the above step (110 mg, 0.26 mmol) were transformed to the corresponding aldehydes using IBX (110 mg, 0.4 mmol) in EtOAc (3 mL) which further was reacted with $Ph_3PCH_2I_2$ (420 mg, 0.8 mmol) in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (5 mL) to get compounds **52(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compounds **52(a-d)** (103 mg, 75%) as colorless oil. R_f = 0.5 (10% EtOAc in hexane); ^1H NMR ($CDCl_3$, 300 MHz) δ 6.51-6.47 (m, 1H),

6.29-6.24 (m, 1H), 5.63-5.53 (m, 2H), 5.09-5.05 (m, 1H), 4.93-4.83 (m, 2H), 4.29-4.21 (m, 2H), 4.05 (dd, *J* = 8.1, 6.3 Hz, 1H), 3.75-3.68 (m, 1H), 3.62-3.49 (m, 3H), 3.46-3.39 (m, 1H), 1.67-1.61 (m, 2H), 1.51 (s, 3H), 1.46 (s, 3H), 1.41-1.40 (m, 6H), 1.35 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 137.4 (137.3), 129.9, 129.1 (129.1), 109.8, 109.6 (109.5), 108.4, 85.9 (85.7), 81.4, 75.7 (75.6), 74.9 (74.7), 73.9 (73.7), 72.3, 72.1, 68.8 (68.7), 67.0, 31.3, 28.5, 28.2, 26.9, 25.9, 25.7, 25.6 ppm; IR (neat) ν_{max} 2928, 1214 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{22}H_{35}IO_7Na$ $[M + Na]^+$ 561.1325, found 561.1320.

Following the same synthetic procedure of compounds **3(a-d)**, compounds **52(a-d)** (50 mg, 0.09 mmol) and alkyne **5** (28 mg, 0.11 mmol) were coupled using $Pd(Ph_3P)_2Cl_2$ (7 mg, 0.01 mmol) and CuI (4 mg, 0.02 mmol) in Et_3N (1 mL) to get mixture of corresponding Sonograsia products. Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 10% EtOAc in hexane as eluant) afforded the corresponding compounds (45 mg, 76%) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.78-5.71 (m, 1H), 5.64-5.56 (m, 3H), 5.15 (dd, *J* = 8.7, 6.6 Hz, 1H), 5.02 (t, *J* = 6.6 Hz, 1H), 4.90-4.83 (m, 2H), 4.27-4.07 (m, 2H), 4.04 (dd, *J* = 8.1, 6.3 Hz, 1H), 3.75-3.68 (m, 1H), 3.61-3.49 (m, 3H), 3.45-3.38 (m, 1H), 2.32 (dt, *J* = 6.9, 1.8 Hz, 2H), 2.03 (s, 3H), 1.67-1.60 (m, 2H), 1.51-1.45 (m, 12H), 1.41-1.39 (m, 6H), 1.35-1.34 (m, 6H), 1.28-1.25 (m, 12H), 0.88 (t, *J* = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 171.1, 136.7 (136.7), 130.0, 129.2 (129.1), 113.8 (113.8), 109.5 (109.3), 108.6, 97.3, 76.4, 75.8 (75.7), 74.8 (74.7), 74.5, 73.7, 72.2 (72.1), 68.9, 67.1, 34.2, 33.9, 31.2, 29.6, 29.2, 29.1, 28.8, 28.5, 28.3, 27.6, 26.9, 25.8, 25.7, 25.5, 22.7, 21.4, 19.7, 14.1 ppm; IR (neat) ν_{max} 2933, 2218, 1731 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{62}O_9Na$ $[M+Na]^+$ 685.4292, found 685.4297.

Following the same synthetic procedure of compound **21**, compounds (25 mg, 0.037 mmol) from above step were hydrogenated to get compound **46** using 10 mol% Pd/C (4 mg) in EtOAc (1 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded compound **46** (23.5 mg, 96%) as colorless oil. R_f = 0.35 (20% EtOAc in hexane); $[\alpha]^{26}_D$ = -4.2 (*c* 1.5, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.89-4.81 (m, 1H), 4.28-4.16 (m, 2H), 4.07-4.00 (m, 4H), 3.75-3.68 (m, 1H), 3.66-3.51 (m, 3H), 3.7-3.40 (m, 1H), 2.03 (s, 3H), 1.77-1.63 (m, 4H), 1.51-1.47 (m, 6H), 1.44-1.42 (m, 10H), 1.37-1.32 (m, 11H), 1.28-1.25 (m, 21H), 0.88 (t, *J* = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 109.6, 107.7, 107.5, 78.5, 78.4, 78.2, 74.9, 74.9, 72.6, 68.8, 67.0, 34.3, 33.9, 30.3, 29.8, 29.8, 29.8, 29.7, 29.5, 28.8, 27.3, 26.9, 26.5, 26.1, 26.1, 25.6, 25.5, 22.7, 21.4, 14.1 ppm; IR (neat) ν_{max} 2925, 1728 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{70}O_9Na$ $[M+Na]^+$ 693.4918, found 693.4915.

(4*R*,5*S*)-4-(2-(((*S*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-5-(3-((R)-5-(2-iodovinyl)-2,2-dimethyl-1,3-dioxolan-4-yl)prop-1-en-1-yl)-2,2-dimethyl-1,3-dioxolane [56(a-d)]. Following the same procedure as described before, compound **11**(362 mg, 0.9 mmol) was converted quantitatively to its corresponding aldehyde using IBX (504 mg, 1.8 mmol) in EtOAc (4 mL) which was taken for next reaction without further characterization.

