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A total synthesis of the antitumour macrolide rhizoxin D

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An enantioselective synthesis of rhizoxin D (**2**), isolated from the plant pathogenic fungus *Rhizopus chinensis*, is described. The overall strategy is based on elaboration of the δ-lactone-substituted vinyl stannane **7** and the phosphonate-substituted vinyl iodide **9**, followed by their coupling to the core 16-membered macrolide **6** *via* a sequential intermolecular Horner–Wadsworth–Emmons olefination, leading to **50**, and by an intramolecular Stille reaction. The triene oxazole-containing side chain in rhizoxin D is then introduced using the phosphine oxide **8** in an *E*-selective Horner–Wittig reaction with the macrolide aldehyde **51b**.

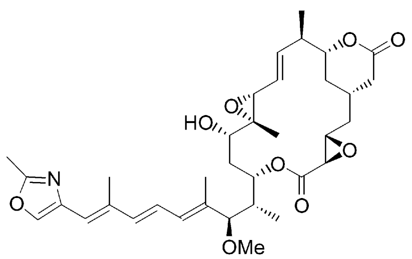
Introduction

Rhizoxin **1** and rhizoxin D (**2**), together with a number of congeners, *e.g.* **3**, **4** and **5**, comprise a family of novel 16-membered macrolides which were first isolated in 1984 from the plant pathogenic fungus *Rhizopus chinensis*.[1,2] Rhizoxin **1** exhibits pronounced antifungal activity and potent *in vitro* cytotoxicity and *in vivo* antitumour activity.[3] Indeed, rhizoxin has now undergone extensive clinical trials as a potential drug candidate for treatment of a number of cancers.[4] Its mechanism of action is similar to other tubulin polymerisation inhibitors such as maytansine, vinblastine, vincristine, podophyllotoxin and colchicine.[5]

The structure of rhizoxin **1** is unprecedented, and is based on a 16-membered macrolide core which accommodates nine stereogenic centres and two epoxides. Two of these stereogenic centres form part of a ring-fused δ-lactone and the structure includes a triene oxazole-containing side chain having two additional stereogenic centres. Rhizoxin D (**2**), *i.e.* didesepoxyrhizoxin, is the putative biogenetic precursor of **1**.[6] The rhizoxins have attracted considerable interest within the synthetic chemistry community and a total synthesis of rhizoxin **1**,[7] together with eight total syntheses of rhizoxin D (**2**)[8,9] have now been published.[10] Our own enantioselestive total synthesis of rhizoxin D was published in a preliminary communication in 2002.[9] In this paper we provide full details of our novel synthesis, and in the context of contemporaneous studies with rhizoxins by other researchers.

Discussion

Although a variety of tactics are available, any synthesis of rhizoxin D (**2**) has needed to address procedures for, and the timing of, elaboration of the macrolide core, and the introduction of the triene oxazole-containing side chain in the structure. These issues are apart from the general problem of incorporating the eleven stereogenic centres in the various sub-units used in any assemblage of the natural product. In seven of the eight total syntheses of rhizoxin D, the macrolide core has been elaborated, often at a late stage, using an intramolecular Horner–Wadsworth–Emmons (HWE) olefination reaction at C2–C3. Our own synthesis is distinguished by using an intramolecular Stille reaction at C10–C11 to close the macrolide, also as a late step in the overall synthesis (Scheme 1). In the syntheses described by Leahy[8c] and Keck,[8d] and their respective co-workers, the intramolecular HWE olefination at C2–C3 was carried out with the triene oxazole-containing side chain intact. In all other syntheses of rhizoxin D[8] the side chain was incorporated following macrocyclisation using combinations of intermolecular Stille, Horner–Wittig and HWE coupling reactions. Most of these strategies towards the total synthesis



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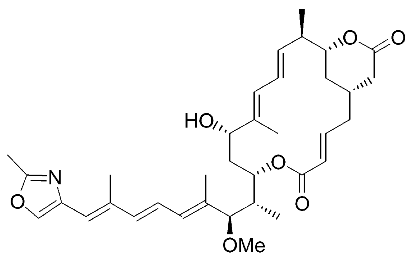

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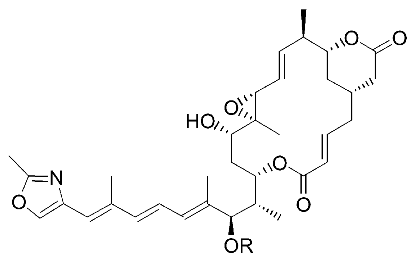

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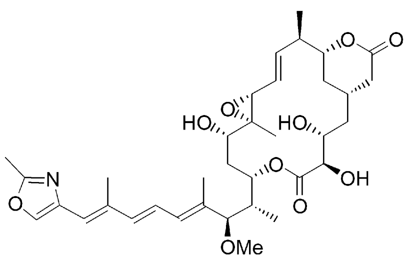

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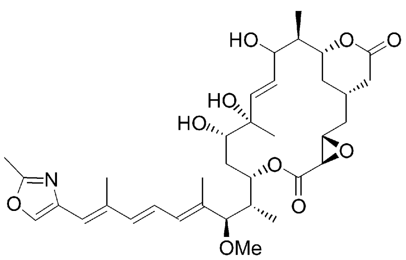

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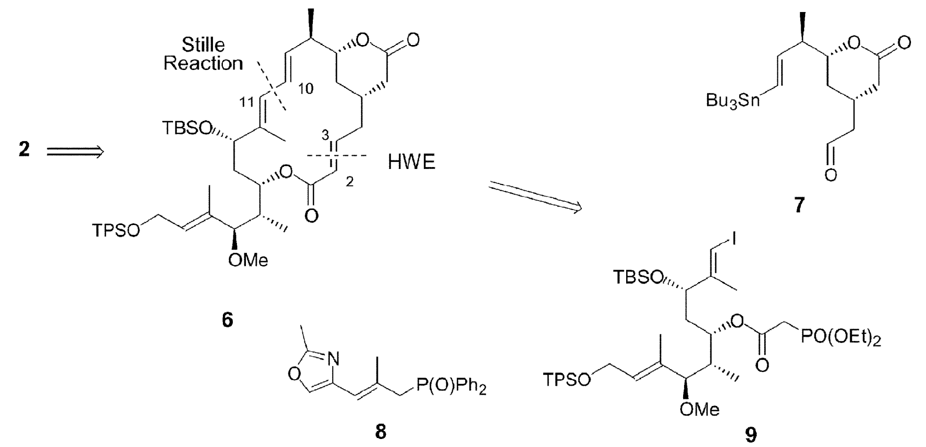


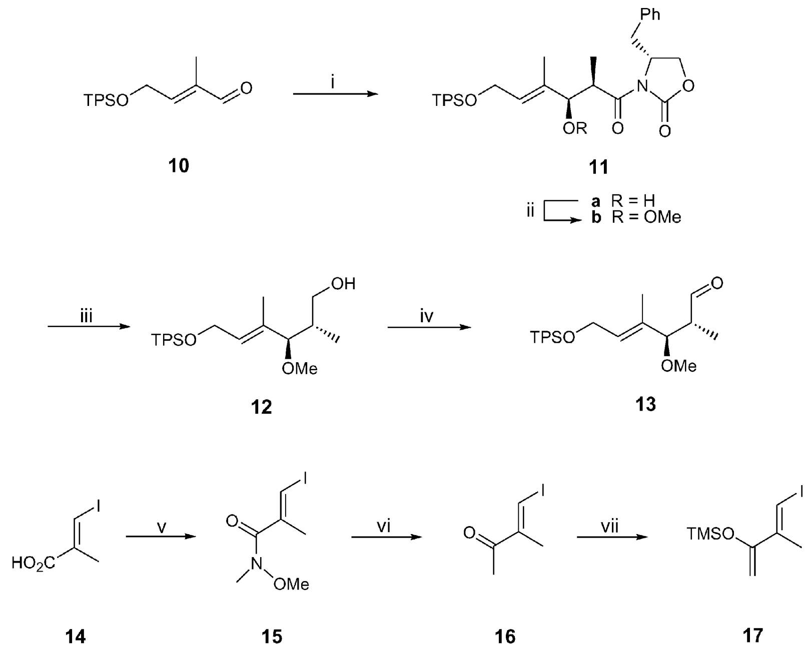
Scheme 1 Overall strategy for the synthesis of rhizoxin D.

of rhizoxin D, including routes to key chiral sub-units, have been collected together in a useful review published recently by Hong and White.[11]

Our own overall synthetic strategy to rhizoxin D (**2**) was based on elaboration of the δ-lactone-substituted vinyl stannane **7** and the phosphonate-substituted vinyl iodide **9** sub-units, and their coupling to the core 16-membered macrolide *via* a sequential intermolecular HWE olefination followed by an intramolecular Stille reaction[12,13] as key steps, leading to **6**. The triene oxazole-containing side chain in the target would then be introduced, as a late step, using the phosphine oxide **8**[14] in an *E*-selective Horner–Wittig reaction (Scheme 1).

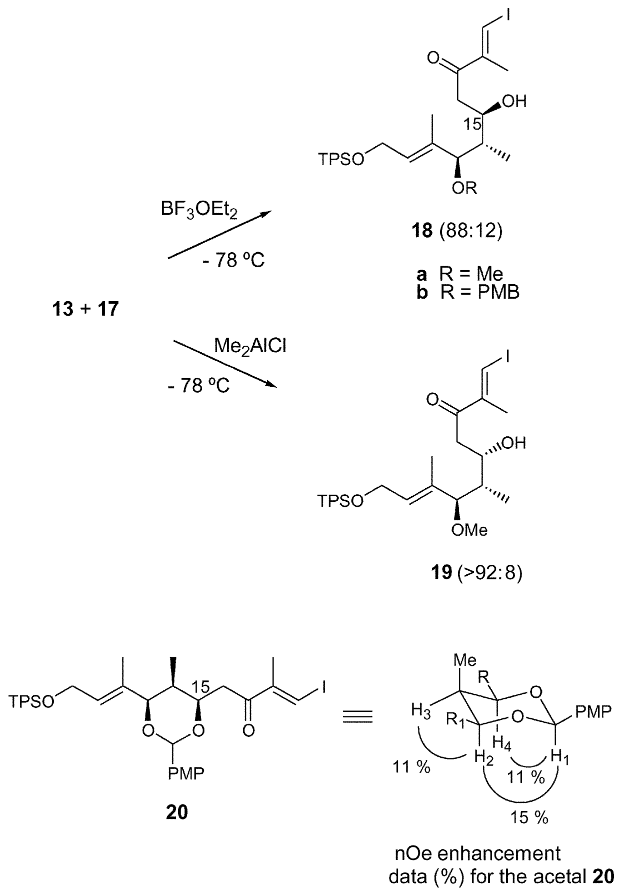
Synthesis of the phosphonate-substituted vinyl iodide 9

The key strategy we used in the synthesis of the sub-unit **9** was a diastereoselective Mukaiyama aldol reaction between the aldehyde **13** and the silyl enol ether **17**. Thus, an Evans aldol reaction[15] between (*R*)-4-benzyl-3-propionyloxazolidin-2-one and the known α,β-unsaturated aldehyde **10**[16] first gave the corresponding imide **11a** as a single diastereoisomer in 87% yield (Scheme 2). The imide **11a** was then converted into the aldehyde **13** in three straightforward steps *via* the methyl ether **11b** and the primary alcohol **12**. Correspondingly, the silyl enol ether **17** was smoothly synthesised in three steps from (*E*)-3-iodo-2-methylpropenoic acid **14**[17] following conversion to the Weinreb amide **15**, which was next treated with MeMgBr to provide the methyl ketone **16**. Deprotonation of **16** using LiHMDS at −78 °C, followed by quenching the resulting enolate with TMSCl then gave the silyl enol ether **17** as an unstable oil. Based on some precedent from the work of Evans *et al.*[18] we first carried out the Mukaiyama aldol reaction between **13** and **17** in the presence of BF_3OEt_2 at −78 °C. These conditions gave predominantly one diastereoisomer (76% de) in 82% yield. Unfortunately, subsequent assignment of the stereochemistry of the secondary alcohol centre (at C-15) in the product (*vide infra*) showed that the BF_3OEt_2-catalysed reaction had given the diastereoisomer **18a** predominantly, with the undesired (Felkin) selectively. After further experimentation we prepared the *p*-methoxybenzyl (PMB) ether **18b** corresponding to the methyl ether **18a**. When this ether was treated with DDQ in DCM at room temperature it was converted into the *p*-methoxyphenyl (PMP) acetal **20** in quantitative yield. NOe experiments with the PMP acetal **20** showed enhancements between all the protons

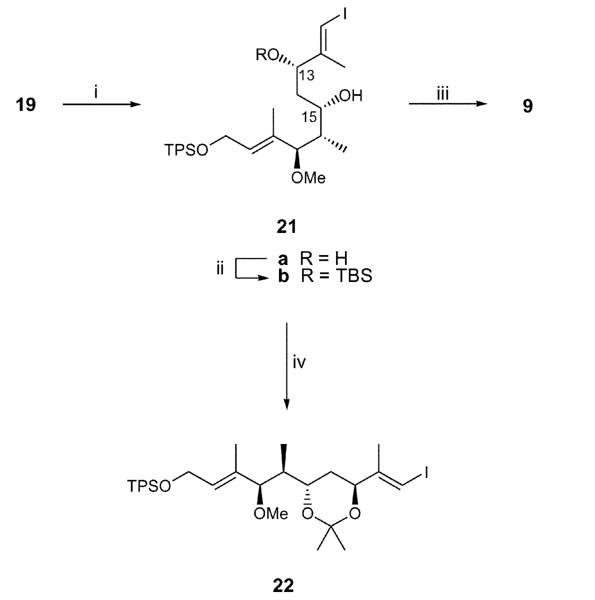


Scheme 2 *Reagents and conditions*: (i) (*R*)-4-benzyl-3-propionyloxazolidin-2-one, Bu_2BOTf, Et_3N, DCM, −78 °C → rt, 3 h, 87%; (ii) MeOTf, 2,6-di-*tert*-butyl-4-methylpyridine (DTBMP), $CHCl_3$, reflux, 6 h, 89%; (iii) $LiBH_4$, MeOH, Et_2O, 0 °C, 2 h, 79%; (iv) Dess–Martin, DCM, rt, 30 min, 99%; (v) NHMeOMe·HCl, ^{i}Pr$_2$EtN, pentafluorophenyl diphenylphosphinate (FDPP), DCM, 0 °C → rt, 18 h, 74%; (vi) MeMgBr, THF, 0 °C, 2 h, 77%; (vii) LiHMDS, THF, −78 °C, 1 h, *then* Et_3N, TMSCl, −78 °C → rt, 2 h, 100%.

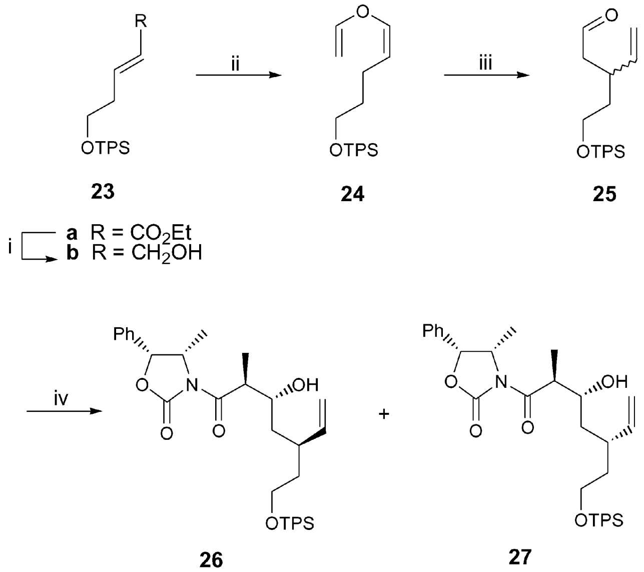
(H_1–H_4) on the lower face of the acetal ring, thereby establishing the ‘undesired’ (β-OH) stereochemistry at C-15 in the BF_3OEt_2-catalysed Mukaiyama aldol reaction between **13** and **17**.



More recent studies by Evans *et al.*[19] demonstrated the rather exceptional chelating ability of the Lewis acid dimethylaluminium chloride in Mukaiyama aldol reactions. We were pleased to find therefore that when these Evans conditions were applied to the aldehyde **13** and the silyl enol ether **17**, the diastereoisomeric aldol **19** with the ‘correct’ stereochemistry for rhizoxin was secured in 43% yield (85% based on recovered aldehyde **13**) and with ⩾92% de. The stereochemical assignment of **19** followed from comparison of its NMR spectroscopic data with those of the minor diastereoisomer formed in the corresponding Mukaiyama aldol reaction between **13** and **17** in the presence of BF_3OEt_2. Furthermore, reduction of the aldol product **19**, using tetramethylammonium triacetoxyborohydride gave the *anti*-1,3-diol (**21a**, 83%) as a single diastereoisomer (Scheme 3), whose acetonide **22** had appropriate signals in its ^{13}C NMR spectrum (δ_C 100.8, 24.8 and 24.2 ppm) consistent with the assigned (*anti*-) stereochemistry.[20] Protection of the C13–OH group in **21a** as its *tert*-butyldimethylsiloxy (TBS) ether **21b**, followed by acylation of the C15–OH group using diethylphosphonoacetic acid finally gave the phosphonate-substituted vinyl iodide sub-unit **9**.



Scheme 3 *Reagents and conditions*: (i) $(Me_4N)BH(OAc)_3$, MeCN–AcOH (2 : 1), −30 °C, 18 h, 83%; (ii) TBSOTf, 2,4,6-collidine, THF, −78 °C, 15 min, 68%; (iii) diethylphosphonoacetic acid, DCC, DMAP, DCM, rt, 2 h, 89%; (iv) *p*-TSA·H_2O, 2,2-dimethoxypropane, rt, 5 h, 89%.

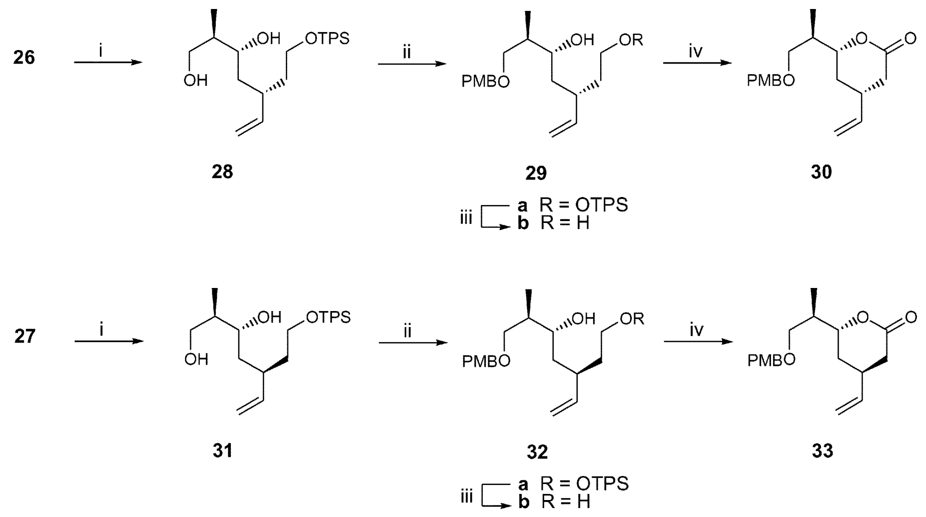


Scheme 4 *Reagents and conditions*: (i) DIBAL-H, THF, −78 °C, 1 h, 93%; (ii) $EtOCH{=}CH_2$, $Hg(O_2CCF_3)_2$, rt, 8 h, 78%; (iii) 170 °C, sealed tube, 36 h, 97%; (iv) Bu_2BOTf, Et_3N, (4*S*,5*R*)-4-methyl-5-phenyl-3-propionyloxazolidin-2-one, CH_2Cl_2, −78 → 0 °C, 2 h, 79%.

Synthesis of the vinyl stannane sub-unit 7

A number of complementary synthetic approaches were investigated to synthesise the chiral δ-lactone-substituted vinyl stannane **7**. In a simple, yet interesting, approach we first prepared the allyl vinyl ether **24** from the known α,β-unsaturated ester **23a**[21] *via* the corresponding primary alcohol **23b**. A Claisen rearrangement with **24** then delivered the racemic γ,δ-unsaturated aldehyde **25** in 97% yield (Scheme 4). The introduction of the 1,3-*syn* arrangement of chiral centres across the δ-lactone unit in **7** was achieved by an Evans aldol reaction between **25** and (4*S*,5*R*)-4-methyl-5-phenyl-3-propionyloxazolidin-2-one which gave a 1 : 1 mixture of the diastereoisomeric imides, **26** and **27**, in a combined yield of 79%. The diastereoisomers were separated by chromatography and their stereochemistries were established from analysis of NMR data recorded for the corresponding δ-lactones **30** and **33** produced from them (Scheme 5). Thus, removal of the chiral auxiliaries in the separated imides **26** and **27**, using lithium borohydride, first gave the corresponding alcohols **28**/**31** which were next converted into their respective PMB ethers **29a** and **32a** in a selective manner using *p*-methoxybenzyl trichloroacetimidate in the presence of camphorsulfonic acid (CSA) at 0 °C.[22] Removal of the triphenylsilyl (TPS) protection groups, followed by oxidation of the resulting 1,5-diols **29b**/**32b** using tetrapropylammonium perruthenate (TPAP), then gave the corresponding diatereoisomeric δ-lactones **30** and **33** respectively.

Examination of coupling constant data between H_2 and H_3 in the ^1H NMR spectrum of the δ-lactone **30** produced from the diastereoisomer **26**, *i.e.* J = 11 and 6 Hz, were consistent with



Scheme 5 *Reagents and conditions*: (i) $LiBH_4$, MeOH, Et_2O, 0 °C, *ca.* 70%; (ii) PMBO(N=H)CCl_3, CSA, CH_2Cl_2, −20 → 0 °C, *ca.* 60%; (iii) TBAF, THF, *ca.* 83%; (iv) TPAP, NMO, CH_2Cl_2, 0 °C, *ca.* 65%.

an axial–axial interaction and an axial–equatorial interaction respectively. Likewise, corresponding coupling constant data, *i.e.* J = 6 and 7 Hz, recorded for the δ-lactone **33** produced from the diastereoisomer **27** were consistent with an equatorial–equatorial and axial–equatorial interaction respectively. These data are captured on Fig. 1 for the two δ-lactones **30** and **33**, and demonstrated that the diastereoisomeric 1,3-diol **29b** derived from the imide **26** had the 'correct' stereochemistry for rhizoxin.

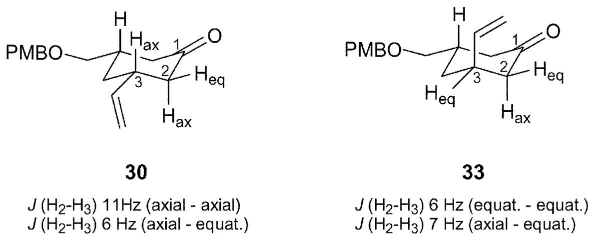
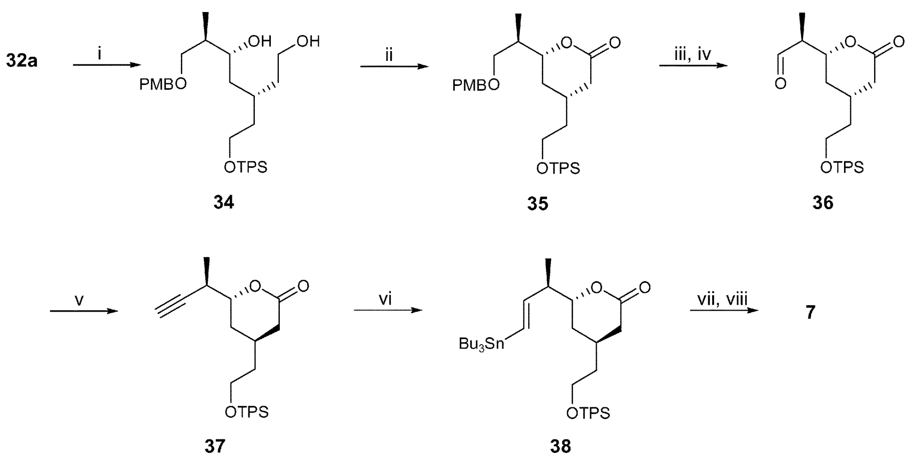


Fig. 1 ^{1}H NMR coupling data between H_2 and H_3 in the δ-lactones **30** and **33**.

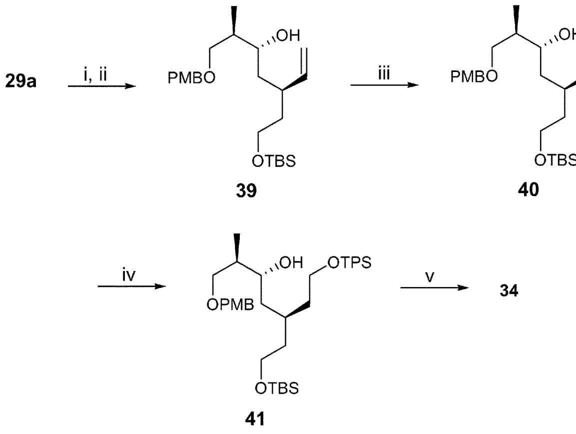
We were now in a position to study the conversions of the diastereoisomeric compounds **29**/**32** and **30**/**33** into the key vinyl stannane intermediate **7** *en route* to rhizoxin D. Much to our initial frustration, our attempts to functionalise the alkene bond in the 1,3-diequatorial lactone **30** by either hydroboration–oxidation, by radical addition of sulfide, or by direct oxidative cleavage met with failure. Instead, therefore, we carried out a hydroboration–oxidation sequence on the alkene **32a** derived from the imide **27** which proved trouble-free and led to the 1,5-diol **34** in 91% yield. Oxidation of **34**, using silver carbonate on Celite next gave the δ-lactone **35** which, in two high yielding steps was then converted into the corresponding aldehyde **36** (Scheme 6). The aldehyde **36** was now treated with dimethyl diazomethylphosphonate, *i.e.* Seyferth's reagent,[23] which led to the terminal acetylene **37** in quantitative yield. Treatment of the acetylene **37** with NBS and $AgNO_3$ then gave the corresponding bromoacetylene which, on further treatment with catalytic Pd_2dba_3/PPh_3 followed by Bu_3SnH, produced the (*E*)-vinyl stannane **38**. The *E*-configuration assigned to the vinyl stannane **38**[24] followed from the magnitude of the vicinal coupling, *i.e.* J = 19 Hz, between the olefinic protons in its ^{1}H NMR spectrum. A small amount of the corresponding *Z*-isomer of **38** (<5%) was produced concurrently and was removed by chromatography. Finally, deprotection of the TPS group in **38** led to the corresponding alcohol which underwent smooth oxidation in the presence of Dess–Martin periodinane to give the aldehyde-substituted vinyl stannane **7** in readiness for coupling to the phosphonate-substituted vinyl iodide **9**.

