# SmI<sub>2</sub>-H<sub>2</sub>O-Mediated 5-*exo*/6-*exo* Lactone Radical Cyclisation Cascades

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### **General Methods**

<sup>1</sup>H-NMR and <sup>13</sup>C-NMR spectra were recorded on Bruker NMR spectrometers (400 MHz and 500 MHz for <sup>1</sup>H-NMR, 100 MHz and 125 MHz for <sup>13</sup>C-NMR). <sup>1</sup>H-NMR chemical shifts ( $\delta_{\rm H}$ ) and <sup>13</sup>C-NMR chemical shifts ( $\delta_C$ ) are quoted in parts per million (ppm) downfield from trimethylsilane (TMS) and coupling constants (J) are quoted in Hertz (Hz). Abbreveations for NMR data are s (singlet), d (doublet), t (triplet), q (quartet), quin (quintet), sxt (sextet). Infrared (IR) spectra were recorded on a Bruker Alpha FTIR spectrometer and mass spectra were recorded on a Micromass Platform II (ESI), Agilent 5975C Triple Axis GCMS (GC-MS, EI/CI) and Waters QTOF (HRMS). <sup>1</sup>H-NMR and <sup>13</sup>C-NMR spectra were assigned with the aid of COSY, HSQC, HMBC and DEPT 90/135 NMR techniques and stereochemistry assigned with the aid of X-ray crystallography. Flash column chromatography was carried out using Sigma Aldrich silica gel 60 Angstrom (Å), 240 – 400 mesh. Thin layer chromatography (TLC) was performed on aluminium sheets pre-coated with silica gel, 0.20 mm (Macherey-Nagel, Polygram<sup>®</sup> Sil G/UV<sub>254</sub>). TLC plates were visualised by UV absorption, phosphomolybdic acid, vanillin or potassium permanganate solution and heating. Diiodoethane was washed with diethyl ether and sodium thiosulfate before use. Tetrahydrofuran (THF) was pre-dried over sodium wire and distilled from sodium benzophenone ketyl prior to use. Diisopropylamine (DIPA) and dichloromethane (DCM) were both distilled from calcium hydride prior to use.

### **Experimental Protocols and Characterisation Data**

## **Preparation of SmI**<sub>2</sub><sup>1</sup>

An oven-dried flask equipped with a dry stirrer bar was flushed with a strong flow of  $N_2$  for 30 minutes and loaded with samarium metal (-40 mesh, 1.4 equiv.) and washed diiodoethane (1 equiv.). The flask was flushed for another 30 minutes, after which freshly distilled and degassed THF (0.1 M) was added under stirring. Using an exit needle and a gentle flow of  $N_2$  for the first 5-10 minutes allowed for any ethene gas formed *in-situ* to evacuate the reaction vessel. Stirring was continued under a positive pressure of  $N_2$  overnight at room temperature. Before titration, the mixture was allowed to settle for one hour and used straight away.

## Ethyl 4-(2-methyl-1,3-dioxolan-2-yl) but anoat $e - S1^2$



To a stirred solution of ethyl 5-oxohexanoate (2.00 mL, 12.6 mmol, 1 equiv.) and ethylene glycol (2.50 mL, 44.3 mmol, 3.5 equiv.) in benzene (18 mL) was added *p*-toluenesulfonic acid monohydrate (48.0 mg, 0.25 mmol, 0.02 equiv.) and the mixture was heated to reflux for 21 hours using Dean-Stark conditions. The solvent was removed *in vacuo* and purification by flash column chromatography (5% EtOAc:hexane) yielded the named compound as a colourless oil (1.95 g, 77%);  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.26 (3H, t, *J* 7.1, CO<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub>), 1.33 (3H, s, CH<sub>3</sub>), 1.61 – 1.79 (4H, m, 2 × CH<sub>2</sub>), 2.33 (2H, t, *J* 7.1, CH<sub>2</sub>), 3.89 – 3.99 (4H, m, 2 × OCH<sub>2</sub>), 4.13 (2H, q, *J* 7.2, CO<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub>);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) 14.2 (CH<sub>2</sub>CH<sub>3</sub>), 19.6 (CH<sub>2</sub>), 23.8 (CH<sub>3</sub>), 34.3 (CH<sub>2</sub>), 38.3 (CH<sub>2</sub>), 60.2 (CH<sub>2</sub>CH<sub>3</sub>), 64.6 (-OCH<sub>2</sub>CH<sub>2</sub>O-), 109.8 (C-OCH<sub>2</sub>CH<sub>2</sub>O-), 173.5 (CO<sub>2</sub>Et).

### **General Procedure A: Alkylation of protected keto-esters**

### Ethyl 2-(2-(2-methyl-1,3-dioxolan-2-yl)ethyl)hept-6-enoate – S2



An oven-dried flask was degassed with N2 and n-BuLi (5.00 mL, 7.89 mmol, 1.1 equiv., 1.6 M in hexane) was added slowly to a mixture of DIPA (1.10 mL, 7.89 mmol, 1.1 equiv.) and THF (4.5 mL) at -78 °C. After stirring the solution for 1 hour at -78 °C, ethyl 4-(2-methyl-1,3-dioxolan-2-yl)butanoate (1.45 g, 7.17 mmol, 1 equiv.) in THF (2.8 mL) was added over 30 minutes using a syringe pump. Stirring was continued for 45 minutes and 5-bromo-1pentene (1.15 mL, 9.75 mmol, 1.36 equiv.) in HMPA (1.5 mL) was added to the mixture, which was allowed to warm to room temperature and stirred overnight. The reaction was quenched with an aqueous saturated solution of NH<sub>4</sub>Cl (20 mL). After separation, the aqueous layer was extracted with EtOAc ( $3 \times 20$  mL). The organic layers were combined and washed with brine (20 mL), dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated in vacuo. Flash column chromatography (5% EtOAc:hexane) yielded the named compound as a yellow oil (1.20 g, 62%);  $\upsilon_{max}$  / cm  $^{-1}$  3078, 2978, 2934, 2862, 1718, 1641, 1446, 1367, 1156, 1027, 911;  $\delta_{H}$  (400 MHz, CDCl<sub>3</sub>) 1.22 (3H, t, J 7.6, CO<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub>), 1.26 (3H, s, CH<sub>3</sub>), 1.31 – 1.38 (2H, m, CH<sub>2</sub>), 1.39 – 1.71 (6H, m, 3 × CH<sub>2</sub>), 1.97 – 2.05 (2H, m, C=CHCH<sub>2</sub>), 2.24 – 2.33 (1H, m, CH), 3.83 -3.93 (4H, m, 2 × OCH<sub>2</sub>), 4.1 (2H, qd, J 7.3, 1.3, CO<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub>), 4.87 - 5.00 (2H, m, C=CHCH<sub>2</sub>), 5.67 – 5.79 (1H, m, C=CHCH<sub>2</sub>);  $\delta_{C}$  (100 MHz, CDCl<sub>3</sub>) 14.2 (CH<sub>2</sub>CH<sub>3</sub>), 23.6 (CH<sub>3</sub>), 26.5 (CH<sub>2</sub>), 26.6 (CH<sub>2</sub>), 31.7 (CH<sub>2</sub>), 33.5 (CH<sub>2</sub>), 36.5 (CH<sub>2</sub>), 45.3 (CH), 60.0 (CH<sub>2</sub>CH<sub>3</sub>), 64.5 (-OCH<sub>2</sub>CH<sub>2</sub>O-), 64.5 (-OCH<sub>2</sub>CH<sub>2</sub>O-), 109.6 (C-OCH<sub>2</sub>CH<sub>2</sub>O-), 114.6 (CH=CH<sub>2</sub>), 138.3 (CH=CH<sub>2</sub>), 175.9 (CO<sub>2</sub>Et); m/z (ESI+) 294 ([M + Na]<sup>+</sup>, 100%); HRMS (ESI+) found 271.1898, expect 271.1904 for C<sub>15</sub>H<sub>27</sub>O<sub>4</sub>.

### **General Procedure B: Deprotection of alkylated keto-esters**

### Ethyl 2-(3-oxobutyl)hept-6-enoate – S3



A mixture of ethyl 2-(2-(2-methyl-1,3-dioxolan-2-yl)ethyl)hept-6-enoate (0.60 g, 2.22 mmol, 1 equiv.), *p*-toluenesulfonic acid monohydrate (0.84 g, 4.44 mmol, 2 equiv.) and acetone (25 mL) was stirred at room temperature for 2 hours. After quenching with an aqueous saturated solution of NaHCO<sub>3</sub> (20 mL), the aqueous layer was extracted with CH<sub>2</sub>Cl<sub>2</sub> ( $3 \times 15$  mL). The organic layers were combined and dried over Na<sub>2</sub>SO<sub>4</sub> and the crude compound was concentrated *in vacuo*. The title compound was obtained by flash column chromatography (5% EtOAc:hexane) as a colourless oil (0.48 g, 96%);  $v_{max}$  / cm<sup>-1</sup> 2935, 1720, 1367, 1158;  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.26 (3H, t, *J* 7.2, CO<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub>), 1.33 – 1.52 (3H, m, 1H from CH<sub>2</sub> + CH<sub>2</sub>), 1.58 – 1.69 (1H, m, 1H from CH<sub>2</sub>), 1.81 (2H, q, *J* 7.5, CH<sub>2</sub>), 2.05 (2H, q, *J* 6.8, C=CHCH<sub>2</sub>), 2.13 (3H, s, CH<sub>3</sub>), 2.29 – 2.38 (1H, m, CH), 2.44 (2H, td, *J* 7.6, 3.0, COCH<sub>2</sub>), 4.14 (2H, q, *J* 6.8, CO<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub>), 4.92 – 5.04 (2H, m, HC=CH<sub>2</sub>), 5.71 – 5.84 (1H, m, HC=CH<sub>2</sub>);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) 14.3 (CH<sub>2</sub>CH<sub>3</sub>), 25.9 (CH<sub>2</sub>), 26.5 (CH<sub>2</sub>), 30.0 (CH<sub>2</sub>), 31.8 (CH<sub>3</sub>), 33.5 (CH<sub>2</sub>), 41.1 (CH<sub>2</sub>), 44.6 (CH), 60.3 (CH<sub>2</sub>CH<sub>3</sub>), 114.7 (CH=CH<sub>2</sub>), 138.3

 $(CH=CH_2)$ , 175.7  $(CO_2Et)$ , 208.0 (CO); m/z (ESI+) 249  $([M + Na]^+, 100\%)$ ; HRMS (ESI+) found 249.1450, expect 249.1461 for  $C_{13}H_{22}O_3Na$ .

### **General Procedure C: Appel reaction**

## (3-Bromoprop-1-yn-1-yl)benzene – $S4^2$



To a stirred mixture of 3-phenyl-2-propyn-1-ol (1.00 g, 7.57 mmol, 1 equiv.) in CH<sub>2</sub>Cl<sub>2</sub> (25 mL) was added CBr<sub>4</sub> (3.01 g, 9.09 mmol, 1.2 equiv.) and the mixture was cooled to 0 °C. PPh<sub>3</sub> (2.38 g, 9.09 mmol, 1.2 equiv.) was added in 3 portions and the reaction was stirred under N<sub>2</sub> at room temperature for 3 hours. The solvent was removed *in vacuo* and inorganic residues were removed by filtration through silica gel (hexane  $\rightarrow$  1% EtOAc:hexane). The crude product was taken through to the next step;  $\delta_{\rm H}$  (500 MHz, CDCl<sub>3</sub>) 4.18 (2H, s, CH<sub>2</sub>Br), 7.3 – 7.4 (3H, m, ArCH), 7.42 – 7.52 (2H, m, ArCH);  $\delta_{\rm C}$  (125 MHz, CDCl<sub>3</sub>) 15.3 (*C*H<sub>2</sub>), 84.2 (C=*C*), 86.7 (*C*=*C*), 122.1 (Ar*C*), 128.3 (Ar*C*H), 128.9 (Ar*C*H), 131.9 (Ar*C*H).

### **General Procedure D: Barbier-type lactonization reaction**

rac-(3R,6S)-6-Methyl-3-(pent-4-en-1-yl)-6-(1-phenylpropa-1,2-dien-1-yl)tetrahydro-2Hpyran-2-one – trans-1a and rac-(3S,6S)-6-ethyl-3-(pent-4-en-1-yl)-6-(1-phenylpropa-1,2dien-1-yl)tetrahydro-2H-pyran-2-one – cis-1a



An oven-dried flask was degassed with N<sub>2</sub> and loaded with NiI<sub>2</sub> (8 mg, 0.027 mmol, 2 mol% with respect to SmI<sub>2</sub>) and SmI<sub>2</sub> (17.0 mL, 1.33 mmol, 3 equiv.) and the mixture was cooled to 0 °C. Immediately after the addition of ethyl 2-(3-oxobutyl)hept-6-enoate (100 mg, 0.44 mmol, 1 equiv.) to the stirring mixture, (3-bromoprop-1-yn-1-yl)benzene (112 mg, 0.57 mmol, 1.3 equiv.) in THF (4.4 mL) was added dropwise over 30 minutes. Once warmed up to room temperature, the reaction was opened to air and stirred until decolourisation occurred. The reaction was quenched with Rochelle's salt (10 mL) and extracted from Et<sub>2</sub>O (3 × 15 mL). The organic layers were washed with brine (20 mL) and dried over Na<sub>2</sub>SO<sub>4</sub>. The solvent was removed *in vacuo* and flash column chromatography (5% EtOAc:hexane) yielded *trans*-1a and *cis*-1a as a yellow oil (28 mg, 21% each, combined yield 42%).

For *trans*-1a:  $v_{max} / cm^{-1} 3075 2931$ , 2860, 1773, 1728, 1445, 1216, 1073, 907, 853, 765, 700;  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.42 - 1.54 (3H, m, 1H from  $CH_2 + CH_2$ ), 1.61 (3H, s,  $CH_3$ ), 1.62 - 1.69 (1H, m, 1H from  $CH_2$ ), 1.83 - 1.87 (1H, m, 1H from  $CH_2$ ), 1.88 - 1.96 (1H, m, 1H from  $CH_2$ ), 2.04 - 2.15 (3H, m, 1H from  $CH_2 + CH_2$ ), 2.23 (1H, ddd, J 14.1, 7.6, 6.3, 1H from  $CH_2$ ), 2.38 - 2.45 (1H, m, CH), 4.93 - 5.06 (2H, m, HC= $CH_2$ ), 5.11 (2H, s, C= $CH_2$ ), 5.80 (1H, ddt, J 17.1, 10.2, 6.7,  $HC=CH_2$ ), 7.25 - 7.29 (1H, m, ArH), 7.30 - 7.37 (2H, m, ArH), 7.41 - 7.47 (2H, m, Ar*H*);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) 22.6 (CH<sub>2</sub>), 26.1 (CH<sub>2</sub>), 28.1 (CH<sub>3</sub>), 30.9 (CH<sub>2</sub>), 31.8 (CH<sub>2</sub>), 33.6 (CH<sub>2</sub>), 38.6 (CH), 78.6 (C=CH<sub>2</sub>), 82.9 (quat. C), 110.3 (C=C=CH<sub>2</sub>), 114.7 (CH=CH<sub>2</sub>), 127.5 (ArCH), 128.4 (ArCH), 129.0 (ArCH), 134.1 (ArC), 138.4 (CH=CH<sub>2</sub>), 174.0 (CO), 207.4 (C=CH<sub>2</sub>); *m*/*z* (ESI+) 319 ([M + Na]<sup>+</sup>, 100%); HRMS (ESI+) found 319.1661, expect 319.1669 for C<sub>20</sub>H<sub>24</sub>O<sub>2</sub>Na.