Following the same synthetic procedure of compounds **6(a-b)**, the aldehyde (370 mg, 0.9 mmol) from above step and sulfone **47** (375 mg, 0.77 mmol) reacted together in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (4 mL) to get compounds **55(a-b)**. Purification of crude mixture using flash column chromatography (SiO_2, 230-400 mesh, 10% EtOAc in hexane as eluant) afforded compounds **55(a-b)** (350 mg, 68%) as colorless oil. R_f = 0.5

(20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.68-7.64 (m, 4H), 7.46-7.35 (m, 6H), 5.80-5.72 (m, 1H), 5.57-5.50 (m, 1H), 4.87 (dd, *J* = 9.3, 6.3 Hz, 1H), 4.28-4.14 (m, 1H), 4.05-4.00 (m, 1H), 3.75-3.68 (m, 3H), 3.64-3.49 (m, 3H), 3.44-3.39 (m, 1H), 2.59-2.52 (m, 1H), 2.41-2.31 (m, 1H), 1.76-1.69 (m, 2H), 1.47 (s, 3H), 1.41 (s, 3H), 136-1.34 (m, 9H), 1.30 (s, 3H), 1.05 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 135.7 (135.7), 133.4, 133.3, 130.8, 129.9, 128.1 (127.9), 109.5, 108.3, 108.2, 76.9, 75.3, 74.8, 74.7, 73.9, 72.1, 68.9 (68.8), 67.1, 62.6, 30.9, 29.8, 28.5 (28.4), 28.2 (28.1), 27.0 (26.9), 25.8, 25.5 (25.5), 19.3 ppm; IR (neat) ν_{max} 2980, 1217 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{56}SiO_8Na$ $[M+Na]^+$ 691.3642, found 691.3640.

Following the same synthetic procedure of compounds **17(a-b)**, compounds **55(a-b)** (350 mg, 0.5 mmol) were converted to the corresponding alcohols using TBAF (1 M in THF, 0.6 mL. 0.6 mmol) in THF (2 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 30% EtOAc in hexane as eluant) afforded the corresponding alcohols (209 mg, 97%) as colorless oil. R_f = 0.5 (40% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.82-5.64 (m, 1H), 5.58-5.52 (m, 1H), 4.90-4.85 (m, 1H), 4.29-4.14 (m, 4H), 4.04 (t, *J* = 7.2 Hz, 1H), 3.74-3.68 (m, 1H), 3.66-3.49 (m, 5H), 3.47-3.41 (m, 1H), 2.42-2.38 (m, 2H), 1.76-1.72 (m, 2H), 1.47 (s, 6H), 1.41 (s, 3H), 1.36 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 129.7, 128.2, 109.5, 108.4, 108.3, 77.7, 76.4, 75.3, 74.8, 73.9, 72.1, 68.8, 66.9 (66.9), 61.7, 30.8, 29.8, 28.5, 28.1, 26.9, 25.9, 25.5, 25.4 ppm; IR (neat) ν_{max} 3430, 2996, 1211 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{22}H_{38}O_8Na$ $[M+Na]^+$ 453.2464, found 453.2462.

Following the same synthetic procedure of compounds **4(a-d)**, the alcohols from the above step (100 mg, 0.23 mmol) were transformed to the corresponding aldehydes using IBX

(129 mg, 0.46 mmol) in EtOAc (2 mL) which further was reacted with $Ph_3PCH_2I_2$ (365 mg, 0.69 mmol) in presence of NaHMDS ((1 M in THF, 0.7 mL. 0.7 mmol) in THF (5 mL) to get mixture of compounds **56(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compounds **56(a-d)** (94 mg, 74%) as colorless oil. R_f = 0.5 (10% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 6.53-6.49 (m, 1H), 6.36-6.30 (m, 1H), 4.87-4.81 (m, 2H), 4.31-4.22 (m, 3H), 4.07-4.02 (m, 1H), 3.74-3.68 (m, 1H), 3.60-3.46 (m, 3H), 3.45-3.41 (m, 1H), 2.27-2.21 (m, 2H), 1.75-1.71 (m, 2H), 1.47-1.16 (m, 6H), 1.41 (s, 3H), 1.37-1.36 (m, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 137.9, 129.8, 128.1, 109.5, 109.1, 108.3, 85.2, 80.9, 75.3, 74.9 (74.8), 73.9, 72.4, 72.2, 68.8, 67.0, 30.9, 29.8, 29.1, 28.5, 28.1, 26.9, 25.9, 25.6 ppm. IR (neat) ν_{max} 2933, 1216 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{23}H_{37}IO_7Na$ $[M + Na]^+$ 575.1482, found 575.1478.

(4*R*,5*S*)-4-(2-(((*S*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-5-(4-((4R,5S)-5-(2-iodovinyl)-2,2-dimethyl-1,3-dioxolan-4-yl)but-1-en-1-yl)-2,2-dimethyl-1,3-dioxolane [59(a-d)]: To a stirred solution of aldehyde **7** (500 mg, 1.2 mmol) in anhydrous CH_2Cl_2 (5 mL) at 0 °C under argon, $Ph_3P{=}CHCO_2Et$ (831 mg, 2.4 mmol) was added. The reaction mixture was warmed to room temperature and stirred for 12 h. The mixture was concentrated in *vacuo*. Purification of the resultant crude residue by flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) provided corresponding *α*, *β*-unsaturated ester (550 mg, 98%) as a colorless oil. R_f=0.7 (10% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.66-7.62 (m, 4H), 7.43-7.35 (m, 6H), 7.13 (dd, *J* = 15.6, 5.4 Hz, 1H), 6.16 (dd, *J* = 15.6, 1.8 Hz, 1H), 4.88-4.84 (m, 1H), 4.34 (q, *J* = 6.6 Hz, 1H), 4.19 (q, *J* = 3.9 Hz, 2H), 3.63-3.61 (m, 2H), 1.44 (s, 3H), 1.34 (s, 3H), 1.29-

1.24 (m, 3H), 1.03 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 166.1, 143.1, 135.8 (135.7), 133.2 (133.1), 129.9 (129.9), 127.9 (127.7), 122.7, 109.4, 78.3, 76.8, 62.6, 60.6, 27.7, 26.9 (26.8), 25.4, 19.3, 14.4 ppm; IR (neat) ν_{max} 2923, 2853, 1720 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{27}H_{36}O_5SiNa$ $[M + Na]^+$ 491.2230, found 491.2232.