Interestingly, the diastereoisomeric imide **26** derived from the Evans aldol reaction with **25**, could also be used to synthesise the same 1,5-diol intermediate **34**, thereby allowing recycling of this easily available precursor. Thus, following the conversion of **26** into the PMB ether **29a**, interchange of the TPS silyl



Scheme 6 *Reagents and conditions*: (i) 9-BBN-H, 0 °C → rt, 12 h; (ii) Ag_2CO_3/Celite, PhH, reflux, 3 h, 91%; (iii) DDQ, CH_2Cl_2, rt, 2 h, 100%; (iv) Dess–Martin, CH_2Cl_2, rt, 1 h, 84%; (v) $(MeO)_2(O)PCHN_2$, KO^{t}Bu, THF, −78 °C, 2 h, 100%; (vi) NBS, $AgNO_3$, acetone, 1 h, then Pd_2dba_3/PPh_3, Bu_3SnH, THF, rt, 3 h, 70%; (vii) TBAF, TsOH, THF, rt, 3 h, 70%; (viii) Dess–Martin, Py, CH_2Cl_2, rt, 1 h, 70%.

ether protecting group for the corresponding TBS ether gave the alkene **39** (Scheme 7). Hydroboration of **39** next gave the 1,5-diol **40** which was then protected as the TPS ether **41**. Finally, selective deprotection of the TBS ether in **41**, using pyridinium *p*-toluenesulfonate (PPTS) in EtOH at 60 °C gave the 1,5-diol **34** whose spectroscopic data were identical with those obtained for the same compound prepared from the opposite diastereoisomer **27**.



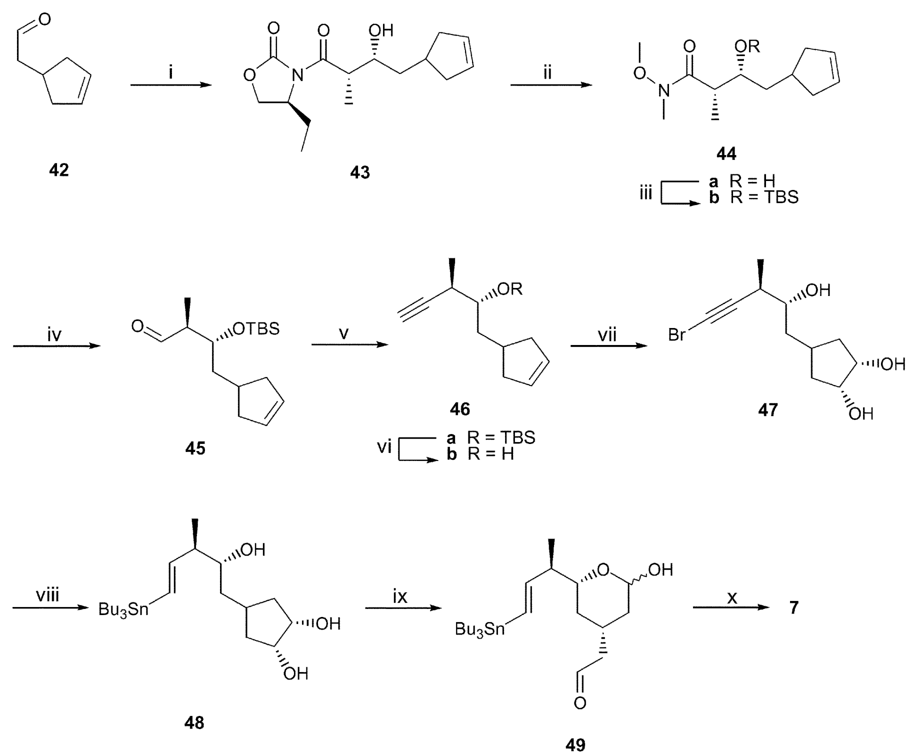
Scheme 7 *Reagents and conditions*: (i) TBAF, THF, rt, 2 h, 99%; (ii) TBSCl, Imidazole, CH_2Cl_2, rt, 2 h, 82%; (iii) 9-BBN-H, 0 °C → rt, 12 h, then NaOH, H_2O_2, 0 °C, 4 h, 95%; (iv) TDPSCl, Imidazole, CH_2Cl_2, rt, 2 h, 96%; (v) PPTS, EtOH, 60 °C, 2 h, 72%.

In an alternative approach to the vinyl stannane sub-unit **7**, which we found more amenable to producing large quantities of this key intermediate, the cyclopentene aldehyde **42** was first subjected to an Evans aldol reaction[15] with (*S*)-4-benzyl-3-propionyloxazolidin-2-one which led to the imide **43** as a single diastereoisomer in 77% yield. Transamidation of the imide using *N*,*O*-dimethylhydroxylamine in the presence of Me_3Al next gave the Weinreb amide **44a** which was then protected as its TBS ether **44b** (Scheme 8). Reduction of the amide **44b**, using DIBAL-H at −78 °C, followed by homologation of the resulting aldehyde **45** using the Seyferth reagent gave the alkyne **46** in excellent overall yield. The alkyne **46a** was next deprotected to **46b**, which was then converted into the bromoalkyne **47**, following sequential bromination, using NBS and silver nitrate, and vicinal dihydroxylation using catalytic OsO_4–NMO. In this manner the triol **47** was obtained as a 7 : 1 mixture of *syn*-diols in 76% overall yield. Hydrostannylation of **47** next led to the *E*-vinyl stannane **48** exclusively. Treatment of **48** with $NaIO_4$ on silica followed by oxidation of the resulting lactol **49** using silver carbonate on Celite, finally gave the aldehyde-substituted vinyl stannane **7**, which was identical with the previously synthesised material.

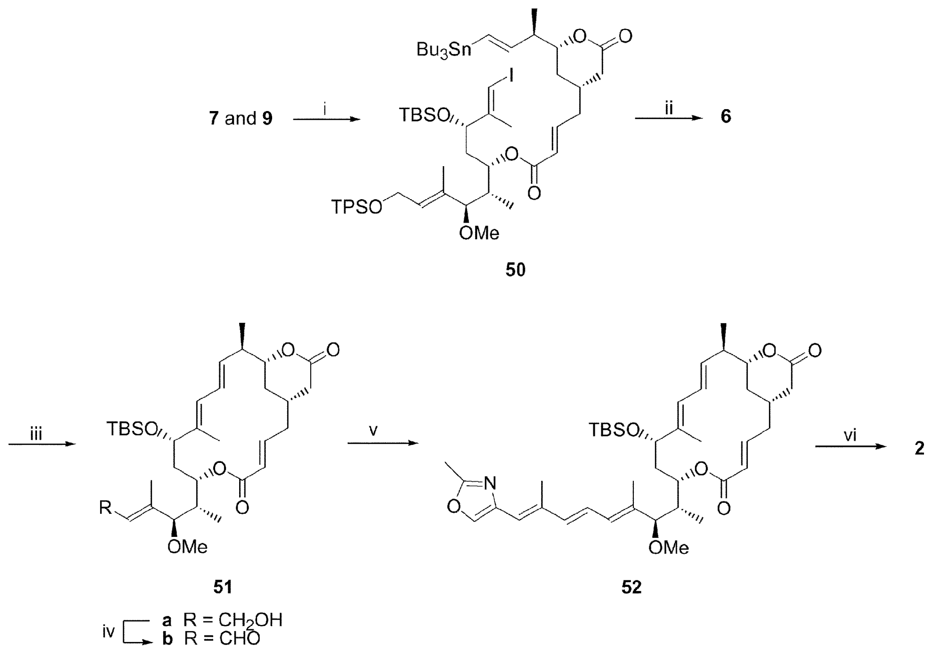
Macrolide formation and end game

With the two sub-units **7** and **9** in hand we were now in a position to synthesise the macrolide **6** and then complete a total synthesis of rhizoxin D, according to Scheme 1.

A Horner–Wadsworth–Emmons olefination reaction between the phosphonate **9** and the aldeyhyde **7**, under Masamune–Roush conditions (LiCl, DBU, MeCN, 0–25 °C)[25] led exclusively to the (*E*)-α,β-unsaturated ester **50**, in 78% yield (see Scheme 9). When this stannane-iodide **50** was treated with Ph_3As–Pd(0) dibenzylideneacetone[26] in degrassed DMF at 70 °C for 5 h, it underwent smooth intramolecular sp^2–sp^2 cross-coupling with preservation of the *E*-geometries of the two alkene bonds leading to the 16-membered macrolide **6** in an acceptable 48% yield.[27] The trimethylsilylethoxymethyl (SEM)–PMB ether corresponding to the TBS–TPS ether **6** was synthesised earlier by Williams *et al.*[8b] and the ^{1}H NMR spectroscopic data for the two compounds were shown to be remarkably similar. Selective removal of the primary TPS protecting group in **6**, followed by oxidation of the resulting allylic alcohol **51a** with MnO_2 next gave the unsaturated aldehyde **51b**. A Horner–Wittig olefination reaction between the aldehyde **51b** and the oxazole-substituted



Scheme 8 *Reagents and conditions*: (i) (*S*)-4-benzyl-3-propionyloxazolidin-2-one, Bu_2BOTf, $^iPr_2EtN$, DCM, −5 °C *then* **42**, DCM, −78 °C → rt, 4 h, 77%; (ii) $AlMe_3$, MeONHMe·HCl, DCM, −10 °C → rt, 2 h, 84%; (iii) TBSOTf, 2,6-lutidine, 0 °C, 45 min, 100%; (iv) DIBAL-H, THF, −78 °C, 2 h, 96%; (v) $(MeO)_2(O)PCHN_2$, KO^{t}Bu, THF, −78 °C, 2 h, 94%; (vi) HF/Py, THF, rt, 2 d, 100%; (vii) NBS, $AgNO_3$ (cat.), acetone, rt, 1 h, *then* OsO_4 (cat.), NMO, acetone–H_2O (2 : 1), rt, 90 min, 76% over two steps; (viii) $Pd(Ph_3P)_4$, Bu_3SnH, THF, rt, 2 h, 100%; (ix) $NaIO_4$ on SiO_2, DCM, rt, 15 min; (x) Ag_2CO_3 on Celite, PhMe, reflux, 3 h, 61% over two steps.



Scheme 9 *Reagents and conditions*: (i) LiCl, DBU, MeCN, 0 °C → rt, 1 h, 78%; (ii) Pd_2dba_3, $AsPh_3$, DMF, 70 °C, 5 h, 48%; (iii) TBAF–AcOH (1 : 1), THF, rt, 8 h, 74%; (iv) MnO_2, CH_2Cl_2, rt, 3 h, 100%; (v) **8**, KHMDS, THF; then add **51b**, −78 → 0 °C, then Yamaguchi esterification, 38%; (vi) HF/Py, Py, THF, rt, 48 h, 78%.

α,β-unsaturated phosphine oxide **8**,[14] at −78 °C in the presence of KHMDS led to the corresponding all-*E* polyene **52**, but with some concomitant ring-opening of the δ-lactone ring in the product. A similar observation was observed by Williams *et al.*[8b] in their synthesis of rhizoxin D. Accordingly, the crude Horner–Wittig olefination product was treated with 2,4,6-trichlorobenzoyl chloride–Et_3N–Me_3N–C_5H_4N, under Yamaguchi conditions, which re-instated the δ-lactone functionality and gave the protected rhizoxin **52** in 38% yield over the two-step sequence. Finally, deprotection of the silyl ether **52** with HF/pyridine gave (+)-rhizoxin D (**2**) which showed chiroptical and spectroscopic data which were indistinguishable from those recorded for the natural product.

In conclusion, we have achieved a concise enantioselective total synthesis of rhizoxin D (**2**), which featured an intramolecular Stille reaction, as the key stratagem, to elaborate the 16-membered macrolide core in the natural product. The synthesis was accomplished in a 21-step longest linear sequence, in an overall yield of 0.45%.

Experimental

General details

All melting points were determined on a Kopfler hot-stage apparatus and are uncorrected. Infrared spectra were recorded using a Perkin-Elmer FT 1600 spectrometer, as either liquid films or as dilute solutions in spectroscopic grade chloroform or dichloromethane.

^{1}H NMR spectra were recorded on a Brüker DPX 360 (360 MHz), a Brüker AV 400 (400 MHz) or a Brüker DRX 500 (500 MHz) instrument as dilute solutions in deuterated chloroform unless otherwise stated. The chemical shifts are reported relative to tetramethylsilane or residual chloroform as an internal standard. The multiplicity of the signals is designated by the following abbreviations: s, singlet; d, doublet; t, triplet; q, quartet; quin., quintet; br., broad; m, multiplet. All coupling constants, *J*, are reported in Hertz (Hz). ^{13}C NMR spectra were recorded on a Jeol JNM-EX 270 (67.8 MHz), a Brüker DPX 360 (90 MHz) or a Brüker DRX 500 (125 MHz) instrument. The spectra were recorded as dilute solutions in deuterated chloroform unless otherwise stated with chemical shifts reported relative to the residual chloroform as an internal standard on a broad band decoupled mode. The multiplicities were obtained using a DEPT sequence, where the following symbols are used for the multiplicities in ^{13}C NMR spectra: q, primary methyl; t, secondary methylene; d, tertiary methine; s, quaternary carbon.

Mass spectra were recorded on an AEI MS-902, a VG Micromass 7070 E, or a VG Autospec instrument using electron-impact ionisation (EI), fast atom bombardment (FAB), chemical ionisation (CI), or electrospray (ES) techniques.

Flash column chromatography was performed using Merck silica gel 60 (230–400 mesh ASTM) as the stationary phase. All reactions were monitored by thin layer chromatography (TLC) using Merck silica gel 60 F_{254} precoated aluminium plates which were visualised under ultraviolet light and then developed with basic potassium permanganate solution, acidic ceric ammonium molybdate solution, or acidic alcoholic vanillin solution.

All solvents and chemicals were used as provided by the supplier, or were dried and/or purified following accepted literature procedures. Syringe needles were dried in an oven at 150 °C and cooled under a stream of nitrogen before use. All reactions were conducted at room temperature in oven-dried glassware under an atmosphere of nitrogen unless otherwise stated. All organic extracts were dried over anhydrous magnesium sulfate and filtered under gravity. Solvents were removed from the extracts on a Büchi rotary evaporator under water pump or oil pressure.

(*E*)-4-(*tert*-Butyldiphenylsiloxy)-2-methyl-but-2-enal 10

The aldehyde was prepared as described in the literature[16] and was obtained as a colourless oil; (Found: C, 74.6; H, 7.6. Calc. for $C_{21}H_{26}O_2Si$: C, 74.5; H, 7.7%); ν_{max}($CHCl_3$, sol.)/cm^{-1} 2719, 1731, 1650, 1589; δ_H (360 MHz, $CDCl_3$), 9.40 (1H, s, C*H*O), 7.68 (4H, m, Ar*H*), 7.44–7.37 (6H, m, Ar*H*), 6.59 (1H, dq, *J* 1.3 and 5.4, C*H*=CCH$_3$), 4.51 (2H, d, *J* 5.4, C*H*$_2$OTPS), 1.56 (3H, d, *J* 1.3, CH=CC*H*$_3$), 1.07 [9H, s, OSiC(C*H*$_3$)$_3$]; δ_C (67.8 MHz, $CDCl_3$), 194.6 (d), 152.5 (d), 137.8 (s), 135.5 (d), 133.0 (s), 129.9 (d), 127.8 (d), 61.2 (t), 26.7 (q), 19.1 (s), 9.3 (q); *m/z* (FAB) 339.1779 (M + H: $C_{21}H_{27}O_2Si$ requires 339.1780), 339 (100%), 281 (20).

(*R*)-4-Benzyl-3-[(2*R*,3*R*)-(*E*)-6-(*tert*-butyldiphenylsiloxy)-3-hydroxy-2,4-dimethylhex-4-enoyl]-oxazolidin-2-one 11a

A solution of dibutylboron triflate in dichloromethane (1.00 M, 8.35 mL, 8.35 mmol), and *N*,*N*-di-*iso*propylethylamine

(1.59 mL, 9.11 mmol) were added sequentially to a stirred solution of (*R*)-4-benzyl-3-propionyloxazolidin-2-one (1.77 g, 7.60 mmol) in dichloromethane (80 mL) at −10 °C. The mixture was stirred at −10 °C for 20 min and then cooled to −78 °C. A solution of the aldehyde **10** (2.57 g, 7.60 mmol) in dichloromethane (10 mL) was added over 10 min *via* cannula. The mixture was stirred at −78 °C for 2 h, then warmed to 0 °C over 30 min and stirred at 0 °C for 30 min. The mixture was quenched at 0 °C by the sequential addition of pH 7 phosphate buffer (20 mL), methanol (20 mL), and hydrogen peroxide (20 mL), and then stirred at 0 °C for 1 h. The aqueous layer was separated and extracted with dichloromethane (3 × 50 mL). The combined organic extracts were dried and then concentrated *in vacuo* to leave an orange oil. The oil was purified by flash column chromatography, eluting with diethyl ether–light petroleum (bp 40–60 °C) (1 : 3) to give the *aldol product* (3.78 g, 87%) as a colourless oil. $[\alpha]_D^{21}$ −18 (*c* 1.02 in $CHCl_3$); (Found: C, 71.5; H, 7.2; N, 2.5. $C_{34}H_{41}NO_5Si$ requires: C, 71.4; H, 7.2; N, 2.45%); ν_{max}(sol.)/cm^{-1} 2931, 2859, 1780, 1694; δ_H (360 MHz, $CDCl_3$) 7.72–7.69 (4H, m, Ar*H*), 7.44–7.30 (9H, Ar*H*), 7.23–7.21 (2H, Ar*H*), 5.81 (1H, t, *J* 6.1, C*H*=CCH$_3$), 4.72–4.65 (1H, m, C*H*Bn), 4.35 (1H, d, *J* 3.7, C*H*OH), 4.31 (2H, d, *J* 6.1, C*H*$_2$OTPS), 4.18–4.16 (2H, m, C*H*$_2$OC=O), 3.97 (1H, dq, *J* 3.7 and 7.0, C*H*CH$_3$), 3.28 (1H, dd, *J* 3.2 and 13.3, C*H*HPh), 2.80 (1H, dd, *J* 9.5 and 13.3, C*H*HPh), 1.47 (3H, s, CH=CC*H*$_3$), 1.19 (3H, d, *J* 7.0, CHC*H*$_3$), 1.06 [9H, s, OSiC(C*H*$_3$)$_3$]; δ_C (90.6 MHz, $CDCl_3$), 176.7 (s), 153.0 (s), 135.5 (d), 135.1 (s), 135.0 (s), 133.8 (s), 129.6 (d), 129.4 (d), 128.9 (d), 127.6 (d), 127.4 (d), 125.9 (d), 74.9 (d), 66.1 (t), 60.8 (t), 55.3 (d), 40.3 (d), 37.7 (t), 26.8 (q), 19.1 (s), 13.5 (q), 10.4 (q); *m*/*z* (ES) 594.2622 (M + Na: $C_{34}H_{41}NO_5SiNa$ requires 594.2652), 594 (100%).

(*R*)-4-Benzyl-3-[(2*R*,3*R*)-(*E*)-6-(*tert*-butyldiphenylsiloxy)-3-methoxy-2,4-dimethylhex-4-enoyl]-oxazolidin-2-one 11b

2,6-Di-*tert*-butyl-4-methylpyridine (1.08 g, 5.25 mmol) and methyl trifluoromethanesulfonate (300 µL, 2.62 mmol) were added sequentially to a stirred solution of **11a** (100 mg, 0.18 mmol) in chloroform (2 mL) at room temperature. The mixture was heated at reflux for 6 h, then allowed to cool to room temperature, and quenched by the careful addition of methanol (1 mL). The mixture was diluted with dichloromethane (30 mL) and then washed with saturated sodium bicarbonate solution (2 × 30 mL). The combined aqueous phases were re-extracted with dichloromethane (2 × 20 mL) and the combined organic phases were then dried and concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with diethyl ether–light petroleum (bp 40–60 °C) (2 : 3) to give the *methyl ether* (91 mg, 89%) as a colourless oil. $[\alpha]_D^{21}$ −25.4 (*c* 0.89 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 2932, 2859, 1779, 1697; δ_H (360 MHz, $CDCl_3$), 7.73–7.67 (4H, m, Ar*H*), 7.45–7.30 (9H, m, Ar*H*), 7.24–7.22 (2H, m, Ar*H*), 5.70 (1H, t, *J* 6.0, C*H*=CCH$_3$), 4.55–4.51 (1H, m, C*H*NC=O), 4.34–4.24 (2H, m, C*H*$_2$OTPS), 4.16 (1H, quin., *J* 6.8, C*H*CH$_3$), 4.07 (1H, dd, *J* 2.1 and 9.0, C*H*HOC=O), 3.95 (1H, t, *J* 9.0, C*H*HOC=O), 3.79 (1H, d, *J* 8.3, C*H*OCH$_3$), 3.29 (1H, dd, *J* 2.7 and 13.3, C*H*HPh), 3.24 (3H, s, CHOC*H*$_3$), 2.77 (1H, dd, *J* 9.7 and 13.3, C*H*HPh), 1.47 (3H, s, CH=CC*H*$_3$), 1.33 (3H, d, *J* 6.8, CHC*H*$_3$), 1.07 [9H, s, OSiC(C*H*$_3$)$_3$]; δ_C (90.6 MHz, $CDCl_3$), 174.8 (s), 153.0 (s), 135.5 (d), 135.4 (d), 135.3 (s), 133.9 (s), 133.8 (s), 133.6 (s), 129.6 (d), 129.5 (d), 129.4 (d), 129.2 (d), 128.9 (d), 127.7 (d), 127.6 (d), 127.3 (d), 86.9 (d), 65.9 (t), 60.6 (t), 56.6 (d), 55.5 (q), 40.9 (d), 37.7 (t), 26.8 (q), 19.2 (s), 13.6 (q), 11.6 (q); *m*/*z* (ES) 608.2859 (M + Na: $C_{35}H_{43}NO_5SiNa$ requires 608.2808), 608 (100%), 585 (3), 333 (5).

(*E*)-(2*S*,3*R*)-6-(*tert*-Butyldiphenylsiloxy)-3-methoxy-2,4-dimethylhex-4-en-1-ol 12

A solution of lithium borohydride in tetrahydrofuran (2.00 M, 0.90 mL, 1.78 mmol) and methanol (72.0 µL, 1.78 mmol) was added sequentially to a stirred solution of the methyl ether **11b** (260 mg, 0.45 mmol) in diethyl ether (10 mL) at 0 °C. The mixture was stirred at 0 °C for 2 h and then quenched with aqueous sodium hydroxide solution (2.00 M, 2.00 mL). The aqueous phase was separated and then extracted with diethyl ether (3 × 5 mL). The combined organic extracts were dried and concentrated *in vacuo* to leave a colourless oil. This oil was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 3) to give the *alcohol* (145 mg, 79%) as a colourless oil. $[\alpha]_D^{21}$ +21.9 (*c* 0.63 in $CHCl_3$); (Found: C, 72.75; H, 8.85. $C_{25}H_{34}O_3Si$ requires: C, 73.1; H, 8.35%); ν_{max}(sol.)/cm^{-1} 3488 (br.), 2961, 2859, 1428; δ_H (360 MHz, $CDCl_3$), 7.69 (4H, m, Ar*H*), 7.43–7.35 (6H, m, Ar*H*), 5.62 (1H, tq, *J* 0.9 and 6.1, C*H*=CCH$_3$), 4.29 (2H, d, *J* 6.1, C*H*$_2$OTPS), 3.54–3.44 (2H, m, C*H*$_2$OH), 3.39 (1H, d, *J* 6.9, C*H*OCH$_3$), 3.18 (3H, s, CHOC*H*$_3$), 1.98 (1H, br. s, CH$_2$O*H*), 1.86–1.79 (1H, m, C*H*CH$_3$), 1.41 (3H, d, *J* 0.9, CH=CC*H*$_3$), 1.05 [9H, s, OSiC(C*H*$_3$)$_3$], 0.95 (3H, d, *J* 6.9, CHC*H*$_3$); δ_C (67.8 MHz, $CDCl_3$), 135.5 (d), 135.0 (s), 133.8 (s), 129.6 (d), 128.0 (d), 127.7 (d), 89.2 (d), 66.1 (t), 60.5 (t), 56.4 (q), 38.2 (d), 26.7 (q), 19.1 (s), 12.6 (q), 12.2(q); *m*/*z* (ES) 435 (100%), 324 (5), 310 (20), 280 (17).

(*E*)-(2*R*,3*R*)-6-(*tert*-Butyldiphenylsiloxy)-3-methoxy-2,4-dimethylhex-4-enal 13

Dess–Martin periodinane (424 mg, 1.00 mmol) was added in a single portion to a stirred solution of the alcohol 12 (206 mg, 0.50 mmol) in dichloromethane (5 mL) at room temperature. The suspension was stirred at room temperature for 30 min and then a saturated solution of sodium thiosulfate (5 mL) was added. The biphasic mixture was stirred for 20 min and then the upper aqueous phase was separated and extracted with dichloromethane (2 × 5 mL). The combined organic extracts were washed with a saturated solution of sodium bicarbonate (2 × 10 mL), dried and concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 4) to give the *aldehyde* (204 mg, 99%) as a colourless oil. $[\alpha]_D^{21}$ +4.2 (*c* 1.05 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 2742, 1732, 1111; δ_H (360 MHz, $CDCl_3$), 9.60 (1H, d, *J* 1.9, C*H*O), 7.69–7.66 (4H, m, Ar*H*), 7.43–7.36 (6H, m, Ar*H*), 5.57 (1H, t, *J* 6.0, C*H*=CCH$_3$), 4.29 (2H, d, *J* 6.0, C*H*$_2$OTPS), 3.72 (1H, d, *J* 6.5, C*H*OCH$_3$), 3.20 (3H, s, OC*H*$_3$), 2.53–2.47 (1H, m, C*H*CH$_3$), 1.37 (3H, s, CH=CC*H*$_3$), 1.06 (3H, d, *J* 7.0, CHC*H*$_3$), 1.04 [9H, s, OSiC(C*H*$_3$)$_3$]; δ_C (90.6 MHz, $CDCl_3$), 203.5 (d), 135.5 (d), 133.7 (s), 132.7 (s), 129.6 (d), 129.2 (d), 127.7 (d), 85.7 (d), 60.6 (t), 56.5 (q), 49.4 (d), 26.8 (q), 19.1 (s), 12.3 (q), 9.3 (q); *m*/*z* (ES) 433.2178 (M + Na: $C_{25}H_{34}O_3SiNa$ requires 433.2175), 433 (100%).