For *cis*-1a:  $v_{max} / cm^{-1} 3075$ , 2930, 2861, 1726, 1447, 1223, 1135, 1093, 911, 763, 700;  $\delta_{H}$  (500 MHz, CDCl<sub>3</sub>) 1.28 - 1.45 (3H, m, 1H from  $CH_2 + CH_2$ ), 1.51 - 1.53 (3H, s,  $CH_3$ ), 1.63 - 1.78 (2H, m, 1H from  $CH_2 + 1H$  from  $CH_2$ ), 1.78 - 1.91 (2H, m, 1H from  $CH_2 + 1H$  from  $CH_2$ ), 1.94 - 2.05 (2H, m,  $CH_2$ ), 2.12 - 2.18 (1H, m, 1H from  $CH_2$ ), 2.28 - 2.37 (1H, m, CH), 4.85 - 5.03 (4H, m, HC= $CH_2 + C=CH_2$ ), 5.67 - 5.77 (1H, m,  $HC=CH_2$ ), 7.18 - 7.30 (5H, m, Ar*H*);  $\delta_C$  (125 MHz, CDCl<sub>3</sub>) 22.9 ( $CH_2$ ), 26.0 ( $CH_2$ ), 28.7 ( $CH_3$ ), 31.2 ( $CH_2$ ), 32.4 ( $CH_2$ ), 33.7 ( $CH_2$ ), 39.8 (CH), 78.7 ( $C=CH_2$ ), 83.3 (quat. C), 110.6 ( $C=C=CH_2$ ), 114.8 ( $CH=CH_2$ ), 127.6 (ArCH), 128.4 (ArCH), 129.1 (ArCH), 134.7 (ArC), 138.4 ( $CH=CH_2$ ), 173.5 (CO), 207.1 ( $C=CH_2$ ); m/z (ESI+) 297.3 ([M + H]<sup>+</sup>, 100%); HRMS (ESI+) found 297.1861, expect 297.1849 for C<sub>20</sub>H<sub>25</sub>O<sub>2</sub>.

### **General Procedure E: Cascade Cyclisation**

(4S,4aS,5S,6S,7R,9aS)-4,5,7-Trimethyl-6-phenyldecahydro-4aH-benzo[7]annulene-4a,7diol 2a and (1S,2R,3R,4S,5R)-1,3-dimethyl-5-(pent-4-en-1-yl)-2-phenylcycloheptane-1,4diol 3a



An oven-dried flask was degassed with N<sub>2</sub> and loaded with distilled H<sub>2</sub>O (2.88 mL, 0.16 mol, 4000 equiv.) and *rac*-(3*R*,6*S*)-6-methyl-3-(pent-4-en-1-yl)-6-(1-phenylpropa-1,2-dien-1yl)tetrahydro-2H-pyran-2-one *trans*-1a (12.0 mg, 0.04 mmol, 1 equiv.) in THF (0.4 mL) and the mixture was stirred at room temperature for 5 minutes. SmI<sub>2</sub> (6.40 mL, 0.62 mmol, 16 equiv.) was added over 30 minutes and the reaction mixture was stirred at room temperature under a positive pressure of N<sub>2</sub> in a sealed flask until decolourisation occurred (48 h). The flask was opened to air and the reaction was quenched with Rochelle's salt (3 mL) and extracted from Et<sub>2</sub>O (3 × 5 mL). The organic layers were combined and washed with brine (10 mL) and dried over Na<sub>2</sub>SO<sub>4</sub>. Flash column chromatography (10% EtOAc:hexane  $\rightarrow$  20% EtOAc:hexane) yielded **3a** (4 mg, 33%) and **2a** (1.2 mg, 10%) as a colourless oil.

For **2a**:  $v_{max} / cm^{-1} 3423$ , 2925, 1450, 1375, 1143, 914, 702;  $\delta_{H}$  (400 MHz, CDCl<sub>3</sub>) 0.73 (3H, d, *J* 6.8, *CH*<sub>3</sub>), 1.07 (3H, s, *CH*<sub>3</sub>), 1.16 - 1.28 (2H, m, *CH*<sub>2</sub>), 1.29 - 1.35 (5H, m, 1H from *CH*<sub>2</sub> + 1H from *CH*<sub>2</sub> + *CH*<sub>3</sub>), 1.37 - 1.54 (4H, m, 1H from *CH*<sub>2</sub> + *CH*<sub>2</sub> + *CH*), 1.56 - 1.72 (2H, m, 1H from *CH*<sub>2</sub> + *CH*CH<sub>3</sub>), 1.80 (1H, dd, *J* 15.2, 11.7, 1H from *CH*<sub>2</sub>), 1.96 - 2.05 (1H, m, 1H from *CH*<sub>2</sub>), 2.21 (1H, q, *J* 7.8, *CH*CH<sub>3</sub>), 3.89 (1H, s, *CH*Ph), 7.21 - 7.29 (1H, m, Ar*H*), 7.29 - 7.35 (2H, m, Ar*H*), 7.37 - 7.41 (2H, m, Ar*H*);  $\delta_{C}$  (100 MHz, CDCl<sub>3</sub>) 13.3 (*C*H<sub>3</sub>), 14.6 (*C*H<sub>3</sub>),

26.0 (CH<sub>2</sub>), 26.3 (CH<sub>2</sub>), 28.2 (CH<sub>3</sub>), 30.8 (2 × CH<sub>2</sub>), 37.4 (CH), 43.2 (CH<sub>2</sub>), 43.6 (CHMe), 45.0 (CH), 49.3 (CHPh), 74.8 (quat. C), 76.8 (quat. C), 126.2 (ArCH), 128.3 (ArCH), 129.6 (ArCH), 145.4 (ArC); m/z (ESI-) 301 ([M - H]<sup>-</sup>, 100%); m/z (ESI+) 267.3 ([M -H<sub>2</sub>O - <sup>-</sup>OH]<sup>+</sup>, 100%); HRMS (ESI+) found 325.2151, expect 325.2144 for C<sub>20</sub>H<sub>30</sub>O<sub>2</sub>Na.

For **3a**:  $\delta_{\rm H}$  (500 MHz, CDCl<sub>3</sub>) 0.98 (3H, s, CH<sub>3</sub>), 1.15 - 1.22 (1H, m, 1H from CH<sub>2</sub>), 1.24 (3H, d, *J* 7.3, CH<sub>3</sub>), 1.27 - 1.41 (1H, m, 1H from CH<sub>2</sub>), 1.42 - 1.68 (5H, m, 1H from CH<sub>2</sub> + 1H from CH<sub>2</sub> + CH<sub>2</sub> + CH<sub>1</sub>, 1.85 - 1.94 (2H, m, CH<sub>2</sub>), 1.94 - 2.06 (2H, m, CH<sub>2</sub>), 2.38 - 2.46 (1H, m, CHCH<sub>3</sub>), 2.85 (1H, s, CHPh), 3.37 (1H, dd, *J* 9.1, 4.3, CHOH), 4.85 - 4.99 (2H, m, HC=CH<sub>2</sub>), 5.69 - 5.83 (1H, m, HC=CH<sub>2</sub>), 7.14 - 7.20 (1H, m, ArH), 7.21 - 7.31 (4H, m, ArH);  $\delta_{\rm C}$  (125 MHz, CDCl<sub>3</sub>) 13.8 (CH<sub>3</sub>), 24.3 (CH<sub>2</sub>), 26.0 (CH<sub>2</sub>), 29.3 (CH<sub>3</sub>), 29.7 (CH<sub>2</sub>), 34.0 (CH<sub>2</sub>), 34.2 (CH<sub>2</sub>), 42.2 (CH<sub>2</sub>), 44.3 (CH), 56.5 (CHPh), 74.2 (quat. C), 80.7 (CHOH), 114.4 (CH=CH<sub>2</sub>), 126.6 (ArCH), 128.3 (ArCH), 129.6 (ArCH), 139.0 (CH=CH<sub>2</sub>), 139.6 (ArC); *m*/z (ESI+) 325.3 ([M + Na]<sup>+</sup>, 100%); *m*/z (ESI+) 267.3 ([M - H<sub>2</sub>O - OH]<sup>+</sup>, 100%).

### **General Procedure F: Cross-metathesis**

### (E)-Ethyl 2-(3-oxobutyl)-7-phenylhept-6-enoate – S5



As described in general procedure F, stirring ethyl 2-(3-oxobutyl)hept-6-enoate (0.58 g, 2.55 mmol, 1 equiv.), styrene (0.88 mL, 7.65 mmol, 3 equiv.) and Grubbs' catalyst second

generation (22 mg, 25.5 µmol, 1 mol%) in CH<sub>2</sub>Cl<sub>2</sub> (6 mL) overnight at reflux with subsequent work-up and purification by flash column chromatography (toluene  $\rightarrow 2\%$ EtOAc:toluene) yielded the named compound as a colourless oil (0.52 g, 67%);  $v_{max}$  / cm<sup>-1</sup> 3025, 2934, 1717, 1447, 1367, 1154, 1026, 965, 734, 693;  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.27 (3H, t, *J* 7.3, CH<sub>2</sub>CH<sub>3</sub>), 1.42 – 1.57 (3H, m, 1 H from CH<sub>2</sub> + CH<sub>2</sub>), 1.64 – 1.75 (1H, m, 1H from CH<sub>2</sub>), 1.82 (2H, q, *J* 7.5, CH<sub>2</sub>), 2.13 (3H, s, CH<sub>3</sub>), 2.21 (2H, q, *J* 6.8, CH<sub>2</sub>), 2.31 – 2.41 (1H, m, CH), 2.45 (2H, td, *J* 7.4, 2.8, CH<sub>2</sub>), 4.15 (2H, q, *J* 7.1, CH<sub>2</sub>CH<sub>3</sub>), 6.16 (1H, dt, *J* 15.8, 6.8, CH<sub>2</sub>CH=CH), 6.38 (1H, d, *J* 15.9, CH<sub>2</sub>CH=CH), 7.2 (1H, tt, *J* 7.1, 1.5, ArH), 7.27 – 7.34 (4H, m, ArH);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) 14.3 (CH<sub>2</sub>CH<sub>3</sub>), 25.9 (CH<sub>2</sub>), 26.9 (CH<sub>2</sub>), 30.0 (CH<sub>3</sub>), 31.9 (CH<sub>2</sub>), 32.8 (CH<sub>2</sub>), 41.1 (CH<sub>2</sub>), 44.6 (CH), 60.3 (CH<sub>2</sub>CH<sub>3</sub>), 125.9 (ArCH), 126.9 (ArCH), 128.4 (ArCH), 130.2 (CH<sub>2</sub>CH=CH and CH<sub>2</sub>CH=CH), 137.7 (ArC), 175.7 (CO<sub>2</sub>Et), 208.0 (CO); *m*/z (ESI+) 325 ([M + Na]<sup>+</sup>, 100%); HRMS (ESI+) found 320.2214, expect 320.2220 for C<sub>19</sub>H<sub>30</sub>O<sub>3</sub>N.

# rac-(3R,6S)-6-Methyl-3-((E)-5-phenylpent-4-en-1-yl)-6-(1-phenylpropa-1,2-dien-1yl)tetrahydro-2H-pyran-2-one – trans-1b



As described in general procedure D, reaction of (*E*)-ethyl 2-(3-oxobutyl)-7-phenylhept-6enoate (0.25 g, 0.33 mmol, 1 equiv.), (3-bromoprop-1-yn-1-yl)benzene (0.20 g, 1.08 mmol, 1.3 equiv.), SmI<sub>2</sub> (33.0 mL, 2.69 mmol, 4 equiv.) and NiI<sub>2</sub> (20.0 mg, 0.06 mmol, 2 mol % with respect to SmI<sub>2</sub>), after work-up and flash column chromatography (5% EtOAc:hexane) yielded *trans*-1b as a yellow oil (combined yield for *cis* and *trans* isomers: 24%, for *trans*- **1b**: 37 mg, 12%);  $v_{max} / cm^{-1} 3025$ , 2450, 1728, 1493, 1448, 1216, 1092, 1074, 965, 765, 697;  $\delta_{H}$  (500 MHz, CDCl<sub>3</sub>) 1.51 - 1.59 (3H, m, 1H from *CH*<sub>2</sub> + *CH*<sub>2</sub>), 1.61 (3H, s, *CH*<sub>3</sub>), 1.64 -1.71 (1H, m, 1H from *CH*<sub>2</sub>), 1.86 (1H, quin, *J* 6.7, 1H from *CH*<sub>2</sub>), 1.93 - 2.01 (1H, m, 1H from *CH*<sub>2</sub>), 2.12 (1H, sxt, *J* 6.9, 1H from *CH*<sub>2</sub>), 2.19 - 2.29 (3H, m, 1H from *CH*<sub>2</sub> + *CH*<sub>2</sub>), 2.40 - 2.48 (1H, m, *CH*), 5.11 (2H, s, C=*CH*<sub>2</sub>), 6.21 (1H, dt, *J* 15.8, 6.9, CH<sub>2</sub>*CH*=*CH*), 6.39 (1H, d, *J* 15.8, CH<sub>2</sub>CH=*CH*), 7.17 - 7.23 (1H, m, Ar*H*), 7.26 - 7.38 (7H, m, Ar*H*), 7.43 - 7.47 (2H, m, Ar*H*);  $\delta_{C}$  (125 MHz, CDCl<sub>3</sub>) 22.7 (*C*H<sub>2</sub>), 26.7 (*C*H<sub>2</sub>), 28.1 (*C*H<sub>3</sub>), 31.0 (*C*H<sub>2</sub>), 31.9 (*C*H<sub>2</sub>), 32.9 (*C*H<sub>2</sub>), 38.6 (*C*H), 78.7 (C=*C*H<sub>2</sub>), 82.9 (quat. C), 110.3 (*C*=C=*C*H<sub>2</sub>), 125.9 (Ar*C*H), 126.9 (Ar*C*H), 127.5 (Ar*C*H), 128.4 (Ar*C*H), 128.5 (Ar*C*H), 129.0 (Ar*C*H), 130.2 (CH<sub>2</sub>*C*H=CH and CH<sub>2</sub>CH=*C*H), 134.1 (Ar*C*), 137.7 (Ar*C*), 174.0 (*C*O), 207.4 (*C*=CH<sub>2</sub>); *m*/*z* (ESI+) 395.2 ([M + Na]<sup>+</sup>, 100%); HRMS (ESI+) found 395.1996, expect 395.1982 for C<sub>26</sub>H<sub>28</sub>O<sub>2</sub>Na.

# rac-(4R,4aR,5S,6S,7R,9aS)-4-Benzyl-5,7-dimethyl-6-phenyldecahydro-1Hbenzo[7]annulene-4a,7-diol – 2b and (1S,2R,3R,4S,5R)-1,3-dimethyl-2-phenyl-5-((E)-5-phenylpent-4-en-1-yl)cycloheptane-1,4-diol – 4b



As described in general procedure E, reaction of *rac*-(3*R*,6*S*)-6-methyl-3-((*E*)-5-phenylpent-4-en-1-yl)-6-(1-phenylpropa-1,2-dien-1-yl)tetrahydro-2H-pyran-2-one *trans*-1b (35.0 mg, 0.09 mmol, 1 equiv.), H<sub>2</sub>O (6.80 mL, 0.38 mol, 4000 equiv.) and SmI<sub>2</sub> (14.0 mL, 1.50 mmol, 16 equiv.), after work-up and flash column chromatography (10% EtOAc:hexane  $\rightarrow$  20% EtOAc:hexane) yielded **4b** (3 mg, 8%) and **2b** (13 mg, 37%) as a colourless oil and a white solid, respectively.

