Pergamon

Tetrahedron 55 (1999) 13471–13494

TETRAHEDRON

Stereoselective Synthesis of Substituted Tetrahydrofurans Using 5-*Endo-trig* Cyclisation Reactions

Donald Craig,*[a] Neil J. Ikin,[a] Neil Mathews,[b] and Alison M. Smith[a]

[a]*Department of Chemistry, Imperial College of Science, Technology and Medicine, London SW7 2AY, U.K.*
[b]*The Wellcome Research Laboratories, Langley Court, South Eden Park Road, Beckenham, Kent BR3 3BS, U.K.*

Received 2 August 1999; revised 2 September 1999; accepted 16 September 1999

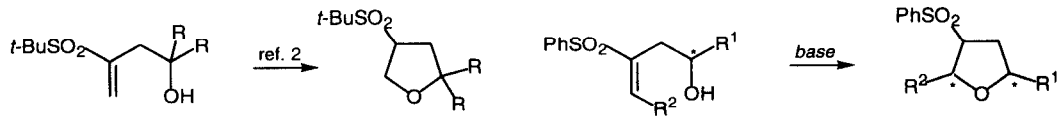
Abstract

Sulfonyl-substituted homoallylic alcohols undergo 5-*endo-trig* cyclisation reactions on treatment with base, with cyclisation stereoselectivity depending on double bond geometry.

Keywords: synthesis, sulfone, cyclisation, tetrahydrofuran

1. INTRODUCTION

Tetrahydrofurans are among the most significant classes of heterocycle in natural products, and consequently a wide range of methods for their synthesis has been developed.[1] In designing synthetic routes to tetrahydrofurans the intuitive disconnection of a carbon–oxygen bond in the ring implies the combination of a nucleophilic oxygen atom with an electrophilic carbon site. Work by Normant and co-workers in the mid-1980s[2] showed that tetrahydrofurans could be made using 5-*endo-trig*[3] reactions of vinylic sulfones possessing distal hydroxyl groups. Treatment of *t*-butylsulfones **1** with base caused efficient 5-*endo-trig* cyclisation to give tetrahydrofurans **2**. We became interested in extending this chemistry to more highly substituted substrates **3**. We were keen to assess the extent of asymmetric induction to the newly-formed stereocentre from that present in **3**, particularly as a function of vinylic sulfone double bond geometry. This paper reports our findings in full.[4]



Scheme 1

2. RESULTS AND DISCUSSION

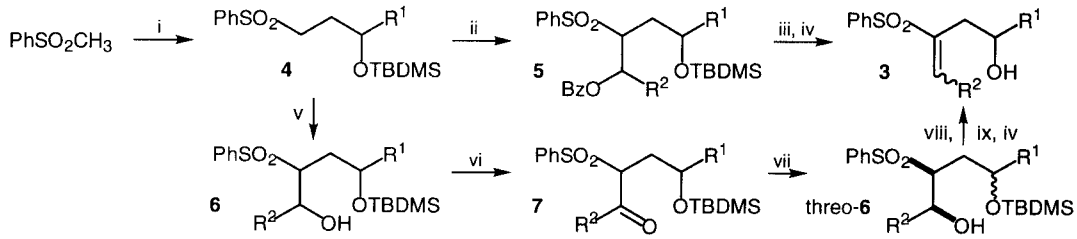
Synthesis of cyclisation substrates 3

Crucial to the viability of our planned study were ready sources of *E*- and *Z*-**3**, and we were able to apply the methodology of Julia to the synthesis of these substrates. Reaction of the lithio-anion of (phenylsulfonyl)methane in THF–DMPU with 2-substituted oxiranes, followed by quenching of the reactions

* e-mail: d.craig@ic.ac.uk

0040-4020/99/$ - see front matter
PII: S0040-4020(99)00832-7

with *t*-butylchlorodimethylsilane gave the expected silyl ethers **4** in good yield. For some of the larger-scale reactions, it was found more convenient to carry out the protection as a discrete step. Our plan for the preparation of *E*-**3** was based on the known[5] E1cB elimination of β-acyloxysulfones. Two sequences were deployed: in the first, reaction of deprotonated **4** with aldehydes followed by acylation *in situ* with benzoyl chloride gave the adducts **5** as four-component diastereomeric mixtures; the alternative method involved low-temperature proton quench of the reaction with aldehydes, isolation and benzoylation in a separate operation. Treatment with potassium *tert*-butoxide followed by desilylation gave predominantly *E*-**3**; the minor, *Z*-isomers were separable by chromatography on silica gel. The synthesis of *Z*-**3** required a change in tactics such as to accommodate the E2-type elimination from substrates analogous to **5** but with only the *threo*- stereochemistry.[6] Since **5**, and therefore the precursor alcohols **6** were formed non-selectively it was necessary to oxidise **6** to the β-ketosulfones **7**, and then to effect selective reduction prior to functionalisation of the *threo*-enriched secondary alcohols **6** in such a way as to activate them towards E2 rather than E1cB reaction. In the event, oxidation with PDC followed by reduction with $NaBH_4$–$CeCl_3$[7] gave *threo*-**6** in good overall yields. Subsequent tosylation, followed by elimination using NaOEt–EtOH gave mixtures containing in most cases predominantly the *Z*-isomers.[5] Desilylation gave *Z*-enriched mixtures of **3** which were separated by HPLC (Scheme 2, Table 1).



Reagents and conditions: (i) method A: *n*-BuLi, THF, -78°C→rt; add DMPU, then oxirane; add TBDMSCl, 0°C; method B: (a) *n*-BuLi, THF, -78°C→rt; add DMPU, then oxirane, 30 min, rt; (b) TBDMSOTf, py, CH_2Cl_2; (ii) method C: *n*-BuLi, THF, -78°C; add R^2CHO, -78°C, then BzCl, -78°C→rt; method D: (a) *n*-BuLi, THF, -78°C; add R^2CHO, -78°C; (b) *n*-BuLi, THF, -78°C; add BzCl, -78°C→rt; (iii) *t*-BuOK, *t*-BuOH, THF, rt; (iv) HF, MeCN; (v) *n*-BuLi, THF, -78°C; add R^2CHO, -78°C; (vi) PDC, 4Å ms, CH_2Cl_2, rt; (vii) $NaBH_4$, $CeCl_3$, MeOH, rt; (viii) *n*-BuLi, TsCl, THF, 0°C; (ix) NaOEt, EtOH, rt.

