"Exploration of diastereoselectivity in unusual Grignard reaction and its application towards synthesis of styryl lactones 7−*epi*−(+)−goniodiol and 8−*epi*−(−)−goniodiol"

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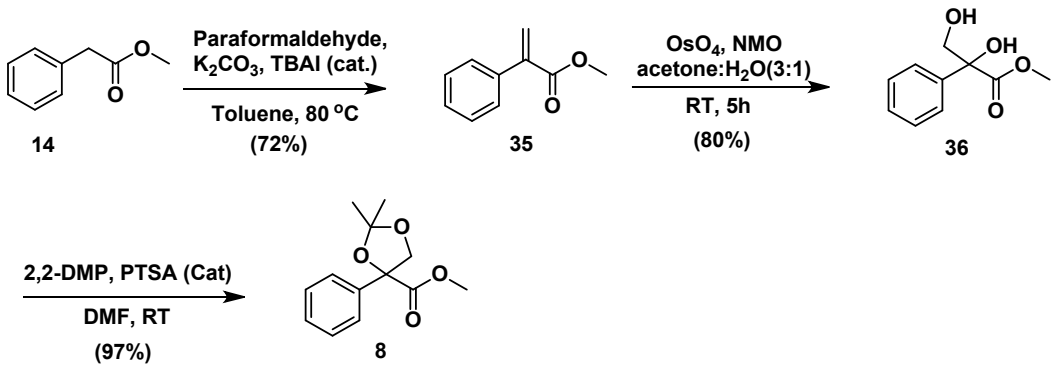
I. General remarks

The ^{1}H NMR spectra were recorded on 200 MHz NMR spectrometer, 400 MHz NMR spectrometer and 500 MHz NMR spectrometer using TMS as the internal standard. The ^{13}C NMR spectra were recorded on 200 NMR spectrometer (50 MHz), 400 NMR spectrometer (100 MHz) and 500 NMR spectrometer (125 MHz). Chemical shifts are reported proportionate to the solvent resonance peak δ 7.26 ($CDCl_3$) for ^{1}H and δ 77.23 ($CDCl_3$) for ^{13}C. ^{1}H NMR signals are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, br s = broad singlet, m = multiplet, ddt = doublet of a doublet of a triplet, ddd = doublet of a doublet of a doublet, dd = doublet of a doublet), coupling constants and number of protons. Mass spectra were recorded on a MS−TOF mass spectrometer. The IR spectra were recorded on a FT−IR spectrometer Perkin−Elmer 1760 FT. Column chromatographic separations were carried out on silica gel (60–120 and 200–400 mesh). Mg metal turnings were activated, washed and dried before use. Commercially available methyl crotonate (**22**), methyl cinnamate, 1,4−dibromobutane, 1,5−dibromopentane, 1,6−dibromohexane, AD−mix−β, OsO_4, TPAP, NMO, phenylselenyl bromide, (diacetoxyiodo)benzene and TEMPO were used as received.

The carboxylic ester of compounds **13**, **14**, **17**, **20** and **21** were prepared from the corresponding acids which are commercially available. Compounds **1**[1], **2**[1], **9**[2], **11**[3], **12**[4], **13a**[5a], **13b**[5b], **15**[6a], **15b**[6b], **16**[7], **17a**[8a], **17b**[8b], **18**[9a], **18b**[9b], **19**[10], **20a**[11a], **20b**[11b], **21b**[11b], **22a**[12a], **22b**[12b], **25b**[14], **32**[13], **33**[16a] and **34**[16b] are reported in literature. ^{1}H NMR and ^{13}C NMR spectra of all compounds and HPLC data for compounds **11a** and **37** are provided.

II. General procedure for preparation of compounds (±)3, (±)4, (±)5, (±)6, (±)7, (±)8 and (±)9



Scheme−5

General procedure for preparation of exomethylene compound from ester[1b]

To a stirred solution of ester (20.62 mmol, 1.0 equiv), paraformaldehyde (35.0 mmol, 1.6 equiv), K_2CO_3 (42.0 mmol, 2.0 equiv) and TBAI (1.03 mmol, 0.04 equiv) were added and reaction mixture was heated in anhydrous toluene (16 mL) at 80–85°C for 5 h. After completion of the reaction, monitored by TLC, reaction mixture was allowed to cool to room temperature. Water (100 mL) was added to the reaction mixture and stirred vigorously for 10 min. The aqueous layer was extracted with DCM (3 X 20 mL), washed with water and brine, dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. The obtained residue was then purified by flash column chromatography using 60–120 silica gel to furnish the respective olefin compound as a colorless oil.

General procedure for preparation of diol from exomethylene compound[1b]

To a stirred solution of exocyclic methylene compound (0.32 mmol, 1.0 equiv) in acetone−water (3:1, 8 mL) at room temperature was added *N*−methylmorpholine−*N*−oxide (NMO) (0.62 mmol, 1.9 equiv) followed by 1M solution of osmium tetroxide (0.0032 mmol, 0.01 equiv) carefully in a dropwise manner. The resulting reaction mixture was continuously stirred for 5 h. The reaction was then quenched with sat. aq. Na_2SO_3 (5 mL) and stirred vigorously for 30 min. The biphasic reaction mixture was then extracted with ethyl acetate (3 X 10 mL) and the combined organic layers were washed with brine (15 mL), dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. The crude product obtained was subjected for column chromatography using 200−400 silica gel with eluent to furnish the respective diol.

General procedure for preparation of acetonide from diol

To a stirred solution of diol (0.45 mmol, 1.0 equiv) in anhydrous DMF (4 mL) as a reaction solvent was added 2,2− DMP (1 mmol, 2.2 equiv) followed by *para* toluenesulphonic acid (0.1 mmol). The reaction mixture was stirred at 25 ^{o}C until the reaction was complete, monitored by TLC (6 h). After completion, reaction mixture was diluted with ethyl acetate. The reaction mixture was subsequently washed with brine and worked up with ethyl acetate (3 X 15 mL). The combined organic extracts were dried over anhydrous sodium sulphate, filtered and concentrated under reduced pressure to furnish a crude residue. The obtained residue was then purified by silica gel column chromatography to furnish the respective acetonide protected ester compound as a viscous oil.

General procedure for unusual Grignard reaction (preparation of compounds 3a, 4a, 5a, 6a, 7a, 8a, 9a, 10a, 11a, 12a, 13a, 14a, 15a, 16a, 17a, 18a, 19a, 20a, 21a, 22a, 23a, 24b, 25b, 32):

In a two neck round bottom flask (100 mL) containing Mg metal turnings (4.75 mmol, 2.9 equiv) in anhydrous THF (3 mL), solution of dibromoalkane (2.33 mmol, 1.4 equiv) in anhydrous THF (2 mL) was added cautiously in a dropwise manner at 0–5 ^{o}C. After addition, the reaction mixture was allowed to warm upto room temperature and vigorously stirred for 2 h. The reaction mixture becomes turbid indicating generation of a Grignard reagent.

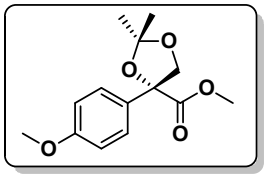
To a pre−cooled (upto 0–5 ^{o}C) solution of ester (1.60 mmol, 1.0 equiv) in THF (2 mL) was added the above generated solution of Grignard reagent carefully in a dropwise manner. After addition, the reaction mixture was warmed upto room temperature within 0.5 h and then stirred for additional 2.5 h. The suspension was quenched slowly with the addition of saturated NH_4Cl solution at 0 ^{o}C, followed by extraction with ethyl acetate (3 X 15 mL). The combined organic extracts were washed with water and brine, dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. The crude residue obtained was purified by column chromatography to furnish pure product.

General procedure for preparation of acetates 10'a and 11'a

To a stirred solution of alcohol (5.98 mmol, 1.0 equiv) in dichloromethane (3 mL) was added acetic anhydride (6.59 mmol, 1.1 equiv), triethylamine (9.42 mmol, 1.5 equiv) and catalytic amount of 4–dimethylaminopyridine (20 mol%). The resulting mixture was stirred at room temperature for 1 h. The reaction mixture was diluted with dichloromethane (10 mL), washed with 10% HCl followed by water and brine. The combined organic extracts were dried over Na_2SO_4, filtered and concentrated under reduced pressure. The crude residue obtained was purified by silica gel column chromatography using (05% ethyl acetate– petroleum ether) as eluent to give the corresponding acetate.

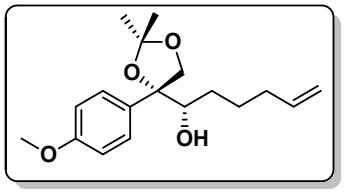
III. Spectral data

Methyl 4−(4−methoxyphenyl)−2,2−dimethyl−1,3−dioxolane−4−carboxylate (±3):



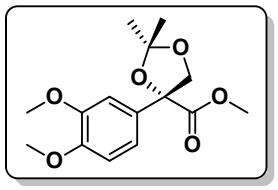
Column chromatography using 60–120 silica gel (8% ethyl acetate–petroleum ether), **Yield:** (0.847 g, 90%), **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.50−7.45 (m, 2H), 7.39−7.26 (m, 2H), 4.88 (d, J = 8.59 Hz, 1H), 3.97 (d, J = 8.59 Hz, 1H), 3.78 (s, 3H), 3.73 (s, 3H), 1.52 (s, 3H), 1.43 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 172.8, 159.5, 130.4, 126.2, 113.8, 111.5, 85.0, 73.3, 55.1, 52.7, 26.4, 25.9; **MS (ESI)** (*m/z*): 289 $[M+Na]^+$; **IR ($CHCl_3$)** ν_{max}: 2989, 1740, 1600 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{14}H_{18}O_5$ $[M+Na]^+$ 289.1154, found 289.1152.

1−(4−(4−Methoxyphenyl)−2,2−dimethyl−1,3−dioxolan−4−yl)hex−5−en−1−ol (±3a)



Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether), **Yield:** (0.910 g, 99%), **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.30 (d, J = 8.85 Hz, 2H), 6.85 (d, J = 8.85 Hz, 2H), 5.72 (ddt, J = 17.01, 10.25, 6.58 Hz, 1H), 4.98−4.87 (m, 2H), 4.39 (d, J = 8.59 Hz, 1H), 4.22 (d, J = 8.59 Hz, 1H), 3.81 (s, 3H), 3.63 (dd, J = 8.46, 1.45 Hz, 1H), 2.09 (br s, 1H), 2.03−1.92 (m, 2H), 1.67−1.61 (m, 1H), 1.50 (s, 3H), 1.44−1.21 (m, 2H), 1.21 (s, 3H), 1.11−1.01 (m, 1H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 158.7, 138.4, 133.7, 127.4, 114.5, 113.2, 109.6, 86.7, 75.5, 70.0, 55.0, 33.4, 30.4, 26.8, 26.0, 25.5; **MS (ESI)** (*m/z*): 329 $[M+Na]^+$; **IR ($CHCl_3$)** ν_{max}: 3445, 2829, 1606, 1461 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{18}H_{26}O_4$ $[M+Na]^+$ 329.1718, found 329.1723.

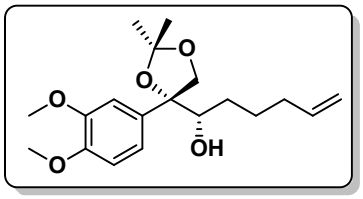
Methyl 4−(3,4−dimethoxyphenyl)−2,2−dimethyl−1,3−dioxolane−4−carboxylate (±4):



Column chromatography using 60–120 silica gel (8% ethyl acetate–petroleum ether), **Yield:** (0.832 g, 90%), **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 6.61 (d, J = 2.27 Hz, 2H), 6.36 (t, J = 2.27 Hz,

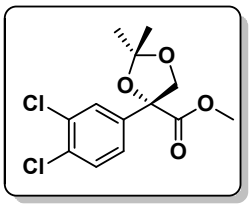
1H), 4.83 (d, J = 8.72 Hz, 1H), 3.93 (d, J = 8.72 Hz, 1H), 3.74 (s, 6H), 3.71 (s, 3H), 1.50 (s, 3H), 1.42 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 172.2, 160.7, 140.5, 111.5, 102.8, 99.9, 85.1, 73.0, 55.1, 52.7, 26.2, 25.4; **MS (ESI)** (*m/z*): 319 $[M+Na]^+$; **IR ($CHCl_3$)** ν_{max}: 2989, 1735, 1620 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{15}H_{20}O_6$ $[M+Na]^+$ 319.1262, found 329.1260.