For **2b**: m. p. 149 – 153 °C (MeOH);  $v_{max} / cm^{-1}$  3472, 2933, 1718, 1610, 1454, 1369, 755, 699;  $\delta_{H}$  (500 MHz, CDCl<sub>3</sub>) 1.11 (3H, s, CH<sub>3</sub>), 1.13 - 1.19 (2H, m, 1H from CH<sub>2</sub> + 1H from CH<sub>2</sub>), 1.20 - 1.26 (1H, m, 1H from CH<sub>2</sub>), 1.31 - 1.38 (1H, m, 1H from CH<sub>2</sub>), 1.41 - 1.50 (5H, m, CH<sub>2</sub> + CH<sub>3</sub>), 1.52 - 1.65 (2H, m, 1H from CH<sub>2</sub> + CH), 1.73 - 1.81 (1H, m, CH), 1.85 (1H, dd, *J* 15.3, 11.8, 1H from CH<sub>2</sub>), 1.99 - 2.13 (3H, m, 1H from CH<sub>2</sub>Ph + CH<sub>2</sub>), 2.52 (1H, q, *J* 7.9, CHCH<sub>3</sub>), 2.87 (1H, dd, *J* 13.4, 3.3, 1H from CH<sub>2</sub>Ph), 3.93 (1H, s, CHPh), 7.05 - 7.09 (2H, m, ArH), 7.14 - 7.18 (1H, m, ArH), 7.22 - 7.26 (3H, m, ArH), 7.31 - 7.35 (2H, m, ArH), 7.40 - 7.44 (2H, m, ArH);  $\delta_{C}$  (125 MHz, CDCl<sub>3</sub>) 13.3 (CH<sub>3</sub>) 25.8 (CH<sub>2</sub>), 26.4 (CH<sub>2</sub>), 26.6 (CH<sub>2</sub>), 28.3 (CH<sub>3</sub>), 30.9 (CH<sub>2</sub>), 34.7 (CH<sub>2</sub>), 43.0 (CHMe), 43.1 (CH<sub>2</sub>), 44.4 (CH), 45.2 (CH), 49.4 (CHPh), 74.7 (quat. C), 77.2 (quat. C), 125.7 (ArCH), 126.3 (ArCH), 128.2 (ArCH), 128.3 (ArCH), 129.1 (ArCH), 129.6 (ArCH), 141.3 (ArC), 145.3 (ArC); HRMS (ESI+) found 401.2473, expect 401.2457 for C<sub>26</sub>H<sub>34</sub>O<sub>2</sub>Na.

For **4b**:  $\delta_{\rm H}$  (500 MHz, CDCl<sub>3</sub>) 0.89 (3H, d, *J* 6.9, CH<sub>3</sub>), 0.95 (3H, s, CH<sub>3</sub>), 1.48 - 1.67 (4H, m, CH<sub>2</sub> + CH<sub>2</sub>), 1.74 - 1.80 (1H, m, 1H from CH<sub>2</sub>), 1.85 - 1.91 (1H, m, 1H from CH<sub>2</sub>), 1.97 - 2.06 (1H, m, 1H from CH<sub>2</sub>), 2.19 - 2.33 (3H, m, *J* 6.3, 1H from CH<sub>2</sub> + CH<sub>2</sub>), 2.55 (1H, sxt, *J* 6.0, CH), 2.77 (1H, s, CHPh), 3.78 (1H, qd, *J* 6.6, 3.2, CHCH<sub>3</sub>), 6.20 (1H, dt, *J* 15.8, 6.9, CH<sub>2</sub>CH=CH), 6.39 (1H, d, *J* 15.8, CH<sub>2</sub>CH=CH), 6.95 - 6.98 (1H, m, ArH), 7.18 - 7.22 (1H, m, ArH), 7.23 - 7.39 (8H, m, ArH);  $\delta_{\rm C}$  (125 MHz, CDCl<sub>3</sub>) 16.2 (CH<sub>3</sub>), 22.9 (CH<sub>2</sub>), 26.4 (CH<sub>2</sub>), 32.0 (CH<sub>3</sub>), 33.0 (CH<sub>2</sub>), 34.9 (CH<sub>2</sub>), 38.5 (CH<sub>2</sub>), 42.2 (CHMe), 53.8 (CH), 63.2 (CHPh), 73.8 (quat. C), 125.9 (ArCH), 126.8 (ArCH), 127.0 (ArCH), 127.9 (ArCH), 128.5 (ArCH), 130.0 (CH<sub>2</sub>CH=CH or CH<sub>2</sub>CH=CH), 130.2 (CH<sub>2</sub>CH=CH or CH<sub>2</sub>CH=CH), 130.4 (ArCH), 137.7 (ArC), 137.7 (ArC), 217.2 (CO); *m*/z (ESI+) 394.5 ([M + NH<sub>4</sub>]<sup>+</sup>, 100%); HRMS (ESI+) found 399.2301, expect 399.2295 for C<sub>26</sub>H<sub>32</sub>O<sub>2</sub>Na.

rac-(4S,4aS,5R,6R,7S,9aR)-7-Methyl-5-(methyl-d)-6-phenyl-4-((S)-phenylmethyld)decahydro-4aH-benzo[7]annulene-5,6-d2-4a,7-diol-d2 – 2b-D<sub>4</sub>



As described in general procedure E, reaction of rac-(3R,6S)-6-methyl-3-((E)-5-phenylpent-4-en-1-yl)-6-(1-phenylpropa-1,2-dien-1-yl)tetrahydro-2H-pyran-2-one trans-1b (30.0 mg, 0.08 mmol, 1 equiv.), D<sub>2</sub>O (6.40 mL, 0.32 mol, 4000 equiv.) and SmI<sub>2</sub> (6.40 mL, 0.64 mmol, 8 equiv.), after work-up and flash column chromatography (10% EtOAc:hexane  $\rightarrow 20\%$ EtOAc:hexane) yielded **2b-D<sub>4</sub>** (7 mg, 23%) as a colourless oil;  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.11 (3H, s CH<sub>3</sub>), 1.12 - 1.19 (2H, m, 1H from CH<sub>2</sub> + 1H from CH<sub>2</sub>), 1.20 - 1.26 (1H, m, 1H from CH<sub>2</sub>), 1.32 - 1.37 (1H, m, 1H from CH<sub>2</sub>), 1.41 - 1.47 (4H, m, CH<sub>2</sub> + CDH<sub>2</sub>), 1.53 - 1.64 (2H, m, 1H from CH<sub>2</sub> + CH), 1.72 - 1.79 (1H, m, CH), 1.84 (1H, dd, J 15.3, 11.7, 1H from CH<sub>2</sub>), 1.98 - 2.08 (2H, m, 1H, CH<sub>2</sub>), 2.84 (1H, d, J 2.8, 1H from CDHPh), 7.07 (2H, d, J 7.3, ArH), 7.16 (1H, t, J 7.3, ArH), 7.21 - 7.27 (3H, m, ArH), 7.33 (2H, t, J 7.3, ArH), 7.39 - 7.44 (2H, m, ArH); δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>) 12.8 (t, J 19.1, CDH<sub>2</sub>), 25.8 (CH<sub>2</sub>), 26.4 (CH<sub>2</sub>), 26.6 (CH<sub>2</sub>), 28.2 (CH<sub>3</sub>), 30.8 (CH<sub>2</sub>), 34.4 (t, J 19.1, CDHPh), 42.4 (t, J 17.3, CDCH<sub>2</sub>D), 43.1 (CH<sub>2</sub>), 44.3 (CH), 45.2 (CH), 48.9 (t, J 19.1, CDPh), 74.7 (quat. C), 77.2 (quat. C), 125.7 (ArCH), 126.3 (ArCH), 128.2 (ArCH), 128.3 (ArCH), 129.1 (ArCH), 129.6 (ArCH), 141.2 (ArC), 145.3 (ArC); m/z (ESI+) 405.7 ([M + Na]<sup>+</sup>, 100%); HRMS (ESI+) found 405.2705, expect 405.2708 for C<sub>26</sub>H<sub>30</sub>D<sub>4</sub>O<sub>2</sub>Na.

**S14** 

Ethyl (E)-2-(3-oxobutyl)-7-(4-(trifluoromethyl)phenyl)hept-6-enoate - S6



As described in general procedure F, ethyl 2-(3-oxobutyl)hept-6-enoate (0.22 g, 0.97 mmol, 1 equiv.), 4-(trifluoromethyl)styrene (0.43 mL, 2.92 mmol, 3 equiv.) and Grubbs' catalyst second generation (9.00 mg, 9.72 µmol, 1 mol%) in CH<sub>2</sub>Cl<sub>2</sub> (2 mL) overnight at reflux with subsequent work-up and purification by flash colum chromatography (toluene  $\rightarrow 2\%$  EtOAc:toluene) yielded the named compound as a colourless oil (0.36 g, 99%);  $v_{max} / cm^{-1}$  2946, 1716, 1635, 1324, 1162, 1108;  $\delta_{\rm H}$  (500 MHz, CDCl<sub>3</sub>) 1.27 (3H, t, *J* 7.3, CH<sub>2</sub>CH<sub>3</sub>), 1.44 - 1.57 (3H, m, 1H from CH<sub>2</sub> + CH<sub>2</sub>), 1.64 - 1.74 (1H, m, 1H from CH<sub>2</sub>), 1.83 (2H, q, *J* 7.5, CH<sub>2</sub>), 2.14 (3H, s, CH<sub>3</sub>), 2.24 (2H, q, *J* 6.7, CH<sub>2</sub>), 2.33 - 2.42 (1H, m, 1H from CH<sub>2</sub>), 2.45 (1H, qd, *J* 7.9, 2.5, CH), 4.15 (2H, q, *J* 7.3, CH<sub>2</sub>CH<sub>3</sub>), 6.29 (1H, dt, *J* 15.8, 6.9, CH<sub>2</sub>CH=CH), 6.41 (1H, d, *J* 15.8, CH<sub>2</sub>CH=CH), 7.42 (2H, d, *J* 8.2, ArH), 7.54 (2H, d, *J* 7.9, ArH);  $\delta_{\rm C}$  (125 MHz, CDCl<sub>3</sub>) 14.3 (CH<sub>2</sub>CH<sub>3</sub>), 25.9 (CH<sub>2</sub>), 26.7 (CH<sub>2</sub>), 30.0 (CH<sub>3</sub>), 31.9 (CH<sub>2</sub>), 32.8 (CH<sub>2</sub>), 41.0 (CH<sub>2</sub>), 44.6 (CH), 60.3 (CH<sub>2</sub>CH<sub>3</sub>), 125.4 (q, *J*<sup>3</sup> 3.6, ArCH), 125.6 (q, *J*<sup>1</sup> 271.6, CF<sub>3</sub>), 126.0 (ArCH), 129.0 (q, *J*<sup>2</sup> 32.7, ArCCF<sub>3</sub>), 129.1 (CH<sub>2</sub>CH=CH), 133.1 (CH<sub>2</sub>CH=CH), 141.1 (ArC), 175.6 (CO<sub>2</sub>Et), 208.0 (CO); *m*/z (ESI+) 393.4 ([M + Na]<sup>+</sup>, 100%); HRMS (ESI+) found 393.1637, expect 393.1653 for C<sub>20</sub>H<sub>2</sub>G<sub>3</sub>F<sub>3</sub>Na.

rac-(3R,6S)-6-Methyl-6-(1-phenyl-propa-1,2-dien-1-yl)-3-((E)-5-(4-(trifluoromethyl)phenyl)pent-4-en-1-yl)tetrahydro-2H-pyran-2-one – trans-1c



As described in general procedure D, reaction of ethyl (E)-2-(3-oxobutyl)-7-(4-(trifluoromethyl)phenyl)hept-6-enoate (0.25 g, 0.68 mmol, 1 equiv.), (3-bromoprop-1-yn-1vl)benzene (0.17 g, 0.88 mmol, 1.3 equiv.), SmI<sub>2</sub> (27.0 mL, 2.72 mmol, 4 equiv.) and NiI<sub>2</sub> (16.0 mg, 0.05 mmol, 2 mol% with respect to SmI<sub>2</sub>), after work-up and flash column chromatography (5% EtOAc:hexane) yielded *trans-*1c as a yellow oil (combined yield for *cis* and *trans* isomers: 24%, for *trans*-1c: 36 mg, 12%); v<sub>max</sub> / cm<sup>-1</sup> 2934, 1728, 1614, 1324, 1162, 1119, 1067;  $\delta_{\rm H}$  (500 MHz, CDCl<sub>3</sub>) 1.53 - 1.59 (3H, m, 1H from CH<sub>2</sub> + CH<sub>2</sub>), 1.62 (3H, s, CH<sub>3</sub>), 1.64 - 1.72 (1H, m, 1H from CH<sub>2</sub>), 1.86 (1H, quin, J 6.4, 1H from CH<sub>2</sub>), 1.91 - 2.01 (1H, m, 1H from CH<sub>2</sub>), 2.12 (1H, sxt, J 6.9, 1H from CH<sub>2</sub>), 2.20 - 2.30 (3H, m, 1H from CH<sub>2</sub>) + CH<sub>2</sub>), 2.40 - 2.48 (1H, m, CH), 5.11 (2H, s, C=CH<sub>2</sub>), 6.31 (1H, dt, J 15.7, 6.7, CH<sub>2</sub>CH=CH), 6.42 (1H, d, J 15.9, CH<sub>2</sub>CH=CH), 7.24 - 7.30 (1H, m, ArH), 7.34 (2H, t, J 7.6, ArH), 7.43 (4H, dd, J 13.1, 7.7, ArH), 7.54 (2H, d, J 8.1, ArH); δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>) 22.7 (CH<sub>2</sub>), 26.4 (CH<sub>2</sub>), 28.1 (CH<sub>3</sub>), 31.0 (CH<sub>2</sub>), 31.8 (CH<sub>2</sub>), 32.9 (CH<sub>2</sub>), 38.6 (CH), 78.7 (C=CH<sub>2</sub>), 83.0 (quat. C), 110.2 (C=C=CH<sub>2</sub>), 124.2 (q, J<sup>1</sup> 271.6, CF<sub>3</sub>), 125.4 (q, J<sup>3</sup> 3.6, ArCH), 126.0 (ArCH), 127.5 (ArCH), 128.4 (ArCH), 128.6 (q, J<sup>2</sup> 32.7, ArCCF<sub>3</sub>), 128.9 (CH<sub>2</sub>CH=CH), 129.0 (ArCH), 133.1 (CH<sub>2</sub>CH=CH), 134.0 (ArC), 141.1 (ArC), 174.0 (CO), 207.4 (*C*=CH<sub>2</sub>); m/z (ESI+) 463.2 ([M + Na]<sup>+</sup>, 100%); HRMS (ESI+) found 463.1848, expect 463.1855 for C<sub>27</sub>H<sub>27</sub>O<sub>2</sub>F<sub>3</sub>Na.