To a stirred solution of above ester (550 g, 1.2 mmol) in anhydrous THF (2 mL) and EtOH (2 mL) at 0 °C under argon, $LiBH_4$ (104 mg, 4.8 mmol) was added portion wise. The reaction mixture was warmed to room temperature and stirred for 12 h. The mixture was cooled again to 0 °C prior to quench it with saturated aqueous NH_4Cl solution (3 mL). The resulting mixture was extracted with EtOAc (2×30 mL), washed with water, brine, dried over Na_2SO_4 and concentrated in *vacuo*. Purification of the resultant crude residue by flash column chromatography (SiO_2, 60-120 mesh, 11% EtOAc in hexane as eluant) provided alcohol **57** (504 mg, 98%) as a colorless oil. R_f =0.4 (20% EtOAc in hexane); $[\alpha]^{28}_D$ = +5.3 (*c* 0.8, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.68-7.65 (m, 4H), 7.44-7.36 (m, 6H), 4.21-4.16 (m, 2H), 3.73-3.63 (m, 4H), 1.77-1.68 (m, 2H), 1.62-1.58 (m, 2H), 1.38 (s, 3H), 1.35 (s, 3H), 1.05 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 135.8 (135.7), 133.5 (133.4), 129.9, 127.9, 108.1, 78.1, 77.8, 62.9, 62.8, 30.4, 28.2, 26.9, 26.3, 25.7, 19.3 ppm; IR (neat) ν_{max} 3443, 2929, 1115 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{25}H_{36}O_4SiNa$ $[M + Na]^+$ 451.2281, found 451.2280.

Following the same oxidation procedure of compounds **17(a-b)**, alcohol **57** (385 mg, 0.9 mmol) from above step was converted to its corresponding aldehyde using IBX (504 mg, 1.8 mmol) in EtOAc (2mL) which was taken for next reaction without further characterization.

Following the same synthetic procedure of compounds **6(a-b)**, the aldehyde (384 mg, 0.9 mmol) from above step and sulfone **47** (375 mg, 0.77 mmol) reacted together in presence of NaHMDS (1 M in THF, 0.8 mL. 0.8 mmol) in THF (4 mL) to get compounds **58(a-b)**. Purification of crude mixture using flash column chromatography (SiO_2, 230-400 mesh, 10% EtOAc in hexane as eluant) afforded compounds **58(a-b)** (363 mg, 69%) as colorless oil. R_f = 0.5 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.68-7.65 (m, 4H), 7.40-7.36 (m, 6H), 5.64-5.58 (m, 1H), 5.51-5.43 (m, 1H), 4.96-4.89 (m, 1H), 4.28-4.19 (m, 2H), 4.18-4.12 (m, 2H), 4.07-4.02 (m, 1H), 3.75-3.65 (m, 3H), 3.63-3.51 (m, 3H), 3.46-3.40 (m, 1H), 2.42-2.29 (m, 1H), 2.24-2.03 (m, 1H), 1.72-1.63 (m, 4H), 1.42 (m, 3H), 1.36 (s, 9H), 1.32 (s, 3H), 1.26 (s, 3H), 1.05 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 135.7 (135.7), 133.5 (133.3), 129.9, 129.5, 127.8 (127.8), 126.5 (126.3), 109.6 (109.5), 108.2 (108.1), 108.0 (107.9), 77.9 (77.8), 75.2 (75.1), 74.8 (74.7), 73.9, 72.3 (72.1), 68.8, 66.9, 62.8 (62.7), 31.1 (30.9), 29.8, 29.5 (29.2), 28.5 (28.4), 28.3, 26.9 (26.9), 25.9 (25.8), 25.7 (25.5), 19.3 ppm. IR (neat) ν_{max} 2985, 1215 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{39}H_{58}SiO_8Na$ $[M+Na]^+$ 705.3799, found 705.3797.

Following the same synthetic procedure of compounds **17(a-b)**, compounds **58(a-b)** (200 mg, 0.3 mmol) were converted to the corresponding alcohols using TBAF (1 M in THF, 0.3 mL. 0.3 mmol) in THF (2 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 30% EtOAc in hexane as eluant) afforded the corresponding alcohols (130 mg, 98%) as colorless oil. R_f = 0.5 (40% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.57-5.58 (m, 1H), 5.49-5.40 (m, 1H), 4.94-4.87 (m, 1H), 4.29-4.21 (m, 2H), 4.18-4.12 (m, 2H), 4.09-4.01 (m, 1H), 3.72-3.68 (m, 1H), 3.66-3.54 (m, 5H), 3.52-3.39 (m, 1H), 2.34-2.26 (m, 1H), 2.19-2.12 (m, 1H), 1.71-1.63 (m, 4H), 1.45 (s, 6H), 1.40 (s, 3H), 1.34 (s, 9H); ^{13}C NMR ($CDCl_3$, 75

MHz, observed minor diastereomeric peaks are given in parentheses) δ 133.4, 126.9 (126.6), 109.6, 108.3, 108.2, 77.9 (77.9), 76.3, 75.0, 74.8 (74.7), 73.8, 72.3 (72.1), 68.8 (68.7), 66.9, 61.8 (61.7), 31.1 (30.9), 29.8, 29.4, 29.1, 28.6 (28.5), 28.3, 26.9, 25.8, 25.6 (25.5) ppm; IR (neat) ν_{max} 3456, 2990, 1216 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{23}H_{40}O_8Na$ $[M+Na]^+$ 467.2621, found 467.2632.

Following the same synthetic procedure of compounds **4(a-d)**, the alcohols from the above step (100 mg, 0.22 mmol) were transformed to the corresponding aldehydes using IBX (123 mg, 0.44 mmol) in EtOAc (2 mL) which further were reacted with $Ph_3PCH_2I_2$ (349 mg, 0.66 mmol) in presence of NaHMDS (1 M in THF, 0.65 mL. 0.65 mmol) in THF (2 mL) to get compounds **59(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compounds **59(a-d)** (94 mg, 76%) as colorless oil. R_f = 0.5 (10% EtOAc in hexane); ^1H NMR ($CDCl_3$, 300 MHz) δ 6.50-6.47 (m, 1H), 6.31-6.25 (m, 1H), 5.75-5.57 (m, 1H), 5.51-5.41 (m, 1H), 4.94-4.88 (m, 1H), 4.82-4.76 (m, 1H), 4.30-4.20 (m, 3H), 4.05 (t, *J* = 8.1 Hz, 1H); 3.74-3.68 (m, 1H), 3.62-3.50 (m, 3H), 3.46-3.40 (m, 1H), 2.28-2.21 (m, 1H), 2.13-2.08 (m, 1H), 2.06-1.94 (m, 1H), 1.71-1.54 (m, 4H), 1.47-1.46 (m, 3H), 1.42 (s, 3H), 1.37-1.36 (m, 6H), 1.25 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 138.0, 133.3, 126.6, 109.6 (109.5), 108.9 (108.9), 108.3 (108.2), 84.8, 81.0, 79.4, 75.2, 74.9 (74.8), 73.9, 72.4, 68.9, 68.8 (68.8), 67.0, 30.9, 30.2, 29.8, 28.5, 28.3, 26.9, 25.9, 25.7, 25.6 ppm; IR (neat) ν_{max} 2930, 1219 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{24}H_{39}IO_7Na$ $[M + Na]^+$ 589.1638, found 589.1635.