1−(4−(3,4−Dimethoxyphenyl)−2,2−dimethyl−1,3−dioxolan−4−yl)hex−5−en−1−ol (±4a):



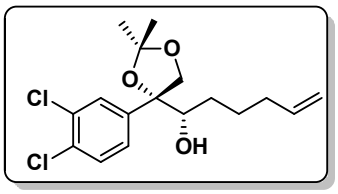
Column chromatography using 200–400 silica gel (12–15% ethyl acetate–petroleum ether), **Yield:** (0.898 g, 98%), **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 6.53 (d, J = 2.15 Hz, 2H), 6.37 (d, J = 2.15 Hz, 1H), 5.75 (ddt, J = 16.80, 10.23, 6.57 Hz, 1H), 5.03−4.83 (m, 2H), 4.36 (d, J = 8.59 Hz, 1H), 4.17 (d, J = 8.59 Hz, 1H), 3.78 (s, 6H), 3.62 (dd, J = 9.28, 5.24 Hz, 1H), 1.98 (br s, 1H), 2.03−1.96 (m, 2H), 1.74−1.57 (m, 2H), 1.49 (s, 3H), 1.43−1.30 (m, 2H), 1.24 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 160.4, 144.4, 138.5, 114.4, 109.9, 104.5, 98.9, 87.0, 75.7, 70.3, 55.2, 33.4, 30.5, 26.7, 25.8, 25.5; **MS (ESI)** (*m/z*): 359 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3494, 2936, 1600, 1158 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{19}H_{28}O_5$ $[M+Na]^+$ 359.1829, found 359.1829.

Methyl 4−(3,4−dichlorophenyl)−2,2−dimethyl−1,3−dioxolane−4−carboxylate (±5):



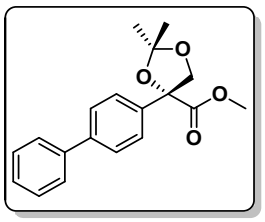
Column chromatography using 60–120 silica gel (8% ethyl acetate–petroleum ether), **Yield:** (0.829 g, 90%), **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.55 (d, J = 1.89 Hz, 1H), 7.38−7.28 (m, 2H), 4.77 (d, J = 8.84 Hz, 1H), 3.89 (d, J = 8.84 Hz, 1H), 3.69 (s, 3H), 1.47 (s, 3H), 1.38 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 171.9, 138.7, 132.8, 132.5, 130.4, 127.3, 124.5, 112.2, 84.2, 73.2, 53.1, 26.1, 25.7; **MS (ESI)** (*m/z*): 328 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3065, 1739, 756 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{13}H_{14}Cl_2O_4$ $[M+Na]^+$ 328.1534, found 328.1539.

1−(4−(3,4−Dichlorophenyl)−2,2−dimethyl−1,3−dioxolan−4−yl)hex−5−en−1−ol (±5a):



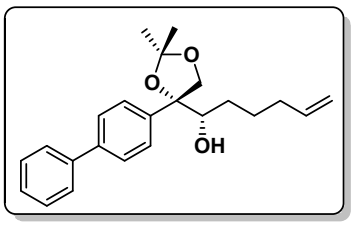
Column chromatography using 200–400 silica gel (12–15% ethyl acetate–petroleum ether), **Yield:** (0.752 g, 95%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.52 (d, J = 1.96 Hz, 1H), 7.42 (d, J = 8.31 Hz, 1H), 7.26−7.23 (m, 1H), 5.74 (ddt, J = 16.87, 10.21, 6.69 Hz, 1H), 4.98−4.90 (m, 2H), 4.42 (d, J = 8.80 Hz, 1H), 4.15 (d, J = 8.80 Hz, 1H), 3.64 (ddd, J = 10.39, 5.01, 1.47 Hz, 1H), 2.07−1.94 (m, 2H), 1.96 (br s, 1H), 1.59−1.54 (m, 1H), 1.50 (s, 3H), 1.42−1.30 (m, 2H), 1.24 (s, 3H), 1.03−0.95 (m, 1H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 142.2, 138.3, 132.2, 131.5, 129.9, 128.5, 125.8, 114.7, 110.3, 86.1, 75.5, 70.4, 33.3, 30.5, 26.7, 25.9, 25.3; **MS (ESI)** (*m/z*): 367 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3446, 2928, 1466, 759 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{17}H_{22}Cl_2O_3$ $[M+Na]^+$ 367.0838, found 367.0835.

Methyl 4−([1,1'−biphenyl]−4−yl)−2,2−dimethyl−1,3−dioxolane−4−carboxylate (±6):



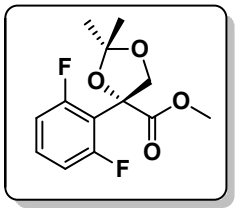
Column chromatography using 60–120 silica gel (10% ethyl acetate–petroleum ether), **Yield:** (0.825 g, 90%); **^{1}H NMR (200 MHz, $CDCl_3$):** δ 7.57 (s, 5H), 7.47−7.34 (m, 4H), 4.93 (d, J = 8.59 Hz, 1H), 4.04 (d, J = 8.59 Hz, 1H), 3.77 (s, 3H), 1.57 (s, 3H), 1.48 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 160.4, 144.4, 138.5, 114.4, 109.9, 104.5, 98.9, 87.0, 75.7, 70.3, 55.2, 33.4, 30.5, 26.7, 25.8, 25.5; **MS (ESI)** (*m/z*): 335 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3070, 1740, 1483 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{19}H_{20}O_4$$[M+Na]^+$ 367.3597, found 367.3595.

1−(4−([1,1'−Biphenyl]−4−yl)−2,2−dimethyl−1,3−dioxolan−4−yl)hex−5−en−1−ol (±6a):



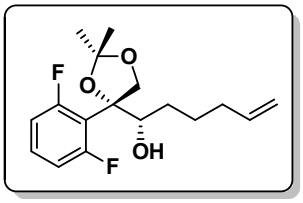
Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether), **Yield:** (0.939 g, 98%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.61−7.57 (m, 4H), 7.46−7.41 (m, 4H), 7.37−7.32 (m, 1H), 5.74 (ddt, J = 16.87, 10.21, 6.69 Hz, 1H), 4.90−4.96 (m, 2H), 4.45 (d, J = 8.80 Hz, 1H), 4.29 (d, J = 8.80 Hz, 1H), 3.70 (ddd, J = 10.39, 4.89, 1.59 Hz, 1H), 2.01 (br s, 1H), 2.07−1.93 (m, 2H), 1.62−1.55 (m, 2H), 1.53 (s, 3H), 1.43−1.33 (m, 1H), 1.25 (s, 3H), 1.11−1.02 (m, 1H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ 140.7, 140.6, 140.2, 138.5, 128.7, 127.3, 127.0, 126.78, 126.71, 114.5, 109.9, 87.0, 75.7, 70.0, 33.4, 30.4, 26.8, 26.1, 25.5; **MS (ESI)** (*m/z*): 375 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3457, 3070, 2930, 1641 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{23}H_{28}O_3$ $[M+Na]^+$ 375.1921, found 375.1923.

Methyl 4−(2,6−difluorophenyl)−2,2−dimethyl−1,3−dioxolane−4−carboxylate (±7):



Column chromatography using 60–120 silica gel (10% ethyl acetate–petroleum ether), **Yield:** (0.862 g, 92%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.36−7.14 (m, 1H), 6.95−6.86 (m, 2H), 4.82 (dt, J = 9.47, 2.02 Hz, 1H), 4.44 (dt, J = 9.47, 1.03 Hz, 1H), 3.76 (s, 3H), 1.61 (s, 3H), 1.40 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 171.2, 163.1 (d, J_{C-F} = 251.7 Hz, 1C), 158.1 (d, J_{C-F} = 252.1 Hz, 1C), 130.1 (t, J = 11.13 Hz, 1C), 115.5 (d, J = 16.10 Hz, 1C), 112.4 (d, J = 2.56 Hz, 1C), 111.9 (d, J = 2.56 Hz, 1C), 111.7, 81.8, 72.2 (t, J = 7.32 Hz, 1C), 53.0, 26.3, 25.3; **MS (ESI)** (*m/z*): 295 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 1740, 1625, 1462, 1065 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{13}H_{14}F_2O_4$ $[M+Na]^+$ 295.0860, found 295.0862.

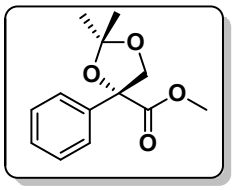
1−(4−(2,6−Difluorophenyl)−2,2−dimethyl−1,3−dioxolan−4−yl)hex−5−en−1−ol (±7a):



Column chromatography using 200–400 silica gel (15% ethyl acetate–petroleum ether); **Yield:** (0.908 g, 99%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.30−7.11 (m, 1H), 6.87 (dd, J = 9.79, 8.40 Hz, 2H), 5.76 (ddt, J = 17.04, 10.25, 6.63 Hz, 1H), 5.01−4.83 (m, 2H), 4.44 (dt, J = 9.72, 2.15 Hz, 1H), 4.35 (dt, J = 9.72, 1.14 Hz, 1H), 3.75 (dd, J = 8.97, 5.05 Hz, 1H), 2.05 (br s, 1H), 1.89−2.17 (m, 2H), 1.71−1.58 (m, 2H), 1.54 (s, 3H), 1.46−1.29 (m, 2H), 1.25 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 163.1 (d, J_{C-F} = 248.4 Hz, 1C), 158.1 (d, J_{C-F} = 249.5 Hz, 1C), 138.5, 129.2 (t, J = 11.16 Hz, 1C), 118.8 (d, J = 20.50 Hz, 1C), 114.6, 112.5 (d, J = 2.56 Hz, 1C), 111.9 (d, J = 2.56

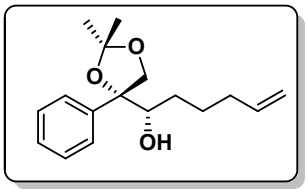
Hz, 1C), 109.6, 86.0 (d, J = 4.03 Hz, 1C), 75.3, 70.2 (t, J = 8.05 Hz, 1C), 33.4, 30.0, 26.3, 25.4, 24.4; **MS (ESI)** (*m/z*): 335 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3454, 2989, 1625, 1065 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{17}H_{22}F_2O_3$ $[M+Na]^+$ 335.1427, found 335.1429.

Methyl 2,2−dimethyl−4−phenyl−1,3−dioxolane−4−carboxylate (±8)[1b]**:**



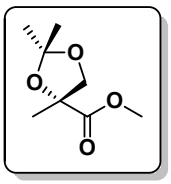
Column chromatography using 60–120 silica gel (10% ethyl acetate–petroleum ether); **Yield:** (0.535 g, 89%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.50−7.42 (m, 2H), 7.40−7.32 (m, 3H), 4.88 (d, J = 8.72 Hz, 1H), 3.97 (d, J = 8.72 Hz, 1H), 3.74 (s, 3H), 1.54 (s, 3H), 1.45 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 172.7, 138.3, 128.4, 128.2, 124.9, 111.7, 85.3, 73.3, 52.8, 26.4, 25.8; **MS (ESI)** (*m/z*): 236 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3075, 1736, 1625 cm^{-1}; **HRMS (ESI):** Calculated for $C_{13}H_{16}O_4$ $[M+Na]^+$ 236.2637, found 236.2635.