Scheme 2

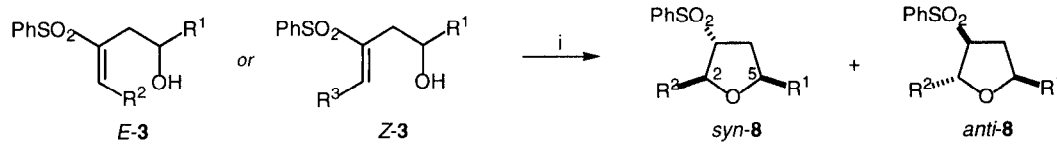
entry	R^1	R^2	% yield of **4** (method)[a]	% yield of **5** (method)[b]	% yield of **6**	% yield of **7**	% yield of *threo*-**6**	% yield of **3** (*E*:*Z*)[c]
a	Me	Me	85 (A)	71 (D)	-	-	-	92 (100:0)
b	Me	*i*-Pr	"	57 (C)[d]	-	-	-	80 (38:62)
c	Me	CH_2OCH_2Ph	"	41 (D)	-	-	-	65 (75:25)[e]
d	Me	Ph	"	89 (D)	-	-	-	85 (86:14)
e	Me	2,4-$(MeO)_2C_6H_3$	"	83 (D)	-	-	-	94 (83:17)
f	*n*-$C_{10}H_{21}$	Me	77 (A)	66 (D)	-	-	-	68 (100:0)
g	CH_2OCH_2Ph	Me	71 (A)	67 (D)	-	-	-	85 (100:0)
h	CH_2OCH_2Ph	2,4-$(MeO)_2C_6H_3$	"	70 (D)	-	-	-	82 (86:14)
i	Ph	Me	96 (A)	89 (C)	-	-	-	55 (100:0)
j	Ph	2,4-$(MeO)_2C_6H_3$	"	80 (D)	-	-	-	55 (80:20)
k	2-(2-methyl-1,3-dioxolan-2-yl)ethyl	Me	77 (A)	96 (C)	-	-	-	69 (100:0)[f]
l	Ph	Me	74 (B)	-	87	90	67	51 (50:50)
m	Ph	*i*-Pr	"	-	98	80	94	66 (10:90)
n	Ph	*i*-Bu	"	-	96	94	90	65 (25:75)
o	CH_2OCH_2Ph	*c*-C_6H_{11}	70 (B)	-	87	87	97	66 (30:70)

[a]For method B, yields are from the two steps from $PhSO_2Me$ [b]for method D, yields are from the two steps from **4**; [c]for entries **a-k** combined yields of **3** are for the two steps from **5**; for entries **l-o** combined yields of **3** are for the three steps from *threo*-**6**; [d]THF–DMPU was used as solvent; [e]elimination was carried out at -78°C; [f]TBAF was used for the deprotection step.

Table 1 Synthesis of cyclisation substrates **3**

Cyclisation reactions

The conditions of Normant and Knochel[2] were found not to be effective for cyclisation of substrates **3**. It was found instead that treatment of **3** with one equivalent of potassium *t*-butoxide in THF containing 5 or 10 equivalents of *t*-butanol led to smooth, and usually rapid cyclisation to give tetrahydrofurans **8**. Only two of the four possible diastereomers were formed, in which the R^2 and phenylsulfonyl groups were mutually *anti*-. Structural assignments followed from n.O.e. measurements:[8] for example, for *syn*-**8f** there was a 7% enhancement of H-2 on irradiation of H-5; *anti*-**8f** showed a 0% enhancement. Also, *syn*-**8** with R^2 = Me frequently gave large enhancements of H-3 upon irradiation of the C-2 Me signal (*syn*-**8f**: 9.5%; *syn*-**8g**: 10%; *syn*-**8k**: 9%). *Anti*-**8** typically showed n.O.e. effects demonstrating the proximity of H-3 and H-5 signal (*anti*-**8f**: 2.7%; *anti*-**8g**: 2%; *anti*-**8k**: 2.5%), indicating a *syn*-relationship of the C-3 phenylsulfonyl group and the C-5 substituent, and by implication an *anti*-relationship of the sulfonyl group with the group at C-2. The cyclisation reactions of *E*- and *Z*-**3** are summarised in Scheme 3 and Table 2.



E-**3** *Z*-**3** *syn*-**8** *anti*-**8**

Reagents and conditions: (i) conditions A: *t*-BuOK (1 equiv), *t*-BuOH (5 equiv), THF, 25°C; conditions B: *t*-BuOK (1 equiv), *t*-BuOH (10 equiv), THF, 25°C.

Scheme 3

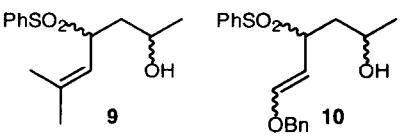
substrate	R^1	R^2	conditions	% yield	*syn*:*anti* **8**[a]
E-**3a**	Me	Me	A	81	57:43
E-**3b**	Me	*i*-Pr	A	0	-
Z-**3b**	Me	*i*-Pr	A	86	11:89
E-**3c**	Me	CH_2OCH_2Ph	A	0	-
E-**3d**	Me	Ph	A	18	100:0
E-**3e**	Me	2,4-$(MeO)_2C_6H_3$	A	60	80:20
E-**3f**	*n*-$C_{10}H_{21}$	Me	A	81	57:43
E-**3g**	CH_2OCH_2Ph	Me	A	86	64:36
E-**3h**	CH_2OCH_2Ph	2,4-$(MeO)_2C_6H_3$	A	76	67:33
E-**3i**	Ph	Me	A or B	76 or 62	67:33
Z-**3i**	Ph	Me	B	62	67:33
E-**3j**	Ph	2,4-$(MeO)_2C_6H_3$	A	19	80:20
E-**3k**	2-(2-methyl-1,3-dioxolan-2-yl)ethyl	Me	A	61	50:50
E-**3m**	Ph	*i*-Pr	B	67	90:10
Z-**3m**	Ph	*i*-Pr	B	83	10:90
E-**3n**	Ph	*i*-Bu	B	47	80:20
Z-**3n**	Ph	*i*-Bu	B	53	67:33
E-**3o**	CH_2OCH_2Ph	*c*-C_6H_{11}	B	69	90:10
Z-**3o**	CH_2OCH_2Ph	*c*-C_6H_{11}	B	87	10:90