(*E*)-3-Iodo-*N*-methoxy-2,*N*-dimethylacrylamide 15

N,*N*-Di-*iso*propylethylamine (383 µL, 2.20 mmol) was added dropwise over 5 min to a stirred solution of (*E*)-3-iodo-2-methylacrylic acid **14** (212 mg, 1.00 mmol),[17] *N*,*O*-dimethylhydroxylamine hydrochloride (107 mg, 1.10 mmol) and pentafluorophenyl diphenylphosphinate (384 mg, 1.00 mmol) in dichloromethane (10 mL) at 0 °C. The mixture was warmed to room temperature, then stirred overnight and quenched by the addition of deionised water (1 mL). The separated aqueous phase was extracted with dichloromethane (3 × 1 mL) and the combined organic extracts were then washed successively with dilute hydrochloric acid (2.0 M, 10 mL), saturated sodium bicarbonate solution (10 mL), and brine (10 mL), then dried and concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 1), to give the *Weinreb amide* (189 mg, 74%) as a colourless oil. (Found: C, 28.7; H, 3.9; N, 5.3. $C_6H_{10}INO_2$ requires: C, 28.3; H, 3.9; N, 5.5%); ν_{max}(sol.)/cm^{-1} 3058 (br.), 1654, 1073; δ_H (360 MHz, $CDCl_3$), 6.80 (1H, q, *J* 1.2, C=C*H*I), 3.64 (3H, s, OC*H*$_3$), 3.23 (3H, s, NC*H*$_3$), 2.04 (3H, d, *J* 1.2, C=CC*H*$_3$); δ_C (90 MHz, $CDCl_3$), 168.5 (s), 143.0 (s), 86.6 (d), 61.4 (q), 33.3 (q), 22.3 (q); *m/z* (ESI) 255.9821 (M + H: $C_6H_{11}INO_2$ requires 255.9834), 256 (100%).

(*E*)-3-Iodo-3-methylbut-3-en-2-one 16

A solution of methylmagnesium bromide in diethyl ether (3.0 M, 0.83 mL, 2.50 mmol) was added over 5 min to a solution of the Weinreb amide **15** (255 mg, 1.00 mmol) in tetrahydrofuran (10 mL) at 0 °C. The mixture was stirred at 0 °C for 2 h and then quenched by the addition of dilute hydrochloric acid (2.0 M, 10 mL). The separated aqueous phase was extracted with diethyl ether (3 × 10 mL), and the combined organic extracts were washed with brine (20 mL), dried, and concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with diethyl ether–light petroleum (bp 40–60 °C) (1 : 1) to give the *methyl ketone* (162 mg, 77%) as a pale yellow oil; (Found: C, 28.9; H, 3.2. C_5H_7IO requires: C, 28.6; H, 3.2%); ν_{max}(film)/cm^{-1} 1676, 1360; δ_H (360 MHz, $CDCl_3$), 7.78 (1H, q, *J* 0.9, C=C*H*I), 2.36 (3H, s, C*H*$_3$C=O), 2.01 (3H, d, *J* 0.9, C=CC*H*$_3$); δ_C (67.8 MHz, $CDCl_3$), 192.7 (s), 149.5 (s), 100.8 (d), 26.5 (q), 20.1 (q); *m/z* (ESI) 210.9624 (M + H: C_5H_8IO requires 210.9620), 210 (100%), 209 (62), 73 (27).

[(*E*)-3-Iodo-2-methyl-1-methyleneallyloxy]-trimethylsilane 17

A solution of lithium hexamethyldisilazane in hexanes (1.0 M, 2.84 mL, 2.84 mmol) was added dropwise over 5 min to a stirred solution of the methyl ketone **16** (300 mg, 1.42 mmol) in tetrahydrofuran (14 mL) at −78 °C. The mixture was stirred at −78 °C for 20 min and then triethylamine (600 µL, 4.26 mmol) and trimethylsilyl chloride (544 µL, 4.26 mmol) were added. The mixture was stirred at −78 °C for 30 min, then warmed to room temperature and stirred for a further 30 min. The mixture was concentrated *in vacuo* and the residue was then washed with pentane (3 × 5 mL). The washings were concentrated *in vacuo* to leave the *enol silane* (400 mg, quantitative) as an unstable yellow oil; δ_H (360 MHz, C_6D_6), 7.18 (1H, q, *J* 0.4, C=C*H*I), 4.56 (1H, d, *J* 1.7, C=C*H*H), 4.42 (1H, *J* 1.7, C=CH*H*), 2.02 (3H, d, *J* 0.4, C=CC*H*$_3$), 0.19 (9H, s, TMS-*Me*), which was used without further purification.

(1*E*,8*E*)-(5*R*,6*S*,7*R*)-10-(*tert*-Butyldiphenylsiloxy)-5-hydroxy-1-iodo-7-methoxy-2,6,8-trimethyldeca-1,8-dien-3-one 18a

Freshly distilled boron trifluoride diethyl etherate (111 µL, 0.880 mmol) was added dropwise over 15 min to a stirred solution of the aldehyde **13** (242 mg, 0.59 mmol) and the silyl enol ether **17** (333 mg, 1.18 mmol) in toluene (10 mL) at −78 °C. The mixture was stirred at −78 °C for 1 h and then left in a freezer at −85 °C for 72 h. The mixture was allowed to warm to room temperature and then quenched by the careful addition of a saturated solution of ammonium chloride (5 mL). The mixture was extracted with dichloromethane (3 × 10 mL) and the combined organic extracts were dried and concentrated *in vacuo* to leave a yellow oil. The oil was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 4) to give the *aldol product* (300 mg, 82%) as a colourless oil. $[\alpha]_D^{21}$ +8.4 (*c* 1.09 in $CHCl_3$); (Found: C, 58.6; H, 6.7. $C_{30}H_{41}IO_4Si$ requires: C, 58.2; H, 6.7%); ν_{max}(sol.)/cm^{-1} 3475 (br.), 2930, 1672, 703; δ_H (360 MHz, $CDCl_3$), 7.84 (1H, s, IC*H*=C), 7.72–7.69 (4H, m, Ar*H*), 7.44–7.37 (6H, m, Ar*H*), 5.66 (1H, tq, *J* 1.1 and 6.0, C*H*=CCH$_3$), 4.33 (2H, d, *J* 6.0, C*H*$_2$OTPS), 4.17 (1H, ddd, *J* 2.2, 3.6 and 8.6, C*H*OH), 3.59 (1H, d, *J* 6.0, C*H*OCH$_3$), 3.22 (3H, s, OC*H*$_3$), 2.97 (1H, dd, *J* 8.6 and 16.7, C*H*HC=O), 2.66 (1H, dd, *J* 3.6 and 16.7, C*H*HC=O), 2.03 (3H, d, *J* 1.1, CH=CC*H*$_3$), 1.62 (1H, ddq, *J* 2.2, 6.0 and 7.0, C*H*CH$_3$), 1.37 (3H, s, ICH=CC*H*$_3$), 1.06 [9H, s, OSiC(C*H*$_3$)$_3$], 0.93 (3H, d, *J* 7.0, CHC*H*$_3$); δ_C (90.6 MHz, $CDCl_3$), 196.4 (s), 148.9 (s), 135.5 (d), 133.9 (s), 133.3 (s), 129.6 (d), 127.9 (d), 127.6, (d), 100.6 (d), 89.1 (d), 69.7 (d), 60.7 (t), 56.6 (q), 42.9 (t), 39.9 (d), 26.8 (q), 19.8 (q), 19.1 (s), 12.5 (q), 7.7 (q); *m/z* (ES) 643.1760 (M + Na: $C_{30}H_{41}IO_4SiNa$ requires 643.1717), 643 (100%).

(1*E*,8*E*)-(5*R*,6*S*,7*R*)-6-(*tert*-Butyldiphenylsiloxy)-5-hydroxy-1-iodo-7-(4-methoxybenzyloxy)-2,6,8-trimethyldec-1,8-dien-3-one 18b

A solution of trifluoromethanesulfonic acid (2 drops) in diethyl ether (1 mL) was added to a stirred solution of the aldol adduct **11a** (1.36 g, 2.34 mmol) and 4-methoxybenzyl trichloroacetimidate (0.91 mL, 4.76 mmol) in diethyl ether (50 mL) at room temperature. The mixture was stirred at room temperature for 5 min and then quenched by the addition of saturated sodium bicarbonate solution (30 mL). The separated aqueous phase was extracted with diethyl ether (30 mL) and the combined organic extracts were washed with dilute hydrochloric acid (2.0 M, 2 × 30 mL), and brine (30 mL), then dried and concentrated *in vacuo* to leave a colourless oil. The oil was purified by flash column chromatography, eluting with diethyl ether–light petroleum (bp 40–60 °C) (1 : 3) to give (*R*)-4-benzyl-3-[(2*R*,3*R*)-(*E*)-6-(*tert*-butyldiphenylsiloxy)-3-(4-methoxybenzyloxy)-2,4-dimethylhex-4-enoyl]-oxazolidin-2-one (1.32 g, 81%) as a colourless oil. $[\alpha]_D^{21}$ −1.24 (*c* 0.97 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 1778, 1698, 1073; δ_H (360 MHz, $CDCl_3$), 7.79–7.74 (4H, m, Ar*H*), 7.49–7.33 (6H, m, Ar*H*), 7.30 (2H, d, *J* 8.6, Ar*H*), 7.23 (2H, d, *J* 8.6, Ar*H*), 5.82 (1H, t, *J* 6.0, C=C*H*), 4.52 (1H, d, *J* 11.7, C*H*HAr), 4.47–4.34 (3H, m, C*H*N and C*H*$_2$OTPS), 4.24–4.16 (1H, m, C*H*CH$_3$), 4.20 (1H, d, *J* 11.7, CH*H*Ar), 4.06–4.03 (2H, m, C*H*$_2$OC=O), 3.86–3.80 (1H, m, C*H*OPMB), 3.84 (3H, s, OC*H*$_3$), 3.29 (1H, dd, *J* 3.0 and 13.3, C*H*HPh), 2.77 (1H, dd, *J* 9.6 and 13.3, CH*H*Ph), 1.57 (3H, s, C=CC*H*$_3$), 1.34 (3H, d, *J* 6.7, CHC*H*$_3$), 1.13 (9H, s, TPS-^{t}Bu); δ_C (90.6 MHz, $CDCl_3$), 174.4 (s), 159.0 (s), 152.9 (s), 135.5 (d), 135.4 (d), 135.3 (s), 133.8 (s), 133.7 (s), 133.6 (s), 130.4 (s), 129.6 (d), 129.5 (d), 129.3 (d), 128.9 (d), 128.8 (d), 127.7 (d), 127.6 (d), 127.2 (d), 113.6 (d), 83.0 (d), 69.7 (t), 65.7 (t), 60.6 (t), 55.5 (d), 55.1 (q), 40.9 (d), 37.6 (t), 26.7 (q), 19.1 (s), 12.9 (q), 12.0 (q); *m/z* (ESI) 714.3226 (M + Na: $C_{42}H_{49}NNaO_6Si$ requires 714.3227), 714 (100%), 715 (21).

Methanol (0.31 mL, 7.51 mmol) was added rapidly, followed by a solution of lithium borohydride in diethyl ether (2.00 M, 3.76 mL, 7.51 mmol) over 5 min, to a stirred solution of the above oxazolidinone (1.30 g, 1.88 mmol) in diethyl ether (20 mL) at 0 °C. The mixture was warmed to room temperature over 3 h and then quenched by the addition of sodium hydroxide solution (2.0 M, 10 mL). The biphasic mixture was stirred for 1 h at room temperature and the separated aqueous phase was then extracted with diethyl ether (2 × 10 mL). The combined organic extracts were dried and concentrated *in vacuo* to leave a residue which was purified by flash column chromatography, eluting with diethyl ether–light petroleum (bp 40–60 °C) (1 : 1) to give (*E*)-(2*R*,3*R*)-6-(*tert*-butyldiphenylsiloxy)-3-(4-methoxybenzyloxy)-2,4-dimethylhex-4-en-1-ol (905 mg, 93%) as a colourless oil. $[\alpha]_D^{21}$ +44.6 (*c* 0.63 in $CHCl_3$); (Found: C, 74.1; H, 8.25. $C_{32}H_{42}O_4Si$ requires: C, 74.1; H, 8.2%); ν_{max}(sol.)/cm^{-1} 3627, 1613, 1044; δ_H (360 MHz, $CDCl_3$), 8.63–8.61 (4H, m, Ar*H*), 8.31–8.23 (6H, m, Ar*H*), 8.08 (2H, d, *J* 8.5, Ar*H*), 7.69 (2H, d, *J* 8.5, Ar*H*), 6.35 (1H, tq, *J* 1.0 and 6.1, C=C*H*), 4.96 (1H, d, *J* 11.4, C*H*HAr), 4.86 (2H, d, *J* 6.1, C*H*$_2$OTPS), 4.63 (1H, d, *J* 11.4, CH*H*Ar), 4.27 (3H, s, OC*H*$_3$), 4.03 (1H, d, *J* 6.8 C*H*OPMB), 3.93 (1H, dd, *J* 6.0 and 11.0, C*H*HOH), 3.84 (1H, dd, *J* 4.9 and 11.0, CH*H*OH), 2.17–2.06 (2H, m, O*H* and C*H*CH$_3$), 1.68 (3H, d, *J* 1.0, C=CC*H*$_3$), 1.24 (9H, s, TPS-^{t}Bu), 1.10 (3H, d, *J* 6.9, CHC*H*$_3$); δ_C (90.6 MHz, $CDCl_3$), 159.1 (s), 135.5 (d), 135.2 (s), 133.8 (s), 130.5 (s), 129.6 (d), 129.5 (d), 128.1 (d), 127.7 (d), 113.7 (d), 85.8 (d), 69.8 (t), 65.9 (t), 60.5 (t), 55.2 (q), 38.2 (d), 26.8 (q), 19.1 (s), 12.7 (q), 12.4 (q); *m/z* (ESI) 541.2798 (M + Na: $C_{32}H_{42}NaO_4Si$ requires 541.2751), 541 (100%), 519 (4).

Dess–Martin periodinane (127 mg, 0.30 mmol) was added in a single portion to a stirred solution of the above alcohol (90.0 mg, 0.20 mmol) in dichloromethane (2 mL) at room temperature. The suspension was stirred at room temperature for 30 min and then quenched by the addition of saturated sodium thiosulfate solution (2 mL). The biphasic mixture was stirred at room temperature for 30 min and the separated aqueous phase was then extracted with dichloromethane (3 × 4 mL). The combined organic extracts were washed with saturated sodium bicarbonate solution (5 mL) and brine (5 mL), then dried and concentrated *in vacuo* to leave a residue. The crude residue was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 4) to give (*E*)-(2*R*,3*R*)-6-(*tert*-butyldiphenylsiloxy)-3-(4-methoxybenzyloxy)-2,4-dimethylhex-4-enal the *aldehyde* (83 mg, 93%) as a colourless oil. $[\alpha]_D^{21}$ +35.1 (*c* 1.06 in $CHCl_3$); (Found: C, 74.15; H, 7.7. $C_{32}H_{40}O_4Si$ requires: C, 74.4; H, 7.8%); ν_{max}(sol.)/cm^{-1} 2739, 1723, 1613, 1052; δ_H (360 MHz, $CDCl_3$), 9.60 (1H, d, *J* 2.0, C*H*O), 7.76–7.73 (4H, m, Ar*H*), 7.47–7.44 (6H, m, Ar*H*), 7.26 (2H, d, *J* 8.6, Ar*H*), 6.93 (2H, d, *J* 8.6, Ar*H*), 5.76 (1H, tq, *J* 0.9 and 6.0, C=C*H*), 4.49 (1H, d, *J* 11.4, C*H*HAr), 4.43–4.32 (2H, m, CH_2OTPS), 4.20 (1H, d, *J* 11.4, CH*H*Ar), 3.96 (1H, d, *J* 6.8, C*H*OPMB), 3.85 (3H, s, OCH_3), 2.58 (1H, d quin., *J* 2.0 and 6.8, C*H*CH$_3$), 1.48 (3H, d, *J* 0.9, C=CCH_3), 1.12 (3H, d, *J* 6.8, CHCH_3), 1.11 (9H, s, TPS-^{t}Bu); δ_C (90.6 MHz, $CDCl_3$), 203.5 (d), 159.2 (s), 135.5 (d), 133.7 (s), 133.0 (s), 130.1 (s), 129.7 (d), 129.5 (d), 127.7 (d), 113.7 (d), 84.8 (d), 69.7 (t), 60.6 (t), 55.2 (q), 49.3 (d), 26.8 (q), 19.1 (s), 12.3 (q), 9.5 (q); *m/z* (ESI) 571.2838 (M + Na + MeOH: $C_{33}H_{44}NaO_5Si$ requires 571.2856), 571 (100%), 539 (5).

Freshly distilled boron trifluoride diethyletherate (39.0 µL, 310 µmol) was added over 5 min to a solution of the above aldehyde (80.0 mg, 155 µmol) and the enol silane **17** (250 mg crude) in toluene (2 mL) at −78 °C and the mixture was then placed in a freezer at −85 °C for 14 h. The mixture was quenched at −78 °C with ammonium hydroxide solution (2.0 M, 2 mL) and then warmed to room temperature. The two layers were separated and the aqueous phase was then extracted with dichloromethane (2 × 2 mL). The combined organic extracts were dried and concentrated *in vacuo* to leave a colourless oil. The oil was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 6) to give the *aldol product* (47 mg, 42%; 56% based on recovered starting material) as a colourless oil. $[\alpha]_D^{21}$ +24.4 (*c* 0.63 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 3494 (br.), 1671, 1054; δ_H (360 MHz, $CDCl_3$), 7.75–7.71 (5H, m, C=C*H*I and Ar*H*), 7.44–7.37 (6H, m, Ar*H*), 7.24 (2H, d, *J* 8.7, Ar*H*), 6.88 (2H, d, *J* 8.7, Ar*H*), 5.74 (1H, tq, *J* 1.1 and 6.0, C=C*H*), 4.44 (1H, d, *J* 11.2, C*H*HAr), 4.37 (2H, d, *J* 6.0, CH_2OTPS), 4.15 (1H, d, *J* 11.2, CH*H*Ar), 4.14–4.10 (1H, m, C*H*OH) 3.84 (3H, s, OCH_3), 3.80 (1H, d, *J* 6.0, C*H*OPMB), 2.99 (1H, d, *J* 2.6, O*H*), 2.91 (1H, dd, *J* 8.7 and 16.9, C*H*HC=O), 2.61 (1H, dd, *J* 3.6 and 16.9, CH*H*C=O), 2.01 (3H, d, *J* 1.1, C=CCH_3), 1.70–1.60 (1H, m, C*H*CH$_3$), 1.43 (3H, d, *J* 0.8, IC=CCH_3), 1.08 (9H, s, TPS-^{t}Bu), 0.95 (3H, d, *J* 7.0, CHCH_3); δ_C (90.6 MHz, $CDCl_3$), 196.5 (s), 159.2 (s), 148.8 (s), 135.6 (d), 133.9 (s), 133.6 (s), 130.3 (s), 129.6 (d), 128.2 (d), 127.7 (d), 113.8 (d), 100.7 (d), 85.8 (d), 70.1 (t), 69.4 (d), 60.7 (t), 55.3 (q), 42.3 (t), 39.9 (d), 26.8 (q), 19.8 (q), 19.2 (s), 12.7 (q), 8.1 (q); *m/z* (ESI) 749.2150 (M + Na: $C_{37}H_{47}INaO_5Si$ requires 749.2135), 749 (100%).

(*E*)-[(4*R*,5*R*,6*R*)-6-[(*E*)-3-(*tert*-Butyldiphenylsiloxy)-1-methylpropenyl]-2-(4-methoxyphenyl)-5-methyl-[1,3]dioxan-4-yl]-4-iodo-3-methylbut-3-en-2-one 20

Freshly recrystallised 2,3-dichloro-5,6-dicyano-1,4-benzoquinone (5.60 mg, 24.8 µmol) was added in a single portion to a stirred solution of the aldol adduct **18b** (12.0 mg, 16.5 µmol) in dichloromethane (0.3 mL) at room temperature. The mixture was stirred at room temperature for 1 h, then diluted with dichloromethane (5 mL) and filtered through a pad of Celite, washing with dichloromethane (5 mL). The combined washings were concentrated *in vacuo* to leave a brown oil which was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 6) to give the *acetal* (12 mg, 99%) as a colourless oil. $[\alpha]_D^{21}$ −6.4 (*c* 0.75 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 1678, 1033; δ_H (360 MHz, $CDCl_3$), 7.86 (1H, s, C=C*H*I), 7.70–7.68 (4H, m, Ar*H*), 7.42–7.34 (8H, m, Ar*H*), 6.90 (2H, d, *J* 8.8, Ar*H*), 5.81 (1H, tq, *J* 1.2 and 6.3, C=C*H*), 5.57 (1H, s, C*H*Ar), 4.47 (1H, ddd, *J* 2.3, 5.3 and 7.4, C*H*OR), 4.30 (2H, d, *J* 6.3, CH_2OTPS), 4.25 (1H, br. s, C*H*OR), 3.82 (3H, s, OCH_3), 3.15 (1H, dd, *J* 7.4 and 16.4, C*H*HC=O), 2.69 (1H, dd, *J* 5.3 and 16.4, CH*H*C=O), 2.03 (3H, d, *J* 1.2, C=CCH_3), 1.79 (1H, tq, *J* 2.3 and 6.9, C*H*CH$_3$), 1.43 (3H, s, IC=CCH_3), 1.04 (9H, s, TPS-^{t}Bu), 0.87 (3H, d, *J* 6.9, CHCH_3); δ_C (90.6 MHz, $CDCl_3$), 194.4 (s), 159.8 (s), 148.9 (s), 135.6 (d), 133.9 (s), 133.5 (s), 131.1 (s), 129.5 (d), 127.5 (d), 124.3 (d), 113.5 (d), 100.9 (2 × d), 82.5 (d), 76.9 (d), 60.7 (t), 55.3 (q), 41.4 (t), 33.3 (d), 26.8 (q), 19.9 (q), 19.2 (s), 13.3 (q), 6.3 (q); *m/z* (ESI) 725.2136 (M + H: $C_{37}H_{46}IO_5Si$ requires 725.2159), 748 (30%), 725 (100).

(1*E*,8*E*)-(5*S*,6*S*,7*R*)-10-(*tert*-Butyldiphenylsiloxy)-5-hydroxy-1-iodo-7-methoxy-2,6,8-trimethyldeca-1,8-dien-3-one 19

A solution of dimethylaluminium chloride in hexanes (1.00 M, 2.10 mL, 2.10 mmol) was added over 5 min to a stirred solution of the aldehyde **13** (340 mg, 0.83 mmol) in dichloromethane (10 mL) at −78 °C. The mixture was stirred at −78 °C for 5 min and then a solution of the enol silane **17** (650 mg) in dichloromethane (2 mL) was added. The mixture was stirred at −78 °C for 2 h and then quenched −78 °C by the cautious addition of ammonium chloride solution (2.0 M, 10 mL). The biphasic mixture was warmed to room temperature, poured into deionised water (10 mL) and the separated aqueous phase was then extracted with dichloromethane (2 × 20 mL). The combined organic extracts were dried and concentrated *in vacuo* to leave an orange oil which was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 6) to give the *aldol product* (224 mg, 43%; 85% based on recovered starting material) as a colourless oil. $[\alpha]_D^{21}$ −12 (*c* 1.10 in $CHCl_3$); (Found: C, 58.3; H, 6.5. $C_{30}H_{41}IO_4Si$ requires: C, 58.2; H, 6.7%); ν_{max}(sol.)/cm^{-1} 3462 (br.), 2931, 1668, 703; δ_H (360 MHz, $CDCl_3$) 7.84 (1H, s, IC*H*=C), 7.71–7.68 (4H, m, Ar*H*), 7.45–7.36 (6H, m, Ar*H*), 5.60 (1H, br. t, *J* 6.0, C*H*=CCH$_3$), 4.31 (2H, d, *J* 6.0, CH_2OTPS), 4.08–4.02 (1H, m, C*H*OH), 3.62 (1H, d, *J* 4.6, C*H*OCH$_3$), 3.36 (1H, d, *J* 4.2, O*H*), 3.23 (3H, s, OCH_3), 2.90–2.75 (2H, m, CH_2C=O), 2.03 (3H, d, *J* 1.0, CH=CCH_3), 1.84–1.76 (1H, m, C*H*CH$_3$), 1.38 (3H, s, ICH=CCH_3), 1.05 [9H, s, OSiC(CH_3)$_3$], 0.87 (3H, d, *J* 7.0, CHCH_3); δ_C (90.6 MHz, $CDCl_3$) 197.0 (s), 148.9 (s), 135.5 (d), 133.8 (s), 133.6 (s), 129.6 (d), 127.6 (d), 126.9 (d), 100.7 (d), 86.1 (d), 69.8 (d), 60.7 (t), 56.8 (q), 41.8 (t), 40.4 (d), 26.7 (q), 19.8 (q), 19.1 (s), 13.1 (q), 10.2 (q); *m/z* (ES) 643.1706 (M + Na: $C_{30}H_{41}IO_4SiNa$ requires 643.1717), 643 (100%), 619 (5).