1−(2,2−Dimethyl−4−phenyl−1,3−dioxolan−4−yl)hex−5−en−1−ol (±8a):



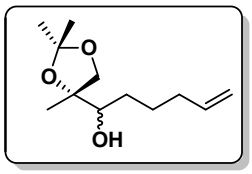
Column chromatography using 60–120 silica gel (15% ethyl acetate–petroleum ether), **Yield:** (0.458 g, 98%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.30−7.16 (m, 5H), 5.62 (ddt, J = 17.01, 10.25, 6.58 Hz, 1H), 4.87−4.76 (m, 2H), 4.31 (d, J = 8.59 Hz, 1H), 4.12 (d, J = 8.59 Hz, 1H), 3.54 (dd, J = 10.29, 3.35 Hz, 1H), 1.95−1.82 (m, 2H), 1.89 (br s, 1H), 1.57−1.45 (m, 1H), 1.41 (s, 3H), 1.38−1.17 (m, 2H), 1.11 (s, 3H), 1.01−0.86 (m, 1H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 141.7, 138.5, 127.9, 127.3, 126.2, 114.4, 109.8, 87.0, 75.6, 70.0, 33.4, 30.4, 26.8, 25.9, 25.4; **MS (ESI)** (*m/z*): 299 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}**:** 3494, 2989, 1462 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{17}H_{24}O_3$ $[M+Na]^+$ 299.1618, found 299.1613.

Methyl−2,2,4−trimethyl−1,3−dioxolane−4−carboxylate (±9)[2] :



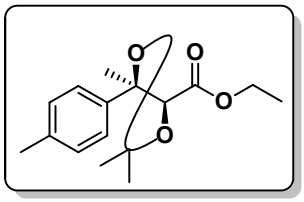
Column chromatography using 60–120 silica gel (8% ethyl acetate–petroleum ether); **Yield:** (0.603 g, 93%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 4.38 (d, J = 8.72 Hz, 1H), 3.79 (d, J = 8.71 Hz, 1H), 3.78 (s, 3H), 1.44 (s, 3H), 1.36 (d, J =2.53 Hz, 6H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 173.9, 110.9, 81.0, 72.7, 52.2, 26.3, 25.7, 22.8; **MS (ESI)** (*m/z*): 197 $[M+Na]^+$.

1− (2,2,4−Trimethyl−1,3−dioxolan−4−yl)hex−5−en−1−ol (±9a)



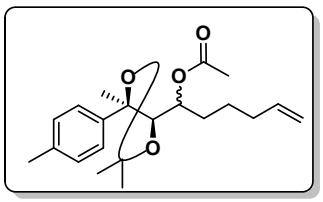
Column chromatography using 200–400 silica gel (08% ethyl acetate–petroleum ether); **Yield:** (0.482 g, 98%); **^{1}H NMR (200 MHz, $CDCl_3$)**: first diastereomer δ 5.80 (ddt, J = 16.89, 10.26, 6.63 Hz, 1H), 5.08−4.87 (m, 2H), 4.02 (d, J = 8.34 Hz, 1H), 3.65 (d, J = 8.46 Hz, 1H), 3.53 (d, J = 10.36 Hz, 1H), 2.28 (br s, 1H), 1.43 (s, 3 H), 1.36 (s, 3H), 2.15−1.97 (m, 2H), 1.78−1.48 (m, 2H), 1.44−1.13 (m including s at 1.24 for 3H, 5H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 138.5, 114.7, 109.2, 83.8, 74.3, 70.0, 33.5, 30.5, 27.4, 26.5, 25.8, 21.7; **MS (ESI)** (*m/z*): 237 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3478, 1620 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{12}H_{22}O_3[M+Na]^+$ 237.1461, found 237.1460.

Ethyl−2,2,5−trimethyl−5−(*p*−tolyl)−1,3−dioxolane−4−carboxylate (±10)



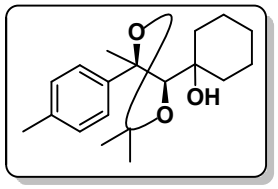
Column chromatography using 60–120 silica gel (8% ethyl acetate–petroleum ether); **Yield:** (0.743 g, 79%); **^{1}H NMR (500 MHz, $CDCl_3$)**: (*dr*: 9.5:0.5) δ 7.86 (d, J = 8.55 Hz, 0.09H), 7.46 (d, J = 8.24 Hz, 1.92H), 7.30 (d, J = 8.55 Hz, 0.09H), 7.17 (d, J = 8.24 Hz, 1.92H), 4.70 (s, 1H), 4.36−4.28 (m, 2H), 2.35 (s, 3H), 1.67 (s, 3H), 1.50 (s, 3H), 1.38 (s, 3H), 1.34 (t, J = 7.02 Hz, 3H); **^{13}C NMR (125 MHz, $CDCl_3$)** of major isomer: δ 169, 142.1, 136.9, 128.8, 125.1, 110.1, 84.3, 83.1, 61.3, 28.0, 26.3, 25.6, 20.9; 14.1, **MS (ESI)** (*m/z*): 301 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 1735, 1615, 1455 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{16}H_{22}O_4$ $[M+Na]^+$301. 3435, found 301. 3439.

1−(2,2,5−Trimethyl−5−(*p*−tolyl)−1,3−dioxolan−4−yl)hex−5−en−1−yl acetate (±10'a)



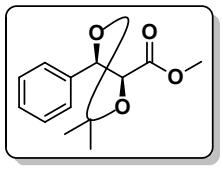
Column chromatography using 200–400 silica gel (5% ethyl acetate–petroleum ether); **Yield:** 53%, **^{1}H NMR (400 MHz, $CDCl_3$)**: (*dr*: 8:2) δ 7.40 (d, J =7.78 Hz, 0.18H), 7.35 (d, J = 8.70 Hz, 1.82H), 7.16 (d, J = 8.70 Hz, 1.67 H), 7.11 (d, J = 7.78 Hz, 0.33H), 5.64 (ddt, J = 16.89, 10.48, 6.70, 1H), 5.28−5.22 (m, 1H), 4.94−4.86 (m, 2H), 3.90 (d, J = 4.58 Hz, 0.80H), 3.80 (d, J = 8.70 Hz, 0.20H), 2.34 (s, 3H), 2.12 (s, 3H), 1.96−1.84 (m, 2H), 1.58 (s, 3H), 1.50 (s, 3H), 1.49 (s, 3H), 1.31−1.28 (m, 2H), 1.22−1.15 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)** of major isomer: δ 170.7, 140.6, 138.1, 137.1, 129.1, 125.4, 114.8, 107.6, 84.4, 83.0, 70.1, 33.2, 31.7, 28.5, 26.5, 24.2, 21.9, 21.3, 20.9; **MS (ESI)** (*m/z*): 369 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 1735, 1615, 1455 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{21}H_{30}O_4$ $[M+Na]^+$369.4605, found 369. 4608.

1−(2,2,5−Trimethyl−5−(p−tolyl)−1,3−dioxolan−4−yl)cyclohexanol (±10b)



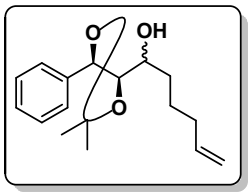
Column chromatography using 200–400 silica gel (8% ethyl acetate–petroleum ether); **Yield:** 43%, **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.40 (d, J = 8.70 Hz, 2H), 7.14 (d, J = 8.70 Hz, 2H), 3.79 (s, 1H), 2.33 (s, 3H), 2.01 (brs, 1H), 1.82−1.61 (m for 2H, containing s at 1.73 corresponds to 3H), 1.57 (s, 3H), 1.56 (s, 3H), 1.52−1.34 (m, 6H), 1.11−1.03 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ 140.7, 136.8, 128.7, 126.7, 106.2, 88.7, 83.4, 71.1, 38.0, 32.5, 28.6, 26.9, 25.4, 21.9, 21.4, 21.1, 20.9; **MS (ESI)** (*m/z*): 327 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3435, 1615, 1515 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{19}H_{28}O_3$ $[M+Na]^+$327. 1934, found 327. 1931.

Methyl 2,2−dimethyl−5−phenyl−1,3−dioxolane−4−carboxylate (11)



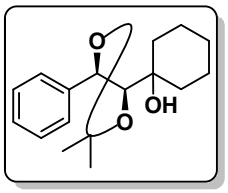
Data tabulated in experimental section IV

1−(2,2−Dimethyl−5−phenyl−1,3−dioxolan−4−yl)hex−5−en−1−yl acetate (11a)



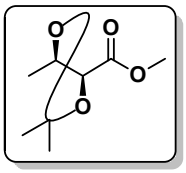
Data tabulated in experimental section IV

1−(2,2−Dimethyl−5−phenyl−1,3−dioxolan−4−l)cyclohexanol (11b)



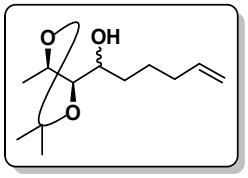
Data tabulated in experimental section IV

Methyl−2,2,5−trimethyl−1,3−dioxolane−4−carboxylate (±12)[4]



Column chromatography using 60–120 silica gel (10% ethyl acetate–petroleum ether); **Yield:** (0.459 g, 70%), **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 4.22−4.09 (m, 1H), 4.02 (d, J = 7.96 Hz, 1H), 3.74 (s, 3H), 1.42−1.38 (m, 9H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 170.7, 110.4, 80.2, 74.9, 52.1, 26.9, 25.5, 18.3; **MS (ESI)** (*m/z*): 197 $[M+Na]^+$.

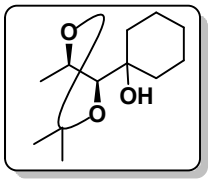
1−((4*R*,5*R*)−2,2,5−Trimethyl−1,3−dioxolan−4−yl)hex−5−en−1−ol (±12a)



Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether); **Yield:** (0.225 g, 46%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 5.82 (ddt, J = 16.80, 10.10, 6.57 Hz, 1H), 5.07−4.95 (m, 2H), 4.12−3.99 (m, 1H), 3.48−3.43 (m, 2H), 2.19−2.06 (m, 3H), 1.64−1.48 (m,

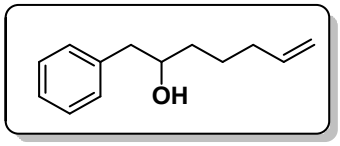
4H), 1.43 (s, 3H), 1.40 (s, 3H), 1.30 (d, J = 6.06 Hz, 3H). **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 138.5, 114.7, 108.4, 85.2, 73.2, 69.9, 34.2, 33.5, 27.4, 26.9, 24.9, 18.0; **MS (ESI)** (*m/z*): 269 $[M+Na+MeOH]^+$; **IR ($CHCl_3$)**ν_{max} : 3435, 1620 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{12}H_{22}O_3$ $[M+Na]^+$ 237.3013, found 237.3016.

1−(2,2,5−Trimethyl−1,3−dioxolan−4−yl)cyclohexanol (±12b)



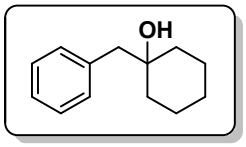
Column chromatography using 200–400 silica gel (10% ethyl acetate–petroleum ether); **Yield:** (0.196 g, 40%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 4.14 (dq, J = 8.07, 6.03 Hz, 1H), 3.44 (d, J = 8.07 Hz, 1H), 1.75−1.48 (m, 8H), 1.40 (s, 3H), 1.39 (s, 3H), 1.32 (d, J = 6.06 Hz, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 107.7, 88.0, 72.0, 69.9, 36.0, 32.5, 27.4, 26.9, 25.6, 21.3, 20.1; **MS (ESI)** (*m/z*): 237 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3435, 2850 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{12}H_{22}O_3$ $[M+Na]^+$ 237.3013, found 237.3013.