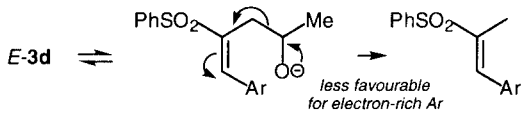
[a]ratios were determined by ^1H nmr integration of crude reaction mixtures

Table 2 Cyclisation of substrates **3**

Several trends emerged from the results collected in Table 2. Firstly, it was immediately apparent that cyclisation of most of the *E*-substrates was only weakly selective for the *syn*-products **8** (entries **a**, **e**-**k**); in general, substrates having CH_3 groups on the vinylic sulfone β-position showed the lowest selectivity. Nevertheless, a minority of substrates showed good levels of *syn*-selectivity (entries **m**, **o**); a common feature of these substrates was the presence of branching in R^2 adjacent to the vinylic sulfone double bond. Crucial to the success of these stereoselective transformations was the presence of increased amounts of *t*-butanol (Scheme 3, conditions B); under conditions A the similarly branched substrate *E*-**3b** gave none of the expected

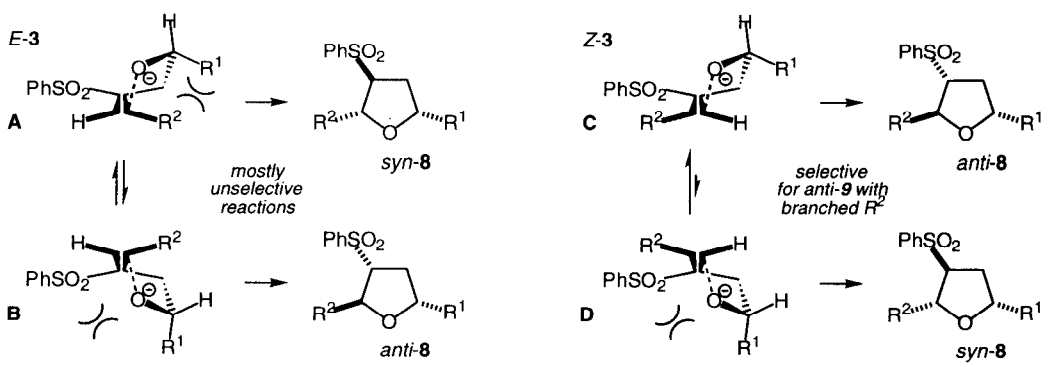
tetrahydrofuran, instead undergoing rapid isomerisation to provide the allylic sulfone **9** in near-quantitative yield. An analogous transformation, giving **10** occurred upon exposure of the γ-oxygenated substrate *E*-**3c** to conditions A. The second trend to emerge was the instability relative to the alkyl-substituted analogues of substrates *E*-**3** possessing β-aryl substitution on the vinylic sulfone. Thus, compound *E*-**3d** gave only small amounts of *syn*-**8d** on base treatment, albeit completely selectively; the major product isolated from this reaction was vinylic sulfone **11** (Ar = Ph). Presumably compound **11** (Ar = Ph) is the product of fragmentation of the conjugate base of *E*-**3d**, with the driving-force provided by delocalisation into the phenyl ring of negative charge in the conjugate base of **11** (Ar = Ph) formed on covalent bond scission (Scheme 4). Support for this hypothesis was provided by the observed attenuation of the fragmentation pathway in the reaction of the more electron-rich aryl-substituted substrates *E*-**3e** and *E*-**3h**, although the low yield of **8** obtained from *E*-**3j** suggests that these competing processes are finely balanced. The third major observation from the wide range of cyclisations carried out was that *Z*-**3** having α-branched R^2 groups underwent efficient cyclisation under conditions A or B, to give **8** with high *anti*-selectivity (entries **b**, **m** and **o**). As the steric demand of R^2 decreases, *syn*-selectivity is observed (entry **n**) although the selectivity is lower than for the isomeric *E*- substrate. For **3i**, possessing a methyl substituent on the vinylic sulfone, cyclisation selectivities were identical for the two geometric isomers; indeed, exposure of *Z*-**3i** to base followed immediately by quenching with acid gave a crude product containing mostly *E*-**3i**. Therefore it may be deduced that whilst more hindered *Z*-**3** undergo highly selective 5-*endo-trig* cyclisations to give mostly *anti*-**8**, less hindered *Z*- substrates enter into competing direct cyclisation and isomerisation–cyclisation processes, with the latter dominating when R^2 is methyl. The difference in the behaviour of *E*- and *Z*-**3b** under the more basic conditions A is striking, and may point towards an internal proton transfer mechanism for isomerisation of the former to the allylic compound. All of the product ratios resulted from kinetic preferences in irreversible transformations; exposure to the cyclisation conditions of isolated, single isomers of products **8** caused only slow decomposition, with no regeneration of isomeric **8** or **3**.





Scheme 4

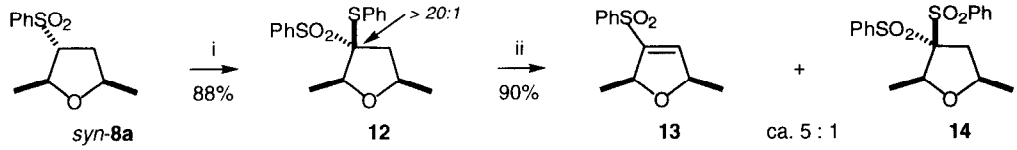
We were prompted to consider models which might explain the considerable differences in selectivities of cyclisation reactions of *E*- and *Z*-**3**. We had reasoned previously[4(i)] that reactions of *E*-**3** might be unselective on account of potentially destabilising interactions in the reactive conformations/transition-states **A** and **B** leading to both *syn*- and *anti*-**8**. This model led us to believe that reactions of *Z*-**3** would be selective for *anti*-**8**, since there was no longer a destabilising interaction in the corresponding reactive conformation **C**. Whilst this prediction was borne out by experiment, the model does not satisfactorily explain why *E*-**3** having more sterically demanding R^2 undergo more *syn*-selective reactions than the less encumbered analogues (Scheme 5).