(*R*)-Tridec-12-yn-5-yl acetate (62a). Following the same synthetic procedure of compounds **19**, epoxide **18** (450 mg, 4.5 mmol) was transformed to compound **60a** using 1-heptyne (0.66 mL, 5.0 mmol), ^{n}BuLi (3 mL, 4.8 mmol, 1.6 M in hexane) and $BF_3.OEt_2$ (0.6 mL, 4.8 mmol) in THF

(10 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compounds **60a** (756 mg, 84%) as colorless oil. R_f = 0.7 (10% EtOAc in hexane); $[\alpha]^{25}_D$ = 1.2 (*c* 1.2, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.71-3.63 (m, 1H), 2.44-2.35 (m, 1H), 2.30-2.23 (m, 1H), 2.19-2.13 (m, 2H), 1.96 (s, 1H), 1.54-1.41 (m, 4H), 1.40-1.23 (m, 8H), 0.92-0.86 (m, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 83.4, 76.2, 70.4, 36.1, 31.2, 28.8, 27.9, 27.9, 22.8, 22.3, 18.8, 14.1, 14.1ppm; IR (neat) ν_{max} 3367, 2926 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{13}H_{24}ONa$ $[M+Na]^+$ 219.1725, found 219.1723.

Following the same synthetic procedure of compounds **20**, compound **60a** (500 mg, 2.54 mmol) was transformed to compound **61a** using KO^{t}Bu (1.14 mg, 10.2 mmol), ^{n}BuLi (6.4 mL, 10.2 mmol) and 1,3-diaminopropane (1.04 mL, 12.7 mmol) in THF (10 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compound **61a** (358 mg, 72%) as colorless oil. R_f = 0.7 (10% EtOAc in hexane); $[\alpha]^{29}_D$ = +0.08 (*c* 9.0, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.58-3.52 (m, 1H), 2.19-1.93 (m, 2H), 1.92 (t, *J* = 2.7 Hz, 1H), 1.55-1.24 (m, 16H), 0.89 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 84.8, 72.1, 68.2, 37.5, 37.3, 29.3, 28.8, 28.5, 27.9, 25.6, 22.9, 18.5, 14.1 ppm; IR (neat) ν_{max} 3313, 2925, 2117 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{13}H_{24}ONa$ $[M+Na]^+$ 219.1725, found 219.1721.

Following the same synthetic procedure of compounds **5**, compound **61a** (300 mg, 1.52 mmol) was transformed to compound **62a** using Ac_2O (0.28 mL, 3.04 mmol) in Pyridine (3 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 2% EtOAc in hexane as eluant) afforded compound **62a** (354 mg, 98%) as colorless oil. R_f = 0.9 (5% EtOAc in hexane); $[\alpha]^{25}_D$ = +0.2 (*c* 0.6, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.88-4.80 (m, 1H), 2.19-2.13 (m, 2H), 2.02 (s, 3H), 1.92 (t, *J* = 2.7 Hz, 1H), 1.53-1.46 (m, 6H), 1.39-1.27 (m,

10H), 0.87 (t, J = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.0, 84.7, 74.4, 68.2, 34.2, 33.9, 29.1, 28.7, 28.5, 27.6, 25.3, 22.7, 21.4, 18.5, 14.1 ppm; IR (neat) ν_{max} 3310, 2933, 2117, 1731 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{15}H_{26}O_2Na$ $[M+Na]^+$ 261.1830, found 261.1826.

(*R*)-Dodec-11-yn-5-yl acetate (62b): Following the same synthetic procedure of compounds **19**, epoxide **18** (450 mg, 4.5 mmol) was transformed to compound **60b** using 1-hexyne (0.57 mL, 5.0 mmol), ^{n}BuLi (3 mL, 4.8 mmol, 1.6 M in hexane) and $BF_3.OEt_2$ (0.6 mL, 4.8 mmol) in THF (10 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compound **60b** (705 mg, 86%) as colorless oil. R_f = 0.7 (10% EtOAc in hexane); $[\alpha]^{29}_D$ = -9.2 (*c* 1.16, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.71-3.63 (m, 1H), 2.42-2.34 (m, 1H), 2.29-2.20 (m, 1H), 2.19-2.13 (m, 2H), 1.99 (s, 1H), 1.54-1.37 (m, 10H), 0.89 (t, J = 6.9 Hz, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 83.3, 76.2, 70.3, 36.0, 31.2, 27.9, 27.9, 22.8, 22.1, 18.5, 14.1, 13.7 ppm; IR (neat) ν_{max} 3370, 2925 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{12}H_{22}ONa$ $[M+Na]^+$ 205.1568, found 205.1573.

Following the same synthetic procedure of compounds **20**, compound **60b** (500 mg, 2.74 mmol) was transformed to compound **61b** using KO^{t}Bu (1.23 g, 11.0 mmol), ^{n}BuLi (6.9 mL, 11.0 mmol, 1.6 M in hexane) and 1,3-diaminopropane (1.12 mL, 13.7 mmol) in THF (10 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compound **61b** (380 mg, 76%) as colorless oil. R_f = 0.7 (10% EtOAc in hexane); $[\alpha]^{29}_D$ = -3.2 (*c* 1.3, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.63-3.54 (m, 1H), 2.21-2.14 (m, 2H), 1.94-1.76 (m, 1H), 1.54-1.41 (m, 10H), 1.35-1.25 (m, 6H), 0.90 (t, J = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 84.8, 72.0, 68.3, 37.4, 37.4, 28.9, 28.5, 27.9, 25.3,

22.9, 18.5, 14.1 ppm; IR (neat) ν_{max} 3309, 2927, 2113 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{12}H_{22}ONa$ $[M+Na]^+$ 205.1568, found 205.1565.