1−Phenylhept−6−en−2−ol (13a) [5]



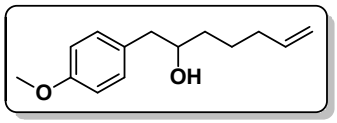
Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether); **Yield:** (0.162 g, 32%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.39−7.22 (m, 5H), 5.85 (ddt, J = 16.80, 10.11, 6.57 Hz, 1H), 5.09−4.94 (m, 2H), 3.91−3.79 (m, 1H), 2.88 (dd, J=13.52, 4.30 Hz, 1H), 2.77−2.61 (m, 1H), 2.16−2.06 (m, 2H), 1.70−1.62 (m, 2H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 138.6, 138.5, 129.4, 128.5, 126.4, 114.6, 72.5, 44.0, 36.2, 33.6, 25.0; **MS (ESI)** (*m/z*): 213 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3445, 2928 cm^{-1}.

1−Benzylcyclohexanol (13b) [5]



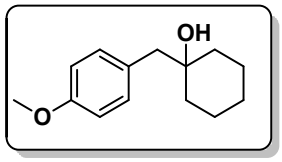
Column chromatography using 200–400 silica gel (10% ethyl acetate–petroleum ether); **Yield:** (0.314 g, 62%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.39−7.23 (m, 5H), 2.78 (s, 2H), 1.82 (br s, 1H), 1.66−1.26 (m, 10H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 137.1, 127.9, 126.2, 71.0, 48.6, 37.1, 25.6, 21.9; **MS (ESI)** (*m/z*): 191 $[M+1]^+$.

1−(4−Methoxyphenyl)hept−6−en−2−ol (14a):



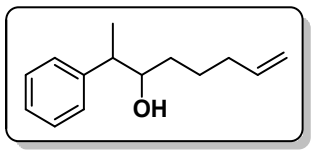
Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether); **Yield:** (0.180 g, 37%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.11 (d, J = 8.59 Hz, 2H), 6.84 (d, J = 8.59 Hz, 2H), 5.81 (ddt, J = 16.93, 10.11, 6.57 Hz, 1H), 3.79 (s, 3H), 3.76 (br s, 1H), 3.81−3.70 (m, 1H), 2.77 (dd, J = 13.77, 4.29 Hz, 1H), 2.67−2.51 (m, 1H), 2.11−2.03 (m, 2H), 1.54−1.47 (m, 4H), 5.05−4.92 (m, 2H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 158.2, 138.6, 130.4, 130.3, 114.5, 113.9, 72.5, 55.2, 43.1, 36.1, 33.6, 25.0; **MS (ESI)** (*m/z*): 243 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3454, 1590, 1420 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{14}H_{20}O_2$ $[M+Na]^+$ 243.2274, found 243.2272.

1−(4−Methoxybenzyl)cyclohexanol (14b)



Column chromatography using 200–400 silica gel (10% ethyl acetate–petroleum ether); **Yield**: (0.293 g, 60%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.11 (d, J = 8.59 Hz, 2H), 6.82 (d, J = 8.59 Hz, 2H), 3.79 (s, 3H), 2.67 (s, 2H), 1.64−1.22 (m, 10H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 158.3, 131.5, 129.0, 113.6, 71.0, 55.1, 47.8, 37.3, 25.8, 22.1; **MS (ESI)** (*m/z*): 243 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3435, 2985, 1620 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{14}H_{20}O_2$ $[M+Na]^+$ 243.2274, found 243.2270.

2−Phenyloct−7−en−3−ol (±15a)[6]:



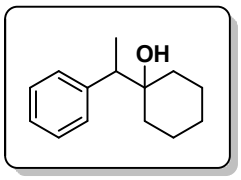
Column chromatography using 200–400 silica gel (10−12% ethyl acetate–petroleum ether); **Yield:** (0.422 g, 68%); (*dr*: 6:4)

1st diast **Yield:** (0.279 g, 45%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.37−7.22 (m, 5H). 5.82 (ddt, J = 16.82, 10.26, 6.63 Hz, 1H), 5.07−4.93 (m, 2H), 3.67 (t, J = 7.58 Hz, 1H), 2.82−2.68 (m, 1H), 2.10−2.03 (m, 2H), 1.67−1.55 (m, 2H), 1.49−1.39 (m, 2H), 1.28 (d, J = 7.58 Hz, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 143.4, 138.7, 128.5, 128.1, 126.6, 114.5, 75.8, 46.1, 33.8, 33.7, 24.9, 17.9; **MS (ESI)** (*m/z*): 227 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3433, 2930, 1602, 1494 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{14}H_{20}O$ $[M+Na]^+$ 227.1406, found 227.1404.

2nd diast. **Yield:** (0.142 g, 23%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.40−7.23 (m, 5H), 5.81 (ddt, J = 16.99, 10.23, 6.66 Hz, 1H), 5.07−4.93 (m, 2H), 3.75−3.66 (m, 1H), 2.88−2.75 (m, 1H),

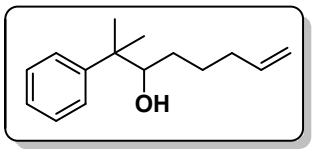
2.11−2.01 (m, 2H), 1.64−1.42 (m, 4H), 1.37 (d, J = 7.07 Hz, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 144.5, 138.6, 128.4, 128.1, 127.7, 126.3, 114.4, 76.0, 45.5, 34.0, 33.5, 25.3, 15.3.

1−(1−Phenylethyl)cyclohexanol (15b) [6]



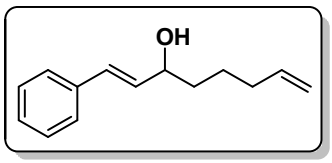
Column chromatography using 200–400 silica gel (8% ethyl acetate–petroleum ether); **Yield:** (0.180 g, 29%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.35−7.18 (m, 5H), 2.76 (q, J = 7.24 Hz, 1H), 1.71−1.45 (m, 6H), 1.33 (d, J = 7.24 Hz, 3H), 1.49−1.32 (m, 2H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 143.4, 129.0, 127.9, 126.3, 72.6, 49.5, 36.0, 34.6, 25.7, 21.9, 14.8; **MS (ESI)** (*m/z*): 227 $[M+Na]^+$.

2−Methyl−2−phenyloct−7−en−3−ol (16a):



Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether); **Yield:** (0.514 g, 89%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.41−7.22 (m, 5H), 5.78 (ddt, J = 16.80, 10.11, 6.57 Hz, 1H), 5.02−4.89 (m, 2H), 3.61 (d, J = 9.85 Hz, 1H), 2.12−1.97 (m, 2H), 1.69−1.38 (m, 4H), 1.34 (s, 3H), 1.32 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 147.1, 138.7, 128.2, 126.4, 126.0, 114.4, 79.4, 42.6, 33.6, 30.8, 26.2, 24.2, 23.4; **MS (ESI)** (*m/z*): 219 $[M+1]^+$; **IR ($CHCl_3$)** ν_{max}: 3422, 2930, 1452 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{15}H_{22}O$ $[M+Na]^+$ 241.1563, found 241.1560.

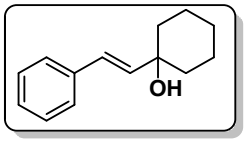
(*E*)−1−Phenylocta−1,7−dien−3−ol (17a) [8]**:**



Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether); **Yield:** (0.149 g, 30%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.41−7.23 (m, 5H), 6.58 (d, J = 15.91 Hz, 1H), 6.22 (dd, J = 15.91, 6.82 Hz, 1H), 5.82 (ddt, J = 16.80, 9.98, 6.82 Hz, 1H), 5.06−4.93 (m, 2H), 4.34−4.25 (m, 1H), 2.16−2.03 (m, 2H), 1.69−1.63 (m, 2H), 1.53−1.45 (m, 2H); **^{13}C NMR (50**

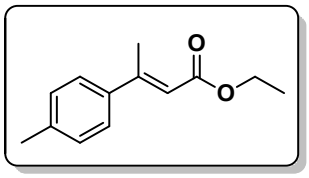
MHz, $CDCl_3$): δ 138.5, 136.6, 132.4, 130.3, 128.5, 127.6, 126.4, 114.7, 72.9, 36.7, 33.6, 24.7; **MS (ESI)** (*m/z*): 225 $[M+Na]^+$.

(*E*)−1−Styrylcyclohexanol (17b) [8]



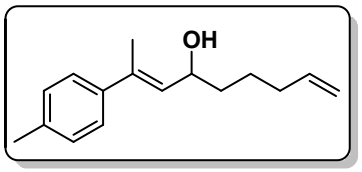
Column chromatography using 200–400 silica gel (10% ethyl acetate–petroleum ether); **Yield:** (0.333 g, 67%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.36−7.17 (m, 5H), 6.59 (d, J = 16.16 Hz, 1H), 6.27 (d, J = 16.16 Hz, 1H), 1.62−1.45 (m, 10H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 137.4, 137.1, 128.5, 127.3, 127.0, 126.4, 71.6, 38.0, 25.5, 22.1; **MS (ESI)** (*m/z*): 225 $[M+Na]^+$.

(*E*)−Methyl 3−(*p*−tolyl)but−2−enoate (18) [9]



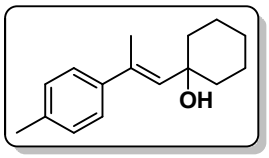
Column chromatography using 60–120 silica gel (10% ethyl acetate–petroleum ether); **Yield:** (0.659 g, 82%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.39 (d, J = 8.33 Hz, 2H), 7.16 (d, J = 8.33 Hz, 2H), 6.13 (d, J = 1.14 Hz, 1H), 4.20 (q, J = 7.14 Hz, 2H), 2.56 (d, J = 1.26 Hz, 3H), 2.35 (s, 3H), 1.31 (t, J = 7.14 Hz, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 166.9, 155.3, 139.1, 139.0, 129.1, 126.1, 116.1, 59.6, 21.0, 17.7, 14.2; **MS (ESI)** (*m/z*): 231 $[M+1]^+$.

(*E*)−2−(*p*−Tolyl)nona−2,8−dien−4−ol (18a):



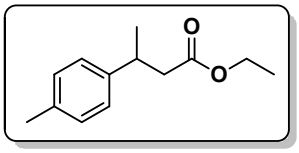
Column chromatography using 200–400 silica gel (8% ethyl acetate–petroleum ether); **Yield:** (0.146 g, 37%), **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.29 (d, J = 8.07 Hz, 1.69H), 7.21 (d, J = 10.27 Hz, 0.32H), 7.12 (d, J = 8.07 Hz, 1.86H), 7.06 (d, J = 10.27 Hz, 0.24H), 5.81 (ddt, J = 16.87, 10.03, 6.60 Hz, 1H), 5.73 (d, J = 8.56 Hz, 1H), 5.03−4.94 (m, 2H), 4.55−4.50 (m, 1H), 2.33 (s, 3H), 2.07 (s, 3H), 2.13−2.02 (m, 1H), 1.70 (br s, 1H), 1.67−1.55 (m, 1H), 1.53−1.44 (m, 4H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 139.9, 138.5, 136.9, 136.7, 129.9, 128.8, 125.5, 114.5, 68.8, 37.0, 33.6, 24.6, 20.9, 16.2; **MS (ESI)** (*m/z*): 253 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3422 cm^{-1}; **HRMS (ESI):** Calculated for $C_{16}H_{22}O$ $[M+Na]^+$ 253.3453, found 253.3451.

(*E*)−1−(2−(*p*−Tolyl)prop−1−en−1−yl)cyclohexanol (18b) [9]



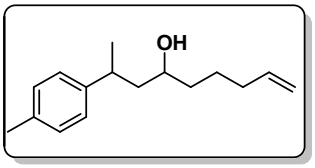
Column chromatography using 200–400 silica gel (8% ethyl acetate–petroleum ether); **Yield:** (0.235 g, 58%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.29 (d, J = 8.34 Hz, 2H), 7.12 (d, J = 8.34 Hz, 2H), 5.80 (d, J = 1.26 Hz, 1H), 2.34 (s, 3H), 2.29 (d, J = 1.26 Hz, 3H), 1.79−1.46 (m, 10H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 141.9, 138.0, 136.5, 133.5, 128.8, 125.7, 72.1, 39.3, 25.4, 22.6, 20.9, 17.1; **MS (ESI)** (*m/z*): 253[M+Na]$^+$.