(1*E*,8*E*)-(3*S*,5*S*,6*S*,7*R*)-10-(*tert*-Butyldiphenylsiloxy)-3,5-dihydroxy-1-iodo-7-methoxy-2,6,8-trimethyldec-1,8-diene 21a

A solution of the β-hydroxyketone **19** (140 mg, 0.23 mmol) in acetonitrile (2 mL) was added over 5 min *via* cannula to a frozen mixture of tetramethylammonium triacetoxyborohydride (475 mg, 1.80 mmol) in acetonitrile (8 mL) and glacial acetic acid (10 mL) at −40 °C. The mixture was left at −30 °C in a freezer for 18 h, then quenched at −30 °C with saturated Rochelle's salt solution (15 mL) and warmed to room temperature. The emulsion was extracted with dichloromethane (50 mL, then 2 × 10 mL) and the combined organic extracts were carefully washed with saturated sodium bicarbonate solution until the aqueous phase remained basic, then dried and concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 4) to give the *diol* (116 mg, 83%) as a pale yellow oil. $[\alpha]_D^{21}$ +8.8 (*c* 0.95 in $CHCl_3$); ν_{max}(film)/cm^{-1} 3422 (br.), 1462, 737; δ_H (360 MHz, $CDCl_3$), 7.72–7.69 (4H, m, Ar*H*), 7.47–7.37 (6H, m, Ar*H*), 6.38 (1H, s, C=C*H*I), 5.61 (1H, br. t, *J* 6.0, C=C*H*), 4.48 (1H, m, C*H*OH), 4.33 (2H, d, *J* 6.0, CH_2OTPS), 3.81 (1H, m, C*H*OH), 3.72 (1H, br. s, O*H*), 3.69 (1H, d, *J* 4.0, C*H*OMe), 3.23 (3H, s, OCH_3), 1.82 (3H, s, IC=CCH_3), 1.79–1.72 (3H, m, C*H*CH_3 and CH_2CHOH), 1.41 (3H, s, C=CCH_3), 1.07 (9H, s, TPS-^{t}Bu), 0.87 (3H, d, *J* 7.1, CHCH_3); δ_C (90.6 MHz, $CDCl_3$), 149.6 (s), 135.5 (d), 133.7 (s), 133.0 (s), 129.6 (d), 127.7 (d), 127.6 (d), 87.3 (d), 77.7 (d), 73.9 (d), 71.9 (d), 60.6 (t), 56.6 (q), 40.6 (d), 38.4 (t), 26.7 (q), 21.7 (q), 19.1 (s), 13.3 (q), 11.7 (q); *m/z* (FAB) 645.1910 (M + Na: $C_{30}H_{43}IO_4SiNa$ requires 645.1873), 646 (10%), 645 (100).

***tert*-Butyl-{(4*R*,5*S*)-(*E*)-5-[(4*S*,6*S*)-6-(*E*)-2-iodo-1-methylvinyl-2,2-dimethyl-[1,3]dioxan-4-yl]-4-methoxy-3-methylhex-2-enyloxy}-diphenylsilane 22**

para-Toluenesulfonic acid monohydrate (1 mg) was added to a stirred solution of the diol **21a** (15.0 mg, 24.0 µmol) in 2,2-dimethoxypropane (0.3 mL) at room temperature and the mixture was stirred at room temperature for 5 h. The mixture was concentrated *in vacuo* to leave a crude residue which was purified by flash column chromatography, eluting with diethyl ether–light petroleum (bp 40–60 °C) (1 : 19) to give the *acetonide* (14 mg, 89%) as a colourless oil. $[\alpha]_D^{21}$ −13 (*c* 0.45 in $CHCl_3$); ν_{max}(film)/cm^{-1} 2958, 1075, 972; δ_H (360 MHz, $CDCl_3$), 7.71–7.68 (4H, m, Ar*H*), 7.43–7.36 (6H, m, Ar*H*), 6.29 (1H, s, C=C*H*I), 5.59 (1H, t, *J* 6.1, C=C*H*), 4.34–4.26 (3H, m, CH_2OTPS and C*H*OR), 3.79 (1H, dt, *J* 7.9 and 8.1, C*H*OR), 3.60 (1H, d, *J* 3.9, C*H*OMe), 3.20 (3H, s, OCH_3), 1.82 (3H, s, IC=CCH_3), 1.71 (2H, dd, *J* 8.0 and 8.1, CH_2CHOR), 1.67–1.61 (1H, m, C*H*CH_3), 1.37 (6H, s, 2 × OCCH_3), 1.35 (3H, s, C=CCH_3), 1.04 (9H, s, TPS-^{t}Bu), 0.74 (3H, d, *J* 7.0, CHCH_3); δ_C (90.6 MHz, $CDCl_3$), 147.4 (s), 135.6 (d), 134.0 (s), 133.8 (s), 129.5 (d), 129.4 (d), 125.8 (d), 100.8 (s), 84.2 (d), 77.7 (d), 70.6 (d), 67.1 (d), 60.9 (t), 57.1 (q), 40.8 (d), 35.0 (t), 26.8 (q), 24.8 (q), 24.2 (q), 20.7 (q), 19.2 (s), 13.5 (q), 8.4 (q); *m/z* (FAB) 663 (45%), 657 (100).

(1*E*,8*E*)-(3*S*,5*S*,6*S*,7*R*)-10-(*tert*-Butyldiphenylsiloxy)-3-(*tert*-butyldimethylsiloxy)-5-hydroxy-1-iodo-7-methoxy-2,6,8-trimethyldec-1,8-diene 21b

tert-Butyldimethylsilyl triflate (33.0 µL, 0.14 mmol) was added to a stirred solution of the diol **21a** (81.0 mg, 0.13 mmol) and 2,4,6-collidine (34.0 µL, 0.26 mmol) in tetrahydrofuran (8 mL) at −78 °C. The mixture was stirred at −78 °C for 15 min, then quenched with saturated sodium bicarbonate solution (8 mL), and warmed to room temperature. The aqueous phase was separated and extracted with dichloromethane (3 × 5 mL) and the combined organic extracts were then dried and concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 9) to give the *silyl ether* (64 mg, 68%) as a colourless oil. $[\alpha]_D^{21}$ −6.0 (*c* 1.0 in $CHCl_3$); ν_{max}(film)/cm^{-1} 3480 (br.), 1463, 1112; δ_H (360 MHz, $CDCl_3$), 7.73–7.70 (4H, m, Ar*H*), 7.44–7.37 (6H, m, Ar*H*), 6.28 (1H, s, C=C*H*I), 5.59 (1H, t, *J* 6.0, C=C*H*), 4.51 (1H, dd, *J* 2.5 and 7.9, C*H*OTBS), 4.33 (2H, d, *J* 6.0, CH_2OTPS), 3.71 (1H, apparent quin., *J* 4.6, C*H*OH), 3.60 (1H, d, *J* 4.3, C*H*OMe), 3.25 (1H, d, *J* 4.6, O*H*), 3.22 (3H, s, OCH_3), 1.80 (3H, s, IC=CCH_3), 1.72–1.66 (2H, m, C*H*CH_3 and CH*H*CHOH), 1.52 (1H, ddd, *J* 2.9, 10.2 and 13.8, C*H*HCHOH), 1.40 (3H, s, C=CCH_3), 1.07 (9H, s, TPS-^{t}Bu), 0.90 (9H, s, TBS-^{t}Bu), 0.87 (3H, d, *J* 7.1, CHCH_3), 0.09 (3H, s, TBS-Me), 0.02 (3H, s, TBS-Me); δ_C (90.6 MHz, $CDCl_3$), 150.1 (s), 135.5 (d), 133.8 (s), 133.4 (s), 129.6 (d), 127.6 (d), 127.1 (d), 86.8 (d), 77.5 (d), 74.8 (d), 70.3 (d), 60.8 (t), 56.6 (q), 41.0 (d), 40.5 (t), 26.8 (q), 25.7 (q), 20.5 (q), 19.1 (s), 18.1 (s), 13.3 (q), 11.0 (q), −4.9 (q), −5.4 (q); *m/z* (ESI) 759.2554 (M + Na: $C_{36}H_{57}IO_4Si_2Na$ requires 759.2539), 760 (20%), 759 (100).

(1*E*,8*E*)-(3*S*,5*S*,6*S*,7*R*)-1-Iodo-10-(*tert*-butyldiphenylsiloxy)-3-(*tert*-butyldimethylsiloxy)-5-(2-diethylphosphonoacetoxy)-7-methoxy-2,6,8-trimethyldec-1,8-diene 9

A solution of diethylphosphonoacetic acid (30.0 µL, 122 µmol) in dichloromethane (0.3 mL) was added over 5 min, followed by *N*,*N*′-dicyclohexylcarbodiimide (38.0 mg, 183 µmol) in a single portion to a stirred solution of the alcohol **21b** (90.0 mg, 122 µmol) and 4-(dimethylamino)pyridine (4.30 mg, 37.0 µmol) in dichloromethane (6 mL) at room temperature. The mixture was stirred at room temperature for 90 min and then concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 3) to give the *phosphonate ester* (100 mg, 89%) as a colourless oil. $[\alpha]_D^{21}$ −7.2 (*c* 0.95 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 1732, 1052, 703; δ_H (360 MHz, $CDCl_3$), 7.71–7.65 (4H, m, Ar*H*), 7.44–7.35 (6H, m, Ar*H*), 6.19 (1H, s, C=C*H*I), 5.59 (1H, br. t, *J* 6.0, C=C*H*), 4.89–4.84 (1H, m, C*H*OC=O), 4.35 (1H, dd, *J* 7.0 and 13.0, C*H*HOTPS), 4.26 (1H, dd, *J* 5.0 and 13.0, CH*H*OTPS), 4.20–4.11 (5H, m, POCH_2 and C*H*OTBS), 3.16 (4H, br. s, C*H*OMe and OCH_3), 2.94 (1H, dd, *J* 14.3 and 21.7, CH_2P), 2.90 (1H, dd, *J* 14.3 and 21.7, CH_2P), 2.08–1.99 (1H, m, C*H*CH_3), 1.77 (3H, s, IC=CCH_3), 1.67 (2H, m, CH_2CHOTBS), 1.45 (3H, s, C=CCH_3), 1.33 (6H, dt, *J* 1.8 and 7.1, POCH_2CH_3), 1.05 (9H, s, TPS-^{t}Bu), 0.93 (3H, d, *J* 6.9, CHCH_3), 0.82 (9H, s, TBS-^{t}Bu), −0.03 (3H, s, TBS-Me), −0.07 (3H, s, TBS-Me); δ_C (90.6 MHz, $CDCl_3$), 164.8 (s), 150.6 (s), 135.5 (d), 133.8 (s), 133.7 (s), 129.5 (d), 128.7 (d), 127.6 (d), 87.8 (d), 78.2 (d), 74.3 (d), 73.8 (d), 62.5 (dt, *J* 6.1), 60.7 (t), 56.1 (q), 38.3 (d), 35.6 (t), 34.6 (dt, *J* 133.0), 26.8 (q), 25.7 (q), 19.1 (q), 19.0 (s), 18.0 (s), 16.3 (dq, *J* 6.1), 11.6 (q), 9.6 (q), −5.0 (q), −5.4 (q); *m/z* (ESI) 937.3065 (M + Na: $C_{42}H_{68}INaPO_8Si_2$ requires 937.3133), 938 (12%), 937 (100).

(*E*)-5-(*tert*-Butyldiphenylsilanyloxy)-pent-2-enoic acid ethyl ester 23a

(Carbethoxymethylene)triphenylphosphorane (7.97 g, 22.9 mmol) was added in four equal portions, over 2 min, to a stirred solution of 1-(*tert*-butyldiphenylsilyloxy)propanal (6.50 g, 20.8 mmol) in dichloromethane (250 mL) at room temperature. The solution was stirred at room temperature for 8 h and then concentrated *in vacuo* to leave a residue that was extracted into pentane (300 mL). The solvent was evaporated *in vacuo* to leave a colourless oil that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 19) to give the ester (7.3 g, 93%)[21] as a colourless oil; (Found: C, 72.4; H, 8.0. Calc. for $C_{23}H_{30}O_3Si$: C 72.2; H, 7.9%); ν_{max} (liquid film)/cm^{-1} 1720, 1656, 1589; δ_H (400 MHz, $CDCl_3$) 7.69–7.67 (4H, m, Ar*H*), 7.47–7.38 (6H, m, Ar*H*), 7.00 (1H, dt, *J* 15.6 and 7.1, C*H*=$CHCO_2$Et), 5.88 (1H, dt, *J* 15.6 and 1.5, CH=C*H*CO_2Et), 4.21 (2H, q, *J* 7.1, CO_2C$H_2$$CH_3$), 3.79 (2H, t, *J* 6.5, CH_2OTBDPS), 2.46 (2H, apparent qd, *J* 6.6 and 1.5, CH_2CH=CH), 1.31 (3H, t, *J* 7.1, CO_2CH_2CH_3), 1.07 [9H, s, OSiC(CH_3)$_3$]; δ_C (67.8 MHz, $CDCl_3$) 166.4 (s, *C*O_2Et), 145.8 (d, *C*H=$CHCO_2$Et), 135.5 (d, Ar), 133.5 (s, Ar), 129.6 (d, Ar), 127.6 (d, Ar), 123.0 (d, CH=*C*HCO_2Et), 62.2 (t, *C*H_2OTBDPS), 60.1 (CO_2*C*H_2CH_3), 35.4 (t, *C*H_2CH_2OTBDPS), 26.7 [q, OSiC(*C*H_3)$_3$], 19.1 [s, OSi*C*(CH_3)$_3$], 14.2 (q, CO_2CH_2*C*H_3); *m/z* (EI) 325.1291 [$M^{+\bullet}$ − C(CH_3)$_3$. $C_{19}H_{21}O_3Si$ requires 325.1260].

(*E*)-5-(*tert*-Butyldiphenylsilanyloxy)-pent-2-en-1-ol 23b

Di-*iso*butylaluminium hydride (1.5 mol dm^{-3} in toluene; 27.6 mL, 41.4 mmol) was added dropwise over 15 min, to a stirred solution (*E*)-5-(*tert*-butyldiphenylsilanyloxy)-pent-2-enoic acid ethyl ester **23a** (7.20 g, 18.8 mmol) in dichloromethane (150 mL) at −78 °C. The mixture was stirred at −78 °C for

1 h, after which it was quenched at −78 °C by the addition of methanol (8 mL), and allowed to warm to room temperature over 1 h. A saturated aqueous solution of potassium sodium tartrate (150 mL) was added to the mixture which was the stirred vigorously at room temperature for 2 h. The mixture was extracted with dichloromethane (80 mL), washed with brine (30 mL), dried over anhydrous magnesium sulfate and concentrated *in vacuo* to leave a residue that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 9) to give the alcohol (5.9 g, 93%) as a colourless oil; (Found: C, 74.2; H, 8.6. $C_{21}H_{28}O_2Si$ requires: C 74.1; H, 8.3%); ν_{max} (liquid film)/cm^{-1} 3344, 3070, 1589; δ_H (400 MHz, $CDCl_3$) 7.70–7.67 (4H, m, Ar*H*), 7.47–7.38 (6H, m, Ar*H*), 5.70–5.68 (2H, m, C*H*=C*H*CH_2OH), 4.09–4.07 (2H, m, CH_2OH), 3.73 (2H, t, *J* 6.7, CH_2OTBDPS), 2.35–2.30 (2H, m, C$H_2$$CH_2$OTBDPS), 1.07 [9H, s, SiC(CH_3)$_3$]; δ_C (67.8 MHz, $CDCl_3$) 136.0 (d, Ar), 134.3 (s, Ar), 131.4 (d, =*C*H), 130.0 (d, Ar), 129.9 (d, =*C*H), 128.1 (d, Ar), 64.1 (t, *C*H_2OH), 63.9 (t, *C*H_2OTBDPS), 36.0 (t, *C*$H_2$$CH_2$OTBDPS), 27.3 [q, OSiC(*C*H_3)$_3$], 19.7 [s, OSi*C*(CH_3)$_3$]; *m*/*z* (EI) 283.1167 [$M^{+\bullet}$ − C(CH_3)$_3$. $C_{17}H_{19}O_2Si$ requires 283.1154].

tert-Butyldiphenyl-(5-vinyloxypent-3-enyloxy)-silane 24

Mercury(II) trifluoroacetate (750 mg, 1.76 mmol) was added in one portion to a stirred solution of (*E*)-5-(*tert*-butyldiphenylsilanyloxy)-pent-2-en-1-ol **23b** (6.00 g, 17.6 mmol) in anhydrous ethyl vinyl ether (120 mL) at room temperature. The solution was stirred at room temperature for 8 h, after which it was concentrated *in vacuo* to leave a colourless oil that was purified by flash column chromatography on silica, eluting with diethyl ether–light petroleum (bp 40–60 °C) (1 : 49) to give the *vinyl ether* (5.0 g, 78%) as a colourless oil; (Found: C, 75.6; H, 8.4. $C_{23}H_{30}O_2Si$ requires: C 75.4; H, 8.3%); ν_{max} (liquid film)/cm^{-1} 1634, 1612; δ_H (250 MHz, $CDCl_3$) 7.70–7.66 (4H, m, Ar*H*), 7.47–7.35 (6H, m, Ar*H*), 6.47 (1H, dd, *J* 14.3 and 6.8, OC*H*=CH_2), 5.82–5.62 (2H, m, C*H*=CHCH_2O and CH=C*H*CH_2O), 4.25–4.16 (3H, m, OCH=C*H*H and CH=CHCH_2O), 4.02 (1H, dd, *J* 6.8 and 2, OCH=C*H*H), 3.72 (2H, t, *J* 6.7, CH_2OTBDPS), 2.38–2.30 (2H, m, C$H_2$$CH_2$OTBDPS), 1.06 [9H, s, OSiC(CH_3)$_3$]; δ_C (67.8 MHz, $CDCl_3$) 151.4 (d, O*C*H=CH_2), 135.5 (d, Ar), 133.8 (s, Ar), 131.7 (d, =*C*H), 129.6 (d, Ar), 127.6 (d, Ar), 126.8 (d, =*C*H), 86.9 (t, OCH=*C*H_2), 68.8 (t, *C*H_2OCH=CH_2), 63.3 (t, *C*H_2OTBDPS), 35.6 (t, *C*$H_2$$CH_2$OTBDPS), 26.8 [q, OSiC(*C*H_3)$_3$], 19.2 [s, OSi*C*(CH_3)$_3$]; *m*/*z* (EI) 309.1322 [$M^{+\bullet}$ − C(CH_3)$_3$. $C_{19}H_{21}O_2Si$ requires 309.1311].

(α)-3-[2-(*tert*-Butyldiphenylsilanyloxy)-ethyl]-pent-4-enal 25

A solution of *tert*-butyldiphenyl-(5-vinyloxypent-3-enyloxy)-silane **24** (3.10 g, 8.47 mmol) in toluene (4 mL) was heated in a sealed tube at 170 °C for 36 h. The reaction vessel was cooled to room temperature over 2 h and the solution was then concentrated *in vacuo* to leave a colourless oil. Purification by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 9) gave the *aldehyde* (3.0 g, 97%) as a colourless oil; (Found: C, 75.3; H, 8.4. $C_{23}H_{30}O_2Si$ requires: C 75.4; H, 8.3%); ν_{max} (liquid film)/cm^{-1} 2716, 1725, 1688, 1640; δ_H (400 MHz, $CDCl_3$) 9.71 (1H, t, *J* 2.2, C*H*O), 7.68 (4H, d, *J* 7.8, Ar*H*), 7.46–7.38 (6H, m, Ar*H*), 5.69–5.60 (1H, m, C*H*=CH_2), 5.07–5.03 (2H, m, CH=CH_2), 3.71 (2H, t, *J* 6.3, CH_2OTBDPS), 2.94–2.89 (1H, m, C*H*CH=CH_2), 2.49–2.37 (2H, m, CH_2CHO), 1.75–1.57 (2H, m, C$H_2$$CH_2$OTBDPS), 1.08 [9H, s, SiC(CH_3)$_3$]; δ_C (67.8 MHz, $CDCl_3$) 202.3 (d, *C*HO), 140.3 (d, *C*H=CH_2), 135.5 (d, Ar), 133.7 (s, Ar), 129.6 (d, Ar), 127.6 (d, Ar), 115.7 (t, CH=*C*H_2), 61.2 (t, *C*H_2OTBDPS), 48.2 (t, *C*H_2CHO), 37.2 (t, *C*$H_2$$CH_2$OTBDPS), 34.9 (d, *C*HCH=CH_2), 26.8 [q, SiC(*C*H_3)$_3$], 19.2 [s, Si*C*(CH_3)$_3$]; *m*/*z* (EI) 309.1286 [$M^{+\bullet}$ − C(CH_3)$_3$. $C_{19}H_{21}O_2Si$ requires 309.1311].

(2′*S*,3′*R*,4*R*,5*S*,5′*S*)-3-{5′-[2″-(*tert*-Butyldiphenylsilanyloxy)-ethyl]-3′-hydroxy-2′-methylhept-6′-enoyl}-4-methyl-5-phenyloxazolidin-2-one 27 and (2′*S*,3′*R*,4*R*,5*S*,5′*R*)-3-{5′-[2″-(*tert*-Butyldiphenylsilanyloxy)-ethyl]-3′-hydroxy-2′-methylhept-6′-enoyl}-4-methyl-5-phenyloxazolidin-2-one 26

A solution of dibutylboron trifluoromethanesulfonate (1.0 mol dm^{-3} in dichloromethane, 7.10 mL, 7.10 mmol) was added dropwise over 5 min to a stirred solution of (4*S*,5*R*)-*N*-propionyl-5-methyl-4-phenyloxazolidin-2-one (1.50 g, 6.46 mmol) and di-*iso*propylethylamine (1.00 g, 1.35 mL, 7.75 mmol) in dichloromethane (40 mL) at 0 °C. The solution was stirred at 0 °C for 30 min and then at −78 °C for 30 min, after which a solution of (α)-3-[2-(*tert*-butyldiphenylsilanyloxy)-ethyl]-pent-4-enal **25** (2.60 g, 7.10 mmol) in dichloromethane (10 mL) was added dropwise over 5 min at −78 °C. The reaction was stirred at −78 °C for 30 min and then at room temperature for a further 90 min, after which it was cooled to 0 °C and quenched by the addition of methanol (30 mL), pH 7 phosphate buffer (15 mL) and hydrogen peroxide (100 vol, 15 mL). The solution was stirred vigorously at 0 °C for 2 h and then extracted with dichloromethane (150 mL). The extracts were washed with brine (50 mL), dried over anhydrous magnesium sulfate and concentrated *in vacuo* to leave a colourless oil. The oil was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 19) to give the (2′*S*,3′*R*,4*S*,5*R*,5′*S*) *isomer* **26** (1.5 g, 39%) as a colourless oil. $[\alpha]_D^{21}$ +11.1 (*c* 1.15 in $CHCl_3$); (Found: C, 72.2; H, 7.8; N, 2.4. $C_{32}H_{36}NO_5Si$ requires: C, 72.1; H, 7.6; N, 2.3%;); ν_{max} (liquid film)/cm^{-1} 3540, 1788, 1698, 1640; δ_H (400 MHz, $CDCl_3$) 7.70 (4H, d, *J* 6.9, Ar*H*), 7.48–7.38 (9H, m, Ar*H*), 7.31 (2H, d, *J* 6.9, Ar*H*), 5.67 (1H, d, *J* 7.2, C*H*Ph), 5.48 (1H, apparent dt, *J* 17 and 10, C*H*=CH_2), 5.08–5.01 (2H, m, CH=CH_2), 4.80 (1H, apparent quin., *J* 6.7, NC*H*CH_3), 4.01–3.98 (1H, m, C*H*OH), 3.77–3.66 (3H, m, CH_2OTBDPS and NCOC*H*CH_3), 2.75 (1H, d, *J* 2.7, CHO*H*), 2.58–2.51 (1H, m, C*H*CH=CH_2), 1.80–1.70 (1H, m, C*H*HCH_2OTBDPS), 1.68–1.54 (2H, m, C*H*HCH_2OTBDPS and C*H*HCHOH), 1.33–1.21 (4H, m, NCOCHCH_3 and C*H*HCHOH), 1.08 [9H, s, OSiC(CH_3)$_3$], 0.90 (3H, d, *J* 6.7, NCHCH_3); δ_C (67.8 MHz, $CDCl_3$) 177.1 (s, N*C*OCHCH_3), 152.5 (s, N*C*OO), 141.6 (d, *C*H=CH_2), 135.5 (d, Ar), 133.9 (s, Ar), 133.1 (s, Ar), 129.5 (d, Ar), 128.7 (d, Ar), 127.5 (d, Ar), 125.5 (d, Ar), 115.8 (t, CH=*C*H_2), 78.8 (d, *C*HPh), 69.0 (d, *C*HOH), 61.8 (t, *C*H_2OTBDPS), 54.6 (d, N*C*HCH_3), 42.8 (d, NCO*C*HCH_3), 39.2 (t, *C*H_2), 38.3 (t, *C*H_2), 37.2 (d, *C*HCH=CH_2), 26.8 [q, OSiC(*C*H_3)$_3$], 19.1 [s, OSi*C*(CH_3)$_3$], 14.3 (q, NCOCH*C*H_3), 10.7 (q, NCH*C*H_3); *m*/*z* (EI) 542.2405 [$M^{+\bullet}$ − C(CH_3)$_3$. $C_{32}H_{36}NO_5Si$ requires 542.2363].

Further elution with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 19) gave the (2′*S*,3′*R*,4*S*,5*R*,5′*R*) *isomer* **27** (1.6 g, 40%) as a colourless oil. $[\alpha]_D^{21}$ +8.7 (*c* 0.66 in $CHCl_3$); ν_{max} (liquid film)/cm^{-1} 3527, 1783, 1738, 1698, 1640; δ_H (400 MHz, $CDCl_3$) 7.69 (4H, dd, *J* 7.5 and 1.6, Ar*H*), 7.46–7.38 (9H, m, Ar*H*), 7.32 (2H, d, *J* 6.4, Ar*H*), 5.68 (1H, d, *J* 7.3, C*H*Ph), 5.60 (1H, apparent dt, *J* 17.3 and 9.5, C*H*=CH_2), 5.05–4.94 (2H, m, CH=CH_2), 4.84–4.75 (1H, m, NC*H*CH_3), 4.10–4.05 (1H, m, C*H*OH), 3.81 (1H, apparent dq, *J* 7.1 and 2.7, NCOC*H*CH_3), 3.74–3.64 (2H, m, CH_2OTBDPS), 3.02 (1H, s, CHO*H*), 2.50–2.40 (1H, m, CH_2CH=CH_2), 1.80–1.72 (1H, m, C*H*HCH_2OTBDPS), 1.65–1.45 (2H, m, C*H*HCH_2OTBDPS and C*H*HCHOH), 1.27–1.24 (4H, d and m, *J* 7.1, NCOCHCH_3 and C*H*HCHOH), 1.07 [9H, s, OSiC(CH_3)$_3$], 0.90 (3H, d, *J* 6.6, NC*H*CH_3); δ_C (101 MHz, $CDCl_3$) 177.4 (s, N*C*OCHCH_3), 152.5 (s, N*C*OO), 142.4 (d, *C*H=CH_2), 135.6 (d, Ar), 134.1 (s, Ar), 133.2 (s, Ar), 129.6 (d, Ar), 128.8 (d, Ar), 127.6 (d, Ar), 125.6 (d, Ar), 115.0 (t, CH=*C*H_2), 78.9 (d, *C*HPh), 69.6 (d, *C*HOH), 61.7 (t, *C*H_2OTBDPS), 54.7 (d, N*C*HCH_3), 41.5 (d, NCO*C*HCH_3), 39.0 (t, *C*H_2CHOH), 37.4 (d, *C*HCH=CH_2), 37.3 (t, *C*$H_2$$CH_2$OTBDPS), 26.9 [q, OSiC(*C*H_3)$_3$], 19.2 [s, OSi*C*(CH_3)$_3$], 14.4 (q, NCOCH*C*H_3), 10.3 (q, NCH*C*H_3);

m/z (FAB, 3-NBA) 600.3106 (M^+ + H. $C_{36}H_{46}NO_5Si$ requires 600.3145).