Following the same procedure of synthesis of compounds **5**, compound **61b** (200 mg, 1.1 mmol) was transformed to compound **62b** using Ac_2O (0.21 mL, 2.2 mmol) in Pyridine (2 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 2% EtOAc in hexane as eluant) afforded compound **62b** (244 mg, 99%) as colorless oil. R_f = 0.9 (5% EtOAc in hexane); $[\alpha]^{28}_D$ = -0.3 (*c* 1.35, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.80-4.72 (m, 1H), 2.10-2.05 (m, 2H), 1.93 (s, 3H), 1.84-1.66 (m, 1H), 1.47-1.38 (m, 6H), 1.35-1.12 (m, 10H), 0.78 (t, *J* = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 84.8, 74.4, 68.3, 34.1, 33.9, 28.7, 28.5, 29.6, 24.9, 22.7, 21.4, 18.5, 14.1 ppm; IR (neat) ν_{max} 3313, 2935, 2115, 1730 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{14}H_{24}O_2Na$ $[M+Na]^+$ 247.1674, found 247.1672.

(*R*)-15-((4*S*,5*R*)-5-(3-((4*S*,5*R*)-5-(2-(((*S*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)propyl)-2,2-dimethyl-1,3-dioxolan-4-yl)pentadecan-5-yl acetate (53). Following the same synthetic procedure of compounds **3(a-d)**, compounds **56(a-d)** (50 mg, 0.09 mmol) and alkyne **62a** (25 mg, 0.1 mmol) were coupled using $Pd(Ph_3P)_2Cl_2$ (0.7 mg, 0.01 mmol) and CuI (4 mg, 0.02 mmol) in Et_3N (1 mL) to get compounds **63(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 10% EtOAc in hexane as eluant) afforded compounds **63(a-d)** (45 mg, 76%) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.85-5.80 (m, 1H), 5.78-5.65 (m, 2H), 5.59-5.48 (m, 1H), 5.14-5.09 (m, 1H), 4.87-4.83 (m, 2H), 4.29-4.18 (m, 3H), 4.04 (dd, *J* = 8.1, 6.3 Hz, 1H), 3.74-3.68 (m, 1H), 3.62-3.50 (m, 3H), 3.46-3.41 (m, 1H), 2.35-2.21 (m, 4H), 2.04 (s, 3H), 1.72 (q, *J* = 6.6 Hz, 2H), 1.57-1.50 (m, 10H), 1.47-1.41 (m, 6H), 1.36-1.33 (m, 8H), 1.29-1.23 (m,

12H), 0.89 (t, J = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 171.1, 137.2, 130.2, 127.9, 113.6, 109.6, 108.7, 108.3, 97.1, 76.4, 75.3, 74.8, 74.5, 73.9, 72.2, 68.9, 67.1, 34.3, 33.9, 30.9, 29.8, 29.2, 28.9, 28.5 (28.5), 28.3, 29.6, 26.9, 25.9, 25.7 (25.6), 25.4, 22.8, 22.7, 21.4, 19.7, 14.1 ppm; IR (neat) ν_{max} 2930, 2218, 1729 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{62}O_9Na$ $[M+Na]^+$ 685.4292, found 685.4289.

Following the same synthetic procedure of compound **21**, compounds **63(a-d)** (25 mg, 0.038 mmol) were hydrogenated to get compound **53** using 10 mol% Pd/C (4 mg) in EtOAc (1 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded compound **53** (24.7 mg, 97%) as colorless oil. R_f = 0.35 (20% EtOAc in hexane); $[\alpha]^{25}_D$ = -0.6 (*c* 0.7, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.87-4.83 (m, 1H), 4.28-4.24 (m, 1H), 4.18-4.13 (m, 1H), 4.10-4.01 (m, 4H), 3.75-3.68 (m, 1H), 3.63-3.57 (m, 2H), 3.55-3.51 (m, 1H), 3.48-3.41 (m, 1H), 2.04 (s, 3H), 1.72-1.70 (m, 3H), 1.52-1.49 (m, 7H), 1.45-1.42 (m, 8H), 1.36 (s, 3H), 1.33-1.29 (m, 14H), 1.28-1.25 (m, 17H), 0.89 (t, J = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 109.6, 107.7, 107.5, 78.2, 77.8, 77.8, 74.9, 74.8, 74.6, 72.2, 68.9, 66.9, 34.3, 33.9, 32.1, 30.3, 29.8, 29.7, 29.5, 28.7, 27.6, 26.9, 26.4, 26.2, 26.1, 25.6, 25.5, 22.8, 21.5, 14.1 ppm; IR (neat) ν_{max} 2928, 1728 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{70}O_9Na$ $[M+Na]^+$ 693.4918, found 693.4915.

(*R*)-14-((4*S*,5*R*)-5-(4-((4*S*,5*R*)-5-(2-(((*S*)-2,2-Dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)butyl)-2,2-dimethyl-1,3-dioxolan-4-yl)tetradecan-5-yl acetate (54): Following the same synthetic procedure of compounds **3(a-d)**, compounds **59(a-d)** (50 mg, 0.09 mmol) and alkyne **62b** (25 mg, 0.11 mmol) were coupled using $Pd(Ph_3P)_2Cl_2$ (7 mg, 0.01 mmol) and CuI (4 mg, 0.02 mmol) in Et_3N (1 mL) to get compounds **64(a-d)**. Purification of

crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 10% EtOAc in hexane as eluant) afforded compounds **64(a-d)** (45.6 mg, 77%) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.83-5.78 (m, 1H), 5.67-5.43 (m, 1H), 5.49-5.39 (m, 1H), 5.10-5.04 (m, 1H), 4.93-4.81 (m, 2H), 4.29-4.16 (m, 3H), 4.07-4.02 (m, 1H), 3.74-3.68 (m, 1H), 3.64-3.50 (m, 3H), 3.46-3.43 (m, 1H), 2.34-2.29 (m, 2H), 2.27-2.09 (m, 2H), 2.03 (s, 3H), 1.73-1.65 (m, 2H), 1.59-1.53 (m, 8H), 1.50-1.46 (m, 5H), 1.42 (s, 3H), 1.39-1.36 (m, 10H), 1.33-1.25 (m, 8H), 0.89 (t, *J* = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 171.1, 137.4, 133.6, 126.5, 113.3, 109.6, 108.5, 108.2, 96.7, 77.8, 76.4 (76.4), 75.2 (75.1), 74.9 (74.8), 74.4, 73.9, 72.5 (72.2), 68.8, 67.0, 34.2, 34.0, 30.9, 30.3, 29.8, 28.9, 28.7, 28.5, 27.6, 26.9, 25.9, 25.6, 25.0, 24.4, 22.7, 21.4, 19.6, 14.1 ppm; IR (neat) ν_{max} 2932, 22183, 1730 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{62}O_9Na$ $[M+Na]^+$ 685.4292, found 685.4293.