Ethyl 3−(*p*−tolyl)butanoate (19) [10]



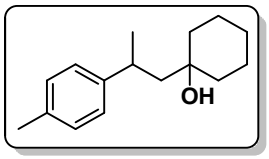
Column chromatography using 60–120 silica gel (10% ethyl acetate–petroleum ether); **Yield:** (0.494 g, 98%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.18−6.96 (m, 4H), 4.06 (q, J = 7.20 Hz, 2H), 3.39−3.09 (m, 1H), 2.67−2.40 (m, 2H), 2.29 (s, 3H), 1.27 (d, J = 6.95 Hz, 3H), 1.17 (t, J = 7.14 Hz, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 172.2, 142.5, 135.5, 128.9, 126.4, 59.9, 42.8, 35.9, 21.6, 20.7, 13.9; **MS (ESI)** (*m/z*): 229 [M+Na]$^+$.

2−(*p*−Tolyl)non−8−en−4−ol (±19a):



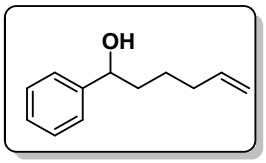
Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether); **Yield:** (0.106 g, 29%); **^{1}H NMR (200 MHz, $CDCl_3$)**: (*dr*: 6:**4**) δ 7.11−7.10 (m, 4H), 5.78 (ddt, J = 16.79, 10.07, 6.72 Hz, 1H), 5.02−4.91 (m, 2H), 3.65−3.61 (m, 0.74H), 3.34−3.30 (m, 0.26H), 3.01−2.92 (m, 0.37H), 2.90−2.83 (m, 0.63H), 2.32 (s, 3H), 2.35−2.31 (m, 1H), 2.06 (br s, 1H), 2.02−1.98 (m, 1H), 1.74−1.64 (m, 2H), 1.56−1.48 (m, 2H), 1.43−1.37 (m, 2H), 1.25 (d, J = 6.95 Hz, 3H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ 144.3, **144.6**, 138.7, **138.6**, 135.6, **135.4**, 129.2, **129.1**, **126.9**, 126.7, 114.56, **114.53**, 70.1, **69.5**, 46.2, **45.7**, **37.4**, 37.0, 36.4, **35.9**, 33.6, **32.7**, **25.7**, 24.7, 22.1, **20.9**; **MS (ESI)** (*m/z*): 255 [M+Na]$^+$; **IR ($CHCl_3$)**ν_{max}: 3445, 2928 cm^{-1}; **HRMS (ESI):** Calculated for $C_{16}H_{24}O$ [M+Na]$^+$ 255.1719, found 255.1715.

1−(2−(*p*−Tolyl)propyl)cyclohexanol (19b)



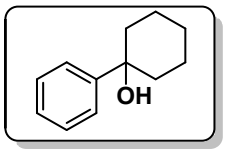
Column chromatography using 200–400 silica gel (10% ethyl acetate–petroleum ether); **Yield**: (0.226 g, 62%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.18−7.08 (m, 4H), 3.03−2.90 (m, 1H), 2.31 (s, 3H), 1.93 (dd, J = 14.53, 8.85 Hz, 1H), 1.74 (dd, J = 14.53, 4.80 Hz, 1H), 1.59−1.37 (m, 8H), 1.25 (d, J = 6.95 Hz, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 145.1, 135.4, 129.3, 126.9, 71.9, 50.8, 38.1, 37.8, 34.7, 25.7, 25.2, 22.1, 22.0, 20.9; **MS (ESI)** (*m/z*): 255 $[M+Na]^+$; **IR ($CHCl_3$)** ν_{max}: 3445, 2928, 1610 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{16}H_{24}O$ $[M+Na]^+$ 255.1719, found 255.1715.

1−Phenylhex−5−en−1−ol (20a) [11]



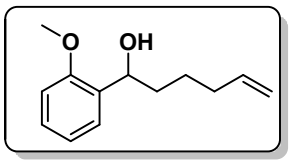
Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether); **Yield**: (0.398 g, 77%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.32−7.20 (m, 5H), 5.72 (ddt, J = 17.01, 10.22, 6.66 Hz, 1H), 4.98−4.86 (m, 2H), 4.59 (dd, J = 7.14, 5.87 Hz, 1H), 2.07−1.92 (m, 2H), 1.95 (br s, 1H), 1.85−1.57 (m, 2H), 1.52−1.21 (m, 2H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 144.8, 138.4, 128.4, 127.5, 125.8, 114.8, 74.4, 38.5, 33.6, 25.0; **MS (ESI)** (*m/z*): 199 $[M+Na]^+$.

1−Phenylcyclohexanol (20b) [11]



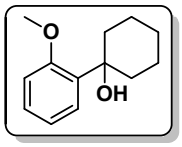
Column chromatography using 200–400 silica gel (10% ethyl acetate–petroleum ether); **Yield**: (0.113 g, 22%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.48−7.41 (m, 2H), 7.35−7.19 (m, 3H), 1.82−1.55 (m, 10H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 149.4, 128.1, 126.6, 124.5, 73.0, 38.8, 25.6, 22.2; **MS (ESI)** (*m/z*): 199 $[M+Na]^+$.

1−(2−Methoxyphenyl)hex−5−en−1−ol (21a):



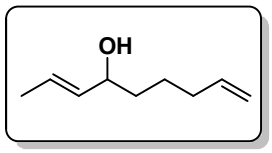
Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether); **Yield:** (0.337 g, 68%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.29−7.16 (m, 2H), 6.96−6.81 (m, 2H), 5.79 (ddt, J = 16.81, 10.11, 6.57 Hz, 1H), 5.02−4.81 (m, 3H), 3.83 (s, 3H), 2.60 (br s, 1H), 2.12−1.80 (m, 2H), 1.78−1.70 (m, 2H), 1.57−1.33 (m, 2H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 156.3, 138.7, 132.7, 128.0, 126.8, 120.7, 114.5, 110.3, 70.3, 55.1, 36.7, 33.6, 25.2; **MS (ESI)** (*m/z*): 229 $[M+Na]^+$; **IR ($CHCl_3$)ν_{max}:** 3454 cm^{-1}; **HRMS (ESI):** Calculated for $C_{13}H_{18}O_2$ $[M+Na]^+$ 229.1197, found 229.1199.

1−(2−Methoxyphenyl)cyclohexanol (21b) [11]**:**



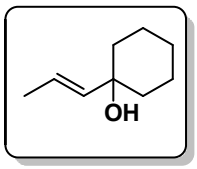
Column chromatography using 200–400 silica gel (10% ethyl acetate–petroleum ether); **Yield:** (0.148 g, 30%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.31−7.14 (m, 2H), 6.95−6.86 (m, 2H), 3.88 (s, 3H), 2.03−1.53 (m, 10H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ 157.2, 136.5, 127.8, 125.7, 121.1, 111.3, 72.9, 55.2, 36.7, 26.0, 21.9; **MS (ESI)** (*m/z*): 229 $[M+Na]^+$; **IR ($CHCl_3$)ν_{max}**: 3454, 2963, 1620 cm^{-1}; **HRMS (ESI):** Calculated for $C_{13}H_{18}O_2$ $[M+Na]^+$ 229.1197, found 229.1196.

(*E*)−Nona−2,8−dien−4−ol (22a) [12]



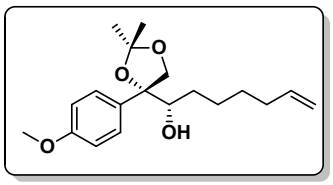
Column chromatography using 200–400 silica gel (10% ethyl acetate–petroleum ether); **Yield:** (0.151 g, 33%); **^{1}H NMR (200 MHz, $CDCl_3$)**: (*E:Z*: 7:**3**) δ 5.88−5.40 (m, 3H), 5.04−4.09 (m, 2H), 4.06−3.97 (m, 1H), 2.11−2.01 (m, 2H), 1.70 (d, J = 5.43 Hz, 3H), 1.54−1.45 (m, 4H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ **139.1**, 138.6, 134.4, 126.6, **126.3**, 114.7, 72.9, **38.1**, 36.7, **25.6**, 24.8, **22.7**, 22.5, **17.9**, 17.7; **MS (ESI)** (*m/z*): 163 $[M+Na]^+$.

(*E*)−1−(Prop−1−en−1−yl)cyclohexanol (22b) [12]



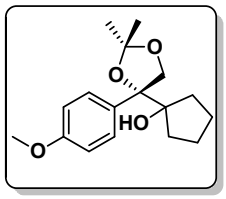
Column chromatography using 200–400 silica gel (10% ethyl acetate–petroleum ether); **Yield:** (0.288 g, 60%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 5.76−5.51 (m, 2H), 1.69 (d, J = 5.05 Hz, 3H), 1.64−1.43 (m, 10H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ 139.1, 122.5, 71.1, 38.0, 25.6, 22.2, 17.8; **MS (ESI)** (*m/z*): 163 $[M+Na]^+$.

1−(4−(4−Methoxyphenyl)−2,2−dimethyl−1,3−dioxolan−4−yl)hept−6−en−1−ol (±23a):



Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether); **Yield:** (0.615 g, 93%); **^{1}H NMR (200 MHz, $CDCl_3$):** (*dr*: 7:**3**) δ 7.28 (d, J = 9.10 Hz, 2H), 6.85 (d, J = 9.10 Hz, 2H), 5.84−5.67 (m, 1H), 4.98−4.85 (m, 2H), 4.45 (d, J = 8.33 Hz, 0.25H), 4.37 (d, J = 8.59 Hz, 0.75H), 4.20 (d, J = 8.59 Hz, 0.75H), 4.10 (d, J = 8.33 Hz, 0.25H), 3.78 (s, 3H), 3.66−3.56 (m, 1H), 2.00 (br s, 1H), 2.03−1.82 (m, 2H), 1.62−1.55 (m, 2H), 1.49 (s, 3H), 1.42−1.26 (m, 4H), 1.19 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ 158.9, **158.7**, **138.8**, 138.7, **134.9**, 133.7, 127.5, **126.7**, 114.48, **114.41**, **113.5**, 113.4, **110.1**, 109.7, **87.2**, 86.9, **76.4**, 75.8, **72.7**, 69.8, 55.1, 33.7, **32.8**, **31.7**, 30.8, 28.7, 27.0, 26.2, 25.8, **25.7**; **MS (ESI)** (*m/z*): 343 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3435 cm^{-1}; **HRMS (ESI):** Calculated for $C_{19}H_{28}O_4$ $[M+Na]^+$ 343.1880, found 343.1882.