### rac-(4S,4aS,5R,6R,7S,9aR)-5,7-Dimethyl-6-phenyl-4-(4-

### (trifluoromethyl) benzyl) decahydro-4aH-benzo[7] annulene-4a, 7-diol - 2c



As described in general procedure E, reaction of rac-(3R,6S)-6-methyl-6-(1-phenyl-propa-1,2-dien-1-yl)-3-((*E*)-5-(4-(trifluoromethyl)phenyl)pent-4-en-1-yl)tetrahydro-2H-pyran-2-one trans-1c (40.0 mg, 0.09 mmol, 1 equiv.), H<sub>2</sub>O (6.50 mL, 0.36 mol, 4000 equiv.) and SmI<sub>2</sub> (7.30 mL, 0.73 mmol, 8 equiv.), after work-up and flash column chromatography (10% EtOAc:hexane  $\rightarrow$  20% EtOAc:hexane) yielded 2c (10 mg, 24%) as a colourless oil;  $v_{max}$  /  $cm^{-1}$  3458, 2953, 2872, 1623, 1451, 1321, 1186, 1121, 1085;  $\delta_{H}$  (500 MHz, CDCl<sub>3</sub>) 1.12 (3H, m, CHCH<sub>3</sub>), 1.14 - 1.19 (2H, m, 1H from CH<sub>2</sub> + 1H from CH<sub>2</sub>), 1.22 - 1.27 (2H, m 1H from  $CH_2 + 1H$  from  $CH_2$ ), 1.40 - 1.51 (5H, m,  $CH_2 + CH_3$ ), 1.53 - 1.65 (2H, m, 1H from  $CH_2 + CH_3$ ) CH), 1.78 (1H, tt, J 11.3, 4.1, CH), 1.85 (1H, dd, J 15.3, 11.8, 1H from CH<sub>2</sub>), 1.99 - 2.07 (2H, m, CH<sub>2</sub>), 2.19 (1H, dd, J 13.2, 11.3, 1H from CH<sub>2</sub>Ph), 2.48 (1H, q, J 7.6, CHCH<sub>3</sub>), 2.91 (1H, dd, J 13.2, 2.8, 1H from CH<sub>2</sub>Ph), 3.91 (1H, s, CHPh), 7.18 (2H, d, J 7.9, ArH-CF<sub>3</sub>), 7.23 -7.27 (1H, ArH), 7.34 (2H, t, J 7.6, ArH), 7.41 (2H, d, J 7.3, ArH), 7.50 (2H, d, J 7.9, ArH-CF<sub>3</sub>); δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>) 13.2 (CH<sub>3</sub>), 25.7 (CH<sub>2</sub>), 26.4 (CH<sub>2</sub>), 26.6 (CH<sub>2</sub>), 28.3 (CH<sub>3</sub>), 30.8 (CH<sub>2</sub>), 34.7 (CH<sub>2</sub>), 42.9 (CHMe), 43.1 (CH<sub>2</sub>), 44.2 (CH), 45.1 (CH), 49.4 (CHPh), 74.7(quat. C), 77.2 (quat. C), 125.1 (q, J<sup>3</sup> 3.6, ArCH), 125.4 (q, J<sup>1</sup> 271.6, CF<sub>3</sub>) 126.4 (ArCH), 128.2 (q, J<sup>2</sup> 31.8, ArCCF<sub>3</sub>), 128.4 (ArCH), 129.4 (ArCH), 129.6 (ArCH), 145.2 (ArC), 145.6 (ArC); m/z (ESI+) 469.5 ([M + Na]<sup>+</sup>, 100%); HRMS (ESI+) found 469.2321, expect 469.2330 for C<sub>27</sub>H<sub>33</sub>O<sub>2</sub>F<sub>3</sub>Na.

Ethyl (E)-7-(4-bromophenyl)-2-(3-oxobutyl)hept-6-enoate – S7



As described in general procedure F, ethyl 2-(3-oxobutyl)hept-6-enoate (0.20 g, 0.88 mmol, 1 equiv.), Hoveyda-Grubbs II catalyst (5.50 mg, 8.80  $\mu$ mol, 1 mol%) and 4-bromostyrene (0.49 g, 2.65 mmol, 3 equiv.) in CH<sub>2</sub>Cl<sub>2</sub> (5 mL) after work-up and column chromatography on silica gel eluting with (petroleum ether -10% EtOAc:petroleum ether) gave the title compound as a yellow oil (0.15 g, 45%); v<sub>max</sub> /cm<sup>-1</sup> 2935, 1716, 1487, 1445, 1401, 1366, 1154, 1096, 1072, 1026;  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.27 (3H, t, *J* 7.1, CH<sub>2</sub>CH<sub>3</sub>), 1.41 - 1.56 (3H, m, 1H from CH<sub>2</sub> + CH<sub>2</sub>), 1.61 - 1.74 (1H, m, 1H from CH<sub>2</sub>), 1.78 - 1.86 (2H, m, CH<sub>2</sub>), 2.13 (3H, s, CH<sub>3</sub>), 2.17 - 2.24 (2H, m, CH<sub>2</sub>), 2.32 - 2.40 (1H, m, CH), 2.41 - 2.49 (2H, m, CH<sub>2</sub>CCO), 4.15 (2H, q, *J* 7.1, CH<sub>2</sub>CH<sub>3</sub>), 6.12 - 6.22 (1H, m, CH=CHPh), 6.27 - 6.36 (1H, m, CH=CHPh), 7.20 (2H, d, *J* 8.6, ArH), 7.41 (2H, d, *J* 8.6, ArH);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) 14.3 (CH<sub>3</sub>), 25.9 (CH<sub>2</sub>), 26.8 (CH<sub>2</sub>), 30.0 (CH<sub>3</sub>), 31.9 (CH<sub>2</sub>), 32.8 (CH<sub>2</sub>), 41.1 (CH<sub>2</sub>), 44.6 (CH), 60.3 (CH<sub>2</sub>CH<sub>3</sub>), 120.5 (ArC), 127.5 (ArCH), 129.1 (CH<sub>2</sub>CH=CH), 131.1 (CH<sub>2</sub>CH=CH), 131.5 (ArCH), 136.6 (ArC), 175.6 (CO<sub>2</sub>Et), 207.9 (CO); *m*/z (ESI+) 381.0 ([M+H]<sup>+</sup>, 100%).

rac-(3R,6S)-3-((E)-5-(4-Bromophenyl)pent-4-en-1-yl)-6-methyl-6-(1-phenyl-2l5-propa-1,2dien-1-yl)tetrahydro-2H-pyran-2-one – trans-1d



As described in general procedure D, reaction of ethyl (E)-7-(4-bromophenyl)-2-(3oxobutyl)hept-6-enoate (0.24 g, 0.63 mmol, 1 equiv.), (3-bromoprop-1-yn-1-yl)benzene (0.16 g, 0.82 mmol, 1.3 equiv.), SmI<sub>2</sub> (23.0 mL, 2.22 mmol, 3.5 equiv.) and NiI<sub>2</sub> (14.0 mg, 0.04 mmol, 2 mol% with respect to SmI<sub>2</sub>), after work-up and flash column chromatography (5% EtOAc:hexane) yielded *trans-1d* as a yellow oil (combined yield for *cis* and *trans* isomers: 22%, for *trans*-1d: 30 mg, 11%);  $v_{max}$  / cm<sup>-1</sup> 2934, 1726, 1487, 1216, 1072;  $\delta_{\rm H}$  (500 MHz,  $CDCl_3$ ) 1.51 - 1.59 (3H, m, 1H from  $CH_2 + CH_2$ ), 1.62 (3H, m,  $CH_3$ ), 1.63 - 1.71 (1H, m, 1H) from CH<sub>2</sub>), 1.86 (1H, quin, J 6.6, 1H from CH<sub>2</sub>), 1.92 - 1.98 (1H, m, 1H from CH<sub>2</sub>), 2.11 (1H, sxt, J 7.3, 1H from CH<sub>2</sub>), 2.19 - 2.27 (3H, m, 1H from CH<sub>2</sub> + CH<sub>2</sub>), 2.40 - 2.47 (1H, m, CH), 5.12 (2H, s, C=CH<sub>2</sub>), 6.20 (1H, dt, J 15.8, 6.9, CH<sub>2</sub>CH=CH), 6.32 (1 H, d, J 15.8, CH<sub>2</sub>CH=CH), 7.18 - 7.21 (2H, m, ArH), 7.26 - 7.30 (1H, m, ArH), 7.31 - 7.35 (2H, m, ArH), 7.39 - 7.42 (2H, m, ArH), 7.43 - 7.46 (2H, m, ArH); δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>) 22.7 (CH<sub>2</sub>) 26.5 (CH<sub>2</sub>) 28.1 (CH<sub>3</sub>) 31.0 (CH<sub>2</sub>) 31.9 (CH<sub>2</sub>) 32.9 (CH<sub>2</sub>) 38.6 (CH) 78.7 (C=CH<sub>2</sub>) 83.0 (quat. C) 110.3 (C=C=CH<sub>2</sub>) 120.5 (ArC) 127.5 (ArCH) 128.4 (ArCH) 129.0 (ArCH) 129.1 (CH<sub>2</sub>CH=CH) 131.1 (CH<sub>2</sub>CH=CH) 131.5 (ArCH) 134.0 (ArC) 136.6 (ArC) 173.9 (CO) 207.4 (C=CH<sub>2</sub>); m/z (ESI+) 485.5 ([M + K]<sup>+</sup>, 100%); HRMS (ESI+) found 451.1267, expect 451.1267 for C<sub>26</sub>H<sub>28</sub>O<sub>2</sub>Br.

## rac-(4S,4aS,5R,6R,7S,9aR)-4-(4-Bromobenzyl)-5,7-dimethyl-6-phenyldecahydro-4aHbenzo[7]annulene-4a,7-diol – 2d



As described in general procedure E, reaction of rac-(3R,6S)-3-((E)-5-(4-bromophenyl)pent-4-en-1-yl)-6-methyl-6-(1-phenyl-propa-1,2-dien-1-yl)tetrahydro-2H-pyran-2-one trans-1d (70 mg, 0.16 mmol, 1 equiv.), H<sub>2</sub>O (11.2 mL, 0.62 mol, 4000 equiv.) and SmI<sub>2</sub> (12.5 mL, 1.24 mmol, 8 equiv.), after work-up and flash column chromatography (10% EtOAc:hexane  $\rightarrow$  20% EtOAc:hexane) yielded 2d (14 mg, 20%) as a white solid; m. p. 151 – 155 °C (MeOH); υ<sub>max</sub> / cm<sup>-1</sup> 3472, 2962, 2924, 1622, 1492, 1470, 1432, 1016; δ<sub>H</sub> (500 MHz, CDCl<sub>3</sub>) 1.12 (3H, s, CH<sub>3</sub>), 1.14 - 1.16 (1H, m, 1H from CH<sub>2</sub>), 1.21 - 1.26 (1H, m, 1H from CH<sub>2</sub>), 1.27 - 1.33 (1H, m, 1H from CH<sub>2</sub>), 1.43 (3H, d, J 7.6, CH<sub>3</sub>), 1.45 - 1.48 (2H, m, CH<sub>2</sub>), 1.52 - 1.59 (2H, m, 1H from CH<sub>2</sub> + CH), 1.60 - 1.65 (1H, m, 1H from CH<sub>2</sub>), 1.72 (1H, tt, J 7.6, 3.7, CH), 1.84 (1H, dd, J 15.3, 11.8, 1H from CH<sub>2</sub>), 1.99 - 2.11 (3H, m, 1H from CH<sub>2</sub>Ph + CH<sub>2</sub>), 2.47 (1H, q, J 7.7, CHCH<sub>3</sub>), 2.80 (1H, dd, J 13.6, 3.5, 1H from CH<sub>2</sub>Ph), 3.90 (1H, s, CHPh), 6.94 (2H, d, J 8.2, ArH), 7.23 - 7.28 (2H, m, ArH), 7.31 - 7.38 (4H, m, ArH), 7.41 (2H, d, J 7.3, ArH);  $\delta_{C}$  (125 MHz, CDCl<sub>3</sub>) 13.2 (CH<sub>3</sub>), 25.7 (CH<sub>2</sub>), 26.4 (CH<sub>2</sub>), 26.5 (CH<sub>2</sub>), 28.3 (CH<sub>3</sub>), 30.8 (CH<sub>2</sub>), 34.2 (CH<sub>2</sub>), 42.9 (CHMe), 43.1 (CH<sub>2</sub>), 44.3 (CH), 45.1 (CH), 49.4 (CHPh), 74.7 (quat. C), 77.2 (quat. C), 119.4 (ArC), 126.4 (ArCH), 128.4 (ArCH), 129.6 (ArCH), 130.8 (ArCH), 131.2 (ArCH), 140.3 (ArC), 145.2 (ArC); *m*/*z* (ESI+) 479.3 ([M + Na]<sup>+</sup>, 100%); HRMS (ESI+) found 479.1570, expect 479.1562 for C<sub>26</sub>H<sub>33</sub>O<sub>2</sub>BrNa.

### Ethyl (E)-2-(3-oxobutyl)-7-(p-tolyl)hept-6-enoate – S8



As described in general procedure F, ethyl 2-(3-oxobutyl)hept-6-enoate (0.60 g, 2.65 mmol, 1 equiv.), 4-methylstyrene (1.00 g, 7.96 mmol, 3 equiv.) and Grubbs' catalyst second generation (45.0 mg, 53.1 µmol, 1 mol%) in CH<sub>2</sub>Cl<sub>2</sub> (10 mL) overnight at reflux with subsequent work-up and purification by flash colum chromatography (toluene  $\rightarrow 2\%$  EtOAc:toluene) yielded the named compound as a colourless oil (0.58 g, 69%);  $v_{max}$  / cm<sup>-1</sup> 2934, 1717, 1512, 1446, 1367, 1155;  $\delta_{\rm H}$  (500 MHz, CDCl<sub>3</sub>) 1.27 (3H, t, *J* 7.3, CH<sub>2</sub>CH<sub>3</sub>), 1.44 - 1.54 (3H, m, 1H from CH<sub>2</sub> + CH<sub>2</sub>), 1.64 - 1.73 (1H, m, 1H from CH<sub>2</sub>), 1.82 (2H, q, *J* 7.3, CH<sub>2</sub>), 2.13 (3H, s, CH<sub>3</sub>), 2.20 (2H, q, *J* 6.7, CH<sub>2</sub>), 2.33 (3H, s, CH<sub>3</sub>), 2.34 - 2.39 (1H, m, 1H from CH<sub>2</sub>), 2.44 (2H, td, *J* 7.5, 3.9, CH), 4.15 (2H, q, *J* 7.3, CH<sub>2</sub>CH<sub>3</sub>), 6.13 (1H, dt, *J* 15.7, 7.0, CH<sub>2</sub>CH=CH), 6.34 (1H, d, *J* 15.8, CH<sub>2</sub>CH=CH), 7.10 (2H, d, *J* 7.9, ArH), 7.23 (2H, d, *J* 8.2, ArH);  $\delta_{\rm C}$  (125 MHz, CDCl<sub>3</sub>) 14.3 (CH<sub>2</sub>CH<sub>3</sub>), 21.1 (ArCH<sub>3</sub>), 25.9 (CH<sub>2</sub>), 27.0 (CH<sub>2</sub>), 29.9 (CH<sub>3</sub>), 31.8 (CH<sub>2</sub>), 32.7 (CH<sub>2</sub>), 41.1 (CH<sub>2</sub>), 44.6 (CH), 60.2 (CH<sub>2</sub>CH<sub>3</sub>), 125.8 (ArCH), 129.1 (CH<sub>2</sub>CH=CH + CH<sub>2</sub>CH=CH), 130.0 (ArCH), 134.8 (ArC), 136.5 (ArC), 175.7 (CO<sub>2</sub>Et), 208.0 (CO); *m*/z (ESI+) 317.5 ([M + H]<sup>+</sup>, 100%); HRMS (ESI+) found 339.1931, expect 339.1936 for C<sub>20</sub>H<sub>28</sub>O<sub>3</sub>Na.

rac-(3R,6S)-6-Methyl-6-(1-phenyl-2l5-propa-1,2-dien-1-yl)-3-((E)-5-(p-tolyl)pent-4-en-1yl)tetrahydro-2H-pyran-2-one – trans-1e



As described in general procedure D, reaction of ethyl (E)-2-(3-oxobutyl)-7-(p-tolyl)hept-6enoate (0.23 g, 0.71 mmol, 1 equiv.), (3-bromoprop-1-yn-1-yl)benzene (0.18 g, 0.95 mmol, 1.3 equiv.), SmI<sub>2</sub> (25.0 mL, 2.49 mmol, 3.5 equiv.) and NiI<sub>2</sub> (16.0 mg, 0.05 mmol, 2 mol% with respect to SmI<sub>2</sub>), after work-up and flash column chromatography (5% EtOAc:hexane) yielded *trans*-1e as a yellow oil (combined yield for *cis* and *trans* isomers: 20%, for *trans*-1e: 28 mg, 10%);  $v_{max}$  / cm<sup>-1</sup> 2923, 1726, 1512, 1492, 1446, 1215, 1091;  $\delta_{H}$  (400 MHz, CDCl<sub>3</sub>) 1.51 - 1.55 (2H, m, CH<sub>2</sub>), 1.59 - 1.71 (5H, m, CH<sub>2</sub> + CH<sub>3</sub>), 1.85 (1H, quin, J 6.6, 1H from CH<sub>2</sub>), 1.92 - 2.00 (1H, m, 1H from CH<sub>2</sub>), 2.11 (1H, sxt, J 6.8, 1H from CH<sub>2</sub>), 2.18-2.25 (3H, m, 1H from  $CH_2 + CH_2$ ), 2.33 (3H, s, Ar $CH_3$ ), 2.39 - 2.47 (1H, m, CH), 5.11 (2H, s, C= $CH_2$ ), 6.17 (1H, dt, J 15.6, 7.1, CH<sub>2</sub>CH=CH), 6.35 (1H, d, J 15.9, CH<sub>2</sub>CH=CH), 7.10 (2H, d, J 7.8, ArH), 7.23 (2H, d, J 8.3, ArH), 7.28 - 7.30 (1H, m, ArH), 7.31 - 7.36 (2H, m, ArH), 7.43 -7.46 (2H, m, ArH); δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>) 21.1 (ArCH<sub>3</sub>), 22.6 (CH<sub>2</sub>), 26.7 (CH<sub>2</sub>), 28.1 (CH<sub>3</sub>), 31.0 (CH<sub>2</sub>), 31.8 (CH<sub>2</sub>), 32.9 (CH<sub>2</sub>), 38.6 (CH), 78.7 (C=CH<sub>2</sub>), 82.9 (quat. C), 110.2 (C=C=CH<sub>2</sub>), 125.8 (ArCH), 127.5 (ArCH), 128.4 (ArCH), 128.9 (ArCH), 129.1 (ArCH), 129.2 (CH<sub>2</sub>CH=CH), 130.0 (CH<sub>2</sub>CH=CH), 134.0 (ArC), 134.9 (ArC), 136.6 (ArC), 174.0 (CO), 207.4 (C=CH<sub>2</sub>); m/z (ESI+) 387.2 ([M + H]<sup>+</sup>, 100%); HRMS (ESI+) found 387.2310, expect 387.2319 for C<sub>27</sub>H<sub>31</sub>O<sub>2</sub>.