Following the same synthetic procedure of compound **21**, compounds **64(a-d)** (25 mg, 0.037 mmol) were hydrogenated to get compound **54** using 10 mol% Pd/C (4 mg) in EtOAc (1 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded compound **53** (24 mg, 98%) as colorless oil. R_f = 0.35 (20% EtOAc in hexane); $[\alpha]^{28}_D$ = +5.4 (*c* 0.9, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.89-4.81 (m, 1H), 4.31-4.25 (m, 1H), 4.23-4.11 (m, 1H), 4.09-3.99 (m, 4H), 3.75-3.68 (m, 1H), 3.66-3.51 (m, 3H), 3.48-3.41 (m, 1H), 2.03 (s, 3H), 1.73-1.66 (m, 3H), 1.54-1.44 (m, 10H), 1.42 (s, 9H), 1.36-1.25 (m, 30H), 0.88 (t, *J* = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 109.6, 107.7, 107.4, 78.2, 78.1, 77.9, 74.9, 74.8, 74.6, 72.6, 68.8, 66.9, 34.3, 33.9, 30.3, 29.8, 29.7, 29.7, 28.8, 27.6, 26.9, 26.6, 26.4, 26.2, 25.8, 25.6, 25.5, 22.8, 21.4, 14.1 ppm; IR (neat) ν_{max} 2930, 1726 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{70}O_9Na$ $[M+Na]^+$ 693.4918, found 693.4908.

(*R*)-Tetradec-13-yn-7-yl acetate (70a). Following the same synthetic procedure of compounds **19**, epoxide **67a** (500 mg, 4.38 mmol) was transformed to compound **68a** using 1-heptyne (0.63 mL, 4.82 mmol), ^{n}BuLi (3.0 mL, 4.82 mmol, 1.6 M in hexane) and $BF_3.OEt_2$ (0.65 mL, 5.3 mmol) in THF (10 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compound **68a** (775 mg, 84%) as colorless oil. R_f = 0.7 (10% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.72-3.64 (m, 1H), 2.44-2.36 (m, 1H), 2.22-2.14 (m, 2H), 1.52-1.38 (m, 4H), 1.37-1.25 (m, 10H), 0.93-0.86 (m, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 83.4, 76.2, 70.4, 36.4, 31.9, 31.2, 29.8, 29.4, 27.9, 25.8, 22.7, 22.1, 18.6, 14.2 ppm; IR (neat) ν_{max} 3372, 2930 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{14}H_{26}ONa$ $[M+Na]^+$ 233.1881, found 233.1880.

Following the same synthetic procedure of compounds **20**, compound **68a** (450 mg, 2.14 mmol) was transformed to compound **69a** using KO^{t}Bu (960 mg, 8.56 mmol), ^{n}BuLi (5.34 mL, 8.56 mmol, 1.6 M in hexane) and 1,3-diaminopropane (0.88 mL, 10.7 mmol) in THF (10 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compound **69a** (329 mg, 73%) as colorless oil. R_f = 0.7 (10% EtOAc in hexane); $[\alpha]^{25}_D$ = -0.13 (*c* 1.0, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.59-3.51 (m, 1H), 2.22-2.16 (m, 2H), 1.93 (t, *J* = 2.7 Hz, 1H), 1.56-1.49 (m, 2H), 1.47-1.39 (m, 8H), 1.38-1.28 (m, 8H), 0.88 (t, *J* = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 84.8, 72.1, 68.3, 37.7, 37.4, 31.9, 19.5, 18.9, 28.6, 25.8, 25.3, 18.5, 14.2 ppm; IR (neat) ν_{max} 3310, 2927, 2115 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{14}H_{26}ONa$ $[M+Na]^+$ 233.1881, found 233.1878.

Following the same synthetic procedure of compounds **5**, compound **69a** (100 mg, 0.47 mmol) was transformed to compound **70a** using Ac_2O (0.09 mL, 0.94 mmol) in Pyridine (1 mL).

Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 2% EtOAc in hexane as eluant) afforded compound **70a** (117 mg, 98%) as colorless oil. R_f = 0.9 (5% EtOAc in hexane); $[\alpha]^{25}_D$ = +0.3 (*c* 4.5, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.88-4.80 (m, 1H), 2.19-2.13 (m, 2H), 2.02 (s, 3H), 1.91 (t, *J* = 2.4 Hz, 1H), 1.55-1.46 (m, 6H), 1.41-1.25 (m, 12H), 0.86 (t, *J* = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.0, 84.6, 77.6, 77.2, 76.7, 74.4, 68.3, 34.2, 34.1, 31.8, 29.3, 28.7, 28.4, 25.4, 24.9, 22.7, 21.4, 18.4, 14.1 ppm; IR (neat) ν_{max} 3313, 2930, 2111, 1733 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{16}H_{28}O_2Na$ $[M+Na]^+$ 275.1987, found 275.1986.

(*R*)-Tetradec-13-yn-6-yl acetate (70b). Following the same synthetic procedure of compounds **19**, epoxide **67b** (500 mg, 3.9 mmol) was transformed to compound **68b** using 1-hexyne (0.54 mL, 4.7 mmol), ^{n}BuLi (3.0 mL, 4.7 mmol, 1.6 M in hexane) and $BF_3.OEt_2$ (0.63 mL, 5.1 mmol) in THF (10 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compound **68b** (770 mg, 83%) as colorless oil. R_f = 0.7 (10% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.72-3.64 (m, 1H), 2.44-2.36 (m, 1H), 2.31-2.22 (m, 1H), 2.19-2.13 (m, 2H), 1.61-1.41 (m, 5H), 1.38-1.25 (m, 11H), 0.92-0.87 (m, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 83.5, 76.2, 70.4, 36.3, 31.9, 31.2, 28.8, 27.9, 25.5, 22.7, 22.3, 18.9, 14.2, 14.1 ppm; IR (neat) ν_{max} 3365, 2925 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{14}H_{26}ONa$ $[M+Na]^+$ 233.1881, found 233.1883.