(2*R*,3*R*,5*S*)-5-[2′-(*tert*-Butyldiphenylsilanyloxy)-ethyl]-2-methylhept-6-ene-1,3-diol 28

Lithium borohydride (60 mg, 2.75 mmol) was added, cautiously over 2 min, to a stirred solution of the imide **26** (550 mg, 9.18 mmol) in methanol (88 mg, 110 mm^3, 2.75 mmol) and diethyl ether (10 mL) at 0 °C. The solution was allowed to warm to room temperature over 30 min, and then stirred at room temperature for a further 2 h. The mixture was quenched with aqueous sodium hydroxide (2 mol dm^{-3}, 3 mL, 6 mmol) and extracted into diethyl ether (20 mL). The ether extracts were dried over anhydrous magnesium sulfate and concentrated *in vacuo* to leave a colourless oil that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (3 : 7) to leave the 1,3-*diol* (390 mg, 96%) as a colourless oil. $[\alpha]_D^{21}$ +10.2° (*c* 0.92 in $CHCl_3$); ν_{max} (liquid film)/cm^{-1} 3379, 1667, 1640, 1589; δ_H (400 MHz, $CDCl_3$) 7.69 (4H, d, *J* 6.2, Ar*H*), 7.44–7.38 (6H, m, Ar*H*), 5.49 (1H, apparent dt, *J* 17.8 and 9.1, C*H*=CH_2), 5.04–5.00 (2H, m, CH=CH_2), 3.86 (1H, br. d, *J* 8.7, C*H*OH), 3.72–3.68 (4H, m, CH_2OH and CH_2OTBDPS), 2.50–2.43 (2H, m, C*H*CH=CH_2 and O*H*), 2.28 (1H, br. s, O*H*), 1.79–1.69 (2H, m, C*H*CH_3 and C*H*HCH_2OTBDPS), 1.64–1.55 (2H, m, C*H*HCH_2OTBDPS and C*H*HCHOH), 1.33–1.26 (1H, m, C*H*HCHOH), 1.07 [9H, s, OSiC(CH_3)$_3$], 0.90 (3H, d, *J* 6.9, CHCH_3); δ_C (67.8 MHz, $CDCl_3$) 141.9 (d, *C*H=CH_2), 135.5 (d, Ar), 134 (s, Ar), 129.5 (d, Ar), 127.6 (d, Ar), 115.6 (t, CH=*C*H_2), 72.0 (d, *C*HOH), 67.0 (t, *C*H_2OH), 61.7 (t, *C*H_2OTBDPS), 39.7 (d, *C*HCH_3), 38.9 (t, *C*H_2), 38.1 (t, *C*H_2), 37.2 (d, *C*HCH=CH_2), 26.8 [q, OSiC(*C*H_3)$_3$], 19.1 [s, OSi*C*(CH_3)$_3$], 10.6 (q, CH*C*H_3); *m/z* (EI) 351.1766 [$M^{+\bullet}$ – C(CH_3)$_3$ – H_2O. $C_{22}H_{27}O_2Si$ requires 351.1780].

(2*R*,3*R*,5*S*)-5-[2′-(*tert*-Butyldiphenylsilanyloxy)-ethyl]-1-(4-methoxybenzyloxy)-2-methylhept-6-en-3-ol 29a

Camphorsulfonic acid (20 mg) was added, in a single portion, to a solution of the 1,3-diol **28** (β-vinyl) (3.0 g, 7.04 mmol) and 4-methoxybenzyl 2,2,2-trichloroacetimidate (2.2 g, 7.75 mmol) in dichloromethane (50 mL) at −20 °C. The mixture was then stirred at 0 °C for 72 h. The solution was concentrated *in vacuo* to leave an orange oil that was then purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 9) to give the *ether* (2.4 g, 62%) as a colourless oil. $[\alpha]_D^{21}$ +9.5° (*c* 1.16 in $CHCl_3$); (Found: C, 74.2; H, 8.8. $C_{34}H_{46}O_4Si$ requires: C, 74.7; H, 8.5%); ν_{max} (liquid film)/cm^{-1} 3488, 1638, 1612; further elution with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 4) gave unreacted starting material (0.7 g, 23%).

(3*S*,5*R*,6*R*)-7-(4-Methoxybenzyloxy)-6-methyl-3-vinylheptane-1,5-diol 29b

Tetrabutylammonium fluoride (635 mg, 2.01 mmol) was added in a single portion to a stirred solution of the TPS ether **29a** (110 mg, 201 µmol) in tetrahydrofuran (2 mL) at room temperature. The solution was stirred at room temperature for 2 h, and then concentrated *in vacuo* to leave a coloured residue that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (3 : 1) to give the 1,5-*diol* (61 mg, 99%) as a colourless oil. $[\alpha]_D^{21}$ +8.4° (*c* 1.14 in $CHCl_3$); (Found: C, 69.7; H, 9.5. $C_{18}H_{28}O_4$ requires: C 70.1; H, 9.2%); ν_{max} (liquid film)/cm^{-1} 3378, 1639, 1613; δ_H (400 MHz, $CDCl_3$) 7.24–7.21 (2H, m, Ar*H*), 6.88–6.85 (2H, m, Ar*H*), 5.53 (1H, ddd, *J* 19.1, 10.0 and 9.1, C*H*=CH_2), 5.09–5.01 (2H, m, CH=CH_2), 4.41 (2H, apparent d, *J* 6.8, CH_2OAr), 3.79–3.74 (4H, m, OCH_3 and C*H*OH), 3.67–3.55 (2H, m, CH_2OH), 3.48–3.43 (2H, m, CH_2OPMB), 2.99 (1H, br. s, O*H*), 2.77 (1H, br. s, O*H*), 2.46–2.41 (1H, m, C*H*CH=CH_2), 1.85–1.79 (1H, m, C*H*CH_3), 1.61–1.49 (3H, m, C$H_2$$CH_2$OH and C*H*HCHOH), 1.25–1.19 (1H, m, C*H*HCHOH), 0.89 (3H, d, *J* 7.1, CHCH_3); δ_C (67.8 MHz, $CDCl_3$) 159.1 (s, Ar), 142.3 (d, *C*H=CH_2), 130.0 (s, Ar), 129.1 (d, Ar), 115.3 (t, CH=*C*H_2), 113.7 (d, Ar), 73.9 (t, *C*H_2OPMB), 72.8 (t, O*C*H_2Ar), 71.2 (d, *C*HOH), 60.4 (t, *C*H_2OH), 55.1 (q, O*C*H_3), 38.7 (t, *C*H_2CHOH), 38.4 (d, *C*HCH_3), 38.3 (t, *C*$H_2$$CH_2$OH), 37.4 (d, *C*HCH=$CH_2$), 11.2 (q, CH*C*$H_3$); *m/z* (FAB, 3-NBA) 309.2043 (M^+ + H. $C_{18}H_{29}O_4$ requires 309.2066).

3-Ethenyl-7-(4-methoxybenzyl)-6-methylheptan-5-olide (1′*R*,4*R*,6*R*)-6-[2′-(4-methoxybenzyloxy)-1′-methylethyl]-4-vinyltetrahydropyran-2-one 30

Tetrapropylammonium perruthenate(VII) (23 mg, 65 µmol) was added cautiously to a stirred suspension of the 1,5-diol **29b** (200 mg, 649 µmol), *N*-methylmorpholine *N*-oxide (228 mg, 1.95 mmol) and activated 4 Å molecular sieves (500 mg) in dichloromethane (20 mL) at 0 °C under an atmosphere of argon. The slurry was warmed to room temperature and stirred at room temperature for 24 h. The mixture was then concentrated *in vacuo* to leave a yellow residue that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 4) to give the *lactone* (130 mg, 65%) as a colourless oil; δ_H (400 MHz, $CDCl_3$) 7.25 (2H, d, *J* 8.3, Ar*H*), 6.88 (2H, d, *J* 8.5, Ar*H*), 5.73 (1H, ddd, *J* 17.0, 10.4 and 6.6, C*H*=CH_2), 5.10–5.05 (2H, m, CH=CH_2), 4.53 (1H, dt, *J* 12 and 3.0, C*H*OCO), 4.44 (2H, apparent q, *J* 9.0, OCH_2Ar), 3.81 (3H, s, ArOCH_3), 3.52 (1H, apparent t, *J* 8.4, C*H*HOPMB), 3.39 (1H, dd, *J* 9.2 and 5.3, C*H*HOPMB), 2.73 (1H, ddd, *J* 17.5, 5.9 and 1.6, C*H*HCO_2), 2.65–2.60 (1H, m, C*H*CH=CH_2), 2.22 (1H, dd, *J* 17.5 and 10.8, C*H*HCO_2), 2.02–1.95 (1H, m, C*H*CH_3), 1.98 (1H, br. d, *J* 12, C*H*HCHOCO), 1.51 (1H, apparent q, *J* 12, C*H*HCHOCO), 0.98 (3H, d, *J* 6.9, CHCH_3); δ_C (67.8 MHz, $CDCl_3$) 171.0 (s, *C*=O), 159.1 (s, Ar), 139.8 (d, *C*H=CH_2), 130.3 (s, Ar), 129.3 (d, Ar), 114.7 (t, *C*H_2=CH), 113.7 (d, Ar), 80.1 (d, *C*HOCO), 72.9 (t, O*C*H_2Ar), 71.2 (t, *C*H_2OPMB), 55.2 (q, ArO*C*H_3), 38.2 (d, *C*HCH_3), 35.5 (t, *C*$H_2$$CO_2$), 35.5 (d, *C*HCH=$CH_2$), 32.1 (t, *C*$H_2$CHOCO), 11.0 (q, CH*C*$H_3$); *m/z* (EI) 304.1690 ($M^{+\bullet}$. $C_{18}H_{24}O_4$ requires 304.1675).

(2*R*,3*R*,5*R*)-5-[2-(*tert*-Butyldiphenylsilanyloxy)-ethyl]-2-methylhept-6-ene-1,3-diol 31

Lithium borohydride (153 mg, 7.01 mmol) was added, cautiously over 2 min, to a stirred solution of the oxazolidinone **27** (1.40 g, 2.34 mmol) in methanol (225 mg, 28.5 mL, 7.01 mmol) and diethyl ether (30 mL) at 0 °C. The solution was allowed to warm to room temperature over 30 min and then stirred at room temperature for a further 30 min. The mixture was quenched with aqueous sodium hydroxide solution (2 mol dm^{-3}, 10 mL, 20 mmol) and extracted into diethyl ether (100 mL). The ether extracts were dried over anhydrous magnesium sulfate, washed with brine, and concentrated *in vacuo* to leave a colourless oil that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (2 : 3) to give the 1,3-*diol* (700 mg, 70%) as a colourless oil. $[\alpha]_D^{21}$ +5.4 (*c* 1.14 in $CHCl_3$); (Found: C, 72.7; H, 9.3. $C_{26}H_{38}O_3Si$ requires: C 73.2; H, 9.0%); ν_{max} (liquid film)/cm^{-1} 3374, 3071, 3049, 1640, 1589; δ_H (400 MHz, $CDCl_3$) 7.67 (4H, dd, *J* 7.8 and 1.5, Ar*H*), 7.45–7.37 (6H, m, Ar*H*), 5.64 (1H, apparent dt, *J* 17.2 and 9.5, C*H*=CH_2), 5.07–4.99 (2H, m, CH=CH_2), 3.97–3.93 (1H, m, C*H*OH), 3.70–3.64 (4H, m, CH_2OH and CH_2OTBDPS), 2.50–2.36 (3H, m, C*H*CH=CH_2 and 2 × O*H*), 1.78–1.69 (2H, m, C*H*CH_3 and C*H*HCH_2OTBDPS), 1.55–1.45 (3H, m, C*H*HCH_2OTBDPS and CH_2CHOH), 1.06 [9H, s, OSiC(CH_3)$_3$], 0.93 (3H, d, *J* 7.1, CHCH_3); δ_C (67.8 MHz, $CDCl_3$) 143.1 (d, *C*H=CH_2), 135.5 (d, Ar), 133.8 (s, Ar), 129.6 (d, Ar), 127.6 (d, Ar), 115.3 (t, CH=*C*H_2), 73.6 (d, *C*HOH), 67.3 (t, *C*H_2OH), 61.5 (t, *C*H_2OTBDPS), 39.5 (t, *C*H_2CHOH), 38.8 (d, *C*H), 38.7 (d, *C*H), 37.6 (t, *C*$H_2$$CH_2$OTBDPS), 26.8 [q, OSiC($CH_3$)$_3$], 19.2 [s, OSi*C*($CH_3$)$_3$], 9.9 (q, CH*C*$H_3$); *m/z* (EI) 351.1771 [$M^{+\bullet}$ − C(CH_3)$_3$ − H_2O. $C_{22}H_{27}O_2Si$ requires 351.1780].

(2*R*,3*R*,5*R*)-5-[2-(*tert*-Butyldiphenylsilanyloxy)-ethyl]-1-(4-methoxybenzyloxy)-2-methylhept-6-en-3-ol 32a

Camphorsulfonic acid (10 mg) was added, in a single portion, to a stirred solution of the 1,3-diol **31** (3.04 g, 7.14 mmol) and 4-methoxybenzyl 2,2,2-trichloroacetimidate (2.20 g, 7.85 mmol) in dichloromethane (30 mL) at −20 °C. The mixture was stirred at 0 °C for 72 h and then concentrated *in vacuo* to leave an orange oil that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 9) to give the *ether* (2.34 g, 60%) as a colourless oil. $[\alpha]_D^{21}$ +6.9 (*c* 0.96 in $CHCl_3$); ν_{max} (liquid film)/cm^{-1} 3502, 1713, 1612; δ_H (400 MHz, $CDCl_3$) 7.68 (4H, dd, *J* 7.8 and 1.6, Ar*H*), 7.45–7.37 (6H, m, Ar*H*), 7.26 (2H, d, *J* 8.4, Ar*H*), 6.89 (2H, d, *J* 8.4, Ar*H*), 5.64–5.56 (1H, m, C*H*=CH_2), 5.00–4.95 (2H, m, CH=C*H_2*), 4.45 (2H, apparent d, *J* 4.0, OC*H_2*Ar), 3.90–3.86 (1H, m, C*H*OH), 3.81 (3H, s, OC*H_3*), 3.71–3.65 (2H, m, C*H_2*OTBDPS), 3.51–3.48 (2H, m, C*H_2*OPMB), 2.37 (1H, br. s, O*H*), 2.42–2.33 (1H, m, C*H*CH=CH_2), 1.88–1.82 (1H, m, C*H*HCH_2OTBDPS), 1.77–1.70 (1H, m, C*H*CH_3), 1.55–1.44 (3H, m, C*H*HCH_2OTBDPS and C*H_2*CHOH), 1.06 [9H, s, OSiC(C*H_3*)$_3$], 0.93 (3H, d, *J* 7.0, CHC*H_3*); δ_C (101 MHz, $CDCl_3$) 159.3 (s, Ar), 143.1 (d, *C*H=CH_2), 135.7 (d, Ar), 134.1 (s, Ar), 130.4 (s, Ar), 129.6 (d, Ar), 129.3 (d, Ar), 127.7 (d, Ar), 114.7 (t, CH=*C*H_2), 113.9 (d, Ar), 74.5 (t, *C*H_2OPMB), 73.1 (t, O*C*H_2Ar), 71.9 (d, *C*HOH), 61.8 (t, *C*H_2OTBDPS), 55.3 (q, ArO*C*H_3), 39.6 (t, *C*H_2CHOH), 38.0 (d, *C*HCH_3), 37.6 (t, *C*H_2CH_2OTBDPS), 37.4 (d, *C*HCH=CH_2), 26.9 [q, OSiC(*C*H_3)$_3$], 19.3 [s, OSi*C*(CH_3)$_3$], 10.4 (q, CH*C*H_3); *m/z* (FAB, 3-NBA) (%) 547 (3), 121 (100).

(3*R*,5*R*,6*R*)-7-(4-Methoxybenzyloxy)-6-methyl-3-vinylheptane-1,5-diol 32b

Tetrabutylammonium fluoride (180 mg, 550 µmol) was added in one portion to a stirred solution of the alkene **32a** (100 mg, 180 µmol) in tetrahydrofuran (5 mL) at room temperature. The solution was stirred at room temperature for 2 h, and then the mixture was concentrated *in vacuo* to leave a coloured residue that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 3) to leave the 1,5-*diol* (47 mg, 83%) as a colourless oil; ν_{max} ($CHCl_3$)/cm^{-1} 3620, 3482, 1612, 1514; δ_H (400 MHz, $CDCl_3$) 7.24 (2H, d, *J* 8.6, Ar*H*), 6.88 (2H, d, *J* 8.6, Ar*H*), 5.73–5.63 (1H, m, C*H*=CH_2), 5.08–5.00 (2H, m, CH=C*H_2*), 4.43 (2H, d, *J* 5.0, OC*H_2*Ar), 3.89–3.86 (1H, m, C*H*OH), 3.81 (3H, s, ArOC*H_3*), 3.72–3.60 (2H, m, C*H_2*OH), 3.49–3.46 (2H, m, C*H_2*OPMB), 2.82 (1H, br. s, O*H*), 2.37–2.30 (1H, m, C*H*CH=CH_2), 1.95–1.83 (2H, m, O*H* and CH*H*CH_2OH), 1.80–1.72 (1H, m, C*H*CH_3), 1.58–1.39 (3H, m, CH*H*CH_2OH and C*H_2*CHOH), 0.92 (3H, d, *J* 7.1, CHC*H_3*); δ_C (101 M, $CDCl_3$) 159.3 (s, Ar), 143.2 (d, *C*H=CH_2), 130.2 (s, Ar), 129.3 (d, Ar), 114.7 (t, CH=*C*H_2), 113.7 (d, Ar), 74.4 (t, O*C*H_2Ar), 73.1 (t, *C*H_2OPMB), 71.6 (d, *C*HOH), 61.0 (t, *C*H_2OH), 55.3 (q, ArO*C*H_3), 39.5 (t, *C*H_2CHOH), 38.2 (d, *C*HCH_3), 37.6 (d, *C*HCH=CH_2), 37.1 (t, *C*H_2CH_2OH), 10.7 (q, CH*C*H_3).

(1′*S*,4*S*,6*R*)-6-[2′-(4-Methoxybenzyloxy)-1′-methylethyl]-4-vinyltetrahydropyran-2-one 33

Tetrapropylammonium perruthenate(VII) (5 mg, 14 µmol) was added cautiously to a stirred suspension of the 1,5-diol **32b** (43 mg, 140 µmol), *N*-methylmorpholine *N*-oxide (50 mg, 420 µmol) and activated 4 Å molecular sieves (200 mg) in dichloromethane (5 mL) at 0 °C under an atmosphere of argon. The slurry was warmed to room temperature and stirred at room temperature for 24 h The mixture was then concentrated *in vacuo* to leave a yellow residue that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 4) to give the *lactone* (24 mg, 57%) as a colourless oil; ν_{max} ($CHCl_3$)/cm^{-1} 1724, 1602; δ_H (400 MHz, $CDCl_3$) 7.26–7.22 (2H, m, Ar*H*), 6.90–6.87 (2H, m, Ar*H*), 5.84 (1H, ddd, *J* 16.9, 10.6 and 6.4, C*H*=CH_2), 5.15–5.05 (2H, m, CH=C*H_2*), 4.49 (1H, dt, *J* 11.4 and 4.0, C*H*OCO), 4.43 (2H, apparent q, *J* 11.0, OC*H_2*Ar), 3.81 (3H, s, ArOC*H_3*), 3.47 (1H, dd, *J* 9.3 and 7.4, C*H_2*OPMB), 3.39 (1H, dd, *J* 9.3 and 5.3, C*H_2*OPMB), 2.79–2.74 (1H, m, C*H*CH=CH_2), 2.57 (1H, dd, *J* 16.6 and 6.1, C*H*HCO_2), 2.50 (1H, ddd, *J* 16.6, 7.4 and 0.6, C*H*HCO_2), 2.01–1.90 (2H, m, C*H*HCHOCO and C*H*CH_3), 1.69 (1H, dt, *J* 14.1 and 7.6, C*H*HCHOCO), 1.01 (3H, d, *J* 7.0, CHC*H_3*); δ_C (67.8 MHz, $CDCl_3$) 172.1 (s, *C*=O), 159.2 (s, Ar), 139.6 (d, *C*H=CH_2), 130.3 (s, Ar), 129.3 (d, Ar), 115.3 (t, *C*H_2=CH), 113.8 (d, Ar), 77.1 (d, *C*HOCO), 72.9 (t, O*C*H_2Ar), 71.4 (t, *C*H_2OPMB), 55.3 (q, ArO*C*H_3), 37.9 (d, *C*HCH_3), 34.1 (t, *C*H_2CO_2), 32.8 (d, *C*HCH=CH_2), 30.7 (t, *C*H_2CHOCO), 11.5 (q, CH*C*H_3).

(3*R*,5*R*,6*R*)-3-[2-(*tert*-Butyldiphenylsilanyloxy)-ethyl]-7-(4-methoxybenzyloxy)-6-methylheptane-1,5-diol 34

(a) From the alkene 32a. A solution of 9-borabicyclo-[3.3.1]nonane (0.5 mol dm^{-3} in tetrahydrofuran, 4.0 mL, 2.02 mmol) was added dropwise over 5 min to a stirred solution of the alkene **32a** (500 mg, 920 µmol) in tetrahydrofuran (2 mL) at 0 °C. The solution was stirred at 0 °C for 30 min and then at room temperature for 12 h, after which it was cooled to 0 °C. An aqueous solution of sodium hydroxide (2 mol dm^{-3}, 5 mL) was added in one portion to the solution, followed immediately by the dropwise addition of hydrogen peroxide (100 vol, 5 mL) over 5 min. The heterogeneous mixture was stirred vigorously at 0 °C for 4 h, extracted with diethyl ether (40 mL), washed with brine (10 mL) and then dried over anhydrous magnesium sulfate. The solution was concentrated *in vacuo* to leave a residue that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (3 : 7) to give the *alcohol* (470 mg, 91%) as a colourless oil. $[\alpha]_D^{21}$ +12.4 (*c* 0.50 in $CHCl_3$); ν_{max} ($CHCl_3$)/cm^{-1} 3429, 1612, 1513; δ_H (400 MHz, $CDCl_3$) 7.68 (4H, dd, *J* 7.8 and 1.5, Ar*H*), 7.75–7.37 (6H, m, Ar*H*), 7.24 (2H, apparent d, *J* 8.6, Ar*H*), 6.88 (2H, apparent d, *J* 8.6, Ar*H*), 4.43 (2H, apparent dd, *J* 18.3 and 11.6, OC*H_2*Ar), 3.81–3.78 (4H, m, ArOC*H_3* and C*H*OH), 3.73–3.63 (4H, m, C*H_2*OTBDPS and CH_2C*H_2*OH), 3.52–3.44 (2H, m, C*H_2*OPMB), 3.03 (1H, br. s, O*H*), 2.49 (1H, br. s, O*H*), 1.88–1.75 (2H, m, C*H*CH_2CH_2OH and C*H*CH_3), 1.66–1.40 (5H, m, C*H_2*CH_2OTBDPS, C*H_2*CH_2OH and C*H*HCHOH), 1.27–1.18 (1H, m, C*H*HCHOH), 1.06 [9H, s, OSiC(C*H_3*)$_3$], 0.89 (3H, d, *J* 7.1, CHC*H_3*); δ_C (101 MHz, $CDCl_3$) 135.7 (d, Ar), 134.0 (s, Ar), 130.1 (s, Ar), 129.7 (d, Ar), 129.4 (d, Ar), 127.8 (d, Ar), 114.0 (d, Ar), 74.7 (t, *C*H_2OPMB), 73.4 (d, *C*HOH), 73.2 (t, O*C*H_2Ar), 62.3 (t, *C*H_2OH), 60.6 (t, *C*H_2OTBDPS), 55.4 (q, O*C*H_3), 38.4 (d, *C*HCH_3), 38.1 (t, *C*H_2CHOH), 38.1 (t, *C*H_2CH_2OH), 37.6 (t, *C*H_2CH_2OTBDPS), 28.9 (d, *C*HCH_2CH_2OH), 27.0 [q, OSiC(*C*H_3)$_3$], 19.2 [s, OSi*C*(CH_3)$_3$], 11.0 (q, CH*C*H_3).

(b) From the TBS ether 41. Pyridinium *p*-toluenesulfonate (40 mg, 1.60 µmol) was added to a stirred solution of the TBS ether **41** (100 mg, 150 µmol) in ethanol (2 mL) at room temperature. The solution was stirred and heated at 55 °C for 2 h and then concentrated *in vacuo*. The residue was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (3 : 7) to give the *alcohol* (60 mg, 72%) as a colourless oil which exhibited identical data to those presented under section (a) above.