# rac-(4S,4aS,5R,6R,7S,9aR)-5,7-Dimethyl-4-(4-methylbenzyl)-6-phenyldecahydro-4aHbenzo[7]annulene-4a,7-diol – 2e



As described in general procedure E, reaction of rac-(3R,6S)-6-methyl-6-(1-phenyl-215propa-1,2-dien-1-yl)-3-((E)-5-(p-tolyl)pent-4-en-1-yl)tetrahydro-2H-pyran-2-one trans-1e (28.0 mg, 0.07 mmol, 1 equiv.), H<sub>2</sub>O (5.20 mL, 0.29 mol, 4000 equiv.) and SmI<sub>2</sub> (5.80 mL, 0.58 mmol, 8 equiv.), after work-up and flash column chromatography (10% EtOAc:hexane  $\rightarrow$  20% EtOAc:hexane) yielded **2e** (7 mg, 26%) as a yellow oil;  $v_{max}$  / cm<sup>-1</sup> 3486, 2965, 2879, 1514, 1479, 1398, 1085; δ<sub>H</sub> (400 MHz, CDCl<sub>3</sub>) 1.11 (3H, s, CH<sub>3</sub>), 1.12 - 1.18 (1H, m, 1H from CH<sub>2</sub>), 1.19 - 1.26 (1H, m, 1H from CH<sub>2</sub>), 1.29 - 1.34 (1H, m, 1H from CH<sub>2</sub>), 1.39 - 1.51 (5H, m, CH<sub>2</sub> + CH<sub>3</sub>), 1.53 - 1.63 (3H, m, 1H from CH<sub>2</sub> + 1H from CH<sub>2</sub> + CH), 1.70 - 1.77 (1H, m, CH), 1.85 (1H, dd, J 15.4, 11.9, 1H from CH<sub>2</sub>), 1.98 - 2.09 (3H, m, 1H from CH<sub>2</sub>Ph + CH<sub>2</sub>), 2.31 (3H, s, ArCH<sub>3</sub>), 2.51 (1H, q, J 7.6, CHCH<sub>3</sub>), 2.82 (1H, dd, J 13.4, 3.3, 1H from CH<sub>2</sub>Ph), 3.92 (1H, s, CHPh), 6.95 (2H, d, J 7.8, ArH), 7.06 (2H, d, J 7.8, ArH), 7.22 - 7.27 (1H, m, Ar*H*), 7.33 (2H, dd, *J* 7.8, 7.1, Ar*H*), 7.42 (2H, d, *J* 7.1, Ar*H*); δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>) 13.3 (CH<sub>3</sub>), 21.0 (ArCH<sub>3</sub>), 25.8 (CH<sub>2</sub>), 26.4 (CH<sub>2</sub>), 26.6 (CH<sub>2</sub>), 28.3 (CH<sub>3</sub>), 30.9 (CH<sub>2</sub>), 34.2 (CH<sub>2</sub>), 43.0 (CHMe), 43.2 (CH<sub>2</sub>), 44.4 (CH), 45.2 (CH), 49.4 (CHPh), 74.7 (quat. C), 77.2 (quat. C), 126.3 (ArCH), 128.3 (ArCH), 128.9 (ArCH), 129.0 (ArCH), 129.6 (ArCH), 135.1 (Ar*C*), 138.0 (Ar*C*), 145.3 (Ar*C*); *m*/*z* (ESI+) 415.5 ([M + Na]<sup>+</sup>, 100%); HRMS (ESI+) found 415.2626, expect 415.2613 for  $C_{27}H_{36}O_2Na$ .

Ethyl (E)-7-(2-chlorophenyl)-2-(3-oxobutyl)hept-6-enoate – S9



As described in general procedure F, ethyl 2-(3-oxobutyl)hept-6-enoate (0.30 g, 1.33 mmol, 1 equiv.), 2-chlorostyrene (0.51 mL, 3.98 mmol, 3 equiv.) and Grubbs' catalyst second generation (12.0 mg, 13.3 µmol, 1 mol%) in CH<sub>2</sub>Cl<sub>2</sub> (3 mL) overnight at reflux with subsequent work-up and purification by flash colum chromatography (toluene  $\rightarrow 2\%$  EtOAc:toluene) yielded the named compound as a colourless oil (0.29 g, 66%);  $v_{max}$  / cm<sup>-1</sup> 2935, 1718, 1470, 1440, 1367, 1156;  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.27 (3H, t, *J* 7.1, CH<sub>2</sub>CH<sub>3</sub>), 1.43 - 1.58 (3H, m, 1H from CH<sub>2</sub> + CH<sub>2</sub>), 1.64 - 1.75 (1H, m, 1H from CH<sub>2</sub>), 1.79 - 1.87 (2H, m, CH<sub>2</sub>), 2.14 (3H, s, CH<sub>3</sub>), 2.26 (2H, q, *J* 6.6, CH<sub>2</sub>), 2.33 - 2.42 (1H, m, CH), 2.42 - 2.49 (2H, m, CH<sub>2</sub>), 4.16 (2H, q, *J* 7.2, CH<sub>2</sub>CH<sub>3</sub>), 6.11 - 6.22 (1H, m, CH<sub>2</sub>CH=CH), 6.75 (1H, d, *J* 16.1, CH<sub>2</sub>CH=CH), 7.09 - 7.23 (2H, m, ArH), 7.33 (1H, d, *J* 7.8, ArH), 7.49 (1H, d, *J* 7.7, ArH);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) 14.4 (CH<sub>3</sub>), 26.0 (CH<sub>2</sub>), 26.8 (CH<sub>2</sub>), 30.0 (CH<sub>3</sub>), 31.9 (CH<sub>2</sub>), 33.0 (CH<sub>2</sub>), 41.1 (CH<sub>2</sub>), 44.6 (CH), 60.3 (CH<sub>2</sub>CH<sub>3</sub>), 126.5 (2 × CH=CHPh), 126.6 (ArCH), 126.8 (ArCH), 128.0 (ArCH), 129.6 (ArCH), 133.2 (ArC), 135.8 (ArC), 175.7 (CO<sub>2</sub>Et), 208.0 (CO); *m*/z (ESI+) 337.3 ([M + H]<sup>+</sup>, 100%); HRMS (ESI+) found 359.1377, expect 359.1390 for C<sub>19</sub>H<sub>25</sub>O<sub>3</sub>ClNa.

rac-(3R,6S)-3-((E)-5-(2-Chlorophenyl)pent-4-en-1-yl)-6-methyl-6-(1-phenyl-2l5-propa-1,2dien-1-yl)tetrahydro-2H-pyran-2-one – trans-1f



As described in general procedure D, reaction of ethyl ethyl (E)-7-(2-chlorophenyl)-2-(3oxobutyl)hept-6-enoate (0.36 g, 1.07 mmol, 1 equiv.), (3-bromoprop-1-yn-1-yl)benzene (0.27 g, 1.39 mmol, 1.3 equiv.), SmI<sub>2</sub> (34.0 mL, 3.74 mmol, 3.5 equiv.) and NiI<sub>2</sub> (16.0 mg, 74.6  $\mu$ mol, 2 mol% with respect to SmI<sub>2</sub>), after work-up and flash column chromatography (5% EtOAc:hexane) yielded *trans-***1f** as a yellow oil (combined yield for *cis* and *trans* isomers: 20%, for *trans*-1f: 44 mg, 10%);  $v_{max}$  / cm<sup>-1</sup> 2929, 1945, 1721, 1492, 1469, 1215, 1074;  $\delta_{H}$ (400 MHz, CDCl<sub>3</sub>) 1.43 - 1.56 (6H, m, 1H from CH<sub>2</sub> + CH<sub>2</sub> + CH<sub>3</sub>), 1.55 - 1.64 (1H, m, 1H from CH<sub>2</sub>), 1.74 - 1.82 (1H, m, 1H from CH<sub>2</sub>), 1.84 - 1.92 (1H, m, 1H from CH<sub>2</sub>), 2.03 (1 H, sxt, J 6.7, 1H from CH<sub>2</sub>), 2.11 - 2.23 (3H, m, 1H from CH<sub>2</sub> + CH<sub>2</sub>), 2.32 - 2.39 (1H, m, CH), 5.03 (2H, s, C=CH<sub>2</sub>), 6.07 - 6.17 (1H, m, CH<sub>2</sub>CH=CH), 6.67 (1H, d, J 15.7, CH<sub>2</sub>CH=CH), 7.05 (1H, t, J 7.3, ArH), 7.11 (1H, t, J 7.3 ArH), 7.15 - 7.21 (2H, m, ArH), 7.24 - 7.28 (2H, m, ArH), 7.36 (2H, d, J 7.5, ArH), 7.41 (1H, d, J 7.6 ArH); δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>) 22.9 (CH<sub>2</sub>), 26.8 (CH<sub>2</sub>), 28.4 (CH<sub>3</sub>), 31.5 (CH<sub>2</sub>), 32.3 (CH<sub>2</sub>), 33.2, (CH<sub>2</sub>), 38.6 (CH), 78.9 (C=CH<sub>2</sub>), 83.0 (quat. C), 110.5 (C=C=CH<sub>2</sub>), 126.4 (CH<sub>2</sub>CH=CH), 126.5 (CH<sub>2</sub>CH=CH), 126.8 (ArCH), 127.7 (ArCH), 128.1 (ArCH), 128.6 (ArCH), 129.2 (ArCH), 129.5 (ArCH), 132.7 (ArCH), 133.3 (ArC), 134.1 (ArC), 135.7 (ArC), 174.5 (CO), 208.3 (C=CH<sub>2</sub>); m/z (ESI+) 407.3 ([M +  $H_{1}^{+}$ , 100%); HRMS (ESI+) found 429.1603, expect 429.1592 for  $C_{26}H_{27}O_2CINa$ .

S25

rac-(4S,4aS,5R,6R,7S,9aR)-4-(2-Chlorobenzyl)-5,7-dimethyl-6-phenyldecahydro-4aHbenzo[7]annulene-4a,7-diol – 2f



As described in general procedure E, reaction of rac-(3R,6S)-6-methyl-6-(1-phenyl-215propa-1,2-dien-1-yl)-3-((E)-5-(p-tolyl)pent-4-en-1-yl)tetrahydro-2H-pyran-2-one trans-1f (38.0 mg, 0.09 mmol, 1 equiv.), H<sub>2</sub>O (6.70 mL, 0.37 mol, 4000 equiv.) and SmI<sub>2</sub> (7.5 mL, 0.75 mmol, 8 equiv.), after work-up and flash column chromatography (10% EtOAc:hexane  $\rightarrow$  20% EtOAc:hexane) yielded 2f (7 mg, 17%) as a white solid; m. p. 149 - 155 °C (MeOH);  $v_{max}$  / cm<sup>-1</sup> 3329, 2918, 2852, 1448, 1386, 1264;  $\delta_{H}$  (500 MHz, CDCl<sub>3</sub>) 1.11 (3H, s,  $CH_3$ ), 1.12 - 1.20 (2H, m, 1H from  $CH_2$  + 1H from  $CH_2$ ), 1.22 - 1.24 (1H, m, 1H from  $CH_2$ ), 1.42 - 1.47 (2H, m, CH<sub>2</sub>), 1.48 (3H, d, J 7.6, CH<sub>3</sub>), 1.54 - 1.60 (2H, m, 1H from CH<sub>2</sub> + CH), 1.86 (1H, dd, J 15.4, 11.7, 1H from CH<sub>2</sub>), 1.98 - 2.07 (4H, m, 1H from CH<sub>2</sub> + CH + CH<sub>2</sub>), 2.37 (1 H, dd, J 13.1, 11.2, 1H from CH<sub>2</sub>Ph), 2.46 (1H, q, J 7.9, CHCH<sub>3</sub>), 2.94 (1H, dd, J 13.2, 4.4, 1H from CH<sub>2</sub>Ph), 3.91 (1H, s, CHPh), 7.05 - 7.08 (1H, m, ArH), 7.10 - 7.13 (2H, m, ArH), 7.23 - 7.26 (1H, m, ArH), 7.29 - 7.31 (1H, m, ArH), 7.32 - 7.36 (2H, m, ArH), 7.40 - 7.44 (2H, m, ArH); δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>)\* 13.3 (CH<sub>3</sub>), 25.7 (CH<sub>2</sub>), 26.4 (CH<sub>2</sub>), 26.4 (CH<sub>2</sub>), 28.3 (CH<sub>3</sub>), 30.7 (CH<sub>2</sub>), 32.7 (CH<sub>2</sub>), 41.7 (CHMe), 43.0 (CH<sub>2</sub>), 43.1 (CH), 45.1 (CH), 49.5 (CHPh), 126.3 (ArCH), 126.4 (ArCH), 127.2 (ArCH), 128.3 (ArCH), 129.4 (ArCH), 129.6 (ArCH), 131.9 (ArCH), 134.2 (ArC), 138.7 (ArC), 145.3 (ArC); m/z (ESI+) 435.7 ([M + Na]<sup>+</sup>, 100%). \*two quaternary carbons not observed.