Following the same synthetic procedure of compounds **20**, compound **68b** (450 mg, 2.14 mmol) was transformed to compound **69b** using KO^{t}Bu (960 mg, 8.56 mmol), ^{n}BuLi (5.34 mL, 8.56 mmol, 1.6 M in hexane) and 1,3-diaminopropane (0.88 mL, 10.7 mmol) in THF (10 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% EtOAc in hexane as eluant) afforded compound **69b** (334 mg, 74%) as colorless oil. R_f = 0.7

(10% EtOAc in hexane); $[\alpha]^{25}_{D}$ = -2.2 (*c* 1.2, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.59-3.51 (m, 1H), 2.21-2.16 (m, 2H), 1.93 (t, *J* = 2.4 Hz, 1H), 1.53-1.48 (m, 1H), 1.44-1.39 (m, 6H), 1.37-1.29 (m, 10H), 0.91-0.87 (m, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 84.8, 72.1, 68.2, 37.6, 37.5, 32.0, 29.8, 28.8, 28.5, 25.6, 25.5, 22.8, 18.5, 14.2 ppm; IR (neat) ν_{max} 3310, 2926, 2117 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{14}H_{26}ONa$ $[M+Na]^+$ 233.1881, found 233.1880.

Following the same synthetic procedure of compounds **5**, compound **69b** (100 mg, 0.47 mmol) was transformed to compound **70b** using Ac_2O (0.09 mL, 0.94 mmol) in Pyridine (1 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 2% EtOAc in hexane as eluant) afforded compound **70b** (118 mg, 99%) as colorless oil. R_f = 0.9 (5% EtOAc in hexane); $[\alpha]^{29}_{D}$ = +0.1 (*c* 2.7, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.92-4.82 (m, 1H), 2.20-2.15 (m, 2H), 2.04 (s, 3H), 1.93 (t, *J* = 2.7 Hz, 1H), 1.56-1.47 (m, 6H), 1.33-1.22 (m, 12H), 0.90-0.86 (m, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 84.8, 74.5, 68.3, 34.2, 34.2, 31.9, 29.1, 28.7, 28.5, 25.3, 25.1, 22.7, 21.4, 18.5, 14.1 ppm; IR (neat) ν_{max} 3313, 2933, 2115, 1731 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{16}H_{28}O_2Na$ $[M+Na]^+$ 275.1987, found 275.1986.

(*R*)-16-((4*S*,5*R*)-5-(2-((4*S*,5*R*)-5-(2-(((S)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)hexadecan-7-yl acetate (65). Following the same synthetic procedure of compounds **3(a-d)**, compounds **49(a-d)** (50 mg, 0.09 mmol) and alkyne **70a** (28 mg, 0.11 mmol) were coupled using $Pd(Ph_3P)_2Cl_2$ (7 mg, 0.01 mmol) and CuI (4 mg, 0.02 mmol) in Et_3N (1 mL) to get compounds **71(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 10% EtOAc in hexane as eluant) afforded compounds **71(a-d)** (44 mg, 74%) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.78-5.72 (m, 1H), 5.64-5.53 (m, 3H), 5.17-5.12 (m,

1H), 5.04-5.00 (m, 1H), 4.91-4.81 (m, 2H), 4.29-4.14 (m, 2H), 4.07-4.02 (m, 1H), 3.78-3.69 (m, 1H), 3.63-3.49 (m, 3H), 3.45-3.40 (m, 1H), 2.21 (dt, J = 6.9, 1.8 Hz, 2H), 2.03 (s, 3H), 1.67-1.62 (m, 2H), 1.53-1.45 (m, 10H), 1.41-1.40 (m, 7H), 1.35-1.34 (m, 7H), 1.26-1.25 (m, 12H), 0.87 (t, J = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 171.0, 136.8, 130.0, 129.2, 113.8, 109.5, 109.4, 108.6, 97.0, 75.8, 75.7, 74.9, 74.5, 74.4, 73.8, 72.3 (72.1), 68.9, 67.1, 34.3, 34.2, 31.9, 31.2, 29.8, 29.3, 29.1, 28.8, 28.5, 28.3, 26.9, 25.9, 25.7 (25.6), 25.4, 25.1, 22.7, 21.4, 19.7, 14.2 ppm; IR (neat) ν_{max} 2930, 2216, 1732 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{62}O_9Na$ $[M+Na]^+$ 685.4292, found 685.4290.

Following the same synthetic procedure of compound **21**, compounds **71(a-d)** (20 mg, 0.03 mmol) were hydrogenated to get compound **65** using 10 mol% Pd/C (4 mg) in EtOAc (1 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded compound **65** (18.2 mg, 97%) as colorless oil. R_f = 0.35 (20% EtOAc in hexane); $[\alpha]^{28}_D$ = +3.8 (*c* 0.9, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.90-4.81 (m, 1H), 4.28-4.18 (m, 2H), 4.07-4.02 (m, 4H), 3.75-3.68 (m, 1H), 3.65-3.58 (m, 2H), 3.55-3.50 (m, 1H), 3.47-3.41 (m, 1H), 2.03 (s, 3H), 1.78-1.60 (m, 3H), 1.49-1.42 (m, 14H), 1.37-1.33 (m, 10H), 1.29-1.25 (m, 25H), 0.87 (t, J = 6.9 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 109.6, 107.8, 107.5, 78.5, 78.3, 78.2, 74.9, 74.8, 74.6, 72.3, 68.8, 67.0, 34.3, 31.9, 30.3, 29.8, 29.7, 29.3, 28.7, 27.3, 26.9, 26.5, 26.1, 25.9, 25.5, 25.4, 22.7, 21.4, 14.2 ppm; IR (neat) ν_{max} 2928, 1730 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{70}O_9Na$ $[M+Na]^+$ 693.4918, found 693.4916.