Scheme 5

Derivatisation reactions of **8**

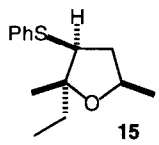
The final part of our study addressed some derivatisation reactions of **8**. Of particular interest was the stability of the conjugate bases of **8** resulting from deprotonation α- to the C-3 phenylsulfonyl group, since the earlier workers[2] had reported that related tetrahydrofurans underwent ring-opening in the presence of *n*-butyllithium at low temperature. Because of this reported lability, we opted to look at the reaction of the lithio-anion of *syn*-**8a** (R^1 = R^2 = Me) with reactive electrophiles which were likely to react at low temperature, minimising the likelihood of ring-opening. In the event, it was found that generation of lithiated *syn*-**8a** could be accomplished by treatment with *n*-BuLi at -93°C; after addition of DMPU as a co-solvent in order to maximise the nucleophilicity of the anion, low-temperature quenching with PhSSPh followed by acid yielded the thioacetal

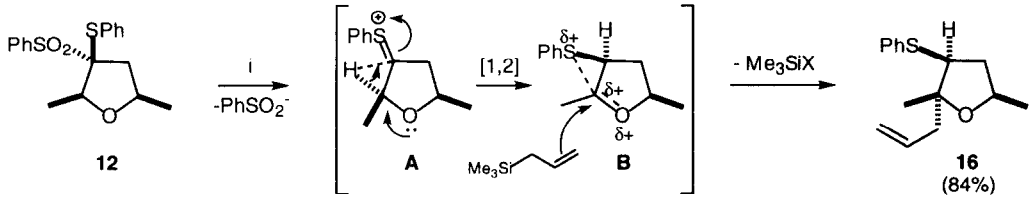


Reagents and conditions: (i) *n*-BuLi, THF, -93°C; DMPU (10% v/v), then PhSSPh (1.5 eq), -93°C→-78°C, then AcOH–THF (1 eq); (ii) CH_3CO_3H (10 eq), CH_3CO_2H–H_2O, CH_2Cl_2, rt, 12 h.

Scheme 6

S,*S*-dioxide **12** in high yield, and with excellent stereoselectivity. Although **12** is the product of approach of the electrophile from the more hindered face, *syn*- to the C-2 methyl group, this trajectory places the phenylsulfonyl group in the less hindered *anti*- orientation. Compound **12** entered into facile *S*-oxidation reactions, yielding the vinylic sulfone **13** *directly*[9] on exposure to peracid, together with a small amount of the disulfone **14** (Scheme 6). Compound **12** entered also into C–C bond-forming reactions. Treatment of a 1:1 mixture of **12** and allyltrimethylsilane with Et_2AlCl gave a 4:1 mixture of **15** and **16**; **16** was the sole product when $AlCl_3$ was used instead of Et_2AlCl in an otherwise identical reaction (Scheme 7). The formation of compounds **15** and **16** may be rationalised in terms of sequences involving (i) initial Lewis acid-mediated ionisation with loss of phenylsulfinate giving **A**; (ii) ring oxygen-assisted 1,2-migration of the C-2 hydrogen, yielding an anchimerically sulfur-stabilised oxocarbenium ion **B**;[10] (iii) trapping of this cationic species with a nucleophilic group (Et or allyl) from Al or Si. Whilst we have not carried out experiments to prove this mechanistic hypothesis, we have demonstrated the existence of oxygen-assisted 1,2-hydride shifts in related cationic systems in which the positive charge is stabilised initally by divalent sulfur.[11]





Reagents and conditions: (i) $AlCl_3$ (1.1 equiv) added to *syn*-**8a** + allyltrimethylsilane, CH_2Cl_2, -78°C.

Scheme 7

3. CONCLUSIONS

The foregoing results demonstrate that for vinylic sulfone substrates **3** the 5-*endo-trig* cyclisation reaction is a facile process which gives 2,5-disubstituted tetrahydrofurans with moderate to excellent stereoselectivities. We have demonstrated also that one of the product tetrahydrofurans **8** may be elaborated in such a way as to enable a carbon–carbon bond-forming reaction on the THF template, and that this process is highly stereoselective. Related ongoing work in our laboratory is addressing the analogous pyrrolidine-forming reactions,[12] particularly in the context of indolizidine-containing alkaloids, and the results of these studies will be reported in due course.

4. EXPERIMENTAL

General procedures

^{1}H Nmr spectra were recorded on either Bruker AM-500, Jeol GX-270Q or Bruker WM-250 spectometers, using residual isotopic solvent ($CHCl_3$, δ_H = 7.26 ppm) as an internal reference. Infra-red spectra were recorded on a Perkin-Elmer 881 or a Mattson 5000 FTIR spectrometer. Mass spectra were recorded using VG-7070B or Jeol SX-102 instruments. Elemental combustion analysis were performed in the Imperial College Chemistry Department microanalytical laboratory. Melting points were measured on a Reichert hot stage apparatus and are uncorrected. Chromatography refers to flash column chromatography on Merck Kieselgel 60 (230-400 mesh). Tlc refers to thin-layer chromatography performed on pre-coated Merck Kieselgel 60 F_{254} glass-backed plates and visualized with ultraviolet light (254 nm), iodine, acidic ammonium molybdate (IV), acidic ethanolic vanillin, aqueous potassium manganate(VII), 4,4'-bis(dimethylamino)benzhydrol in acetone and acidic methanolic 2,4-dinitrophenylhydrazine, as appropriate. Reactions were carried out at room temperature (rt) unless otherwise stated. Ether and THF were distilled from sodium-benzophenone ketyl; CH_2Cl_2 from phosphorus pentoxide; toluene and TMEDA from sodium wire and DMSO from calcium hydride. Where appropriate, all reagents were purified before use according to standard procedures.[13]

Preparation of 3-(*tert*-butyldimethylsilyloxy)-1-(phenylsulfonyl)butane (4a).