### Ethyl (E)-4,4-dimethylhepta-2,6-dienoate – S10



An oven-dried round bottom flask was flushed with N<sub>2</sub> and loaded with (carbethoxymethylene)triphenylphosphorane (12.0 g, 34.0 mmol, 1.7 equiv.) and dry toluene (60 mL). To the stirred solution was added 2,2-dimethyl-4-pentenal (1.36 mL, 10.0 mmol, 1 equiv.) and the resulting solution was heated at 80 °C overnight. After cooling to room temperature, the solvent was removed *in vacuo* and flash column chromatography (5% Et<sub>2</sub>O:hexane) yielded **S10** (3.31 g, 91%) as a colourless oil;  $v_{max} / cm^{-1} 3091$ , 2982, 1707, 1679, 1382, 1302, 1279, 1186, 1018;  $\delta_{H}$  (400 MHz, CDCl<sub>3</sub>) 1.01 (6H, s, 2 × CH<sub>3</sub>), 1.24 (3H, t, *J* 7.2, CH<sub>2</sub>CH<sub>3</sub>), 2.06 (2H, dt, *J* 7.4, 1.1, CH<sub>2</sub>), 4.14 (2H, q, *J* 7.1, CH<sub>2</sub>CH<sub>3</sub>), 4.93 - 5.03 (2H, m, CH=CHCO<sub>2</sub>Et);  $\delta_{C}$  (100 MHz, CDCl<sub>3</sub>) 14.1 (CH<sub>3</sub>), 26.0 (2 × CH<sub>3</sub>), 36.6 (quat. *C*), 46.3 (*C*H<sub>2</sub>), 60.0 (*C*H<sub>2</sub>CH<sub>3</sub>), 117.6 (CH=*C*H<sub>2</sub>), 117.8 (*C*H=CHCO<sub>2</sub>Et), 134.1 (*C*H=CH<sub>2</sub>), 157.4 (CH=CHCO<sub>2</sub>Et), 166.9 (*C*O<sub>2</sub>Et); *m*/*z* (ESI+) 183.1 ([M + H]<sup>+</sup>, 100%); HRMS (ESI+) found 205.1205, expect 205.1204 for C<sub>11</sub>H<sub>18</sub>O<sub>2</sub>Na.

### Methyl 4,4-dimethylhept-6-enoate – S11



Magnesium powder (2.70 g, 0.11 mol, 8 equiv.) was added slowly to a stirred solution of ethyl (*E*)-4,4-dimethylhepta-2,6-dienoate (2.50 g, 13.7 mmol, 1 equiv.) in dry MeOH (130 mL) in an oven-dried round bottom flask flushed with N<sub>2</sub>.The reaction was stirred at room temperature overnight and more magnesium powder (0.67 g, 27.5 mmol, 2 equiv.) was

added. After stirring for an additional 2 hours, the reaction was neutralised with 2 M HCl and EtOAc was added (150 mL). The layers were separated and the aqueous layer was washed with EtOAc (150 mL). The organic layers were combined, washed with brine (150 mL) and dried over MgSO<sub>4</sub>. Concentration *in vacuo* and filtration through silica gel yielded **S11** (1.21 g, 53%) as a crude colourless oil, which was taken through to the next step;  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 0.87 (6H, s, 2 × CH<sub>3</sub>), 1.53 - 1.59 (2H, m, CH<sub>2</sub>CH<sub>2</sub>CO<sub>2</sub>CH<sub>3</sub>), 1.95 (2H, dt, *J* 7.4, 1.1, CH<sub>2</sub>CH=CH<sub>2</sub>), 2.25 - 2.31 (2H, m, CH<sub>2</sub>CO<sub>2</sub>CH<sub>3</sub>), 3.66 (3H, s, CO<sub>2</sub>CH<sub>3</sub>), 4.97 - 5.07 (2H, m, CH=CH<sub>2</sub>), 5.80 (1H, m, CH=CH<sub>2</sub>);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) 26.5 (2 × CH<sub>3</sub>), 29.3 (CH<sub>2</sub>), 32.7 (quat. *C*), 36.4 (*C*H<sub>2</sub>), 46.2 (*C*H<sub>2</sub>), 51.5 (CO<sub>2</sub>CH<sub>3</sub>), 117.1 (CH=CH<sub>2</sub>), 135.0 (CH=CH<sub>2</sub>), 174.7 (CO<sub>2</sub>Me).

### Methyl (E)-4,4-dimethyl-7-phenylhept-6-enoate – S12



As described in general procedure F, methyl 4,4-dimethylhept-6-enoate (1.20 g, 7.05 mmol, 1 equiv.), styrene (2.40 mL, 21.2 mmol, 3 equiv.) and Grubb's catalyst second generation (60.0 mg, 70.5 µmol, 1 mol%) in CH<sub>2</sub>Cl<sub>2</sub> (18 mL) overnight at reflux with subsequent work-up and purification by flash colum chromatography (toluene  $\rightarrow 2\%$  EtOAc:toluene) yielded the named compound as a colourless oil (0.8 g, 46%);  $v_{max}$  / cm<sup>-1</sup> 3042, 2979, 1744, 1465, 1214, 1180;  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 0.93 (6H, s, 2 × CH<sub>3</sub>), 1.60 - 1.67 (2H, m, CH<sub>2</sub>CH<sub>2</sub>CO<sub>2</sub>CH<sub>3</sub>), 2.12 (2H, dd, *J* 7.5, 0.8, CH<sub>2</sub>CH), 2.30 - 2.36 (2H, m, CH<sub>2</sub>CO<sub>2</sub>CH<sub>3</sub>), 3.68 (3H, s, CO<sub>2</sub>CH<sub>3</sub>), 6.18 - 6.29 (1H, m, CH=CHPh), 6.39 (1H, d, *J* 15.5, CH=CHPh), 7.22 (1H, t, *J* 7.2, ArH), 7.31 (2H, t, *J* 7.5, ArH), 7.37 (2H, d, *J* 7.3, ArH);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) 26.6 (2 × CH<sub>3</sub>), 29.4 (CH<sub>2</sub>), 33.5 (quat. *C*), 36.5 (CH<sub>2</sub>), 45.4 (CH<sub>2</sub>), 51.6 (CO<sub>2</sub>CH<sub>3</sub>), 126.0 (ArCH), 126.9 (ArCH),

127.0 (*C*H=CHPh), 128.5 (Ar*C*H), 132.4 (CH=*C*HPh), 137.7 (Ar*C*), 174.7 (*C*O<sub>2</sub>Me); *m/z* (ESI+) 269.3 ([M + Na]<sup>+</sup>, 100%).

## 2-(2-Iodoethyl)-2-methyl-1,3-dioxolane – S13<sup>3</sup>

To a rapidly stirred solution of methyl vinyl ketone (3.00 mL, 36.0 mmol, 1 equiv.) and NaI (6.50 g, 43.3 mmol, 1.2 equiv.) in MeCN (36 mL) was quickly added TMSCI (5.50 mL, 43.3 mmol, 1.2 equiv.) and the mixture was stirred for 25 minutes. Ethylene glycol (2.40 mL, 43.3 mmol, 1.2 equiv.) was added quickly and the reaction was stirred vigorously for another 25 minutes. The reaction mixture was then poured into a separating funnel containing 5% NaHCO<sub>3</sub> (15 mL) and hexane (60 mL), creating an aqueous bottom layer, the reaction mixture in the middle and a top hexane layer. The bottom layer was removed and the organic layers washed with 5% sodium thiosulfate (15 mL). The aqueous layers were combined and extracted with EtOAc (2 × 60 mL). The organic layers were combined and dried over MgSO<sub>4</sub>. The solvent was removed *in vacuo*, keeping the water bath below 25 °C, and flash column chromatography (5% EtOAc:hexane) yielded the named compound as an orange oil (1.2 g, 15%);  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.29 - 1.33 (3H, m, CH<sub>3</sub>), 2.26 - 2.34 (2H, m, CH<sub>2</sub>), 3.13 - 3.20 (2H, m, CH<sub>2</sub>), 3.87 - 4.02 (4H, m, -OCH<sub>2</sub>CH<sub>2</sub>O-).

Methyl (E)-4,4-dimethyl-2-(2-(2-methyl-1,3-dioxolan-2-yl)ethyl)-7-phenylhept-6-enoate – S14



As described in general procedure A, alkylation of methyl (E)-4,4-dimethyl-7-phenylhept-6enoate (0.22 g, 0.89 mmol, 1 equiv.) using LDA (0.75 M, 1.3 mL, 0.98 mmol, 1.1 equiv.), then 2-(2-iodoethyl)-2-methyl-1,3-dioxolane (0.28 g, 1.22 mmol, 1.36 equiv.) and HMPA (0.2 mL), after work-up and purification yielded S14 as an orange oil (75 mg, 17%);  $v_{max}$  / cm<sup>-1</sup> 2983, 2893, 1714, 1479, 1392, 1210, 1181, 1080; δ<sub>H</sub> (500 MHz, CDCl<sub>3</sub>) 0.89 (3H, s, J 4.4, CH<sub>3</sub>), 0.90 (3H, s, J 4.4, CH<sub>3</sub>), 1.29 (3H, s, CH<sub>3</sub>), 1.33 (1H, dd, J 14.2, 2.2, 1H from CH<sub>2</sub>), 1.51 - 1.58 (2H, m, 1H from CH<sub>2</sub> + 1H from CH<sub>2</sub>), 1.64 - 1.71 (2H, m, 1 H from CH<sub>2</sub> + 1 H from CH<sub>2</sub>), 1.87 (1H, dd, J 14.2, 9.8, 1H from CH<sub>2</sub>), 2.10 (2H, dd, J 7.6, 0.9, CH<sub>2</sub>), 2.42 -2.50 (1H, m, CH), 3.67 (3H, s, CO<sub>2</sub>CH<sub>3</sub>), 3.86 - 3.96 (4H, m, -OCH<sub>2</sub>CH<sub>2</sub>O-), 6.18 - 6.26 (1H, m, CH=CHPh), 6.37 (1H, d, J 15.8, CH=CHPh), 7.21 (1H, tt, J 7.3, 1.3, ArCH), 7.31 (2H, t, J 7.3, ArCH), 7.36 (2H, d, J 7.3, ArCH); δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>) 23.8 (CH<sub>3</sub>), 26.7 (CH<sub>3</sub>), 26.9 (CH<sub>3</sub>), 29.3 (CH<sub>2</sub>), 34.2 (quat. C), 36.7 (CH<sub>2</sub>), 41.4 (CH), 44.4 (CH<sub>2</sub>), 45.9 (CH<sub>2</sub>), 51.5 (CO<sub>2</sub>CH<sub>3</sub>), 64.6 (2 × -OCH<sub>2</sub>CH<sub>2</sub>O-), 109.6 (C-OCH<sub>2</sub>CH<sub>2</sub>O-), 126.0 (ArCH), 126.9 (ArCH), 127.2 (CH=CHPh), 128.5 (ArCH), 132.4 (CH=CHPh), 137.7 (ArC), 177.6 (CO<sub>2</sub>Me); m/z (ESI+) 383.5 ([M + Na]<sup>+</sup>, 100%); HRMS (ESI+) found 383.2211, expect 383.2198 for C<sub>22</sub>H<sub>32</sub>O<sub>4</sub>Na.

### Methyl (E)-4,4-dimethyl-2-(3-oxobutyl)-7-phenylhept-6-enoate – S15



As described in general procedure B, reaction of methyl (*E*)-4,4-dimethyl-2-(2-(2-methyl-1,3-dioxolan-2-yl)ethyl)-7-phenylhept-6-enoate (0.21 g, 0.58 mmol, 1 equiv.) and *p*-toluenesulfonic acid monohydrate (0.22 g, 1.17 mmol, 2 equiv.) in acetone (10 mL), after work-up and purification yielded **S15** as a pale yellow oil (0.15 g, 83%);  $v_{max}$  / cm<sup>-1</sup> 2958, 1729, 1714, 1465, 1365, 1186, 1156;  $\delta_{\rm H}$  (500 MHz, CDCl<sub>3</sub>) 0.89 (3H, s, *J* 4.4, CH<sub>3</sub>), 0.90 (3H, s, *J* 4.4, CH<sub>3</sub>), 1.31 (1H, dd, *J* 14.2, 2.5, 1H from CH<sub>2</sub>), 1.78 (2H, q, *J* 7.6, CH<sub>2</sub>), 1.86 (1H, dd, *J* 14.2, 9.8, 1H from CH<sub>2</sub>), 2.08 - 2.12 (5H, m, CH<sub>2</sub> + CH<sub>3</sub>), 2.41 (2H, q, *J* 7.4, CH<sub>2</sub>), 2.46 - 2.53 (1H, m, CH), 3.67 (3H, s, CO<sub>2</sub>CH<sub>3</sub>), 6.17 - 6.25 (1H, m, CH=CHPh), 6.38 (1H, d, *J* 15.8, CH=CHPh), 7.20 (1H, tt, *J* 7.3, 1.3, ArCH), 7.30 (2H, t, *J* 7.3, ArCH), 7.36 (2H, d, *J* 7.6, ArCH);  $\delta_{\rm C}$  (125 MHz, CDCl<sub>3</sub>) 26.6 (CH<sub>3</sub>), 26.9 (CH<sub>3</sub>), 28.5 (CH<sub>2</sub>), 29.9 (CH<sub>3</sub>), 34.1 (quat. C), 40.5 (CH), 40.8 (CH<sub>2</sub>), 44.2 (CH<sub>2</sub>), 45.7 (CH<sub>2</sub>), 51.5 (CO<sub>2</sub>CH<sub>3</sub>), 125.9 (ArCH), 126.9 (ArCH), 127.0 (CH=CHPh), 128.4 (ArCH), 132.4 (CH=CHPh), 137.6 (ArC), 177.1 (CO<sub>2</sub>Me), 207.6 (CO); *m*/z (ESI+) 339.4 ([M + Na]<sup>+</sup>, 100%); HRMS (ESI+) found 339.1934, expect 339.1936 for C<sub>20</sub>H<sub>28</sub>O<sub>3</sub>Na.

rac-(3S,6S)-3-((E)-2,2-Dimethyl-5-phenylpent-4-en-1-yl)-6-methyl-6-(1-phenyl-2l5-propa-1,2-dien-1-yl)tetrahydro-2H-pyran-2-one – trans-1g



As described in general procedure D, reaction of methyl (E)-4,4-dimethyl-2-(3-oxobutyl)-7phenylhept-6-enoate (0.10 g, 0.32 mmol, 1 equiv.), (3-bromoprop-1-yn-1-yl)benzene (0.08 g, 0.41 mmol, 1.3 equiv.), SmI<sub>2</sub> (11 mL, 1.11 mmol, 3.5 equiv.) and NiI<sub>2</sub> (7 mg, 22.1 µmol, 2 mol % with respect to SmI<sub>2</sub>), after work-up and flash column chromatography (5% EtOAc:hexane) yielded *trans-*1g as a yellow oil (combined yield for *cis* and *trans* isomers: 26%, for *trans*-1g: 13 mg, 13%); δ<sub>H</sub> (500 MHz, CDCl<sub>3</sub>) 0.87 (3H, s, J 4.4, CH<sub>3</sub>), 0.88 (3H, s, J 4.4, CH<sub>3</sub>), 1.17 (1H, dd, J 14.2, 5.4, 1H from CH<sub>2</sub>), 1.62 - 1.70 (4H, m, 1H from CH<sub>2</sub> + CH<sub>3</sub>), 1.83 - 1.91 (1H, m, 1H from CH<sub>2</sub>), 2.01 - 2.13 (2H, m, CH<sub>2</sub>), 2.15 - 2.22 (1H, m, 1H from CH<sub>2</sub>), 2.25 (1H, dd, J 14.2, 4.1, 1H from CH<sub>2</sub>), 2.27 - 2.34 (1H, m, 1H from CH<sub>2</sub>), 2.51 - 2.58 (1H, m, CH), 5.14 (2H, s, C=CH<sub>2</sub>), 6.19 - 6.26 (1H, m, CH=CHPh), 6.32 (1H, d, J 15.8, CH=CHPh), 7.21 (1H, tt, J 7.3, 1.6, ArCH), 7.27 - 7.32 (3H, m, ArCH), 7.32 - 7.37 (4H, m, ArCH), 7.47 (2H, d, J 7.3, ArCH); δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>) 26.1 (CH<sub>2</sub>), 26.9 (CH<sub>3</sub>), 26.9 (CH<sub>3</sub>), 28.8 (CH<sub>3</sub>), 32.4 (CH<sub>2</sub>), 34.3 (quat. C), 35.2 (CH), 42.9 (CH<sub>2</sub>), 45.9 (CH<sub>2</sub>), 78.7 (C=CH<sub>2</sub>), 82.7 (quat. C), 110.4 (C=C=CH<sub>2</sub>), 126.0 (ArCH), 126.9 (ArCH), 127.2 (ArCH), 127.5 (ArCH), 128.5 (ArCH), 128.9 (ArCH), 132.4 (CH<sub>2</sub>CH=CH and CH<sub>2</sub>CH=CH), 133.7 (ArC), 137.7 (ArC), 175.0 (CO), 207.3 (C=CH<sub>2</sub>); m/z (ESI+) 423.5 ([M + Na]<sup>+</sup>, 100%).