(1′*R*,4*R*,6*R*)-4-[2-(*tert*-Butyldiphenylsilanyloxy)-ethyl]-6-[2′-(4-methoxybenzyloxy)-1′-methylethyl]-tetrahydropyran-2-one 35

A freshly prepared precipitate of silver nitrate on Celite (2.2 g) was added to a stirred solution of the 1,5-diol **34** (130 mg, 230 μmol), in benzene (20 mL) at room temperature. The slurry was then stirred and heated at 80 °C for 3 h, after which it was cooled to room temperature, filtered through a pad of Celite and concentrated *in vacuo* to leave a colourless oil. The oil was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 4) to give the *lactone* (117 mg, 91%) as a colourless oil. $[\alpha]_D^{21}$ −8.9 (*c* 0.81 in $CHCl_3$); ν_{max} ($CHCl_3$)/cm^{-1} 1719, 1612; δ_H (400 MHz, $CDCl_3$) 7.65 (4H, d, *J* 7.6, Ar*H*), 7.44–7.38 (6H, m, Ar*H*), 7.26 (2H, d, *J* 6.9, Ar*H*), 6.89 (2H, d, *J* 6.9), 4.49–4.40 (3H, m, ArCH_2O and C*H*OCO), 3.81 (3H, s, ArOCH_3), 3.71 (2H, t, *J* 5.4, CH_2OTBDPS), 3.52 (1H, apparent t, *J* 8.5, CH*H*OPMB), 3.92–3.56 (1H, m, CH*H*OPMB), 2.67 (1H, dd, *J* 17.5 and 5.8, CHCH*H*CO_2), 2.25–2.10 (1H, m, C*H*CH_2CO_2), 2.04 (1H, dd, *J* 17.5 and 11.0, CHCH*H*CO_2), 1.97–1.90 (1H, m, C*H*CH_3), 1.76 (1H, br. d, $J \approx 13$, CH*H*CHOCO), 1.55 (2H, apparent q, *J* 5.8, CH_2CH_2OTBDPS), 1.30 (1H, apparent q, *J* 12.3, CH*H*CHOCO), 1.06 [9H, s, C(CH_3)]$_3$, 0.95 (3H, d, *J* 6.9, CHCH_3); δ_C (67.8 MHz, $CDCl_3$) 171.6 (s, *C*=O), 159.2 (s, Ar), 135.5 (d, Ar), 133.5 (s, Ar), 130.4 (s, Ar), 129.7 (d, Ar), 129.3 (d, Ar), 127.7 (d, Ar), 113.8 (d, Ar), 80.2 (d, *C*HOC=O), 72.9 (t, ArCH_2O), 71.4 (t, CH_2OPMB), 60.8 (t, CH_2OTBDPS), 55.2 (q, ArOCH_3), 38.8 (t, CH_2CH_2OTBDPS), 38.1 (d, *C*HCH_3), 36.4 (t, CH_2CO_2), 32.4 (t, CH_2CHOCO), 28.5 (d, *C*HCH_2CO_2), 26.8 [q, C(CH_3)$_3$], 19.1 [s, *C*(CH_3)$_3$], 10.9 (q, CHCH_3); *m/z* (EI) 503.2248 [$M^{+\bullet}$ − C(CH_3)$_3$. $C_{30}H_{35}O_5Si$ requires 503.2254].

(2*R*,4′*R*,6′*R*)-2-{4′-[2-(*tert*-Butyldiphenylsilanyloxy)-ethyl]-6′-oxo-tetrahydropyran-2′-yl}-propionaldehyde 36

2,3-Dichloro-5,6-dicyanobenzoquinone (35 mg, 150 μmol) was added in a single portion to a stirred solution of the δ-lactone **35** (55 mg, 98 μmol) in dichloromethane (2 mL) and water (0.1 mL) at room temperature. The slurry was stirred at room temperature for 2 h and then quenched by the addition of saturated aqueous sodium bicarbonate solution (5 mL). The mixture was extracted with dichloromethane (50 mL), washed with brine (10 mL) and dried over anhydrous magnesium sulfate. The solution was then concentrated *in vacuo* to leave a residue that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (3 : 1) to give the corresponding *alcohol* (43 mg, 100%) as a colourless oil. $[\alpha]_D^{21}$ −4.1 (*c* 1.26 in $CHCl_3$); ν_{max} ($CHCl_3$)/cm^{-1} 3446, 1732, 1589; δ_H (400 MHz, $CDCl_3$) 7.66–7.65 (4H, m, Ar*H*), 7.47–7.38 (6H, m, Ar*H*), 4.49 (1H, dt, *J* 12.0 and 3.0, C*H*OC=O), 3.74–3.70 (3H, m, CH_2OTBDPS and CH*H*OH), 3.60 (1H, dd, *J* 10.8 and 5.5, CH*H*OH), 2.68 (1H, ddd, *J* 17.5, 5.9 and 1.8, CH*H*CO_2), 2.34–2.14 (1H, m, C*H*CH_2CO_2), 2.06 (1H, dd, *J* 17.5 and 10.8, CH*H*CO_2), 1.88–1.78 (2H, m, C*H*CH_3 and CH*H*CHCH_2CO_2), 1.57 (2H, apparent q, *J* 6, CH_2CH_2OTBDPS), 1.34 (1H, apparent q, *J* ≈ 13, CH*H*CHCH_2CO_2), 1.06 [9H, s, C(CH_3)$_3$], 0.95 (3H, d, *J* 7.0, CHCH_3); δ_C (101 MHz, $CDCl_3$) 171.6 (s, *C*=O), 135.6 (d, Ar), 133.6 (s, Ar), 129.8 (d, Ar), 127.8 (d, Ar), 80.5 (d, *C*HOC=O), 64.4 (t, CH_2OH), 60.9 (t, CH_2OTBDPS), 39.8 (d, *C*HCH_3), 38.9 (t, CH_2CH_2OTBDPS), 36.5 (t, CH_2CO_2), 32.4 (t, CH_2CHOC=O), 28.7 (d, *C*HCH_2CO_2), 26.9 (q, C(CH_3)$_3$), 19.2 (s, *C*(CH_3)$_3$), 10.6 (q, CHCH_3); *m/z* (EI) 383.1691 [$M^{+\bullet}$ − C(CH_3)$_3$. $C_{22}H_{27}O_4Si$ requires 383.1679].

Dess–Martin periodinane (73 mg, 170 μmol) was added to a stirred solution of the above alcohol (50 mg, 114 μmol) and water (3.1 mg, 3.1 mm^3, 170 μmol) in dichloromethane (2.5 mL) at 0 °C. The slurry was stirred at room temperature for 1 h and then quenched by the addition of a saturated aqueous solution of sodium thiosulfate (2 mL), extracted into dichloromethane (20 mL), dried over anhydrous $MgSO_4$ and concentrated *in vacuo* to leave a colourless residue. The residue was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (2 : 3) to give the *aldehyde* (42 mg, 84%) as a colourless oil. $[\alpha]_D^{21}$ +5.7 (*c* 0.84 in $CHCl_3$); ν_{max} ($CHCl_3$)/cm^{-1} 1726, 1685; δ_H (360 MHz, $CDCl_3$) 9.74 (1H, d, *J* 0.9 C*H*O), 7.67–7.64 (4H, m, Ar*H*), 7.47–7.38 (6H, m, Ar*H*), 4.64 (1H, ddd, *J* 12.1, 4.5 and 2.9, C*H*OH), 3.72 (2H, t, *J* 6.0, CH_2OTBDPS), 2.71 (1H, ddd, *J* 17.5, 5.7 and 1.8, C*H*HCO_2), 2.59–2.53 (1H, m, C*H*CH_3), 2.27–2.19 (1H, m, C*H*CH_2CH_2OTBDPS), 2.08 (1H, dd, *J* 17.5 and 10.9, C*H*HCO_2), 1.89 (1H, br. d, *J* 14, C*H*HCHOCO), 1.56 (2H, apparent q, *J* 6.2, CH_2CH_2OTBDPS), 1.33–1.23 (1H, m, C*H*HCHOCO), 1.21 (3H, d, *J* 7.2, CHCH_3), 1.06 [9H, s, SiC(CH_3)$_3$]; δ_C (67.8 MHz, $CDCl_3$) 202.0 (d, *C*HO), 170.5 (s, *C*=O), 135.5 (d, Ar), 133.4 (s, Ar), 129.8 (d, Ar), 127.7 (d, Ar), 79.1 (d, *C*HOCO), 60.6 (t, CH_2OTBDPS), 50.2 (d, *C*HCH_3), 38.6 (t, CH_2CH_2OTBDPS), 36.2 (t, CH_2CO_2), 32.2 (t, CH_2CHOCO), 28.5 (d, *C*HCH_2CH_2OTBDPS), 26.8 [q, SiC(CH_3)$_3$], 19.1 [s, Si*C*(CH_3)$_3$], 8.5 (q, CHCH_3); *m/z* (EI) 381.1514 [$M^{+\bullet}$ − C(CH_3)$_3$. $C_{22}H_{25}O_4Si$ requires 381.1522].

(1′*R*,4*R*,6*R*)-4-[2-(*tert*-Butyldiphenylsilanyloxy)-ethyl]-6-(1′-methylprop-2′-ynyl)-tetrahydropyran-2-one 37

A solution of potassium *tert*-butoxide (11 mg, 96 μmol) in tetrahydrofuran (1 mL) was added dropwise over 2 min to a stirred solution of dimethyl diazomethylphosphonate (13 mg, 88 μmol) in tetrahydrofuran (1 mL) at −78 °C. The solution was stirred at −78 °C for 30 min, after which it was added to a solution of the aldehyde **36** (35 mg, 80 μmol) in tetrahydrofuran (0.5 mL) at −78 °C. The mixture was stirred at −78 °C for 2 h and then quenched by the addition of water (1 mL), allowed to warm to room temperature and extracted into diethyl ether (10 mL). The organic extracts were dried over anhydrous magnesium sulfate and concentrated *in vacuo* to leave a colourless oil that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (2 : 3) to give the *acetylene* (32 mg, 92%) as a colourless oil. $[\alpha]_D^{21}$ +5.6 (*c* 1.00 in $CHCl_3$); ν_{max} ($CHCl_3$)/cm^{-1} 3307, 2990, 2858, 1727; δ_H (400 MHz, $CDCl_3$) 7.67–7.65 (4H, m, Ar*H*), 7.47–7.38 (6H, m, Ar*H*), 4.16–4.10 (1H, m, C*H*OCO), 3.73 (2H, t, *J* 5.9, CH_2OTBDPS), 2.77–2.65 (2H, m, C*H*HCOO and C*H*CH_3), 2.25–2.16 (2H, m, C*H*CH_2CH_2OTBDPS and C*H*HCOO), 2.12 (1H, d, *J* 2.4, C≡C*H*), 1.65–1.56 (3H, m, CH_2CH_2OTBDPS and C*H*HCHOCO), 1.36–1.25 (4H, m, CHCH_3 and C*H*HCHOCO), 1.06 [9H, s, OSiC(CH_3)$_3$]; δ_C (101 MHz, $CDCl_3$) 170.8 (s, *C*=O), 135.6 (d, Ar), 133.6 (s, Ar), 129.9 (d, Ar), 127.8 (d, Ar), 84.0 (s, *C*≡C), 82.3 (d, *C*HOCO), 71.4 (s, *C*≡C), 60.9 (t, CH_2OTBDPS), 38.7 (t, CH_2CH_2OTBDPS), 36.4 (t, CH_2CO_2), 32.2 (d, *C*HCH_3), 32.1 (t, CH_2CHOCO), 28.3 (d, *C*HCH_2CH_2OTBDPS), 27.0 [q, SiC(CH_3)$_3$], 19.3 [s, Si*C*(CH_3)$_3$], 17.1 (q, CHCH_3).

(1′*R*,2′*E*,4*R*,6*R*)-4-[2-(*tert*-Butyldiphenylsilanyloxy)-ethyl]-6-(1′-methyl-3′-tributylstannanylallyl)-tetrahydropyran-2-one 38

Silver nitrate (1 mg) was added to a stirred solution of the acetylene **37** (30 mg, 69 μmol) and *N*-bromosuccinimide (14 mg, 76 μmol) in acetone (1 mL) at room temperature. The solution was stirred at room temperature for 3 h, filtered through a plug of silica and concentrated *in vacuo* to leave the crude bromoacetylene intermediate. A solution of this bromoacetylene (35 mg, 68 μmol) in tetrahydrofuran (2 mL) was added added dropwise over 5 min to a stirred solution of triphenylphosphine (0.7 mg, 2.7 μmol) and tris(dibenzylideneacetone) dipalladium complex (0.6 mg, 0.7 μmol) in degassed tetrahydrofuran (1 mL) at room temperature. The solution was stirred at room temperature for 5 min and then tributyltin hydride (43 mg, 40 mm^3, 150 μmol) was added dropwise over 1 min. The mixture was stirred at room temperature for 30 min, diluted with potassium fluoride solution (20% in water, 5 mL) and stirred vigorously for 3 h. The mixture was extracted into diethyl ether, dried over anhydrous magnesium sulfate and concentrated *in vacuo* to leave a colourless oil that was purified by flash column chromatography on silica, eluting with diethyl ether–light petroleum (bp 40–60 °C) (1 : 4) to give the *vinyl stannane* (35 mg, 70%) as a colourless oil. $[\alpha]_D^{21}$ +3.0 (*c* 0.46 in $CHCl_3$); ν_{max} ($CHCl_3$)/cm^{-1} 3072, 2960, 2929, 1721; δ_H (400 MHz, $CDCl_3$) 7.65 (4H, dd, *J* 6.8 and 1.1, Ar*H*), 7.47–7.38 (6H, m, Ar*H*), 6.03 (1H, d, *J* 19, C*H*=CH), 5.87 (1H, dd, *J* 19 and 7.0, C*H*=CH), 4.15–4.11 (1H, m, C*H*OCO), 3.70 (2H, t, *J* 5.9, CH_2OTBDPS), 2.66 (1H, dd, *J* 17.2 and 5.7, C*H*HCOO), 2.47–2.42 (1H, m, C*H*CH_3), 2.20–2.11 (1H, m, C*H*CH_2CH_2OTBDPS), 2.01 (1H, dd, *J* 17.3 and 11.0, C*H*HCOO), 1.88 (1H, br. d, *J* 14, C*H*HCHOCO), 1.60–1.43 (8H, m, CH_2CH_2OTBDPS and 3 × CH_2CH_2), 1.35–1.27 (7H, m, C*H*HCHOCO and 3 × CH_2CH_2), 1.11 (3H, d, *J* 6.5, CHCH_3), 1.06 [9H, s, OSiC(CH_3)$_3$], 0.97–0.80 (15H, m, 3 × C$H_3CH_2CH_2$ and 3 × CH_2Sn); δ_C (101 MHz, $CDCl_3$) 171.5 (s, *C*=O), 148.7 (d, *C*H=CH), 135.6 (d, Ar), 133.6 (s, Ar), 130.0 (d, *C*H=CH), 129.8 (d, Ar), 127.8 (d, Ar), 83.8 (d, *C*HOCO), 60.8 (t, *C*H_2OTBDPS), 46.4 (d, *C*HCH_3), 39.0 (t, *C*H_2CH_2OTBDPS), 36.5 (t, *C*H_2CO_2), 32.5 (t, *C*H_2CHOCO), 29.2 (t, *C*H_2CH_2), 28.4 (d, *C*HCH_2CH_2OTBDPS), 27.3 (t, *C*H_2CH_2), 26.9 [q, OSiC(*C*H_3)$_3$], 19.2 [s, OSi*C*(CH_3)$_3$], 15.5 (q, CH*C*H_3), 13.8 (*C*$H_3CH_2CH_2$), 9.6 (t, *C*H_2Sn); *m/z* (FAB, 3-NBA, MeOH) 727.3594 (M^+ + H. $C_{39}H_{63}O_3Si^{120}Sn$ requires 727.3568).

(1′*R*,2′*E*,2*R*,4*R*)-[2-(1′-Methyl-3′-tributylstannanylallyl)-6-oxotetrahydropyran-4-yl]-acetaldehyde 7

(a) From the TBS ether 38. Tetrabutylammonium fluoride (44 mg, 140 µmol) was added to a stirred solution of the TPS ether **38** (34 mg, 47 µmol) and *p*-toluenesulfonic acid (10 mg, 52 µmol) in tetrahydrofuran (2 mL) at room temperature. The solution was stirred at room temperature for 3 h and then concentrated *in vacuo* to leave a red residue that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (3 : 2) to give the corresponding *alcohol* (16 mg, 70%) as a colourless oil. $[\alpha]_D^{21}$ +21.7 (*c* 0.24 in $CHCl_3$); ν_{max} ($CHCl_3$)/cm^{-1} 3620, 3442, 1720, 1602; δ_H (400 MHz, $CDCl_3$) 6.04 (1H, d, *J* 19, C*H*=CH), 5.86 (1H, dd, *J* 19 and 7.1, C*H*=CH), 4.18–4.13 (1H, m, C*H*OCO), 3.72 (2H, t, *J* 6.2, CH_2OH), 2.77–2.72 (1H, m, C*H*HCOO), 2.49–2.43 (1H, m, C*H*CH_3), 2.19–2.05 (2H, m, C*H*CH_2CH_2OH and C*H*HCOO), 1.99 (1H, br. d, *J* 15.7, C*H*HCHOCO), 1.64–1.41 (8H, m, CH_2CH_2OH and 3 × CH_2CH_2), 1.36–1.26 (7H, m, C*H*HCHOCO and 3 × CH_2CH_2), 1.13 (3H, d, *J* 6.8, CHCH_3), 0.97–0.84 (15H, m, 3 × C$H_3CH_2CH_2$ and 3 × CH_2Sn); δ_C (67.8 MHz, $CDCl_3$) 171.4 (s, *C*=O), 148.6 (d, *C*H=CH), 130.1 (d, *C*H=CH), 83.6 (d, *C*HOCO), 59.7 (t, *C*H_2OH), 46.6 (d, *C*HCH_3), 38.9 (t, *C*H_2CH_2OH), 36.4 (t, *C*H_2CO_2), 32.5 (t, *C*H_2CHOCO), 29.1 (t, *C*H_2CH_2), 28.2 (d, *C*HCH_2CH_2OH), 27.2 (t, *C*H_2CH_2), 15.6 (q, CH*C*H_3), 13.7 (q, *C*$H_3CH_2CH_2$), 9.5 (t, *C*H_2Sn).

A solution of the alcohol (4 mg, 8 µmol) in dicloromethane (0.5 mL) was added to a stirred solution of Dess–Martin periodinane (7 mg, 16 µmol) and pyridine (1.3 mg, 1.3 mm^3, 16 µmol) in dichloromethane (0.5 mL) at room temperature. The slurry was stirred at room temperature for 1 h and then quenched by the addition of a saturated solution of sodium thiosulfate (1 mL), extracted into dichloromethane (10 mL), dried over anhydrous $MgSO_4$ and concentrated *in vacuo* to leave a white residue. The residue was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 4) to give the *lactone aldehyde* (2.7 mg, 70%) as a colourless oil. $[\alpha]_D^{21}$ +12 (*c* 1.00 in $CHCl_3$); (Found: C, 56.4; H, 8.6. $C_{23}H_{42}O_3Sn$ requires: C, 56.7; H, 8.7%); ν_{max}(sol.)/cm^{-1} 2730 (w), 1731; δ_H (360 MHz, $CDCl_3$), 9.74 (1H, apparent s, C*H*O), 6.02 (1H, d, *J* 19.1, SnC*H*=C), 5.82 (1H, dd, *J* 7.1 and 19.1, SnCH=C*H*), 4.16 (1H, ddd, *J* 2.9, 6.6 and 11.7, C*H*OCO), 2.74 (1H, dd, *J* 5.7 and 17.5, C*H*HCOO), 2.57–2.40 (4H, m, C*H*CH_2CHO, CH_2CHO and C*H*CH_3), 2.07 (1H, dd, *J* 10.0 and 17.5, CH*H*COO), 1.99 (1H, br. d, *J* 14.7, C*H*HCHOCO), 1.52–1.43 (6H, m, Bu_3Sn-3 × CH_2), 1.34–1.22 (7H, m, CH*H*CHOCO and Bu_3Sn-3 × CH_2), 1.09 (3H, d, *J* 6.8, CHCH_3) 0.93–0.81 (15H, m, Bu_3Sn-3 × CH_2 and 3 × CH_3); δ_C (90.6 MHz, $CDCl_3$), 199.4 (d), 170.3 (s), 148.3 (d), 130.3 (d), 83.2 (d), 49.8 (t), 46.3 (d), 35.8 (t), 32.1 (t), 29.0 (t), 27.1 (t), 25.8 (d), 15.4 (q), 13.6 (q), 9.4 (t); *m/z* (FAB), 427.1427 (M − Bu: $C_{19}H_{33}O_3{}^{118}Sn$ requires 427.1446), 429 (100%), 427 (80).

(b) From the triol 48. Silica-supported sodium periodate (4.00 g, 4.80 mmol) was added in one portion to a stirred solution of the triol **48** (790 mg, 1.61 mmol) in dichloromethane (10 mL) at room temperature. The slurry was stirred at room temperature for 15 min, then filtered and washed with dichloromethane (2 × 10 mL). The combined filtrates were concentrated *in vacuo* to leave an oil which was purified by flash column chromatography eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 1) to give the corresponding lactol **49** (636 mg, 81%) as a colourless oil (1 : 1 mixture of anomers).

Silver carbonate on Celite (50 wt%, 7.10 g, 13.0 mmol) was added in one portion to a stirred solution of the lactol (630 mg, 1.30 mmol) in toluene (40 mL) at room temperature, and the resulting slurry was heated at reflux for 3 h and then cooled to room temperature. The slurry was filtered, and the residue was washed with ethyl acetate. The combined filtrates were concentrated *in vacuo* to leave an oil which was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 3) to give the *lactone* (473 mg, 61% over two steps) as a colourless oil whose spectroscopic data were identical with those presented under section (a) above.

(2*R*,3*R*,5*S*)-5-[2-(*tert*-Butyldimethylsilanyloxy)-ethyl]-1-(4-methoxybenzyloxy)-2-methylhept-6-en-3-ol 39

tert-Butylchlorodimethylsilane (690 mg, 4.53 mmol) was added in a single portion to a stirred solution of the 1,5-diol **29a** (1.28 g, 4.12 mmol) and imidazole (310 mg, 4.53 mmol) in dichloromethane (40 mL) at room temperature. The white suspension was stirred at room temperature for 2 h after which it was concentrated *in vacuo* to leave a white solid. The residue was washed with diethyl ether (150 mL), the imidazole hydrochloride salt removed by filtration and the organic extracts concentrated *in vacuo* to leave a colourless oil that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 9) to give the *silyl ether* (1.43 g, 82%) as a colourless oil. $[\alpha]_D^{21}$ +5.2 (*c* 0.54 in $CHCl_3$); ν_{max} ($CHCl_3$)/cm^{-1} 3482, 1612; δ_H (400 MHz, $CDCl_3$) 7.24 (2H, d, *J* 8.6, Ar*H*), 6.88 (2H, d, *J* 8.6, Ar*H*), 5.50 (1H, apparent dt, *J* 19.5 and 9.8, C*H*=CH_2), 5.06–5.02 (2H, m, CH=CH_2), 4.44 (2H, d, *J* 7.7, OCH_2Ar), 3.81 (3H, s, ArOCH_3), 3.78–3.74 (1H, m, C*H*OH), 3.67–3.55 (2H, m, CH_2OTBDMS), 3.47 (2H, d, *J* 5.7, CH_2OPMB), 2.51 (1H, d, *J* 5.2, O*H*), 2.45–2.36 (1H, m, C*H*CH=CH_2), 1.88–1.82 (1H, m, C*H*CH_3), 1.68–1.59 (1H, m, CH_2CH_2OTBDMS), 1.56–1.47 (2H, m, C*H*HCHOH and C*H*HCH_2OTBDMS), 1.29–1.22 (1H, m, C*H*HCHOH), 0.93–0.89 [12H, m, CHCH_3 and OSiMe_2C(CH_3)$_3$], 0.05 [6H, s, OSi(CH_3)$_2$C(CH_3)$_3$]; δ_C (67.8 MHz, $CDCl_3$) 159.2 (s, Ar), 142.2 (d, *C*H=CH_2), 130.2 (s, Ar), 129.2 (d, Ar), 115.4 (t, CH=*C*H_2), 113.8 (d, Ar), 74.1 (t, *C*H_2OPMB), 72.9 (t, O*C*H_2Ar), 71.3 (d, *C*HOH), 61.3 (t, *C*H_2OTBDMS), 55.2 (q, ArO*C*H_3), 39.2 (t, *C*H_2CHOH), 38.5 (t, *C*H_2CH_2OTBDMS), 38.4 (d, *C*HCH_3), 37.4 (d, *C*HCH=CH_2), 26.0 [q, OSiC(*C*H_3)$_3$], 18.3 [s, OSi*C*(CH_3)$_3$], 11.3 (q, CH*C*H_3), −5.3 [q, OSi(*C*H_3)$_2$]; *m/z* (EI) 365.2127 [$M^{+\bullet}$ − C(CH_3)$_3$. $C_{20}H_{33}O_4Si$ requires 365.2148].