Method A: To a stirred solution of (phenylsulfonyl)methane (1.56 g, 10.0 mmol, 1.0 equiv) in THF (38 ml) under argon at -78°C was added, dropwise via syringe *n*-BuLi (4.4 ml of a 2.5M solution in hexanes, 11.0 mmol, 1.1 equiv). After stirring for 2 min at -78°C the bright yellow solution was warmed to rt in a water bath over 5 min, during which time a precipitate formed. DMPU (16 ml, 30% v/v) was added, causing the precipitate to dissolve, followed by 2-methyloxirane (0.73 ml in 1 ml of THF, 10.5 mmol, 1.05 equiv). Tlc after 15 min indicated complete reaction and the solution was then cooled to 0°C over 10 min. A pre-mixed/centrifuged mixture of TBDMSCl (3 g, 20 mmol, 2 equiv), Et_3N (3.6 ml, 25.6 mmol, 2.56 equiv) and THF (12.4 ml) (13 ml of mixture) was added dropwise to the solution causing it to become paler in colour. Tlc indicated complete reaction. After addition of water and separation of the organic phase, the aqueous layer was extracted with EtOAc (3 x 150 ml). The combined organic layers were washed with saturated aqueous $NaHCO_3$ (100 ml), and alternately with water (100 ml) and brine (3 x 100 ml), then dried ($MgSO_4$) and concentrated under reduced pressure to give a brown oil. This was purified by chromatography (20% ether–petrol) to give **4a** (2.79 g, 85%) as a colourless oil; R_f 0.61, 70% ether–petrol; ν_{max} (film) 2957, 2935, 2890, 2859, 1448, 1308, 1258, 1147, 1088 cm^{-1}; δ_H (250 MHz) 7.96-7.85 (2H, m, *ortho* protons on $PhSO_2$), 7.72-7.50 (3H, m, *meta* and *para* protons on $PhSO_2$), 3.90 (1H, m, H-3), 3.18 (2H, m, H-1), 1.93-1.63 (2H, m, H-2), 1.10 (3H, d, J 7.0 Hz, H-4), 0.84 (9H, s, *t*-BuSi), 0.01 (3H, s, MeSi), -0.03 (3H, s, MeSi); *m/z* (EI) 313 [M-Me]$^+$, 271, 199, 159, 149, 143, 135, 125, 115, 73 (Found: [M-*t*-Bu]$^+$, 271.0824. $C_{16}H_{28}O_3SSi$ requires [M-*t*-Bu]$^+$, 271.0824).

Preparation of 3-(*tert*-butyldimethylsilyloxy)-1-(phenylsulfonyl)tridecane (4f).

This was prepared on a 20 mmol scale using method A to give, after chromatography (11% ether–petrol), **4f** (7.02 g, 77%) as a colourless oil; R_f 0.65, 50% ether–petrol; ν_{max} (film) 2957, 2933, 2888, 2860, 1472, 1464, 1449, 1378, 1307, 1258, 1174, 1149, 1088, 1021, 986, 837, 778, 749, 690 cm^{-1}; δ_H (250 MHz) 7.94-7.85 (2H, m, *ortho* protons on $PhSO_2$), 7.70-7.50 (3H, m, *para* and *meta* protons on $PhSO_2$), 3.72 (1H, m, H-3), 3.16 (2H, t, J 8.0 Hz, H-1), 1.95-1.66 (2H, m, H-2), 1.45-1.10 (18H, m, H-4 - H-12), 0.97-0.83 (3H, m, H-13), 0.81 (9H, s, *t*-BuSi), -0.02 (3H, s, MeSi), -0.07 (3H, s, MeSi); *m/z* (EI) 439 [M-Me]$^+$, 397 [M-*t*-Bu]$^+$, 285, 199, 171, 135, 125, 115 (Found: [M-*t*-Bu]$^+$, 397.2241. $C_{25}H_{46}O_3SSi$ requires [M-*t*-Bu]$^+$, 397.2233).

Preparation of 1-benzyloxy-2-(*tert*-butyldimethylsilyloxy)-4-(phenylsulfonyl)butane (4g).

This was prepared on a 11.9 mmol scale using method A to give, after chromatography (18% ether–petrol), **4g** (3.99 g, 71%) as a colourless oil; R_f 0.70, 75% ether–petrol; ν_{max} (film) 2956, 2929, 2879, 2859, 1472, 1448, 1308, 1254, 1147, 1088, 1000, 837 cm^{-1}; δ_H (250 MHz) 7.97-7.83 (2H, m, *ortho* protons on $PhSO_2$), 7.76-7.50 (3H, m, *meta* and *para* protons on $PhSO_2$), 7.42-7.19 (5H, m, Ph), 4.49 (1H, d, J 13.5 Hz, PhC*H*$_2$),

4.42 (1H, d, J 13.5 Hz, PhCH_2), 3.91 (1H, quintet, J 5.5 Hz, H-2), 3.37 (1H, dd, J 9.5, 5.5 Hz, H-1), 3.24 (1H, dd, J 9.5, 7.0 Hz, H-1), 3.17 (2H, t, J 8.5 Hz, H-4), 2.04-1.78 (2H, m, H-3), 0.83 (9H, s, *t*-BuSi), 0.00 (3H, s, MeSi), -0.01 (3H, s, MeSi); *m/z* (EI) 377 [M-*t*-Bu]$^+$, 313, 271, 257, 243, 199, 91, 77 (Found: C, 63.54; H, 7.98. $C_{23}H_{34}O_4SSi$ requires C, 63.55; H, 7.89%).

Preparation of 1-(*tert*-butyldimethylsilyloxy)-1-phenyl-3-(phenylsulfonyl)propane (4i).

This was prepared on a 10 mmol scale using method A to give, after chromatography (20% ether–petrol), **4i** (3.75 g, 96%) as a colourless oil; R_f 0.54, 60% ether–petrol; ν_{max} (film) 2953, 2929, 2885, 2855, 1446, 1307, 1256, 1152, 1087, 1071, 836 cm^{-1}; δ_H (270 MHz) 7.91-7.17 (10H, m, $PhSO_2$, Ph), 4.80 (1H, t, J 5.5 Hz, H-1), 3.13 (2H, m, H-3), 2.12-1.98 (2H, m, H-2), 0.85 (9H, s, *t*-BuSi), -0.03 (3H, s, MeSi), -0.18 (3H, s, MeSi); *m/z* (EI) 390 [M]$^+$, 375, 333, 221, 135, 117, 57 (Found: C, 64.38; H, 7.89. $C_{21}H_{30}O_3SSi$ requires C, 64.57; H, 7.74%).

Preparation of 2-(3-(*tert*-butyldimethylsilyloxy)-5-(phenylsulfonyl)pentyl)-2-methyl-1,3-dioxolane (4k).

This was prepared on a 9.47 mmol scale using method A to give, after chromatography (40% ether–petrol), **4k** (3.12 g, 77%) as a colourless oil; R_f 0.63, ether; ν_{max} (film) 2953, 2883, 2856, 1446, 1310, 1254, 1143, 1083, 836 cm^{-1}; δ_H (250 MHz) 7.97-7.84 (2H, m, *ortho* protons on $PhSO_2$), 7.70-7.50 (3H, m, *meta* and *para* protons on $PhSO_2$), 3.89 (4H, m, H-1', H-2'), 3.76 (1H, m, H-3), 3.15 (2H, t, J 8.0 Hz, H-1), 1.93-1.34 (6H, m, H-2, H-4, H-5), 1.26 (3H, s, H-7), 0.80 (9H, s, *t*-BuSi), 0.00 (3H, s, MeSi), -0.06 (3H, s, MeSi); *m/z* (EI) 413 [M-Me]$^+$, 341, 327, 281, 269, 253, 111, 87, 43 (Found: [M-Me]$^+$, 413.1818. $C_{21}H_{36}O_5SSi$ requires [M-Me]$^+$, 413.1818).