S32

### **General Procedure G: Sonogashira reaction**

## 5-Phenylpent-4-yn-1-ol - S16<sup>4</sup>



An oven dried flask was degassed with N<sub>2</sub> and loaded with THF (25 mL), DIPA (10 mL), iodobenzene (2.70 mL, 24.1 mmol, 2 eq.) and 4-pentyn-1-ol (1.10 mL, 13.4 mmol, 1 equiv.). PdCl<sub>2</sub>(PPh<sub>3</sub>)<sub>2</sub> (173 mg, 0.25 mmol, 2 mol%) and CuI (30 mg, 0.16 mmol, 1 mol%) were added to the mixture, which was heated under reflux for 18 hours. The reaction mixture was filtered through celite, the residue washed and the filtrate concentrated *in vacuo*. The crude product was purified by flash column chromatography (15%  $\rightarrow$  25% EtOAc:petroleum ether) to give the named compound as a dark orange oil (1.55 g, 78%);  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.82 (2H, quin, *J* 6.6, CH<sub>2</sub>), 2.50 (2H, t, *J* 7.1, CH<sub>2</sub>), 2.74 (1H, br. s, OH), 3.76 (2H, t, *J* 5.2, CH<sub>2</sub>), 7.19 - 7.30 (3H, m, ArH), 7.36 - 7.41 (2H, m, ArH);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) 15.8 (CH<sub>2</sub>), 31.2 (CH<sub>2</sub>), 61.3 (CH<sub>2</sub>), 80.9 (C=C), 89.3 (C=C), 123.6 (ArC), 127.5 (ArCH), 128.1, (ArCH), 131.4, (ArCH).

## (5-Iodopent-1-yn-1-yl)benzene – S17<sup>4</sup>

As described in general procedure C, reaction of 5-phenylpent-4-yn-1-ol (0.15 g, 0.94 mmol, 1 equiv.), PPh<sub>3</sub> (0.37 g, 1.43 mmol, 1.5 equiv.), imidazole (95.0 mg, 1.46 mmol, 1.5 equiv.) and I<sub>2</sub> (0.36 g, 1.42 mmol, 1.5 equiv.) after work-up and flash column chromatography (hexane) yielded the named compound as a colourless oil (0.18 g, 72%);  $\delta_{\rm H}$  (400 MHz,

CDCl<sub>3</sub>) 2.11 (2H, quin, *J* 6.8, CH<sub>2</sub>), 2.57 (2H, t, *J* 6.7, CH<sub>2</sub>), 3.38 (2H, t, *J* 6.8, CH<sub>2</sub>), 7.27 - 7.33 (3H, m, Ar*H*), 7.36 - 7.45 (2H, m, Ar*H*);  $\delta_{C}$  (100 MHz, CDCl<sub>3</sub>) 5.4 (CH<sub>2</sub>), 20.4 (CH<sub>2</sub>), 32.1 (CH<sub>2</sub>), 81.7 (C=C), 87.8 (C=C), 123.5 (ArC), 127.8 (ArCH), 128.2 (ArCH), 131.6 (ArCH).

Ethyl 2-(3-oxobutyl)-7-phenylhept-6-ynoate – S18



As described in general procedure A, treatment of ethyl 4-(2-methyl-1,3-dioxolan-2yl)butanoate (1.00 g, 4.94 mmol, 1 equiv.) in THF (2 mL) with 2.0 M LDA in hexane (3.50 mL, 5.50 mmol, 1.1 equiv.), followed by addition of (5-bromopent-1-yn-1-yl)benzene (1.32 g, 5.93 mmol, 1.2 equiv.) in HMPA (1.0 mL), after work-up gave the crude acetal protected keto-ester, which was used without further purification. As described in general procedure B, reaction of the crude ester with *p*-toluenesulfonic acid monohydrate (1.89 g, 9.89 mmol, 2 equiv.) in acetone (50 mL), after work-up and purification by column chromatography on silica gel (petroleum ether  $\rightarrow$  CH<sub>2</sub>Cl<sub>2</sub>:petroleum ether) gave the title compound (0.98 g, 66% over 2 steps) as a colourless oil; v<sub>max</sub> /cm<sup>-1</sup> 2937, 1716, 1598, 1490, 1366, 1257, 1153, 1096, 1069, 1025;  $\delta_{\rm H}$  (500 MHz, CDCl<sub>3</sub>) 1.27 (3H, t, *J* 7.1, CH<sub>2</sub>CH<sub>3</sub>), 1.57 - 1.70 (3H, m, 1H from CH<sub>2</sub> + CH<sub>2</sub>), 1.76 - 1.82 (1H, m, 1H from CH<sub>2</sub>), 1.85 (2H, q, *J* 7.8, CH<sub>2</sub>), 2.13 (3H, s, CH<sub>3</sub>), 7.26 - 7.31 (3H, m, ArH), 7.37 - 7.41 (2H, m, ArH);  $\delta_{\rm C}$  (125 MHz, CDCl<sub>3</sub>) 14.3 (CH<sub>3</sub>), 19.2 (CH<sub>2</sub>), 25.8 (CH<sub>2</sub>), 26.3 (CH<sub>2</sub>), 30.0 (CH<sub>3</sub>), 31.4 (CH<sub>2</sub>), 41.0 (CH<sub>2</sub>), 44.3 (CH), 60.3 (CH<sub>2</sub>CH<sub>3</sub>), 81.0 (PhC=C), 89.4 (PhC=C), 123.8 (ArC), 127.6 (ArCH), 128.2 (ArCH), 131.5 (ArCH), 175.5 (CO<sub>2</sub>Et), 207.9 (CO); m/z (ESI+) 301.3 ([M+H]<sup>+</sup>, 100%); HRMS (ESI+) found 323.1613, expect 323.1623 for C<sub>19</sub>H<sub>24</sub>O<sub>3</sub>Na.

## (3-Bromoprop-1-ynyl)dimethyl(phenyl)silane – S19<sup>2</sup>

Si Br

A solution of LDA was prepared by adding *n*-BuLi (1.54 M solution in hexane, 11.4 mL, 17.6 mmol, 1.1 equiv.) to diisopropylamine (2.40 g, 17.6 mmol, 1.1 equiv.) in Et<sub>2</sub>O (27 mL) at -78 °C under N<sub>2</sub> and stirring for 1 h. To this solution was added propargylic bromide (80% solution in toluene, 1.78 mL, 16.0 mmol, 1 equiv.) and the reaction was stirred for 1 h before the addition of chlorodimethyl(phenyl)silane (2.68 g, 16.0 mmol, 1 equiv.) and the resulting reaction mixture allowed to warm to room temperature overnight. The reaction was quenched by the addition of aqueous saturated NH<sub>4</sub>Cl (15 mL) and the aqueous layer extracted with Et<sub>2</sub>O (3 × 30 mL). The combined organic layers were washed with brine (20 mL), dried (Na<sub>2</sub>SO<sub>4</sub>) and concentrated *in vacuo* to yield the crude product. Purification by column chromatography on silica gel eluting with 1:80 Et<sub>2</sub>O in pentane, gave the title compound (3.70 g, 91%) as a yellow oil;  $\delta_{\rm H}$  (500 MHz, CDCl<sub>3</sub>) 0.31 (6H, s, Si(CH<sub>3</sub>)<sub>2</sub>Ph), 3.82 (2H, s, CH<sub>2</sub>), 7.22-7.27 (3H, m, ArH), 7.48-7.50 (2H, m, ArH);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) -1.3 (Si(CH<sub>3</sub>)<sub>2</sub>Ph), -1.1 (Si(CH<sub>3</sub>)<sub>2</sub>Ph), 14.5 (CH<sub>2</sub>), 90.3 (C≡CCH<sub>2</sub>), 101.6 (C≡CSi), 127.9 (ArCH), 133.6 (ArCH), 133.8 (ArCH), 136.2 (ArC).

(3R,6S)-6-(1-(Dimethyl(phenyl)silyl)-propa-1,2-dien-1-yl)-6-methyl-3-(5-phenylpent-4-yn-1-yl)tetrahydro-2H-pyran-2-one – trans-1h



As described in general procedure D, reaction of methyl (E)-4,4-dimethyl-2-(3-oxobutyl)-7phenylhept-6-enoate 0.44 (3-bromoprop-1-(109)mmol, 1 equiv.), mg, ynyl)dimethyl(phenyl)silane (112 mg, 0.57 mmol, 1.3 equiv.), SmI<sub>2</sub> (13.0 mL, 1.33 mmol, 3 equiv.) and NiI<sub>2</sub> (10.0 mg, 0.03 mmol, 2 mol % with respect to SmI<sub>2</sub>), after work-up and flash column chromatography (petroleum ether  $\rightarrow$  5% EtOAc:petroleum ether) yielded *trans*-1h as a colourless oil (combined yield for cis and trans isomers: 41%, for trans-1h: 73 mg, 21%); v<sub>max</sub> /cm<sup>-1</sup> 2954, 1927, 1731, 1489, 1428, 1249, 1098; δ<sub>H</sub> (500 MHz, CDCl<sub>3</sub>) 0.35 - 0.38 (3H, s, SiCH<sub>3</sub>), 0.45 - 0.49 (3H, s, SiCH<sub>3</sub>), 1.33 (3H, s, CH<sub>3</sub>), 1.35 - 1.49 (4H, m, 1H from CH<sub>2</sub> + 1H from  $CH_2 + CH_2$ ), 1.58 - 1.64 (1H, m, 1H from  $CH_2$ ), 1.70 - 1.83 (4H, m,  $CH_2 + CH_2$ ), 1.89 (1H, ddd, J 13.7, 7.9, 5.5, 1H from CH<sub>2</sub>), 2.27 (2H, td, J 7.0, 2.4, CH), 4.53 (2H, s, C=CH<sub>2</sub>), 7.18 - 7.33 (8H, m, ArH), 7.47 - 7.51 (2H, m, ArH); δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>) -1.9 (SiCH<sub>3</sub>), -1.5 (SiCH<sub>3</sub>), 19.4 (CH), 22.8 (CH<sub>2</sub>), 26.1 (CH<sub>2</sub>), 29.6 (CH<sub>3</sub>), 30.7 (CH<sub>2</sub>), 33.3 (CH<sub>2</sub>), 38.3 (CH<sub>2</sub>), 72.3 (C=C=CH<sub>2</sub>), 80.9 (C≡CPh), 84.8 (quat. C), 89.7 (C≡CPh), 102.7 (C=C=CH<sub>2</sub>), 127.5 (ArCH), 127.8 (ArCH), 128.2 (ArCH), 129.2 (ArCH), 131.5 (ArCH), 131.9 (ArC), 134.1 (ArCH), 137.8 (ArC), 173.6 (CO), 207.9 (C=C=CH<sub>2</sub>); m/z (ESI+) 429.0  $([M+H]^+, 100\%)$ ; HRMS (ESI+) found 451.2048, expect 451.2069 for C<sub>28</sub>H<sub>32</sub>O<sub>2</sub>SiNa.
#### 6-Allyl-6-methyltetrahydro-2H-pyran-2-one - S20<sup>5</sup>



As described in general procedure D, reaction of methyl 5-oxohexanoate (300 mg, 1.90 mmol, 1 equiv.), allyl bromide (252 mg, 2.09 mmol, 1.1 equiv.), SmI<sub>2</sub> (76.0 mL, 7.59 mmol, 3 equiv.) and NiI<sub>2</sub> (48.0 mg, 0.15 mmol, 2 mol % with respect to SmI<sub>2</sub>), after work-up and flash column chromatography (petroleum ether  $\rightarrow$  10% EtOAc:petroleum ether) yielded **S20** as a colourless oil (245 mg, 84%);  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.37 (3H, s, CH<sub>3</sub>), 1.63 - 1.71 (1H, m, 1H from CH<sub>2</sub>), 1.77 - 1.93 (3H, m, 1H from CH<sub>2</sub> + CH<sub>2</sub>), 2.40 - 2.58 (4H, m, CH<sub>2</sub> + CH<sub>2</sub>), 5.10 - 5.19 (2H, m, CH=CH<sub>2</sub>), 5.80 (1H, ddt, *J* 14.5, 10.2, 7.3, CH=CH<sub>2</sub>);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) 16.5 (CH<sub>2</sub>), 26.3 (CH<sub>3</sub>), 29.3 (CH<sub>2</sub>), 31.4 (CH<sub>2</sub>), 46.1 (CH<sub>2</sub>CH=CH<sub>2</sub>), 83.6 (quat. *C*), 119.4 (CH=CH<sub>2</sub>), 132.3 (CH=CH<sub>2</sub>), 171.2 (CO).

#### 6-Cinnamyl-6-methyltetrahydro-2H-pyran-2-one – S21<sup>5</sup>



As described in general procedure F, methyl 4,4-dimethylhept-6-enoate 6-allyl-6methyltetrahydro-2H-pyran-2-one (500 mg, 3.57 mmol, 1 equiv.), *trans*-stilbene (1.93 g, 10.7 mmol, 3 equiv.) and Hoveyda–Grubbs second generation catalyst (52.0 mg, 82.0 µmol, 2.3 mol%) in CH<sub>2</sub>Cl<sub>2</sub> (10 mL) overnight at reflux with subsequent work-up and purification by flash column chromatography (petroleum ether  $\rightarrow$  2% EtOAc:petroleum ether) yielded the named compound as a yellow oil (300 mg, 40%);  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.34 (3H, s, CH<sub>3</sub>), 1.59 - 1.67 (2H, m, CH<sub>2</sub>), 1.73 - 1.87 (2H, m, CH<sub>2</sub>), 2.33 - 2.47 (2H, m, CH<sub>2</sub>), 2.50 (2H, dd, *J*  7.4, 1.1, CH<sub>2</sub>CH=CHAr), 6.12 (1H, dt, J 15.7, 7.5, PhCH=CH), 6.39 (1H, d, J 15.7, PhCH=CH), 7.12 - 7.31 (5H, m, ArH); δ<sub>C</sub> (100 MHz, CDCl<sub>3</sub>) 16.5 (CH<sub>2</sub>), 26.4 (CH<sub>3</sub>), 29.3 (CH<sub>2</sub>), 31.6 (CH<sub>2</sub>), 45.4 (CH<sub>2</sub>), 84.0 (quat. *C*), 123.8 (PhCH=CH), 126.1 (ArCH), 127.4 (ArCH), 128.5 (ArCH), 134.2 (PhCH=CH), 136.9 (ArC), 171.2 (CO).