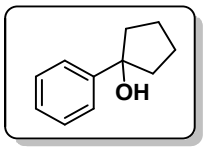
1−(4−(4−Methoxyphenyl)−2,2−dimethyl−1,3−dioxolan−4−yl)cyclopentan−1−ol (±24b):



Column chromatography using 200–400 silica gel (15% ethyl acetate–petroleum ether); **Yield:** (0.519 g, 91%); **^{1}H NMR (200 MHz, $CDCl_3$):** δ 7.32 (d, J = 8.85 Hz, 1H), 6.82 (d, J = 8.85 Hz, 1H), 4.46 (d, J = 8.46 Hz, 1H), 4.22 (d, J = 8.46 Hz, 1H), 3.79 (s, 3H), 1.79−1.66 (m, 5H), 1.50 (s, 3H), 1.56−1.42 (m, 3H), 1.16 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ 158.7, 135.4, 128.0, 112.9, 109.9, 87.5, 85.3, 72.1, 55.1, 35.7, 35.0, 26.5, 25.7, 24.0, 23.6; **MS (ESI)** (*m/z*): 315

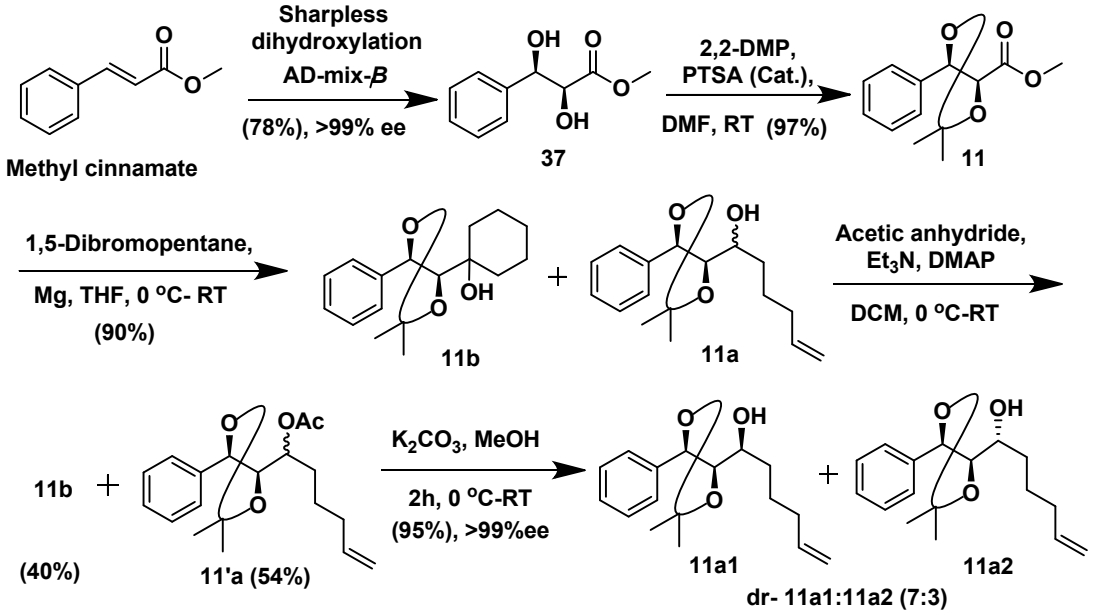
$[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3435, 1620, 1405 cm^{-1}; **HRMS (ESI):** Calculated for $C_{17}H_{24}O_4$ $[M+Na]^+$ 315.1675, found 315.1678.

1−Phenylcyclopentanol (25b) [14]



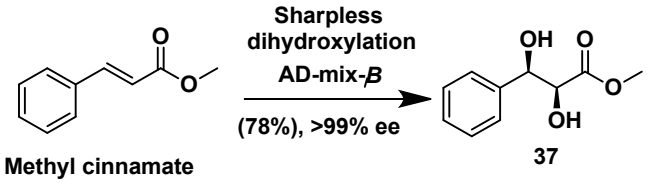
Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether); **Yield:** (0.529 g, 89%); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.44−7.37 (m, 2H), 7.30−7.11 (m, 3H), 1.94−1.74 (m, 8H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ 147.0, 128.1, 126.7, 125.0, 83.4, 41.8, 23.8; **MS (ESI)** (*m/z*): 185 $[M+Na]^+$.

IV. Diastereoselective synthesis of styryl lactones 7−*epi*−(+)−goniodiol (32) and 8−*epi*−(−)−goniodiol (33)



Scheme−5: Preparation of (11a)

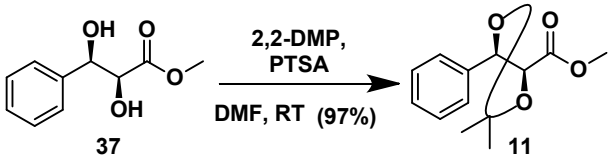
Preparation of (2*S*,3*R*)−methyl 2,3−dihydroxy−3−phenylpropanoate (37) [3]



To a stirred solution of potassium ferricyanide (18.2 g, 3.0 mmol, 3.0 equiv) and potassium carbonate (7.66 g, 3.0 mmol, 3.0 equiv) in water (150 mL), methane sulphonamide (1.94 g, 1.1 mmol, 1.1 equiv) was added followed by *tert*−butanol (150 mL) and vigorously stirred until the reaction suspension became clear. Then ligand $(DHQD)_2PHAL$ (0.045g, 4.0 mol%) followed by 1M solution of osmium tetroxide in *tert*−butanol (0.010 mL, 1.0 mol%) were added to it at 0 °C and the resulting suspension was stirred until orange color was obtained. To this mixture, solution of methyl cinnamate (3 g, 1.0 mmol, 1.0 equiv) in *tert*−butanol (5 mL) was added in dropwise manner. The resultant heterogeneous reaction mixture was stirred robustly at 0 °C until the reaction was complete (monitored by TLC; 24 h). The reaction mixture was quenched by addition of sodium sulfite (5 g) and the resulting suspension stirred at room temperature for 0.5

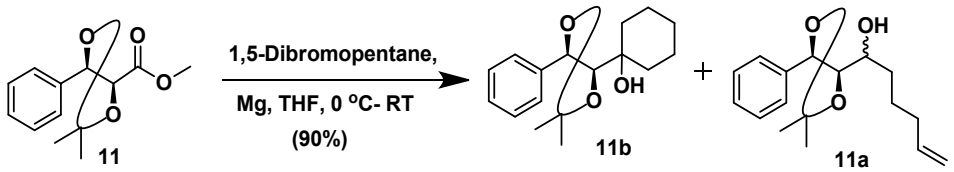
h. The reaction mixture was shifted into a 100 mL separatory funnel and extracted with ethyl acetate (4 X 20 mL). The organic layer was washed with brine, then dried over anhydrous sodium sulphate, filtered and concentrated under reduced pressure to furnish a residue. The obtained residue was purified by using 60–120 silica gel column chromatography (30% ethyl acetate–petroleum ether) to furnish the diol **37** as a colorless oil (5.65 g, 78%, 99% *ee*); $[\alpha]^{25}_{D}$ = −10.4 (*c* 1, $CHCl_3$); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.37−7.25 (m, 5H), 4.96 (br s, 1H), 4.32 (br s, 1H), 3.76 (s, 3H), 3.36 (br s, 1H), 3.15 (br s, 1H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ 173.1, 139.9, 128.3, 127.9, 126.2, 74.8, 74.4, 52.7; **MS (ESI)** (*m/z*): 219 $[M+Na]^+$.

Preparation of (4*S*,5*R*) −methyl 2,2−dimethyl−5−phenyl−1,3−dioxolane−4−carboxylate (11)[3]



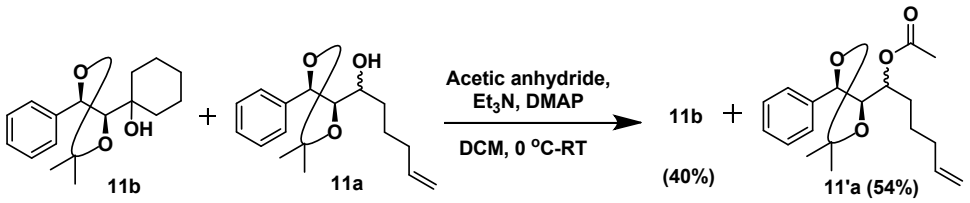
To a stirred solution of (2*S*,3*R*)−methyl 2,3−dihydroxy−3−phenylpropanoate (**37**) (0.800 g, 0.45 mmol, 1.0 equiv) in anhydrous DMF (4 mL) as a reaction solvent, was added 2,2−DMP (0.403 mL, 1 mmol, 1.1 equiv) followed by *para* toluenesulphonic acid (0.067 g, 0.1 mmol, 0.1 equiv). The reaction mixture was stirred at 25 ^oC and monitored by TLC. After completion (6 h), reaction mixture was diluted with ethyl acetate. The reaction mixture was subsequently washed with brine and worked up with ethyl acetate (3 X 15 mL). The combined organic extracts were dried over anhydrous sodium sulphate, filtered and concentrated under reduced pressure to furnish a crude residue. The obtained residue was then purified by column chromatography using 60–120 silica gel (5% ethyl acetate–petroleum ether) to furnish the respective acetonide protected ester compound as a viscous oil; (0.934 g, 97%); $[\alpha]^{25}_{D}$ = +23 (*c* 1, $CHCl_3$); **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.41−7.33 (m, 5H), 5.15 (d, *J* = 7.71 Hz, 1H), 4.33 (d, *J* = 7.71 Hz, 1H), 3.79 (s, 3H), 1.61 (s, 3H), 1.56 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 170.6, 137.7, 128.58, 128.51, 126.4, 111.5, 81.2, 80.6, 52.3,26.9, 25.8; **MS (ESI)** (*m/z*): 259 $[M+Na]^+$.

The unusual Grignard reaction



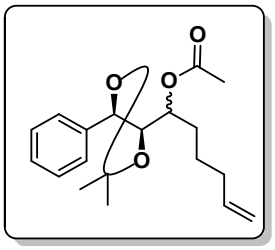
The above transformation was carried out as per the general procedure for unusual Grignard reaction described in section II.

Preparation of 1−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)hex−5−en−1−yl acetate (11'a)



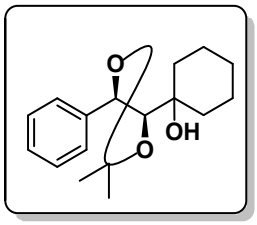
To a stirred solution of a mixture of 1−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)hex−5−en−1−ol (**11a**) and 1−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−l)cyclohexanol (**11b**) (0.5 g) in dichloromethane (3 mL) was added acetic anhydride (0.280 g , 6.59 mmol), triethylamine (0.160 g, 9.42 mmol), and catalytic amount of 4–dimethylaminopyridine. The resulting mixture was stirred at room temperature for 1 h. The reaction mixture was diluted with dichloromethane (10 mL), washed with 10% HCl followed by water and brine. The combined organic extracts were dried over Na_2SO_4, filtered and concentrated under reduced pressure. The crude residue obtained was purified by 200–400 silica gel column chromatography using (5% ethyl acetate– petroleum ether) as eluent to give pure 1−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)hex−5−en−1−yl acetate (**11'a**) (0.310 g, 54%) and unreacted 1−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−l)cyclohexanol (**11b**) (0.230 g, 40%) was recovered.

Data for **1−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)hex−5−en−1−yl acetate (11'a)**



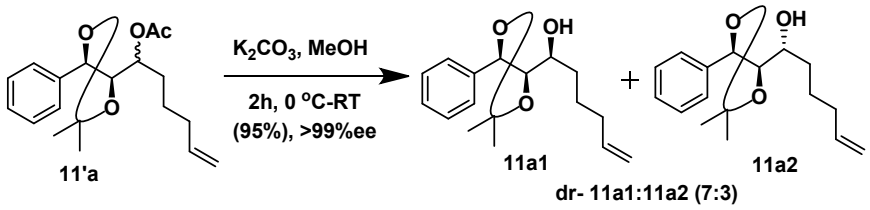
^{1}H NMR (500 MHz, $CDCl_3$): (*dr*: 7:**3**) δ 7.40−7.35 (m, 4H), 7.33−7.30 (m, 1H), 5.70 (m, 1H), 5.18−5.14 (m, 0.25H), 5.06−5.03 (m, 0.75H), 4.97−4.91 (m, 2H), 4.82 (d, J = 8.24 Hz, 0.25H), 4.69 (d, J = 8.55 Hz, 0.75H), 3.98 (dd, J = 8.24, 6.10 Hz, 0.25H), 3.86 (dd, J = 8.55, 2.75 Hz, 0.75H), 2.10 (s, 2.12H), 2.02−1.97 (m, 2 H), 1.84 (s, 0.88H), 1.75−1.67 (m, 1H), 1.63−1.60 (m, 1H), 1.57 (s, 3H), 1.51 (s, 3H), 1.37−1.32 (m, 2H); **^{13}C NMR (125 MHz, $CDCl_3$)**: δ 170.7, **170.4**, 138.1, **137.5**, 128.6, **128.5**, 128.3, **127.5**, 126.7, 114.8, 109.4, 83.9, **83.2**, **80.8**, 78.9, **72.8**, 70.3, 33.3, 31.0, **30.5**, 27.1, 26.8, 26.7, 24.7, 24.2, **20.9**, 20.8; **MS (ESI)** (*m/z*): 341 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 2850, 1740, 1620 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{19}H_{26}O_4$ $[M+Na]^+$ 341.1935, found 341.1932.