(3*S*,5*R*,6*R*)-3-[2-(*tert*-Butyldimethylsilanyloxy)-ethyl]-7-(4-methoxybenzyloxy)-6-methylheptane-1,5-diol 40

A solution of 9-borabicyclo[3.3.1]nonane (0.5 mol dm^{-3} in tetrahydrofuran, 14.9 mL, 7.45 mmol) was added dropwise over 5 min to a stirred solution of the alkene **39** (1.43 g, 3.39 mmol) in tetrahydrofuran (5 mL) at 0 °C. The solution was stirred at 0 °C for 30 min and then at room temperature for

12 h, after which it was cooled to 0 °C. An aqueous solution of sodium hydroxide (2 mol dm^{-3}, 10 mL) was added in one portion to the solution, followed immediately by the dropwise addition of hydrogen peroxide (100 vol, 10 mL) over 5 min. The heterogeneous mixture was stirred vigorously at 0 °C for 4 h, extracted with diethyl ether (100 mL), washed with brine (10 mL) and then dried over anhydrous magnesium sulfate. The solution was concentrated *in vacuo* to leave a residue that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (3 : 7) to give the *alcohol* (1.49 g, 95%) as a colourless oil. $[\alpha]_D^{21}$ +13.9 (*c* 0.42 in $CHCl_3$); ν_{max} (liquid film)/cm^{-1} 3395, 2929, 1612, 1586; δ_H (400 MHz, $CDCl_3$) 7.27 (2H, d, *J* 8.7, Ar*H*), 6.89 (2H, d, *J* 8.7, Ar*H*), 4.44 (2H, apparent d, *J* 3.3, OC*H*$_2$Ar), 3.88 (1H, apparent d, *J* 8.7, C*H*OH), 3.82 (3H, s, ArOC*H*$_3$), 3.71–3.66 (4H, m, C*H*$_2$OTBDMS and C*H*$_2$OH), 3.50 (2H, d, *J* 5.7, C*H*$_2$OPMB), 2.91 (1H, br. s, O*H*), 2.07 (1H, br. s, O*H*), 1.87–1.79 (2H, m, C*H*CH$_3$ and C*H*CH$_2$CH$_2$OTBDMS), 1.72–1.51 (5H, m, C*H*HCHOH, C*H*$_2$CH$_2$OTBDMS and C*H*$_2$CH$_2$OH), 1.33–1.28 (1H, m, C*H*HCHOH), 0.92 (3H, d, *J* 7.1, CHC*H*$_3$), 0.90 [9H, s, OSiC(C*H*$_3$)$_3$], 0.06 [6H, s, OSi(C*H*$_3$)$_2$]; δ_C (67.8 MHz, $CDCl_3$) 159.2 (s, Ar), 130.1 (s, Ar), 129.2 (d, Ar), 113.8 (d, Ar), 74.3 (t, *C*H$_2$OPMB), 73.0 (t, O*C*H$_2$Ar), 71.4 (d, *C*HOH), 61.5 (t, *C*H$_2$OTBDMS), 61.2 (t, *C*H$_2$OH), 55.2 (q, ArO*C*H$_3$), 38.8 (t, *C*H$_2$CHOH), 38.3 (d, *C*HCH$_3$), 37.7 (t, *C*H$_2$CH$_2$OTBDMS), 36.4 (t, *C*H$_2$CH$_2$OH), 29.0 (d, *C*HCH$_2$CH$_2$OTBDMS), 25.9 [q, OSiC(*C*H$_3$)$_3$], 18.3 [s, OSi*C*(CH$_3$)$_3$], 11.0 (q, CH*C*H$_3$), −5.4 [q, OSi(*C*H$_3$)$_2$].

(2*R*,3*R*,5*R*)-5-[2-(*tert*-Butyldimethylsilanyloxy)-ethyl]-7-(*tert*-butyldiphenylsilanyloxy)-1-(4-methoxybenzyloxy)-2-methylheptan-3-ol 41

tert-Butylchlorodiphenylsilane (0.96 g, 0.91 mL, 3.50 mmol) was added in a single portion to a stirred solution of the primary alcohol **40** (1.40 g, 3.18 mmol) and imidazole (240 mg, 3.50 mmol) in dichloromethane (30 mL) at room temperature. The colourless suspension stirred at room temperature for 2 h after which it was concentrated *in vacuo* to leave a white solid. The residue was washed with diethyl ether (200 mL), the imidazole hydrochloride salt removed by filtration and the organic extracts concentrated *in vacuo* to leave a colourless oil that was purified by flash column chromatography on silica, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 9) to give the *silyl ether* (2.07 g, 96%) as a colourless oil. $[\alpha]_D^{21}$ +7.7 (*c* 1.22 in $CHCl_3$); (Found: C, 70.7; H, 9.4. $C_{40}H_{62}O_5Si_2$ requires: C, 70.8; H, 9.2%); ν_{max} ($CHCl_3$)/cm^{-1} 3475, 1612, 1588; δ_H (270 MHz, $CDCl_3$) 7.66–7.62 (4H, m, Ar*H*), 7.40–7.30 (6H, m, Ar*H*), 7.22–7.18 (2H, m, Ar*H*), 6.86–6.82 (2H, m, Ar*H*), 4.39 (2H, s, OC*H*$_2$Ar), 3.76 (4H, apparent s, ArOC*H*$_3$ and C*H*OH), 3.66 (2H, t, *J* 6.8, C*H*$_2$OTBDPS), 3.59 (2H, t, *J* 6.8, C*H*$_2$OTBDMS), 3.47–3.41 (2H, m, C*H*$_2$OPMB), 2.71 (1H, d, *J* 4.3, O*H*), 1.78–1.73 (2H, m, C*H*CH$_3$ and C*H*CH$_2$CH$_2$OTBDMS), 1.60–1.36 (5H, m, C*H*HCHOH, C*H*$_2$CH$_2$OTBDMS and C*H*$_2$CH$_2$OTBDPS), 1.28–1.21 (1H, m, C*H*HCHOH), 1.01 [9H, s, OSiC(C*H*$_3$)$_3$], 0.86–0.84 [12H, m, OSiC(C*H*$_3$)$_3$ and CHC*H*$_3$], 0.00 [6H, s, OSi(C*H*$_3$)$_2$]; δ_C (67.8 MHz, $CDCl_3$) 159.5 (s, Ar), 135.9 (d, Ar), 134.3 (s, Ar), 130.6 (s, Ar), 129.9 (d, Ar), 129.5 (d, Ar), 127.9 (d, Ar), 114.1 (d, Ar), 74.6 (t, *C*H$_2$OPMB), 73.3 (t, O*C*H$_2$Ar), 72.1 (d, *C*HOH), 62.5 (t, *C*H$_2$OTBDPS), 61.7 (t, *C*H$_2$OTBDMS), 55.6 (q, ArO*C*H$_3$), 39.0 (t, *C*H$_2$CHOH), 38.6 (d, *C*HCH$_3$), 37.8 (t, *C*H$_2$CH$_2$OTBDMS), 37.2 (t, *C*H$_2$CH$_2$OTBDPS), 29.1 (d, *C*HCH$_2$CH$_2$OTBDPS), 27.2 [q, OSiC(*C*H$_3$)$_3$], 26.3 [q, OSiC(*C*H$_3$)$_3$], 19.5 [s, OSi*C*(CH$_3$)$_3$], 18.6 [s, OSi*C*(CH$_3$)$_3$], 11.2 (q, CH*C*H$_3$), −5.0 [q, OSi(*C*H$_3$)$_2$].

Cyclopent-3-enylacetaldehyde 42

A solution of di-*iso*butylaluminium hydride in toluene (1.50 M, 42.0 mL, 63.0 mmol) was added over 10 min to a stirred solution of cyclopent-3-enylacetonitrile (4.50 g, 42.0 mmol) in dichloromethane (250 mL) at −78 °C. The mixture was stirred at −78 °C for 2 h, then quenched at −78 °C by the addition of acetone (20 mL), before being warmed to room temperature. The mixture was added to a saturated aqueous solution of Rochelle's salt (250 mL), *via* cannula, and the biphasic mixture was then stirred at room temperature for 14 h. The separated aqueous phase was extracted with dichloromethane (3 × 100 mL) and the combined organic extracts were dried and concentrated *in vacuo.* The residue was purified by flash column chromatography, eluting with diethyl ether–light petroleum (bp 40–60 °C) (1 : 19) to give the *aldehyde* (3.28 g, 70%) as a colourless oil. Bp 71–72 °C/16 mmHg; ν_{max}(film)/cm^{-1} 2719, 1723, 1350; δ_H (400 MHz, $CDCl_3$), 9.76 (1H, t, *J* 1.9, C*H*O), 5.66 (2H, br. s, 2 × C=C*H*), 2.74–2.67 (1H, m, C*H*CH$_2$CHO) 2.64–2.56 (2H, m, C*H*$_2$CH=), 2.51 (2H, dd, *J* 1.9 and 7.1, C*H*$_2$CHO), 2.03–1.98 (2H, m, C*H*$_2$CH=); δ_C (100 MHz, $CDCl_3$), 202.5 (d), 129.5 (d), 50.4 (t), 38.7 (t), 31.3 (d); *m/z* (EI) 110.0727 (M: $C_7H_{10}O$ requires 110.0731), 110 (28%), 93 (19), 66 (100).

(*S*)-4-Benzyl-3-[(2*S*,3*R*)-4-cyclopent-3-enyl-3-hydroxy-2-methylbutanoyl]-oxazolidin-2-one 43

A solution of dibutylboron triflate in dichloromethane (1.00 M, 56.0 mL, 56.0 mmol), and triethylamine (8.46 mL, 60.6 mmol) were added sequentially to a stirred solution of (*S*)-4-benzyl-3-propionyloxazolidin-2-one (10.8 g, 46.6 mmol) in dichloromethane (250 mL) at −10 °C. The mixture was stirred at −10 °C for 20 min, then cooled to −78 °C when a solution of the aldehyde **42** (5.65 g, 51.2 mmol) in dichloromethane (100 mL) was added *via* cannula over 10 min. The mixture was stirred at −78 °C for 1 h, then warmed to 0 °C over 30 min and stirred at 0 °C for a further 30 min. The mixture was quenched at 0 °C by the sequential addition of pH 7 phosphate buffer (100 mL), methanol (200 mL) and hydrogen peroxide (100 mL) and then stirred at 0 °C for 1 h. The aqueous layer was separated, extracted with dichloromethane (3 × 250 mL) and the combined organic extracts were then washed with brine (250 mL), dried and concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with diethyl ether–light petroleum (bp 40–60 °C) (1 : 2) to give the *aldol product* (12.3 g, 77%) as a colourless oil. $[\alpha]_D^{21}$ +58 (*c* 1.03 in $CHCl_3$); (Found: C, 69.8; H, 7.3; N, 3.8. $C_{20}H_{25}NO_4$ requires: C, 69.9; H, 7.3; N, 4.1%); ν_{max}(sol.)/cm^{-1} 3544 (br.), 2927, 1781, 1682; δ_H (500 MHz, $CDCl_3$), 7.36–7.27 (3H, m, Ar*H*), 7.24–7.20 (2H, m, Ar*H*), 5.68–5.65 (2H, m, 2 × C*H*=C), 4.71 (1H, m, C*H*N), 4.26 (1H, t, *J* 9.1, C*H*HO), 4.19 (1H, dd, *J* 2.9 and 9.1, CH*H*O), 4.02 (1H, ddd, *J* 2.7, 3.2 and 9.2, C*H*OH), 3.75 (1H, dq, *J* 3.2 and 7.0, C*H*CH$_3$), 3.25 (1H, dd, *J* 3.3 and 13.4, C*H*HPh), 2.92 (1H, d, *J* 2.9, O*H*), 2.79 (1H, dd, *J* 9.5 and 13.4, CH*H*Ph), 2.55–2.44 (3H, m, C*H*CH$_2$CH=C and C*H*$_2$CH=C), 2.03–1.99 (2H, m, C*H*$_2$CH=C), 1.71 (1H, ddd, *J* 5.3, 9.2 and 13.8, C*H*HCHOH), 1.49–1.43 (1H, m, CH*H*CHOH), 1.27 (3H, d, *J* 7.0, CHC*H*$_3$); δ_C (90.6 MHz, $CDCl_3$), 177.4 (s), 153.0 (s), 135.0 (s), 130.0 (d), 129.5 (d), 129.4 (d), 128.9 (d), 127.4 (d), 70.4 (d), 66.1 (t), 55.0 (d), 42.4 (d), 40.5 (t), 39.3 (t), 38.4 (t), 37.7 (t), 34.1 (d), 10.5 (q); *m/z* (ESI) 366.1682 (M + Na: $C_{20}H_{25}NaNO_4$ requires 366.1681), 366 (100%).

(2*S*,3*R*)-4-Cyclopent-3-enyl-3-hydroxy-*N*-methoxy-2,*N*-dimethylbutyramide 44a

A solution of trimethylaluminium in toluene (2.00 M, 10.6 mL, 21.2 mmol) was added over 5 min to a stirred slurry of *N*,*O*-dimethylhydroxylamine hydrochloride (2.10 g, 21.2 mmol) in dichloromethane (40 mL) at 0 °C. The mixture was warmed to room temperature, where it was stirred for 10 min and then cooled to −10 °C. A solution of the imide 43 (2.42 g, 7.06 mmol) in dichloromethane (30 mL) was added to the mixture at −10 °C over 5 min and stirring was continued for 2 h. The mixture was warmed to room temperature, stirred for a further 90 min, and then poured cautiously into a biphasic mixture of dilute hydrochloric acid (2.0 M, 140 mL) and dichloromethane (70 mL). The biphasic mixture was stirred vigorously for 20 min and then the aqueous phase was separated and extracted with dichloromethane (3 × 70 mL). The combined organic extracts were washed with dilute hydrochloric acid (2.0 M, 70 mL), pH 7 phosphate buffer (70 mL), brine (50 mL) and then dried and concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (2 : 3) to give the *Weinreb amide* (1.31 g, 84%) as a colourless oil. $[\alpha]_D^{21}$ +16 (*c* 1.25 in $CHCl_3$); (Found: C, 63.15; H, 9.45; N, 6.2. $C_{12}H_{21}NO_3$ requires: C, 63.4; H, 9.3; N, 6.2%); ν_{max}(sol.)/cm^{-1} 3472 (br.), 2936, 1633; δ_H (360 MHz, $CDCl_3$), 5.68–5.65 (2H, m, 2 × C*H*=C), 3.93 (1H, ddd, *J* 2.9, 4.3 and 8.9, C*H*OH), 3.71 (3H, s, OC*H*$_3$), 3.21 (3H, s, NC*H*$_3$), 2.87 (1H, m, C*H*CH$_3$), 2.57–2.41 (3H, m, C*H*CH$_2$CH=C and C*H*$_2$CH=C), 2.06–1.96 (2H, m, C*H*$_2$CH=C), 1.71 (1H, ddd, *J* 5.7, 8.9 and 13.4, C*H*HCHOH), 1.41 (1H, ddd, *J* 4.3, 8.2 and 13.4, CH*H*CHOH), 1.18 (3H, d, *J* 7.1, CHC*H*$_3$); δ_C (90.6 MHz, $CDCl_3$), 178.3 (s), 129.9 (d), 129.5 (d), 70.3 (d), 61.5 (q), 40.5 (t), 39.2 (t), 38.9 (d), 38.5 (t), 34.1 (d), 31.8 (q), 10.5 (q); *m/z* (ESI) 291.1669 (M + MeCN + Na: $C_{14}H_{24}NaN_2O_3$ requires 291.1684), 291 (100%), 250 (20).

(2*S*,3*R*)-3-(*tert*-Butyldimethylsiloxy)-4-cyclopent-3-enyl-*N*-methoxy-2,*N*-dimethylbutyramide 44b

tert-Butyldimethylsilyl trifluoromethanesulfonate (8.42 mL, 36.6 mmol) was added dropwise over 10 min to a stirred solution of the alcohol **44a** (5.55 g, 24.4 mmol) and 2,6-lutidine (4.84 mL, 41.5 mmol) in dichloromethane (150 mL) at 0 °C. The mixture was stirred at 0 °C for 45 min and then quenched at 0 °C by the addition of a saturated solution of sodium bicarbonate (100 mL). The aqueous phase was separated and extracted with dichloromethane (2 × 70 mL) and the combined organic extracts were then washed with sodium bisulfate solution (1.0 M, 100 mL), brine (100 mL), dried and concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 4) to give the *silyl ether* (8.70 g, 100%) as a colourless oil. $[\alpha]_D^{21}$ +8.6 (*c* 1.00 in $CHCl_3$); (Found: C, 63.35; H, 10.5; N, 4.1. $C_{18}H_{35}NO_3Si$ requires: C, 63.3; H, 10.3; N, 4.1%); ν_{max}(sol.)/cm^{-1} 2897, 1651; δ_H (360 MHz, $CDCl_3$), 5.66–5.63 (2H, m, 2 × C*H*=C), 3.97 (1H, dt, *J* 5.8 and 6.2, C*H*OTBS), 3.68 (3H, s, OC*H*$_3$), 3.17 (3H, s, NC*H*$_3$), 2.97–2.84 (1H, m, C*H*CH$_3$), 2.51–2.45 (2H, m, C*H*$_2$CH=C), 2.31 (1H, apparent septet, *J* 7.3, C*H*CH$_2$CH=C), 2.04–1.91 (2H, m, C*H*$_2$CH=C), 1.59 (2H, dd, *J* 5.8 and 7.3, C*H*$_2$CHOTBS), 1.13 (3H, d, *J* 7.1, CHC*H*$_3$), 0.89 (9H, s, TBS-^{t}Bu), 0.05 (3H, s, TBS-Me), 0.03 (3H, s, TBS-Me); δ_C (90.6 MHz, $CDCl_3$), 176.2 (s), 129.9 (d), 129.7 (d), 72.5 (d), 61.2 (q), 43.1 (t), 41.3 (d), 39.5 (t), 39.2 (t), 33.7 (d), 32.1 (q), 26.0 (q), 18.1 (s), 13.3 (q), −4.0 (q), −4.3 (q); *m/z* (ESI) 405.2530 (M + MeCN + Na: $C_{20}H_{38}NaN_2O_3Si$ requires 405.2549), 405 (100%), 364 (29), 342 (30).

(2*S*,3*R*)-3-(*tert*-Butyldimethylsiloxy)-4-cyclopent-3-enyl-2-methylbutyraldehyde 45

A solution of di-*iso*butylaluminium hydride in toluene (1.50 M, 24.4 mL, 36.6 mmol) was added dropwise over 20 min to a stirred solution of the amide **44b** (8.70 g, 24.4 mmol) in tetrahydrofuran (120 mL) at −78 °C. The mixture was stirred at −78 °C for 2 h and then quenched at −78 °C with acetone (10 mL). The mixture was warmed to room temperature over 15 min and then added *via* cannula to a saturated aqueous solution of Rochelle's salt (100 mL). The biphasic mixture was stirred vigorously for 18 h and the aqueous phase was then separated and extracted with dichloromethane (3 × 100 mL). The combined organic extracts were washed with brine (100 mL), dried and then concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with diethyl ether–light petroleum (bp 40–60 °C) (1 : 9) to give the *aldehyde* (6.70 g, 96%) as a colourless oil. $[\alpha]_D^{21}$ +61 (*c* 1.00 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 2712 (w), 1723; δ_H (360 MHz, $CDCl_3$), 9.80 (1H, d, *J* 0.9, C*H*O), 5.70–5.65 (2H, m, 2 × C*H*=C), 4.16 (1H, ddd, *J* 3.2, 6.3 and 7.2, C*H*OTBS), 2.56–2.44 (3H, m, C*H*$_2$CH=C and C*H*CH$_3$), 2.28 (1H, apparent septet, *J* 7.4, C*H*CH$_2$CH=C), 2.03–1.94 (2H, m, C*H*$_2$CH=C), 1.68–1.53 (2H, m, C*H*$_2$CHOTBS), 1.07 (3H, d, *J* 7.0, CHC*H*$_3$), 0.87 (9H, s, TBS-^{t}Bu), 0.08 (3H, s, TBS-Me), 0.05 (3H, s, TBS-Me); δ_C (90.6 MHz, $CDCl_3$), 205.4 (d), 129.8 (d), 129.6 (d), 71.1 (d), 51.3 (d), 41.2 (t), 39.1 (t), 38.9 (t), 33.9 (d), 25.8 (q), 18.0 (s), 7.6 (q), −4.3 (q), −4.6 (q); *m/z* (ESI) 305.1885 (M + Na: $C_{16}H_{30}NaO_2Si$ requires 305.1913), 305 (100%).

tert-Butyl-[(1*R*,2*R*)-1-cyclopent-3-enylmethyl-2-methylbut-3-ynyloxy]-dimethylsilane 46a

A solution of dimethyl diazomethylphosphonate (Seyforth's reagent) (4.70 g, 34.5 mmol) in tetrahydrofuran (50 mL) was added *via* cannula over 15 min to a stirred suspension of potassium *tert*-butoxide (3.87 g, 34.5 mmol) in tetrahydrofuran (150 mL) at −78 °C. The mixture was stirred at −78 °C for 30 min and then a solution of the aldehyde **45** (6.50 g, 23.0 mmol) in tetrahydrofuran (50 mL) was added *via* cannula over 10 min. The mixture was stirred at −78 °C for 2 h and then quenched by the addition of deionised water (100 mL). The biphasic mixture was warmed to room temperature and the aqueous phase was then separated and extracted with diethyl ether (3 × 100 mL). The combined organic extracts were dried and then concentrated *in vacuo.* The residue was purified by flash column chromatography, eluting with diethyl ether–light petroleum (bp 40–60 °C) (1 : 19) to give the *alkyne* (6.00 g, 94%) as a colourless oil. $[\alpha]_D^{21}$ +26 (*c* 0.96 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 2111 (w), 1068; δ_H (360 MHz, $CDCl_3$), 5.71–5.65 (2H, m, 2 × C*H*=C), 3.65 (1H, ddd, *J* 4.1, 4.9 and 7.5, C*H*OTBS), 2.62–2.41 (4H, m, C*H*CH$_2$CH=C, C*H*$_2$CH=C and C*H*CH$_3$), 2.06–1.97 (2H, m, C*H*$_2$CH=C), 2.05 (1H, d, *J* 2.5, C≡C*H*), 1.78 (1H, ddd, *J* 5.4, 7.5 and 13.2, C*H*HCHOTBS), 1.60 (1H, ddd, *J* 4.1, 8.6 and 13.2, CH*H*CHOTBS), 1.15 (3H, d, *J* 7.0, CHC*H*$_3$), 0.92 (9H, s, TBS-^{t}Bu), 0.11 (3H, s, TBS-Me), 0.08 (3H, s, TBS-Me); δ_C (90.6 MHz, $CDCl_3$), 130.1 (d), 129.6 (d), 87.1 (s), 74.0 (d), 69.5 (d), 40.7 (t), 39.7 (t), 38.8 (t), 33.5 (d), 32.6 (d), 25.9 (q), 18.2 (s), 16.6 (q), −4.3 (2 × q); *m/z* (FAB) 221.1365 (M-^{t}Bu: $C_{13}H_{21}OSi$ requires 221.1362), 221 (100%), 147 (54).

(2*R*,3*R*)-1-Cyclopent-3-enyl-3-methylpent-4-yn-1-ol 46b

HF/pyridine complex (21.0 mL) was added rapidly to a stirred solution of the silyl ether **46a** (6.00 g, 21.5 mmol) in tetrahydrofuran (150 mL) at room temperature, and the mixture was then stirred at room temperature for 2 days. A saturated solution of sodium bicarbonate (500 mL) was added cautiously and the mixture was then extracted with dichloromethane (4 × 250 mL). The combined organic extracts were washed with brine (500 mL), dried and concentrated *in vacuo.* The residue was purified by flash column chromatography, eluting with diethyl ether–light petroleum (bp 40–60 °C) (1 : 4) to give the *alkyne* (3.63 g, 100%) as a colourless oil. $[\alpha]_D^{21}$ +58 (*c* 1.00 in $CHCl_3$); (Found: C, 80.15; H, 10.0. $C_{11}H_{16}O$ requires: C, 80.4; H, 9.8%); ν_{max}(sol.)/cm^{-1} 3526 (br.), 2174 (w), 1022; δ_H (400 MHz, $CDCl_3$), 5.69–5.63 (2H, m, 2 × C*H*=C), 3.59 (1H, dq, *J* 5.3 and 9.5, C*H*OH), 2.60–2.41 (4H, m, C*H*CH$_2$CH=C, C*H*$_2$CH=C and C*H*CH$_3$), 2.11 (1H, d, *J* 2.4, C≡C*H*), 2.04–1.93 (3H, m, O*H* and C*H*$_2$CH=C), 1.69–1.57 (2H, m, C*H*$_2$CHOH), 1.17 (3H, d, *J* 6.9, CHC*H*$_3$); δ_C (90.6 MHz, $CDCl_3$), 130.0 (d), 129.5 (d), 86.2 (s), 73.0 (d), 70.3 (d), 40.0 (t), 39.5 (t), 38.3 (t), 34.1 (d), 33.0 (d), 15.6 (q); *m/z* (FAB), 165 (14%), 147 (30), 57 (100).

4-[(2*R*,3*R*)-5-Bromo-2-hydroxy-3-methylpent-4-ynyl]-cyclopentane-1,2-diol 47

N-Bromosuccinimide (593 mg, 3.35 mmol) was added in one portion, followed by silver nitrate (5.00 mg), to a stirred solution of the alkyne **46b** (0.50 g, 3.04 mmol) in acetone (15 mL).

The mixture was stirred at room temperature for 2 h and then diluted with diethyl ether–light petroleum (1 : 4; 50 mL). The mixture was washed with deionised water (3 × 20 mL), dried and concentrated *in vacuo* to leave the cude bromoalkyne intermediate as a colourless oil (640 mg, 87%).

Osmium tetroxide (2.5 wt% in ^{t}BuOH, 3.82 mL, 0.30 mmol) was added to a stirred solution of the crude bromoalkyne (640 mg, 2.64 mmol) and 4-methylmorpholine *N*-oxide (713 mg, 6.09 mmol) in acetone–water (2 : 1; 80 mL) at room temperature. The mixture was stirred at room temperature for 90 min and then quenched by the addition of a saturated solution of sodium thiosulfate (30 mL). The mixture was stirred vigorously for 20 min and then extracted with ethyl acetate (5 × 30 mL). The combined organic extracts were dried and concentrated *in vacuo* to leave a residue which was purified by flash column chromatography, eluting with methanol–ethyl acetate (1 : 19) to give the *triol* (640 mg, 76% over two steps) as a colourless crystalline solid (7 : 1 mixture of *cis*-diol isomers). Mp 112–113 °C; (Found: C, 47.6; H, 6.1. $C_{11}H_{17}BrO_3$ requires: C, 47.7; H, 6.2%); ν_{max}(sol.)/cm^{-1} 3292 (br.), 1130; δ_H (360 MHz, CD_3OD), 4.09–4.06 (2H, m, 2 × C*H*OH), 3.42 (1H, ddd, *J* 2.7, 6.9 and 9.5, C*H*OH), 2.63–2.54 (1H, m, C*H*CH$_2$CHOH), 2.48 (1H, apparent quin., *J* 6.9, C*H*CH$_3$), 1.98–1.88 (2H, m, C*H*$_2$CHOH), 1.67–1.42 (4H, m, 2 × C*H*$_2$CHOH), 1.21 (3H, d, *J* 6.9, CHC*H*$_3$); δ_C (90.6 MHz, CD_3OD), 83.3 (s), 74.8 (2 × d), 74.3 (d), 43.0 (t), 41.0 (s), 39.4 (t), 38.2 (t), 35.8 (d), 32.2 (d), 17.2 (q); *m*/*z* (FAB), 259 (M − OH, 100%).