(*R*)-16-((4*S*,5*R*)-5-(2-((4*S*,5*R*)-5-(2-(((*S*)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)ethyl)-2,2-dimethyl-1,3-dioxolan-4-yl)hexadecan-6-yl acetate (66). Following the same synthetic procedure of compounds **3(a-d)**, compounds **49(a-d)** (50 mg,

0.09 mmol) and alkyne **70b** (28 mg, 0.11 mmol) were coupled using $Pd(Ph_3P)_2Cl_2$ (7 mg, 0.01 mmol) and CuI (4 mg, 0.02 mmol) in Et_3N (1 mL) to get compounds **72(a-d)**. Purification of crude mixture using flash column chromatography (SiO_2, 100-200 mesh, 10% EtOAc in hexane as eluant) afforded compounds **72(a-d)** (45 mg, 76%) as colorless oil. R_f = 0.3 (20% EtOAc in hexane); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.79-5.72 (m, 1H), 5.65-5.53 (m, 3H), 5.18-5.12 (m, 1H), 5.07-4.97 (m, 1H), 4.91-4.83 (m, 2H), 4.29-4.16 (m, 2H), 4.07-4.02 (m, 1H), 3.75-3.69 (m, 1H), 3.61-3.49 (m, 3H), 3.46-3.41 (m, 1H), 2.35-2.29 (m, 2H), 2.03 (s, 3H), 1.66-1.61 (m, 4H), 1.51-1.49 (m, 7H), 1.46 (s, 2H), 1.41-1.38 (m, 8H), 1.35-1.33 (m, 7H), 1.29-1.23 (m, 10H), 0.88 (t, J = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz, observed minor diastereomeric peaks are given in parentheses) δ 171.1, 136.8, 130.0, 129.2, 113.8, 109.5 (109.4), 108.7 (108.6), 97.1, 76.4, 75.8, 74.9, 74.8, 74.5 (74.4), 73.9, 72.1, 68.9, 67.0, 34.3, 34.2, 31.8, 31.2, 29.8, 29.1 (29.1), 28.8, 28.5, 28.3, 26.9, 25.9, 25.8, 25.5 (25.4), 25.1, 22.9, 21.4, 14.1 ppm; IR (neat) ν_{max} 2931, 2218, 1727 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{62}O_9Na$ $[M+Na]^+$ 685.4292, found 685.4290.

Following the same synthetic procedure of compound **21**, compounds **72(a-d)** (20 mg, 0.03 mmol) were hydrogenated to get compound **66** using 10 mol% Pd/C (4 mg) in EtOAc (1 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 10% EtOAc in hexane as eluant) afforded compound **66** (19 mg, 98%) as colorless oil. R_f = 0.35 (20% EtOAc in hexane); $[\alpha]^{25}_D$ = +5.8 (*c* 0.7, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 4.89-4.81 (m, 1H), 4.28-4.19 (m, 2H), 4.07-4.02 (m, 4H), 3.75-3.69 (m, 1H), 3.63-3.59 (m, 2H), 3.56-3.51 (m, 1H), 3.47-3.42 (m, 1H), 2.03 (s, 3H), 1.75-1.64 (m, 6H), 1.49-1.48 (m, 6H), 1.45-1.39 (m, 9H), 1.36-1.33 (m, 11H), 1.29-1.25 (m, 20H), 0.89 (t, J = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 171.1, 109.5, 107.8, 107.5, 78.5, 78.4, 78.2, 74.9, 74.8, 74.6, 72.1, 68.8, 67.0, 34.3, 34.2, 31.9, 30.3, 29.8, 29.7, 28.7, 27.2, 26.9, 26.5, 26.1, 25.6, 25.5, 25.1, 22.7, 21.4, 14.1 ppm; IR

(neat) ν_{max} 2930, 1727 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{38}H_{70}O_9Na$ $[M+Na]^+$ 693.4918, found 693.4916.

(6*R*,17*S*,18*R*,21*S*,22*R*)-24-((*R*)-2,3-dihydroxypropoxy)-17,18,21,22-tetrahydroxytetracosan-6-yl acetate (2). Following the same synthetic procedure of compound **1**, compounds **66** (15 mg, 0.022 mmol) was transformed to compound **2** using AcOH:H_2O (4:1, 1.0 mL). Purification of crude mixture using flash column chromatography (SiO_2, 60-120 mesh, 5% MeOH in CH_2Cl_2 as eluant) afforded compound **2** (12 mg, 98%) as colorless oil. R_f = 0.5 (10% MeOH in CH_2Cl_2); $[\alpha]^{22}_D$ = +4.00 (*c* 0.4, MeOH); ^{1}H NMR (C_5D_5N, 300 MHz) δ 5.13-5.05 (m, 1H, merged in water peak), 4.38 (m, 1H), 4.24-4.18 (m, 1H), 4.14-4.07 (m, 4H), 4.04-3.94 (m, 3H), 3.93-3.82 (m, 2H), 2.57 (bd, *J* = 9.3 Hz, 2H), 2.41-2.35 (m, 1H), 2.18-2.09 (m, 6H), 1.95-1.94 (m, 1H), 1.89-1.79 (m, 2H), 1.58-1.50 (m, 5H), 1.34-1.21 (m, 20H), 0.81 (t, *J* = 6.9 Hz, 3H); ^{13}C NMR (C_5D_5N, 75 MHz) δ 170.7, 75.9, 75.2, 74.2, 73.7, 72.9, 71.9, 69.6, 64.7, 34.5, 34.4, 33.6, 31.9, 30.6, 30.3, 30.0, 29.9, 29.8, 29.8, 26.7, 25.7, 25.3, 22.7, 21.1,14.1; IR (neat) ν_{max} 3363, 2927, 1737 cm^{-1}; HRMS (ESI) *m/z* calculated for $C_{29}H_{58}O_9Na$ $[M+Na]^+$ 573.3979, found 573.3975.

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Supporting Information:

General experimental procedure, Tables (1-6), HPLC analysis of mixture of compounds **15a** and **15b**, copies of NMR (^{1}H & ^{13}C) and HRMS of representative compounds. These material are available free of charge via the Internet at http://pubs.acs.org/

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