Data for **1−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−l)cyclohexanol (11b)**



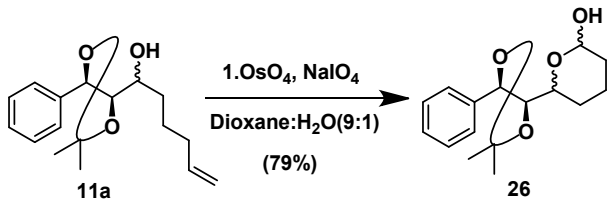
Yield: 40%, **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.46−7.32 (m, 5H), 5.00 (d, J = 8.59 Hz, 1H), 3.93 (d, J = 8.59 Hz, 1H), 2.06 (br s, 1H), 1.70−1.58 (m, 2H), 1.56 (s, 3H), 1.50 (s, 3H), 1.55−1.40 (m, 6H), 1.36−1.27 (m, 2H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 138.6, 128.5, 128.3, 108.6, 87.8, 78.5, 70.3, 36.3, 32.7, 27.6, 27.0, 25.5, 21.4, 21.1; **MS (ESI)** (*m/z*): 299 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3035, 2850, 1620 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{17}H_{24}O_3$ $[M+Na]^+$ 299.1618, found 299.1620.

Preparation of 1−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)hex−5−en−1−ol (11a)



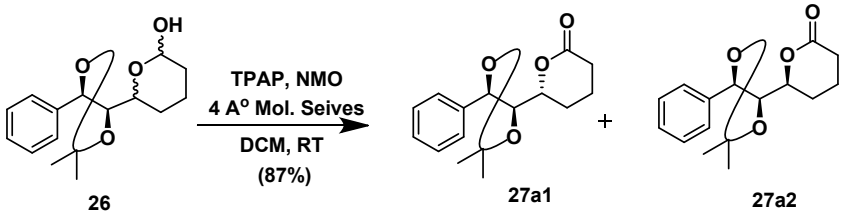
To a stirred solution of 1−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)hex−5−en−1−yl acetate (**11'a**), (0.300 g, 0.068 mmol) in MeOH (0.5 mL) was added K_2CO_3 (0.040 g, 0.146 mmol, 5 equiv) at room temperature. The reaction was vigorously stirred for 30 min, until the reaction was complete as monitored by TLC. The solution was diluted with ethyl acetate (10 mL) and washed with 0.1M aq. NaOH solution (10 mL). The aqueous layer was extracted with ethyl acetate (3 x 10 mL). The combined organic layers were dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. Purification was carried out by column chromatography using 200–400 silica gel (2% ethyl acetate–petroleum ether) to furnish 1−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)hex−5−en−1−ol (**11a**) as a colorless oil (0.247 g, 95%, *ee*: 98%); **^{1}H NMR (200 MHz, $CDCl_3$)**: (*dr*: 7:**3**) δ 7.43−7.29 (m, 5H), 5.79−5.52 (m, 1H), 4.98−4.84 (m, 3 H), 3.94−3.50 (m, 2H), 2.11 (br s, 1 H), 2.02−1.86 (m, 2H), 1.56 (s, 3H), 1.50 (s, 3H), 1.41−1.15 (m, 4H); **^{13}C NMR (125 MHz, $CDCl_3$)**: δ 138.4, **138.2**, 137.6, **137.4**, 128.5, **128.4**, **128.35**, 128.30, **127.7**, 126.8, 114.6, 109.1, **108.8**, 85.6, **85.2**, 79.3, **78.5**, **70.3**, 68.6, 34.6, 33.4, **33.3**, **31.7**, **27.3**, 27.2, 27.0, **26.9**, **25.1**, 24.8; **MS (ESI)** (*m/z*): 328 $[M+Na+MeOH]^+$; **IR ($CHCl_3$)**ν_{max}: 3435, 2989, 1620 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{17}H_{24}O_3$ $[M+Na]^+$ 299.1618, found 299.1614.

Preparation of 6−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)tetrahydro−2*H*−pyran−2−ol (26)



To a stirred solution of 1−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)hex−5−en−1−ol (**11a**) (0.130 g, 0.32 mmol, 1.0 equiv) in dioxane−water (3:1, 8 mL) at room temperature, was added 1M solution of osmium tetroxide (0.0032 mmol, 0.01 equiv) carefully in a dropwise manner. The resulting reaction mixture was continuously stirred for 0.5 h followed by addition of $NaIO_4$ (0.162 g, 0.76 mmol, 2.4 equiv) in one portion. The reaction mixture was then stirred for 20 h. The reaction was then quenched with sat. aq. Na_2SO_3 (5 mL) and stirred vigorously for 30 min. The biphasic reaction mixture was then extracted with ethyl acetate (3 X 10 mL) and the combined organic layers were washed with brine (15 mL), dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. The crude product obtained was subjected for column chromatography using 200−400 silica gel with 25−35 % ethyl acetate– petroleum ether as eluent to furnish 6−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)tetrahydro−2*H*−pyran−2−ol (**26**) (0.098 g, 79% yield) as a colorless oil. **^{1}H NMR (400 MHz, $CDCl_3$)**: (*dr*: 6:4) δ 7.44−7.23 (m, 5H), 5.29−5.17 (m, 0.58 H), 4.91 (d, J = 7.79 Hz, 0.50H), 4.84 (d, J = 8.24 Hz, 0.50H), 4.66 (d, J = 8.70 Hz, 0.42H), 4.09 (ddd, J = 11.45, 4.35, 2.52 Hz, 0.52H), 3.94 (dd, J = 8.24, 4.58 Hz, 0.40H), 3.85 (dd, J = 8.24, 4.58 Hz, 0.60H), 3.60 (ddd, J = 11.45, 4.35, 2.52 Hz, 0.48H), 1.93−1.80 (m, 1H), 1.73−1.58 (m, 3H), 1.53 (s, 3H), 1.49 (s, 3H), 1.39−1.27 (m, 2H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ 138.4, 128.4, 128.1, 127.1, 127.0, 109.4, 96.6, 91.9, 85.0, 84.6, 80.4, 80.0, 76.3, 68.5, 32.8, 27.3, 27.1, 26.3, 26.0, 21.5, 16.9; **MS (ESI)** (*m/z*): 303 $[M+Na]^+$; **IR ($CHCl_3$)**ν_{max}: 3325, 2950, 2851, 1340, 1160, 650 cm^{-1}; **HRMS (ESI)**: Calculated for $C_{16}H_{24}O_4$ $[M+Na]^+$ 303.2064, found 303.2062.

Preparation of 6−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)tetrahydro−2*H*−pyran−2−one (27) [15a]

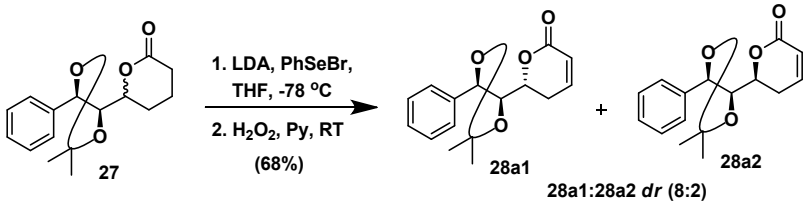


To a stirred solution of 6−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)tetrahydro −2*H*−pyran−2−ol (**26**) (0.088 g, 0.55 mmol, 1.0 equiv) was added solid tetrapropylammonium

perruthenate (TPAP) (0.003 mg, 0.03 mmol, 5 mol%) in one portion followed by *N*−methylmorpholine−*N*−oxide (NMO) (0.039 mg, 0.82 mmol, 1.5 equiv) and powdered 4Å molecular sieves (0.107 g, 0.5 g/mmol of lactol) in anhydrous CH_2Cl_2 (2 mL) at room temperature under argon atmosphere. On completion of the reaction (monitored by TLC, 15 min), reaction mixture was filtered through a short pad of silica, eluting with CH_2Cl_2 and the filtrate was concentrated under reduced pressure to give the crude product which was further washed with aq. Na_2SO_3 (2 X 10 mL) and extracted with CH_2Cl_2 to afford crude lactone. Purification of crude residue by flash column chromatography on silica gel (30% ethyl acetate–petroleum ether) furnished 6−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl) tetrahydro−2*H*−pyran−2−one (**27a1:27a2**) (0.076 g, 87%) as a colorless oil.

^{1}H NMR (200 MHz, $CDCl_3$): (*dr*: 8:**2**) δ 7.49−7.23 (m, 5H), 5.18 (d, *J* = 8.72 Hz, 0.22H), 4.97 (d, *J* = 7.71 Hz, 0.78H), 4.46−4.26 (m, 1H), 3.99 (dd, *J* = 7.71, 5.49 Hz, 0.78H), 3.71 (dd, *J* = 8.72, 1.45 Hz, 0.22H), 2.55 (br s, 1H), 2.68−2.29 (m, 2H), 2.06−1.64 (m, 4H), 1.54 (s, 3H), 1.50 (s, 3H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ **170.5**, 169.8, 138.1, **137.3**, **128.7**, 128.5, 128.3, 126.9, **126.8**, 110.0, **109.8**, **84.9**, 83.9, 80.3, 79.9, **77.9**, **75.3**, **30.0**, 29.7, **27.4**, 27.2, 27.0, **26.6**, **25.5**, 24.1, **18.5**, 18.2; **MS (ESI)** (*m/z*): 301[M+Na]$^+$; **IR ($CHCl_3$)ν_{max}:** 1740, 1620, 1440 cm^{-1}; **HRMS (ESI):** Calculated for $C_{16}H_{22}O_4$ [M+Na]$^+$ 301.3435, found 301.3439.

Preparation of (6*R*)−6−[(4*R*,5*R*)−2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl]−5,6−dihydro−2*H*−pyran−2−one (28a1) and (6*R*)−6−[(4*S*,5*S*)−2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl]−5,6−dihydro−2*H*−pyran−2−one (28a2) [15b]**:**



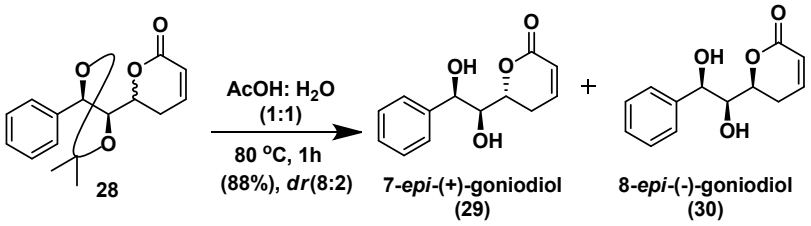
To a stirred solution of diisopropylamine (1.9 mL, 0.60 mmol, 4.0 equiv.), *n*−BuLi [(790 µL, 4.0 equiv.) 1.6 M], in THF (5 mL)] at −78^{o}C, was added dropwise a solution of 6−(2,2−dimethyl−5−phenyl−1,3−dioxolan−4−yl)tetrahydro−2*H*−pyran−2−one (**27**) (0.067 mg, 0.15 mmol, 1.0 eq.) in THF (3 mL) over 15 minutes. After 45 minutes of stirring at this temperature, a THF (2 mL) solution of phenylselenyl bromide (0.075 g, 0.32 mmol) was introduced. The reaction mixture was stirred at the same temperature and after the reaction was complete, monitored by TLC (1 h), reaction mixture was quenched with saturated NH_4Cl (5 mL) and extracted with ether (3 x 10 mL). The combined ethereal extracts were washed with brine (15 mL) and dried over Na_2SO_4. Evaporation of solvent under reduced pressure at room

temperature afforded the crude selenide, which was used without further purification in the next step.