4-[(2*R*,3*R*)-(4*E*)-2-Hydroxy-3-methyltributylstannylpent-4-enyl]-cyclopentane-1,2-diol 48

Freshly distilled tributyltin hydride (1.02 mL, 3.81 mmol) was added over 10 min to a stirred solution of the bromoalkyne **47** (480 mg, 1.73 mmol), tris(dibenzylideneacetone)dipalladium(0) (79.0 mg, 0.09 mmol) and triphenylphosphine (182 mg, 0.69 mmol) in tetrahydrofuran (20 mL) at room temperature. The mixture was stirred at room temperature for 2 h, and then concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 1) to give the *tributylstannane* (920 mg, 100%) as a colourless oil (7 : 1 mixture of *cis*-diol isomers); ν_{max}(sol.)/cm^{-1} 3352 (br.), 1130; δ_H (400 MHz, $CDCl_3$), 5.97 (1H, d, *J* 19.1, SnC*H*=C), 5.85 (1H, dd, *J* 6.6 and 19.1, SnCH=C*H*) 4.13–4.10 (2H, m, 2 × C*H*OH), 3.51–3.44 (1H, m, C*H*OH), 3.18 (1H, br. s, O*H*) 2.51 (1H, apparent septet., *J* 8.9, C*H*CH$_2$CHOH), 2.28–2.22 (2H, m, C*H*CH$_3$ and O*H*), 2.01 (1H, d, *J* 5.3, O*H*), 1.94–1.89 (2H, m, C*H*$_2$CHOH), 1.64–1.52 (2H, m, C*H*$_2$CHOH), 1.51–1.45 (6H, m, Bu$_3$Sn-3 × C*H*$_2$), 1.44–1.37 (2H, m, C*H*$_2$CHOH), 1.35–1.25 (6H, m, Bu$_3$Sn-3 × C*H*$_2$), 1.01 (3H, d, *J* 6.9, CHC*H*$_3$) 0.92–0.85 (15H, m, Bu$_3$Sn-3 × C*H*$_2$ and 3 × C*H*$_3$); δ_C (90.6 MHz, $CDCl_3$), 151.2 (d), 128.9 (d), 73.6 (d), 73.5 (d), 47.4 (d), 41.1 (t), 39.2 (t), 38.4 (t), 31.7 (d), 29.1 (t), 27.2 (t), 14.4 (q), 13.7 (q), 9.5 (t); *m*/*z* (EI), 433.1778 (M − Bu: $C_{19}H_{37}O_3{}^{120}Sn$ requires 433.1764), 433 (100%).

Macrocyclisation precursor 50

1,8-Diazobicyclo[5.4.0]undec-7-ene (18.0 µL, 120 µmol) was added over 5 min to a stirred solution of the phosphonate **9** (100 mg, 109 µmol) and lithium chloride (23.2 mg, 546 µmol) in acetonitrile (1 mL) at room temperature, and the mixture was then stirred for 15 min. The mixture was cooled to 0 °C and a solution of the aldehyde **7** (64.0 mg, 131 µmol) in acetonitrile (0.5 + 0.1 mL) was added at 0 °C over 5 min. The mixture was stirred at 0 °C for 1 h and then concentrated *in vacuo* to leave a residue which was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 5) to give the *E-unsaturated ester* (106 mg, 78%) as a colourless oil. $[\alpha]_D^{21}$ +1.5 (*c* 0.78 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 1722, 1655; δ_H (400 MHz, $CDCl_3$), 7.72–7.68 (4H, m, Ar*H*), 7.46–7.35 (6H, m, Ar*H*), 6.81 (1H, dt, *J* 7.3 and 15.6, C*H*=CHCO$_2$), 6.14 (1H, s, C=C*H*I), 6.05 (1H, d, *J* 19.0, C=C*H*Sn), 5.87 (1H, dd, *J* 7.0 and 19.0, C*H*=CHSn), 5.83 (1H, d, *J* 15.6, C=C*H*CO$_2$), 5.59 (1H, apparent t, *J* 5.7, C=C*H*), 4.84 (1H, dt, *J* 3.5 and 9.2, C*H*OCO), 4.36 (1H, dd, *J* 7.2 and 13.0, C*H*HOTPS), 4.24 (1H, dd, *J* 4.2 and 13.0, CH*H*OTPS), 4.20–4.12 (2H, m, C*H*OTBS and C*H*OCO), 3.15 (4H, br. s, C*H*OMe and OC*H*$_3$), 2.74–2.65 (1H, m, C*H*HCO$_2$), 2.47 (1H, apparent q, *J* 6.9, C*H*CH$_3$), 2.26–2.18 (2H, m, C*H*$_2$CH=C), 2.15–2.03 (3H, m, C*H*CH$_3$, C*H*HCO$_2$ and C*H*CH$_2$CO$_2$), 1.96 (1H, br. d, *J* 14.3, C*H*HCHOCO), 1.76 (3H, s, IC=CC*H*$_3$), 1.71–1.63 (2H, m, C*H*$_2$CHOTBS), 1.54–1.44 (6H, m, Bu$_3$Sn-3 × C*H*$_2$), 1.47 (3H, s, C=CC*H*$_3$), 1.35–1.26 (7H, m, CH*H*CHOCO and Bu$_3$Sn-3 × C*H*$_2$), 1.11 (3H, d, *J* 6.9, CHC*H*$_3$), 1.05 (9H, s, TPS-^{t}Bu), 0.94–0.87 (18H, m, CHC*H*$_3$ and Bu$_3$Sn-3 × C*H*$_2$ and 3 × C*H*$_3$), 0.81 (9H, s, TBS-^{t}Bu), −0.08 (3H, s, TBS-Me), −0.10 (3H, s, TBS-Me); δ_C (90.6 MHz, $CDCl_3$), 170.7 (s), 165.2 (s), 150.5 (s), 148.3 (d), 144.5 (d), 135.5 (d), 133.9 (s), 133.8 (s), 130.3 (d), 129.6 (d), 129.0 (d), 127.7 (d), 124.2 (d), 88.3 (d), 83.3 (d), 78.1 (d), 74.5 (d), 72.2 (d), 60.7 (t), 56.1 (q), 46.1 (d), 38.7 (t), 38.2 (d), 36.0 (t), 35.3 (t), 32.1 (t), 30.9 (d), 29.1 (t), 27.2 (t), 26.8 (q), 25.7 (q), 19.2 (s), 19.0 (s), 18.0 (q), 15.3 (q), 13.7 (q), 11.4 (q), 9.9 (q), 9.5 (t), −5.0 (q), −5.4 (q); *m*/*z* (FAB), 1270 (M + Na) (45%), 1190 (M-^{t}Bu) (100).

Macrocyclic core 6

A 0.001 M stock catalyst solution was prepared by adding tris(dibenzylideneacetone)dipalladium(0) (4.60 mg, 5.00 µmol) and triphenylarsine (12.5 mg, 40.0 µmol) to freeze/pump/thaw (×3) degassed dimethylformamide (10 mL). 1.50 mL (1.50 µmol) of the stock catalyst solution was added to the macrocylisation precursor **50** (18.0 mg, 14.4 µmol) under argon at room temperature. The resulting solution was stirred and heated at 70 °C under argon for 5 h, then cooled and concentrated *in vacuo* (high vacuum) to leave a crude oil. The oil was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 5) to give the *E,E-conjugated diene* (5.70 mg, 48%) as a colourless oil. $[\alpha]_D^{21}$ −11 (*c* 1.30 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 1722, 1652; δ_H (400 MHz, $CDCl_3$), 7.74–7.67 (4H, m, Ar*H*), 7.47–7.34 (6H, m, Ar*H*), 6.73 (1H, ddd, *J* 4.7, 11.0 and 15.7, C*H*=CHCO$_2$), 6.23 (1H, dd, *J* 11.0 and 15.2, C=C*H*CH=C), 5.69 [1H, dq, *J* 1.0 and 11.0, C*H*=C(CH$_3$)], 5.62 (1H, apparent t, *J* 5.7, C=C*H*CH$_2$OTPS), 5.60 (1H, d, *J* 15.7, C=C*H*CO$_2$), 5.06 (1H, dd, *J* 9.7 and 15.2, C=C*H*CHCH$_3$), 4.52 (1H, dd, *J* 3.0 and 10.5, C*H*OCO), 4.37 (1H, dd, *J* 7.2 and 12.9, C*H*HOTPS), 4.27 (1H, dd, *J* 4.8 and 12.9, CH*H*OTPS), 3.87 (1H, dd, *J* 3.1 and 10.7, C*H*OTBS), 3.69 (1H, ddd, *J* 2.6, 9.8 and 12.1, C*H*OCO), 3.18 (1H, d, *J* 9.2, C*H*OMe), 3.16 (3H, s, OC*H*$_3$), 2.77 (1H, ddd, *J* 2.0, 5.2 and 17.8, C*H*HCO$_2$), 2.57–2.51 (1H, m, C*H*HCH=C), 2.30–2.08 (4H, m, 2 × C*H*CH$_3$, CH*H*CHOTBS and C*H*HCO$_2$), 1.98 (1H, br. dd, *J* 2.6 and 14.3, C*H*HCHOCO), 1.81–1.67 (2H, m, CH*H*CH=C and C*H*CH$_2$CO$_2$), 1.74 (3H, d, *J* 1.0, C=CC*H*$_3$), 1.63–1.56 (1H, m, CH*H*CHOTBS), 1.55 (3H, s, C=CC*H*$_3$), 1.21 (3H, d, *J* 6.5 CHC*H*$_3$), 1.06 (9H, s, TPS-^{t}Bu), 0.96 (3H, d, *J* 6.7, CHC*H*$_3$), 0.88 (9H, s, TBS-^{t}Bu), 0.66 (1H, ddd, *J* 12.1, 12.1 and 14.3, CH*H*CHOCO), 0.06 (3H, s, TBS-Me), −0.03 (3H, s, TBS-Me); δ_C (90.6 MHz, $CDCl_3$), 170.4 (s), 165.5 (s), 145.7 (d), 140.1 (s), 135.5 (d), 135.0 (s), 133.7 (s), 133.2 (d), 130.1 (d), 129.6 (d), 129.3 (d), 127.6 (d), 124.6 (d), 124.4 (d), 89.2 (d), 83.4 (d), 78.9 (d), 74.2 (d), 60.6 (t), 56.0 (q), 45.3 (d), 38.2 (d + t), 36.9 (t), 34.6 (t), 34.1 (t), 29.8 (d), 26.8 (q), 25.7 (q), 19.2 (s), 18.0 (s), 16.6 (q), 11.0 (q), 10.9 (q), 9.8 (q) −4.6 (q), −4.9 (q); *m*/*z* (FAB), 851.4704 (M + Na: $C_{49}H_{72}O_7NaSi_2$ requires 851.4714), 852 (M + Na) (100%), 574 (M − OTPS) (46).

Allylic alcohol 51a

A solution of TBAF–AcOH in tetrahydrofuran (1 : 1, 1.00 M, 64.0 µL, 64.0 µmol) was added to a stirred solution of the silyl ether **6** (35.0 mg, 42.3 µmol) in tetrahydrofuran (1 mL) at room temperature under argon. The mixture was stirred at room temperature under argon for 12 h, and then quenched by the addition of a saturated aqueous solution of ammonium chloride (0.5 mL). The mixture was diluted with ethyl actetate (15 mL), washed with brine (10 mL) and the aqueous phase was then separated and extracted with ethyl acetate (2 × 10 mL). The combined organic extracts were dried and concentrated *in vacuo* to leave a crude oil which was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 1) to give the *alcohol* (18.3 mg, 74%) as a colourless oil. $[\alpha]_D^{21}$ −8.3 (*c* 0.60 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 3523 (br.), 1721, 1650; δ_H (360 MHz, $CDCl_3$), 6.74 (1H, ddd, *J* 4.7, 11.0 and 15.7, C*H*=CHCO$_2$), 6.23 (1H, dd, *J* 11.0 and 15.1, C=C*H*CH=C), 5.72 [1H, d, *J* 11.0, C*H*=C(CH$_3$)], 5.61 (1H, d, *J* 15.7, C=C*H*CO$_2$), 5.58 (1H, dd, *J* 6.4 and 6.9, C=C*H*CH$_2$OH), 5.13 (1H, dd, *J* 9.7 and 15.1, C=C*H*CHCH$_3$), 4.53 (1H, dd, *J* 3.1 and 10.5, C*H*OCO), 4.33 (1H, dd, *J* 6.9 and 12.5, C*H*HOH), 4.24 (1H, dd, *J* 6.4 and 12.5, CH*H*OH), 3.90 (1H, dd, *J* 2.9 and 10.7, C*H*OTBS), 3.69 (1H, ddd, *J* 2.6, 9.9 and 12.0, C*H*OCO), 3.19 (4H, br. s, C*H*OMe and OC*H*$_3$), 2.77 (1H, dd, *J* 5.1 and 18.0, C*H*HCO$_2$), 2.55–2.52 (1H, m, C*H*HCH=C), 2.30–2.19 (2H, m, 2 × C*H*CH$_3$), 2.18–2.05 (2H, m, CH*H*CHOTBS and CH*H*CO$_2$), 1.99 (1H, dd, *J* 2.6 and 14.0, C*H*HCHOCO), 1.79–1.71 (2H, m, CH*H*CH=C and C*H*CH$_2$CO$_2$), 1.76 (3H, s, C=CC*H*$_3$), 1.74 (3H, s, C=CC*H*$_3$), 1.61 (1H, br. s, O*H*), 1.56 (1H, dd, *J* 2.9 and 14.9, CH*H*CHOTBS), 1.22 (3H, d, *J* 6.4, CHC*H*$_3$), 0.97 (3H, d, *J* 6.9, CHC*H*$_3$), 0.87 (9H, s, TBS-^{t}Bu), 0.68 (1H, ddd, *J* 12.0, 12.0 and 14.0, CH*H*CHOCO), 0.05 (3H, s, TBS-Me), −0.03 (3H, s, TBS-Me); δ_C (90.6 MHz, $CDCl_3$), 170.4 (s), 165.7 (s), 145.9 (d), 140.0 (s), 137.2 (s), 133.4 (d), 130.0 (d), 128.4 (d), 124.6 (2 × d), 89.3 (d), 83.4 (d), 78.9 (d), 74.1 (d), 58.9 (t), 56.2 (q), 45.3 (d), 38.3 (d), 38.2 (t), 36.9 (t), 34.6 (t), 34.0 (t), 29.8 (d), 25.7 (q), 18.0 (s), 16.6 (q), 11.0 (2 × q), 9.9 (q), −4.6 (q), −5.0 (q); *m*/*z* (ESI), 613.3521 (M + Na: $C_{33}H_{54}O_7NaSi$ requires 613.3537), 613 (M + Na) (100%), 573 (M − OH) (13).

Aldehyde 51b

Manganese dioxide (125 mg, 1.44 mmol) was added in a single portion to a stirred solution of the allylic alcohol **51a** (17.0 mg, 28.8 µmol) in dichloromethane (1 mL) at room temperature. The suspension was stirred rapidly at room temperature for 2 h, and then filtered through a pad of Celite and washed with dichloromethane (2 × 5 mL). The combined filtrates were concentrated *in vacuo*, and the residue was then purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 1) to give the *aldehyde* (17.0 mg, 100%) as a colourless oil. $[\alpha]_D^{21}$ −10.3 (*c* 1.55 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 2856, 1721, 1673, 1650; δ_H (360 MHz, $CDCl_3$), 10.3 (1H, d, *J* 7.9, C*H*O), 6.76 (1H, ddd, *J* 4.8, 11.0 and 15.7, C*H*=CHCO$_2$), 6.24 (1H, dd, *J* 10.9 and 15.2, C=C*H*CH=C), 5.96 (1H, d, *J* 7.9, C=C*H*CHO), 5.71 [1H, d, *J* 10.9, C*H*=C(CH$_3$)], 5.62 (1H, d, *J* 15.7, C=C*H*CO$_2$), 5.14 (1H, dd, *J* 9.7 and 15.2, C=C*H*CHCH$_3$), 4.55 (1H, dd, *J* 3.0 and 10.3, C*H*OCO), 3.89 (1H, dd, *J* 3.1 and 10.5, C*H*OTBS), 3.71 (1H, ddd, *J* 2.6, 9.9 and 12.0, C*H*OCO), 3.42 (1H, d, *J* 7.0, C*H*OCH$_3$), 3.23 (3H, s, OC*H*$_3$), 2.78 (1H, ddd, *J* 2.2, 5.3 and 17.9, C*H*HCO$_2$), 2.56–2.53 (1H, m, C*H*HCH=C), 2.31–2.24 (2H, m, 2 × C*H*CH$_3$), 2.23 (3H, s, C=CC*H*$_3$), 2.20–2.09 (2H, m, CH*H*CHOTBS and CH*H*CO$_2$), 1.98 (1H, dd, *J* 2.4 and 14.1, C*H*HCHOCO), 1.78–1.72 (2H, m, CH*H*CH=C and C*H*CH$_2$CO$_2$), 1.74 (3H, s, C=CC*H*$_3$), 1.65 (1H, dd, *J* 3.1 and 14.8, CH*H*CHOTBS), 1.22 (3H, d, *J* 6.4, CHC*H*$_3$), 0.95 (3H, d, *J* 7.0, CHC*H*$_3$), 0.87 (9H, s, TBS-^{t}Bu), 0.69 (1H, ddd, *J* 11.9, 11.9 and 14.2, CH*H*CHOCO), 0.05 (3H, s, TBS-Me), −0.03 (3H, s, TBS-Me); δ_C (90.6 MHz, $CDCl_3$), 190.7 (d), 170.3 (s), 165.8 (s), 160.2 (s), 146.2 (d), 139.9 (s), 133.5 (d), 130.0 (d), 128.6 (d), 124.6 (d), 124.4 (d), 88.2 (d), 83.3 (d), 78.8 (d), 74.5 (d), 57.2 (q), 45.3 (d), 38.6 (d), 38.2 (t), 36.9 (t), 34.6 (t), 29.7 (d), 29.6 (t), 25.8 (q), 18.0 (s), 16.6 (q), 12.8 (q), 11.0 (q), 9.0 (q), −4.7 (q), −5.0 (q); *m*/*z* (ESI), 611.3359 (M + Na: $C_{33}H_{52}O_7NaSi$ requires 611.3380), 611 (M + Na) (100%), 457 (M − OTBS) (37).

13-(*tert*-Butyldimethylsilyl)-rhizoxin D 52

The macrocycle **51b** and the phosphine oxide **8** were first dried by azeotroping with benzene (× 3) under vacuum. A solution of potassium hexamethyldisilazane in toluene (0.50 M, 95.0 µL, 47.5 µmol) was added dropwise over 1 min to a stirred solution of the phosphine oxide (16.0 mg, 47.5 µmol) in tetrahydrofuran (1 mL) at −78 °C under argon. The resulting bright orange mixture was then added to a solution of the aldehyde **51b** (14.0 mg, 23.8 µmol) in tetrahydrofuran (1 mL) at −78 °C over 2 min *via* cannula. The mixture was stirred at −78 °C for 5 min, then warmed to 0 °C over 10 min and stirred at 0 °C for a further 20 min under argon. The mixture was quenched at 0 °C by the addition of a saturated aqueous solution of ammonium chloride (0.2 mL), and then warmed to room temperature. The mixture was diluted with diethyl ether (10 mL), washed with brine (5 mL), and the organic extracts were then dried and concentrated *in vacuo*.

Triethylamine (13 µL, 95.0 µmol), 2,4,6-trichlorobenzoyl chloride (7.4 µL, 47.5 µmol) and 4-(dimethylamino)-pyridine (1 crystal) were added sequentially to a stirred solution of the residue in tetrahydrofuran (1 mL) at room temperature. The mixture was stirred for 3 h at room temperature, then diluted with diethyl ether (10 mL), washed with brine (10 mL), dried, and concentrated *in vacuo*. The solid residue was purified by flash column chromatography, eluting with ethyl acetate–light petroleum (bp 40–60 °C) (1 : 3) to give the *triene oxazole* (5.0 mg, 30%; 38% based on recovered starting material) as a pale yellow solid. $[\alpha]_D^{21}$ +60 (*c* 0.10 in $CHCl_3$); ν_{max}(sol.)/cm^{-1} 1720, 1650, 1601; δ_H (500 MHz, $CDCl_3$), 7.56 (1H, s, oxazole*H*), 6.76 (1H, ddd, *J* 4.6, 11.0 and 15.5, C*H*=CHCO$_2$), 6.64 (1H, dd, *J* 10.9 and 15.2, CH=C*H*CH=C(CH$_3$)), 6.38 [1H, d, *J* 15.2, C*H*=CHCH=C(CH$_3$)], 6.25 [1H, s, oxazole-C*H*=C(CH$_3$)], 6.21 (1H, dd, *J* 11.1 and 15.3, C=C*H*CH=C), 6.06 [1H, d, *J* 10.9, CH=CHC*H*=C(CH$_3$)], 5.68 [1H, d, *J* 11.1, C*H*=C(CH$_3$)], 5.61 (1H, d, *J* 15.5, C=C*H*CO$_2$), 5.10 (1H, dd, *J* 9.7 and 15.2, C=C*H*CHCH$_3$), 4.54 (1H, dd, *J* 3.0 and 10.6, C*H*OCO), 3.84 (1H, dd, *J* 2.7 and 10.9, C*H*OTBS), 3.69–3.67 (1H, m, C*H*OCO), 3.23 (1H, d, *J* 8.9, C*H*OCH$_3$), 3.19 (3H, s, OC*H*$_3$), 2.77 (1H, ddd, *J* 2.2, 5.3 and 17.9, C*H*HCO$_2$), 2.53 (1H, m, C*H*HCH=C), 2.43 (3H, s, oxazoleC*H*$_3$), 2.30–2.23 (2H, m, 2 × C*H*CH$_3$), 2.15 (3H, s, C=CC*H*$_3$), 2.18–2.06 (2H, m, CH*H*CHOTBS and CH*H*CO$_2$), 1.99 (1H, br. d, *J* 13.5, C*H*HCHOCO), 1.92 (3H, s, C=CC*H*$_3$), 1.76–1.68 (3H, m, CH*H*CH=C, C*H*CH$_2$CO$_2$ and CH*H*CHOTBS), 1.73 (3H, s, C=CC*H*$_3$), 1.20 (3H, d, *J* 6.4, CHC*H*$_3$), 0.99 (3H, d, *J* 7.0, CHC*H*$_3$), 0.88 (9H, s, TBS-^{t}Bu), 0.68 (1H, ddd, *J* 11.9, 11.9 and 13.5, CH*H*CHOCO), 0.04 (3H, s, TBS-Me), −0.06 (3H, s, TBS-Me); *m*/*z* (ESI), 708.4285 (M + H: $C_{41}H_{62}NO_7Si$ requires 708.4296), 708 (M + H) (100%).

Rhizoxin D 2

Pyridine (3 drops) and HF/pyridine complex (3 drops) were added sequentially to a stirred solution of the silyl ether **52** (3.0 mg, 4.2 µmol) in tetrahydrofuran (0.5 mL) in a Teflon flask at room temperature. The mixture was stirred at room temperature for 48 h, and then quenched by the careful addition of a saturated aqueous solution of sodium bicarbonate (5 mL). The mixture was diluted with ethyl acetate (5 mL), and the aqueous phase was then separated. The separated aqueous phase was extracted with ethyl acetate (3 × 5 mL), and the combined organic extracts were washed with dilute sodium bisulfate solution (10 mL), and brine (10 mL), then dried and concentrated *in vacuo*. The residue was purified by preparative TLC (two elutions with ethyl acetate–light petroleum; 3 : 2) to give *rhizoxin D* (2.0 mg, 74%) as a pale yellow solid. R_f 0.28 (ethyl acetate–light petroleum; 3 : 2); $[\alpha]_D^{21}$ +286 (*c* 0.04 in MeOH); λ_{max}(MeOH)/nm 297 (ε/dm^3 mol^{-1} cm^{-1} 38 700), 309 (49 900), 323 (36 500); ν_{max}(sol.)/cm^{-1} 3462, 1715, 1650, 1579; δ_H (500 MHz, $CDCl_3$), 7.55 (1H, s, oxazole*H*), 6.76 (1H, ddd, *J* 4.7, 11.0 and 15.5, C*H*=CHCO$_2$), 6.63 [1H, dd, *J* 10.9 and 15.2, CH=C*H*CH=C(CH$_3$)], 6.41 [1H, d, *J* 15.2, C*H*=CHCH=C(CH$_3$)], 6.28 [1H, s, oxazole-C*H*=C(CH$_3$)], 6.23 (1H, dd, *J* 11.1 and 15.3, C=C*H*CH=C), 6.13 [1H, d, *J* 10.9, CH=CHC*H*=C(CH$_3$)], 5.82 [1H, d, *J* 11.1, C*H*=C(CH$_3$)], 5.61 (1H, d, *J* 15.4, C=C*H*CO$_2$), 5.16 (1H, dd, *J* 9.6 and 15.3, C=C*H*CHCH$_3$), 4.58 (1H, dd, *J* 3.0 and 10.5, C*H*OCO), 3.91 (1H, dd, *J* 3.5 and 13.4, C*H*OH), 3.68 (1H, ddd, *J* 2.6, 9.6 and 11.9, C*H*OCO), 3.26 (1H, d, *J* 9.2, C*H*OCH$_3$), 3.18 (3H, s, OC*H*$_3$), 2.77 (1H, dd, 3.3 and 17.7, C*H*HCO$_2$), 2.53 (1H, m, C*H*HCH=C), 2.47 (3H, s, oxazoleC*H*$_3$), 2.32–2.28 (2H, m, 2 × C*H*CH$_3$), 2.16 (3H, s, C=CC*H*$_3$), 2.14 (1H, m, CH*H*CHOH), 2.08 (1H, dd, *J* 11.3 and 18.1, CH*H*CO$_2$), 1.97 (1H, br. d, *J* 13.9, C*H*HCHOCO), 1.90 (3H, s, C=CC*H*$_3$), 1.80 (3H, s, C=CC*H*$_3$), 1.74 (2H, m, CH*H*CH=C and C*H*CH$_2$CO$_2$), 1.69 (1H, m, CH*H*CHOTBS), 1.20 (3H, d, *J* 6.4, CHC*H*$_3$), 1.00 (3H, d, *J* 6.7, CHC*H*$_3$), 0.68 (1H, ddd, *J* 12.1, 12.1 and 13.9, CH*H*CHOCO); *m*/*z* (ESI), 648.3532 (M + MeOH + Na: $C_{36}H_{51}NNaO_8$ requires 648.3512), 648 (M + MeOH + Na) (100%), 576 (M − OH) (15).

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