Preparation of 5-(*tert*-butyldimethylsilyloxy)-3-phenylsulfonyl-2-hexanol 2-benzoate (5a).

Method D: To a stirred solution of silyl ether **4a** (2.79 g, 8.49 mmol, 1.0 equiv) in THF (50 ml) under argon at -78°C was added *n*-BuLi (5.98 ml of a 1.42M solution in hexanes, 9.34 mmol, 1.1 equiv). After 5 min acetaldehyde (4.94 ml of a 5.16M solution in THF, 25.47 mmol, 3 equiv) was added to the bright yellow solution, resulting in the discharge of most of the colour. Acetic acid (5.82 ml of a 1.75M solution in THF, 10.19 mmol, 1.2 equiv) was added and the mixture allowed to warm to rt. After addition of water the organic phase was separated and the aqueous layer extracted with CH_2Cl_2 (4 x 50 ml). The combined organic layers were washed with water (200 ml), dried ($MgSO_4$) and concentrated under reduced pressure to yield a colourless oil. This was purified by chromatography (33% ether–petrol) to give a 1:1:1:1 mixture of diastereomeric hydroxysulfones (2.83 g, 89%). A portion of the hydroxysulfones (2.71 g, 7.28 mmol, 1.0 equiv) was dissolved in THF (28 ml) and *n*-BuLi (3.2 ml of a 2.5M solution in hexanes, 8.0 mmol, 1.1 equiv) was added dropwise via syringe under argon at -78°C. After 2 min BzCl (845 µl, 7.28 mmol, 1.0 equiv) was added to the bright yellow solution. After a further 5 min at -78°C the reaction was allowed to warm to rt, whereupon the colour was discharged. After addition of saturated aqueous $NaHCO_3$, the organic phase was separated and the aqueous layer extracted with CH_2Cl_2 (4 x 75 ml). The combined organic layers were washed with 1M aqueous NaOH (2 x 120 ml), water (2 x 80 ml), dried ($MgSO_4$) and concentrated under reduced pressure to give a pale yellow oil. This was purified by chromatography (16% ether–petrol) to give a 1:1:1:1 mixture of diastereomeric benzoates **5a** (2.77 g, 80%; 71% over two steps from **4a**) as a colourless oil; R_f 0.51, 50% ether–petrol; ν_{max} (film) 2930, 2899, 2859, 1725, 1604, 1587, 1473, 1463, 1448, 1379, 1320, 1270, 1178, 1150, 1085, 1027, 1004, 975, 907, 837, 809, 777, 745, 714, 689 cm^{-1}; δ_H (500 MHz) 8.00-7.80 (12H, m, *ortho* and *para* protons on $PhSO_2$), 7.75-7.30 (28H, m, *meta* protons on $PhSO_2$, *ortho*, *meta* and *para* protons on Ph), 5.70-5.61 (2H, m, H-2), 5.58 (1H, dq, J 6.5, 3.0 Hz, H-2), 5.28 (1H, m, H-2), 4.30 (1H, m, H-5), 4.22 (2H, m, H-5), 4.00 (1H, m, H-5), 3.79 (1H, dt, J 8.5, 3 0 Hz, H-3), 3.64 (1H, dt, J 7.5, 4.0 Hz, H-3), 3.42 (1H, ddd, J 6.5, 5.0, 2.5 Hz, H-3), 3.38 (1H, d, J 8.0 Hz, H-3), 2.40-1.85 (8H, m, H-4), 1.61 (3H, d, J 5.0 Hz, H-1), 1.49 (3H, d, J 6.5 Hz, H-1), 1.47 (3H, d, J 6.5 Hz, H-1), 1.34 (3H, d, J 6.5 Hz, H-1), 1.27 (3H, d, J 6.0 Hz, H-6), 1.23 (3H, d, J 6.0 Hz, H-6), 1.15 (3H, d, J 6.0 Hz, H-6), 1.08 (3H, d, J 6.0 Hz, H-6), 0.90 (9H, s, *t*-

BuSi), 0.87 (9H, s, *t*-BuSi), 0.78 (9H, s, *t*-BuSi), 0.71 (9H, s, *t*-BuSi), 0.14 (3H, s, MeSi), 0.11 (3H, s, MeSi), 0.09 (3H, s, MeSi), 0.08 (3H, s, MeSi), 0.01 (3H, s, MeSi), -0.01 (3H, s, MeSi), -0.03 (3H, s, MeSi), -0.05 (3H, s, MeSi); *m/z* (EI) 461 $[M\text{-}Me]^+$, 419 $[M\text{-}t\text{-}Bu]^+$, 339, 310, 297, 199, 173, 159, 105 (Found: $[M\text{-}t\text{-}Bu]^+$, 419.1348. $C_{25}H_{36}O_5SSi$ requires $[M\text{-}t\text{-}Bu]^+$, 419.1348).

Preparation of 6-(*tert*-butyldimethylsilyloxy)-2-methyl-4-phenylsulfonyl-3-heptanol 3-benzoate (5b).