To a stirred solution of crude selenide obtained above in 6 mL of CH_2Cl_2, was added pyridine (0.05 mL, 0.42 mmol) at −78 °C followed by addition of H_2O_2 (1.1 mL of 30% w/v in water) in dropwise manner. The resultant mixture was stirred at the same temperature until the reaction was complete (monitored by TLC, 1.5 h). Water (10 mL) was added to the reaction mixture and extracted with CH_2Cl_2 (3 x 10 mL). The combined organic extracts were washed with brine (25 mL) and dried over anhydrous Na_2SO_4. The solvent was removed under reduced pressure and the crude residue thus obtained was subjected for purification by flash column chromatography using 200–400 silica gel (25% ethyl acetate–petroleum ether) as eluent to give enone (**28a1:28a2**) (0.045 g, 68%) as a colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$): (*dr*: 8:**2**) δ 7.45−7.42 (m, 2H), 7.38 (t, J = 7.32 Hz, 2H), 7.33−7.30 (m, 1H), 6.90−6.84 (m, 1H), 6.03−5.99 (m, 1H), 5.24 (d, J = 8.55 Hz, 0.20H), 4.98 (d, J = 7.93 Hz, 0.80H), 4.55 (dt, J = 10.68, 5.04 Hz, 0.80H), 4.42−4.39 (m, 0.20H), 4.11 (dd, J = 7.93, 5.04 Hz, 0.80H), 3.81 (dd, J = 8.55, 1.68 Hz, 0.20H), 2.70−2.65 (m, 0.20H), 2.58−2.45 (m, 1.60H), 2.27−2.21 (m, 0.20H), 1.58 (s, 0.69H), 1.57 (s, 2.31H), 1.55 (s, 0.69H), 1.52 (s, 2.31H); **^{13}C NMR (125 MHz, $CDCl_3$):** δ **163.5**, 162.8, 144.8, **144.7**, 137.7, **137.0**, **128.7**, 128.6, 128.5, 126.9, **126.7**, 121.2, **121.1**, 110.2, **109.9**, **83.7**, 83.0, 80.4, **77.5**, 77.2, **73.4**, **27.2**, 27.1, 26.9, **26.6**, **26.5**, 25.4; **MS (ESI)** (*m/z*): 297 $[M+Na]^+$; **IR ($CHCl_3$)ν_{max}:** 2950, 1729, 1448, 1312 cm^{-1}.

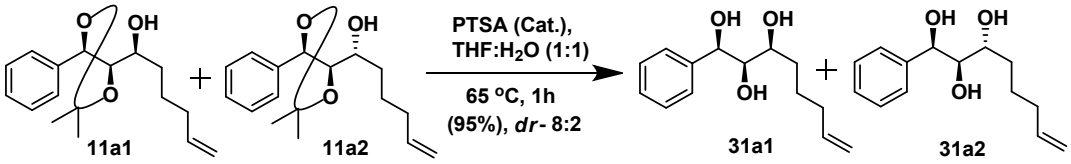
Preparation of 7−*epi*−(+)−goniodiol (29) and 8−*epi*−(−)−goniodiol (30) [15b]



The stirred solution of enone (**28**) (0.03 g, 1.1 mmol) in acetic acid:water (1:1, 3.0 mL) was heated at 80 °C for 1h, After completion of reaction as confirmed with TLC, the reaction mixture was cooled to room temperature. The reaction was quenched with the addition of aq. $NaHCO_3$ (0.5 mL) and the mixture was stirred for 15 min, extraction was carried out using ethyl acetate (3 X 10 mL), the organic layers combined and concentrated under reduced pressure. The crude residue obtained was purified by column chromatography (eluent 25% ethyl acetate–petroleum ether) to furnish a mixture of **29** and **30** (0.022 g, 88%). **^{1}H NMR (500 MHz, $CDCl_3$)**: (*dr*: 8:**2**) δ 7.42−7.31 (m, 5H), 6.92 (ddd, J = 8.85, 6.41, 2.14 Hz, 0.82H), 6.88 (ddd, J = 8.85, 6.41, 2.14 Hz, 0.18H), 6.00 (dd, J = 9.76, 2.44 Hz, 0.80H), 5.97 (dd, J = 10.07, 3.05 Hz, 0.20H), 4.96 (d, J = 7.33 Hz, 0.18H), 4.91 (d, J = 4.58 Hz, 0.82H), 4.44−4.40 (m, 0.82H), 4.24−4.20 (m, 0.18H), 3.95 (t, J = 4.89 Hz, 0.80H), 3.65 (d, J = 7.33 Hz, 0.20H), 2.96 (br s, 1H), 2.81 (br s, 1H),

2.65−2.58 (m, 1H), 2.52−2.47 (m, 1H); ; **^{13}C NMR (125 MHz, $CDCl_3$)**: δ 163.8, **163.6**, **145.8**, 145.6, 140.0, 128.79, **128.71**, 128.3, **126.8**, 126.4, 120.9, **120.6**, **76.5**, 76.1, **74.0**, 71.9, **25.9**, 24.8; **MS (ESI)** (*m/z*): 257 $[M+Na]^+$; **IR ($CHCl_3$)ν_{max}:** 3435, 2930, 1700, 1640 cm^{-1}.

Preparation of (1*R*, 2*R*, 3*S*)−1−phenyloct−7−ene−1,2,3−triol (31a1) and (1*R*, 2*R*, 3*R*)−1−phenyloct−7−ene−1,2,3−triol (31a2)[15c]:

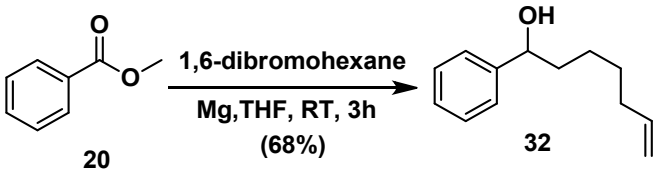


To a stirred solution of alcohol **11** (0.068 g, 1.1 mmol) in THF:water (1:1, 3.0 mL) was added catalytic amount of *para* toluenesulphonic acid. The resulting reaction mixture was heated at 65 °C for 1h. After completion of reaction as confirmed with TLC, the reaction mixture was cooled to room temperature. The reaction mixture was extracted using ethyl acetate (3 X 10 mL) followed by subsequent washing with aq. $NaHCO_3$ (3 X 5 mL). The organic extracts were combined and dried over anhydrous Na_2SO_4. The solvent was removed under reduced pressure and the pure product obtained (**31a1:31a2**) (0.051 g, 95%) as a white solid.

^{1}H NMR (500 MHz, $CDCl_3$): (*dr*: 8:**2**) δ 7.41−7.30 (m, 5H), 5.85−5.72 (m, 1H), 5.04−4.92 (m, 2H), 4.81 (d, J = 5.49 Hz, 1H), 3.74−3.54 (m, 2H), 3.11 (brs, 1H), 1.62−1.34 (m, 4H), 2.87 (brs, 1H), 2.32 (brs, 1H), 2.12−2.07 (m, 0.20H), 2.04−2.01 (m, 1.80H); **^{13}C NMR (125 MHz, $CDCl_3$)**: δ 140.6, 138.4, 128.5, 128.1, **127.9**, 126.6, **126.2**, **114.8**, 114.7, 76.88, 76.80, 75.6, **73.5**, **73.2**, 71.4, 33.7, 33.4, **32.0**, **25.1**, 24.8; **MS (ESI)** (*m/z*): 259 $[M+Na]^+$; **IR ($CHCl_3$)** ν_{max}: 3450, 2928, 1640, 1442 cm^{-1}; **Mp**: 77−79 °C.

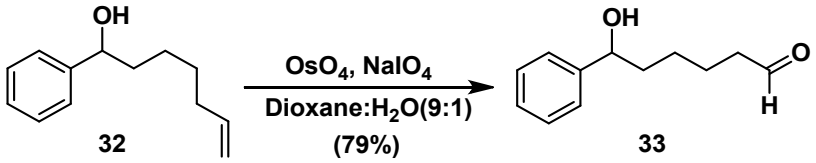
V. Experimental procedure and spectroscopic data for regioselective synthesis of substituted ε−caprolactone

Preparation of 1−phenylhept−6−en−1−ol (32)



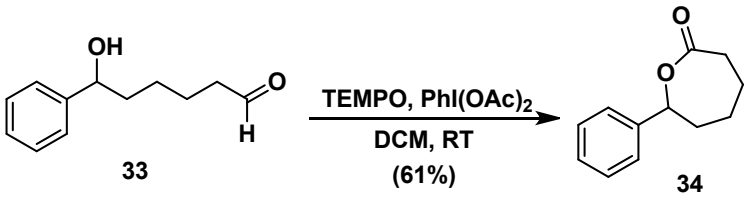
The above transformation was carried out as per the general procedure for unusual Grignard reaction described in section II. Column chromatography using 200–400 silica gel (15% ethyl acetate–petroleum ether); **Yield:** 0.617 g, 66%; **^{1}H NMR (200 MHz, $CDCl_3$):** δ 7.33−7.27 (m, 5H), 5.79 (ddt, J = 16.93, 10.11, 6.70 Hz, 1H), 5.09−4.89 (m, 2H), 4.64 (t, J = 6.07 Hz, 1H), 2.09−2.01 (m, 2H), 1.92 (br s, 1H), 1.77−1.70 (m, 2H), 1.45−1.29 (m, 4H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ 144.9, 138.7, 128.4, 127.5, 125.8, 114.5, 74.6, 38.9, 33.7, 28.8, 25.3; **MS (ESI)** (*m/z*): 213 $[M+Na]^+$; **IR ($CHCl_3$)** ν_{max}: 3435, 1630, 1405 cm^{-1}; **HRMS (ESI):** Calculated for $C_{13}H_{18}O$ $[M+Na]^+$ 213.2560, found 213.2562.

Preparation of 6−hydroxy−6−phenylhexanal (33):



The above transformation was carried out as per the procedure for preparation of compound **29**. Column chromatography using 200–400 silica gel (12% ethyl acetate–petroleum ether); **Yield:** 0.478 g, 79%; **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 9.68 (t, J = 1.71 Hz, 1H), 7.37−7.12 (m, 5H), 4.60 (dd, J = 7.39, 5.75 Hz, 1H), 3.62 (s, 1H, of −O<u>H</u>), 2.36 (td, J = 7.17, 1.71 Hz, 2H), 1.77−1.53 (m, 4H), 1.52−1.36 (m, 2H); **^{13}C NMR (50 MHz, $CDCl_3$)**: δ 201.9, 144.7, 128.4, 127.5, 125.8, 74.2, 67.0, 43.7, 38.7, 25.3, 21.9; **MS (ESI)** (*m/z*): 215 $[M+Na]^+$; **IR ($CHCl_3$)** ν_{max} **:** 2827, 1720, 1605 cm^{-1}.

Preparation of 7−phenyloxepan−2−one (34)[16c]**:**



To a stirred solution of aldehyde **33** (0.400 g, 1.25 mmol) in dichloromethane (7 mL), was added TEMPO (0.42 g, 0.275 mmol) followed by addition of (diacetoxyiodo)benzene (0.88 g, 2.75 mmol). The resultant reaction mixture was stirred at room temperature overnight. On completion of the reaction (monitored by TLC), reaction mixture was diluted with ethyl acetate. The mixture was washed with mixture of saturated aqueous $NaHCO_3/Na_2SO_3$ (1:1 *v*/*v*, 3 X 8 mL) and brine, dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. The residue was purified by flash column chromatography with eluent (8% ethyl acetate–petroleum ether) to furnish **34** (0.241 g, 61%), as a pure product. **^{1}H NMR (200 MHz, $CDCl_3$)**: δ 7.39−7.37 (m, 5H), 5.29 (d, J = 9.29 Hz, 1H), 2.80−2.73 (m, 2H), 2.13−2.00 (m, 4H), 1.83−1.64 (m, 2H); **^{13}C NMR (50 MHz, $CDCl_3$):** δ 174.8, 140.7, 128.4, 128.0, 125.7, 82.0, 37.3, 34.8, 28.5, 22.7; **MS (ESI)** (*m/z*): 213 $[M+Na]^+$; **IR ($CHCl_3$)** ν_{max}**:** 2951, 1730 cm^{-1}; **HRMS (ESI):** Calculated for $C_{12}H_{14}O_2$ $[M+Na]^+$ 213.2542, found 213.2546.