#### (E)-5-Phenylpent-4-en-1-ol – S22<sup>6</sup>

#### Ph\_\_\_\_OH

To a solution of LiAlH<sub>4</sub> (1.04 g, 27.3 mmol, 3 equiv.) in THF (16 mL) was added 5phenylpent-4-yn-1-ol (1.46 g, 9.11 mmol, 1 equiv.) dropwise at 0 °C. The reaction mixture was stirred at 60 °C over night. Once complete and cooled to 0 °C, the reaction was diluted with ether and carefully quenched with H<sub>2</sub>O. After the addition of Rochelle's salt, the layers were separated and the aqueous layer extracted with EtOAc (3 × 20 mL). The combined organic layers were washed with brine (30 mL), dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated *in vacuo*. The compound was purified using flash column chromatography (petroleum ether  $\rightarrow$ 5%  $\rightarrow$  10%  $\rightarrow$  20% EtOAc:petroleum ether), yielding the named compound as an orange oil (1.33 g, 89%);  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.73 – 1.82 (2H, m, CH<sub>2</sub>), 2.07 (1H, s, OH), 2.29 – 2.37 (2H, m, CH<sub>2</sub>), 3.71 (2H, t, *J* 6.4, CH<sub>2</sub>OH), 6.26 (1H, dt, *J* 15.7, 6.9, CH<sub>2</sub>CH=CH), 6.45 (1H, d, *J* 15.9, CH<sub>2</sub>CH=CH), 7.21 – 7.26 (1H, m, ArH), 7.28 – 7.42 (4H, m, ArH);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) 29.3 (CH<sub>2</sub>), 32.1 (CH<sub>2</sub>), 62.2 (CH<sub>2</sub>), 125.8 (ArCH), 126.9 (ArCH), 128.4 (ArCH), 130.0 (CH=CHPh), 130.2 (CH=CHPh), 137.5 (ArC).

#### (E)-(5-Iodopent-1-en-1-yl)benzene - S23<sup>7</sup>

#### Ph\_\_\_\_\_I

As described in general procedure C, reaction of (*E*)-5-phenylpent-4-en-1-ol (1.16 g, 7.16 mmol, 1 equiv.), PPh<sub>3</sub> (2.82 g, 16.8 mmol, 1.5 equiv.), imidazole (0.73 g, 16.8 mmol, 1.5 equiv.) and I<sub>2</sub> (2.73 g, 16.8 mmol, 1.5 equiv.), after work-up and flash column chromatography (hexane) yielded the title compound as a colourless oil (1.65 g, 85%);  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.93 (2H, quin, *J* 7.0, CH<sub>2</sub>), 2.27 (2H, qd, *J* 7.1, 1.4, CH<sub>2</sub>I), 3.16 (2H, t, *J* 6.9, CH<sub>2</sub>CH=CH), 6.08 (1H, dt, *J* 15.8, 7.0, CH<sub>2</sub>CH=CH), 6.39 (1H, d, *J* 15.8, CH<sub>2</sub>CH=CH), 7.14 (1H, tt, *J* 6.5, 1.5, Ar*H*), 7.20 - 7.30 (4H, m, Ar*H*);  $\delta_{\rm C}$  (100 MHz, CDCl<sub>3</sub>) 6.3 (CH<sub>2</sub>), 32.8 (CH<sub>2</sub>), 33.5 (CH<sub>2</sub>), 126.0 (ArCH), 127.1 (ArCH), 128.3 (ArCH), 128.5 (CH=CHPh), 131.3 (CH=CHPh), 137.4 (ArC).

# (3R,6S)-6-Cinnamyl-6-methyl-3-((E)-5-phenylpent-4-en-1-yl)tetrahydro-2H-pyran-2-one – trans-1i



As described in general procedure A, alkylation of (*S*)-6-cinnamyl-6-methyltetrahydro-2Hpyran-2-one (250 mg, 1.08 mmol, 1 equiv.) using LDA (1 M, 1.22 mL, 1.20 mmol, 1.1 equiv.), then (*E*)-(5-iodopent-1-en-1-yl)benzene (887 mg, 3.25 mmol, 2.7 equiv.) in HMPA (0.5 mL), after work-up and purification yielded *trans*-1i as a colourless oil (197 mg, 49%);  $v_{max}$  /cm<sup>-1</sup> 2975, 2944, 1721, 1494, 449, 1380, 1360, 1298, 1199, 1110;  $\delta_{\rm H}$  (400 MHz, CDCl<sub>3</sub>) 1.41 - 1.45 (3H, s, CH<sub>3</sub>), 1.54 - 1.79 (5H, m, 1H from CH<sub>2</sub> + CH<sub>2</sub> + CH<sub>2</sub>), 1.85 - 2.04 (3H, m, 1H from  $CH_2 + CH_2$ ), 2.24 (2H, q, *J* 7.1,  $CH_2$ ), 2.40 - 2.48 (1H, m, CH), 2.50 - 2.62 (2H, m,  $CCH_2CH=CH$ ), 6.13 - 6.25 (2H, m, 2 × PhCH=CH), 6.36 - 6.50 (2H, m, 2 × PhCH=CH), 7.17 - 7.26 (2H, m, Ar*H*), 7.27 - 7.39 (8H, m, Ar*H*);  $\delta_C$  (100 MHz, CDCl<sub>3</sub>) 22.3 (*C*H<sub>2</sub>), 26.7 (*C*H<sub>2</sub>), 27.5 (*C*H<sub>3</sub>), 31.0 (*C*H<sub>2</sub>), 31.4 (*C*H<sub>2</sub>), 32.9 (*C*H<sub>2</sub>), 39.5 (*C*H), 44.6 (*CC*H<sub>2</sub>CH=CH), 83.8 (quat. *C*), 123.9 (PhCH=*C*H), 125.9 (Ar*C*H), 126.2 (Ar*C*H), 126.9 (Ar*C*H), 127.5 (Ar*C*H), 128.5 (Ar*C*H), 128.6 (Ar*C*H), 130.2 (Ph*C*H=*C*H + PhCH=*C*H), 134.2 (Ph*C*H=CH), 137.0 (Ar*C*), 137.7 (Ar*C*), 174.2 (*C*O); *m*/*z* (ESI+) 375.4 ([M+H]<sup>+</sup>, 100%); HRMS (ESI+) found 397.2128, expect 397.2144 for C<sub>26</sub>H<sub>30</sub>O<sub>2</sub>Na.

### Crystal data and Structure Refinements

### Figure S1 Crystal Structure of 2b (CCDC 1009956)



#### Table S1 Crystal data and structure refinement for 2b (CCDC 1009956)

Empirical formula	$C_{26}H_{34}O_2$
Formula weight	378.53
Temperature/K	566(2)
Crystal system	orthorhombic
Space group	Pca2 <sub>1</sub>
a/Å	13.7848(12)
b/Å	12.024(2)
c/Å	12.7279(13)
α/°	90
β/°	90
$\gamma/^{\circ}$	90
Volume/Å <sup>3</sup>	2109.7(5)
Z	4
$\rho_{calc}mg/mm^3$	1.192
$\mu/\text{mm}^{-1}$	0.073
F(000)	824.0
$2\Theta$ range for data collection	6.402 to 50.052°
Index ranges	$-9 \le h \le 16, -14 \le k \le 5, -15 \le l \le 14$

*SmI*<sub>2</sub>–*H*<sub>2</sub>*O*-mediated 5-exo/6-exo lactone radical cyclisation cascades

Reflections collected	4485
Independent reflections	3103[R(int) = 0.0732]
Data/restraints/parameters	3103/1/257
Goodness-of-fit on F <sup>2</sup>	1.043
Final R indexes [I>= $2\sigma$ (I)]	$R_1 = 0.0906, wR_2 = 0.1778$
Final R indexes [all data]	$R_1 = 0.1502, wR_2 = 0.2192$
Largest diff. peak/hole / e Å <sup>-3</sup>	0.25/-0.25

### Figure S2 Crystal Structure of 2d (CCDC 1012766)



### Table S2 Crystal data and structure refinement for 2d (CCDC 1012766)

Empirical formula	C26 H33 Br O2
	0-01-00-0-0-
Formula weight	457.43
Temperature	100(2) K
Wavelength	1.54178 Å
Crystal system	Triclinic
Space group	P-1
Unit cell dimensions	a = 11.0845(3) Å
	b = 12.9326(3) Å
	c = 15.6251(4)  Å
Volume	2210.80(10) Å <sup>3</sup>
Z	4
Density (calculated)	1.374 Mg/m <sup>3</sup>
Absorption coefficient	2.672 mm <sup>-1</sup>
F(000)	960
Crystal size	0.19 x 0.15 x 0.07 mm <sup>3</sup>
Theta range for data collection	3.43 to 72.15°.
Index ranges	-13<=h<=12, -15<=k<=15, -19<=l<=19

Reflections collected	19984
Independent reflections	8306 [R(int) = 0.0292]
Completeness to theta = $67.00^{\circ}$	96.3 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.8350 and 0.712437
Refinement method	Full-matrix least-squares on F <sup>2</sup>
Data / restraints / parameters	8306 / 0 / 529
Goodness-of-fit on F <sup>2</sup>	1.046
Final R indices [I>2sigma(I)]	R1 = 0.0329, wR2 = 0.0829
R indices (all data)	R1 = 0.0368, wR2 = 0.0855
Largest diff. peak and hole	0.512 and -0.551 e.Å <sup>-3</sup>

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### <sup>1</sup>H and <sup>13</sup>C NMR spectra





### Ethyl 2-(3-oxobutyl)hept-6-enoate – S3



# (3R,6S)-6-Methyl-3-(pent-4-en-1-yl)-6-(1-phenylpropa-1,2-dien-1-yl)tetrahydro-2H-pyran-2-one – trans-1a





# (3S,6S)-6-Methyl-3-(pent-4-en-1-yl)-6-(1-phenylpropa-1,2-dien-1-yl)tetrahydro-2H-pyran-2-one – cis-1a



#### (4S,4aS,5S,6S,7R,9aS)-4,5,7-Trimethyl-6-phenyldecahydro-4aH-benzo[7]annulene-4a,7diol - 2a



#### (1S,2R,3R,4S,5R)-1,3-Dimethyl-5-(pent-4-en-1-yl)-2-phenylcycloheptane-1,4-diol -3a

2013-02-05-djp-49.010.001.1r.esp





### (E)-Ethyl 2-(3-oxobutyl)-7-phenylhept-6-enoate – S5



## (3R,6S)-6-Methyl-3-((E)-5-phenylpent-4-en-1-yl)-6-(1-phenylpropa-1,2-dien-1-yl)tetrahydro-2H-pyran-2-one – trans-1b



(1S,2R,3R,4S,5R)-1,3-Dimethyl-2-phenyl-5-((E)-5-phenylpent-4-en-1-yl)cycloheptane-1,4-diol-4b



# (4R,4aR,5S,6S,7R,9aS)-4-Benzyl-5,7-dimethyl-6-phenyldecahydro-1H-benzo[7]annulene-4a,7-diol – 2b



#### (4S, 4aS, 5R, 6R, 7S, 9aR) - 7 - Methyl - 5 - (methyl - d) - 6 - phenyl - 4 - ((S) - phenyl methyl - d) decahydro-data ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - 6 - phenyl - 4 - ((S) - phenyl - d) - ((S) - p

#### 4aH-benzo[7]annulene-5,6-d2-4a,7-diol-d2 - 2b-D4



#### Ethyl (E)-2-(3-oxobutyl)-7-(4-(trifluoromethyl)phenyl)hept-6-enoate – S6



#### (3R,6S)-6-Methyl-6-(1-phenyl-propa-1,2-dien-1-yl)-3-((E)-5-(4-(trifluoromethyl)phenyl)pent-4-en-1-yl)tetrahydro-2H-pyran-2-one – trans-1c



### (4S, 4aS, 5R, 6R, 7S, 9aR) - 5, 7 - Dimethyl - 6 - phenyl - 4 - (4 - (trifluoromethyl) benzyl) decahydro-benzyl) decahydro-benzyl decahydro-benzyl decahydro-benzyl) decahydro-benzyl decahydr

#### 4aH-benzo[7]annulene-4a,7-diol – 2c



### Ethyl (E)-7-(4-bromophenyl)-2-(3-oxobutyl)hept-6-enoate – S7



#### rac-(3R, 6S)-3-((E)-5-(4-Bromophenyl)pent-4-en-1-yl)-6-methyl-6-(1-phenyl-2l5-propa-1, 2-propa-1, 2-propa-1,

#### dien-1-yl)tetrahydro-2H-pyran-2-one – trans-1d



#### (4S,4aS,5R,6R,7S,9aR)-4-(4-Bromobenzyl)-5,7-dimethyl-6-phenyldecahydro-4aHbenzo[7]annulene-4a,7-diol – 2d



#### Ethyl (E)-2-(3-oxobutyl)-7-(p-tolyl)hept-6-enoate – S8



#### rac-(3R,6S)-6-Methyl-6-(1-phenyl-propa-1,2-dien-1-yl)-3-((E)-5-(p-tolyl)pent-4-en-1-

#### yl)tetrahydro-2H-pyran-2-one – trans-1e



110 100 90 Chemical Shift (ppm)

#### (4S, 4aS, 5R, 6R, 7S, 9aR)-5, 7-Dimethyl-4-(4-methylbenzyl)-6-phenyldecahydro-4aH-

#### benzo[7]annulene-4a,7-diol – 2e



#### Ethyl (E)-7-(2-chlorophenyl)-2-(3-oxobutyl)hept-6-enoate – S9



#### rac-(3R, 6S)-3-((E)-5-(2-Chlorophenyl)pent-4-en-1-yl)-6-methyl-6-(1-phenyl-propa-1, 2-phenyl-propa-1, 2-phenyl-phenyl-propa-1, 2-phenyl-propa-1, 2-phenyl-phenyl-propa-1, 2-phenyl-propa-1, 2-phenyl-phenyl-propa-1, 2-phenyl-propa-1, 2-phenyl-phenyl-phenyl-propa-1, 2-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-phenyl-pheny

#### *dien-1-yl)tetrahydro-2H-pyran-2-one – trans-1f*



220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20 Chemical Shift (ppm)

#### rac-(4S,4aS,5R,6R,7S,9aR)-4-(2-Chlorobenzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl)-5,7-dimethyl-6-phenyldecahydro-4aH-benzyl - 5,7-dimethyl-6-phenyldecahydro-4aH-benzyl - 5,7-dimethyl-6-phenzyl - 5,7-dimethyl-6-phenyldecahydro-4aH-benzyl - 5,7-dimethyl-6-phenyldecahydro-4aH-benzyl - 5,7-dimethyl-6-phenyldecahydro-4aH-benzyl - 5,7-dimethyl-6-phenyldecahydro-4aH-benzyl - 5,7-dimethyl-6-phenyldecahydro-4aH-benzyl - 5,7-dimethyl-6-phenyldecahydro-4aH-benzyl - 5,7-dimethyl - 5,7-di

### benzo[7]annulene-4a, 7-diol-2f



#### ethyl (E)-4,4-dimethylhepta-2,6-dienoate – S10



200 192 184 176 168 160 152 144 136 128 120 112 104 96 88 80 72 64 56 48 40 32 24 16 8 0 Chemical Shift (ppm)





#### ethyl (E)-4,4-dimethyl-2-(2-(2-methyl-1,3-dioxolan-2-yl)ethyl)-7-phenylhept-6-enoate – S14





#### $methyl\,(E)\mbox{-}4,\mbox{-}dimethyl\mbox{-}2\mbox{-}(3\mbox{-}oxobutyl)\mbox{-}7\mbox{-}phenylhept\mbox{-}6\mbox{-}enoate\mbox{-}S15$


## (3S,6S)-3-((E)-2,2-dimethyl-5-phenylpent-4-en-1-yl)-6-methyl-6-(1-phenyl-2l5-propa-1,2-dien-1-yl)tetrahydro-2H-pyran-2-one-trans-1g



## Ethyl 2-(3-oxobutyl)-7-phenylhept-6-ynoate - S18



(3R,6S)-6-(1-(Dimethyl(phenyl)silyl)--propa-1,2-dien-1-yl)-6-methyl-3-(5-phenylpent-4-yn-1-yl)tetrahydro-2H-pyran-2-one trans-1h



## (3R,6S)-6-Cinnamyl-6-methyl-3-(5-phenylpent-4-en-1-yl)tetrahydro-2H-pyran-2-one trans-1i