Method C: To a stirred solution of silyl ether **4a** (1.5 g, 4.56 mmol, 1 equiv) in THF (9 ml) under argon at -78°C was added, dropwise *via* syringe *n*-BuLi (2.18 ml of a 2.3M solution in hexanes, 5.01 mmol, 1.1 equiv). After 5 min at -78°C isobutyraldehyde (455 µl, 5.01 mmol, 1.1 equiv) was added to the bright yellow solution, causing the colour to fade slightly. DMPU (3.8 ml of a 30% v/v solution in THF) was added followed by BzCl (530 µl, 4.56 mmol, 1 equiv) and the solution was allowed to warm to rt. After addition of saturated aqueous $NaHCO_3$ the organic phase was separated and the aqueous layer was extracted with EtOAc (3 x 50 ml). The combined organic layers were washed with 1M aqueous NaOH (2 x 30 ml), and alternately with water (3 x 30 ml) and brine (3 x 30 ml). The solution was then dried ($MgSO_4$) and concentrated under reduced pressure to give a pale yellow oil. This was purified by chromatography (10% ether–petrol) to give a 1:1 mixture of diastereomeric benzoates **5b** (1.11 g, 57%) as a colourless oil; R_f 0.35, 25% ether–petrol; ν_{max} (film) 2958, 2930, 2883, 2859, 1724, 1472, 1448, 1308, 1268, 1146, 1084, 1071, 1027, 837, 776, 712, 689, 648 cm^{-1}; δ_H (500 MHz) 8.03-7.80 (6H, m, *ortho* and *para* protons on $PhSO_2$), 7.64-7.34 (14H, m, *meta* protons on $PhSO_2$, *ortho*, *meta* and *para* protons on Ph), 5.28 (1H, dd, J 10.0, 2.0 Hz, H-3), 5.24 (1H, dd, J 6.5, 5.0 Hz, H-3), 4.07-3.98 (2H, m, H-6), 3.86 (1H, ddd, J 8.0, 5.0, 4.0 Hz, H-4), 3.78 (1H, dt, J 10.0, 2.5 Hz, H-4), 2.96 (1H, heptet, J 10.0, 6.5 Hz, H-2), 2.57 (1H, octet, J 6.5 Hz, H-2), 2.08 (1H, ddd, J 15.0, 7.5, 4.0 Hz, H-5), 1.84-1.77 (2H, m, H-5), 1.70 (1H, ddd, J 14.0, 10.5, 2.5 Hz, H-5), 1.14 (3H, d, J 6.5 Hz, Me), 1.07 (3H, d, J 6.0 Hz, Me), 1.03 (3H, d, J 6.0 Hz, Me), 1.02 (3H, d, J 6.5 Hz, Me), 0.97 (3H, d, J 6.5 Hz, Me), 0.95 (3H, d, J 6.5 Hz, Me), 0.82 (9H, s, *t*-BuSi), 0.74 (9H, s, *t*-BuSi), 0.03 (3H, s, MeSi), 0.02 (6H, s, MeSi),-0.02 (3H, s, MeSi); *m/z* (EI) 447, 375, 325, 271, 241, 233, 217, 199, 179, 159, 135, 105, 77, 73 (Found: $[M\text{-}t\text{-}Bu]^+$, 447.1660. $C_{27}H_{40}O_5SSi$ requires $[M\text{-}t\text{-}Bu]^+$, 447.1662).

Preparation of 1-benzyloxy-5-(*tert*-butyldimethylsilyloxy)-3-phenylsulfonyl-2-hexanol 2-benzoate (5c).

This was prepared on a 3.25 mmol scale using method D to give, after chromatography (20% ether–petrol) a 6:4:1 mixture of diastereomeric benzoates **5c** (41% over two steps from **4a**) as a colourless oil; R_f 0.55, 50% ether–petrol; ν_{max} (film) 2931, 2858, 1727, 1603, 1587, 1472, 1449, 1376, 1321, 1269, 1178, 1150, 1095, 1028, 1001, 837, 808, 777, 711 cm^{-1}; δ_H (500 MHz) 7.96-7.76 and 7.65-7.14 (45H, m, $PhSO_2$, Ph), 5.80 (1H, td, J 7.0, 2.0 Hz, H-2), 5.76-5.71 (1H, m, H-2), 5.43-5.40 (1H, m, H-2), 4.56 (1H, d, J 11.5 Hz, $PhCH_2$), 4.54 (1H, d, J 11.5 Hz, $PhCH_2$), 4.50 (1H, d, J 15.0 Hz, $PhCH_2$), 4.47 (1H, d, J 15.0 Hz, $PhCH_2$), 4.44 (1H, d, J 12.5 Hz, $PhCH_2$), 4.42-4.33 (2H, m, 1 x $PhCH_2$, 1 x H-5), 4.21 (1H, q, J 6.5 Hz, H-3), 4.08 (1H, td, J 9.5, 6.0 Hz, H-3), 4.06-4.02 (1H, m, H-5), 3.84 (1H, dt, J 9.5, 4.0 Hz, H-3), 3.80-3.73 (2H, m, 1 x H-5, 1 x H-1), 3.68-3.62 (3H, m, H-1), 3.57 (1H, dd, J 10.5, 6.0 Hz, H-1), 3.52 (1H, dd, J 10.5, 6.0 Hz, H-1), 2.30-2.24 (2H, m, H-4), 2.18-2.13 (1H, m, H-4), 2.04 (1H, ddd, J 15.5, 10.5, 2.0 Hz, H-4), 1.98 (1H, dt, J 15.5, 6.0 Hz, H-4), 1.93-1.85 (1H, m, H-4), 1.27 (3H, d, J 6.5 Hz, H-6), 1.20 (3H, d, J 6.5 Hz, H-6), 1.10 (3H, d, J 6.5 Hz, H-6), 0.87 (18H, s, *t*-BuSi), 0.70 (9H, s, *t*-BuSi), 0.12 (3H, s, MeSi), 0.11 (3H, s, MeSi), 0.09 (3H, s, MeSi), 0.08 (3H, s, MeSi), -0.02 (6H, s, MeSi); *m/z* (EI) 582, 525, 403, 199, 159, 135, 105, 91, 73, 28 (Found: $[M\text{-}t\text{-}Bu]^+$, 525.1767. $C_{32}H_{42}O_6SSi$ requires $[M\text{-}t\text{-}Bu]^+$, 525.1767).

Preparation of 4-(*tert*-butyldimethylsilyloxy)-1-phenyl-2-(phenylsulfonyl)-1-pentanol 1-benzoate (5d).

This was prepared on a 4.60 mmol scale using method D to give, after chromatography (18% ether–petrol) a 6:5:4:2 mixture of diastereomeric benzoates **5d** (89% over two steps from **4a**) as a colourless oil; R_f 0.51, 40%

ether–petrol (2 elutions); ν_{max} (film) 2955, 2931, 2893, 2857, 1737, 1726, 1453, 1321, 1263, 1178, 1149, 1111, 1070, 838 cm^{-1}; δ_H (500 MHz) 7.93-7.70 (12H, m, *ortho* and *para* protons on $PhSO_2$), 7.64-7.10 (48H, m, *meta* protons on $PhSO_2$, *ortho*, *meta* and *para* protons on Ph), 6.69 (1H, s, H-1), 6.56 (1H, s, H-1), 6.38 (1H, d, J 7.5 Hz, H-1), 6.23 (1H, d, J 8.5 Hz, H-1), 4.33 (1H, m, H-4), 4.19-4.12 (2H, m, H-2, H-4), 3.97 (1H, td, J 8.0, 3.0 Hz, H-2), 3.72 (1H, dt, J 9.0, 2.0 Hz, H-2), 3.52 (1H, ddd, J 6.0, 4.5, 2.0 Hz, H-2), 3.43 (1H, m, H-4), 3.25 (1H, m, H-4), 1.13 (3H, d, J 6.0 Hz, H-5), 1.02 (3H, d, J 6.0 Hz, H-5), 0.96 (3H, d, J 6.5 Hz, H-5), 0.91 (3H, d, J 6.0 Hz, H-5), 0.89 (9H, s, *t*-BuSi), 0.88 (9H, s, *t*-BuSi), 0.80 (9H, s, *t*-BuSi), 0.69 (9H, s, *t*-BuSi), 0.13 (3H, s, MeSi), 0.03 (6H, s, MeSi), 0.00 (3H, s, MeSi), -0.02 (3H, s, MeSi), -0.03 (3H, s, MeSi), -0.10 (3H, s, MeSi), -0.16 (3H, s, MeSi); *m/z* (EI) 523 $[M\text{-}Me]^+$, 481 $[M\text{-}t\text{-}Bu]^+$, 359, 235, 213, 199, 179, 135, 105, 84, 49 (Found: $[M\text{-}t\text{-}Bu]^+$, 481.1505. $C_{30}H_{38}O_5SSi$ requires $[M\text{-}t\text{-}Bu]^+$, 481.1505).

Preparation of 4-(*tert*-butyldimethylsilyloxy)-1-(2,4-dimethoxyphenyl)-2-(phenylsulfonyl)-1-pentanol 1-benzoate (5e).

This was prepared on a 5.61 mmol scale using method D to give, after chromatography (35% ether–petrol) a 4:3:1 mixture of diastereomeric benzoates **5e** (83% over two steps from **4a**) as white foam; R_f 0.32, 30% ether–petrol (3 elutions); ν_{max} (film) 2954, 2930, 2854, 1722, 1610, 1448, 1306, 1260, 1209, 1148, 1111, 1028, 836, 711 cm^{-1}; δ_H (500 MHz) 8.04-7.93 (6H, m, *ortho* protons on $PhSO_2$), 7.80-7.27 (24H, m, *meta* and *para* protons on $PhSO_2$, *ortho*, *meta* and *para* protons on Ph), 7.20 (1H, d, J 8.5 Hz, H-6 on $(MeO)_2C_6H_3$), 7.15 (1H, d, J 8.5 Hz, H-6 on $(MeO)_2C_6H_3$), 7.06 (1H, d, J 8.5 Hz, H-6 on $(MeO)_2C_6H_3$), 6.63 (1H, broad s, H-1), 6.54 (1H, d, J 7.5 Hz, H-1), 6.44 (1H, d, J 7.5 Hz, H-1), 6.40 (1H, d, J 2.5 Hz, H-3 on $(MeO)_2C_6H_3$), 6.39-6.33 (3H, m, 3 x H-5 on $(MeO)_2C_6H_3$), 6.28 (1H, d, J 2.5 Hz, H-3 on $(MeO)_2C_6H_3$), 6.25 (1H, d, J 2.5 Hz, H-3 on $(MeO)_2C_6H_3$), 4.20 (1H, dt, J 4.5, 7.5 Hz, H-2), 4.11 (1H, dt, J 4.0, 7.5 Hz, H-2), 3.91-3.88 (1H, m, H-4), 3.75 (3H, s, OMe), 3.74 (3H, s, OMe), 3.73 (6H, s, OMe), 3.62 (1H, sextet, J 6.5 Hz, H-4), 3.59 (6H, s, OMe), 3.56-3.51 (2H, m, 1 x H-2, 1 x H-4), 2.42 (1H, ddd, J 15.0, 7.5, 5.0 Hz, H-3), 2.34 (1H, ddd, J 15.0, 8.0, 4.5 Hz, H-3), 2.24 (1H, ddd, J 15.0, 7.5, 5.0 Hz, H-3), 2.12 (1H, ddd, J 15.0, 7.5, 6.5 Hz, H-3), 1.66 (1H, ddd, J 15.0, 7.5, 5.0 Hz, H-3), 1.59 (1H, ddd, J 15.0, 8.0, 4.5 Hz, H-3), 1.10 (3H, d, J 6.5 Hz, H-5), 0.99 (3H, d, J 6.5 Hz, H-5), 0.91 (9H, s, *t*-BuSi), 0.87 (9H, s, *t*-BuSi), 0.85 (9H, s, *t*-BuSi), 0.83 (3H, d, J 6.5 Hz, H-5), 0.05 (3H, s, MeSi), 0.04 (3H, s, MeSi), 0.03 (3H, s, MeSi), 0.02 (3H, s, MeSi), -0.03 (3H, s, MeSi), -0.11 (3H, s, MeSi); *m/z* (EI) 541, 419, 336, 279, 251, 235, 220, 205, 177, 159, 115, 105, 77, 73 (Found: $[M\text{-}t\text{-}Bu]^+$, 541.1708. $C_{32}H_{42}O_7SSi$ requires $[M\text{-}t\text{-}Bu]^+$, 541.1716).

Preparation of 5-(*tert*-butyldimethylsilyloxy)-3-phenylsulfonyl-2-pentadecanol 2-benzoate (5f).

This was prepared on a 11.8 mmol scale using method D to give, after chromatography (10% ether–petrol), a *ca.* 1:1:1:1 mixture of diastereomeric benzoates **5f** (66% over two steps from **4f**) as a colourless oil; R_f 0.38, 25% ether–petrol; ν_{max} (film) 2929, 2856, 1725, 1604, 1587, 1449, 1361, 1308, 1270, 1178, 1151, 1085, 1070, 1027, 1005, 836, 808, 776, 712, 689 cm^{-1}; δ_H (500 MHz) 7.97-7.30 (40H, m, $PhSO_2$, Ph), 5.73-5.62 (2H, m, H-2), 5.60-5.51 (1H, m, H-2), 5.38-5.32 (1H, m, H-2), 4.18-4.10 (1H, m, H-5), 4.07-3.96 (2H, m, H-5), 3.90-3.81 (1H, m, H-5), 3.79-3.72 (1H, m, H-3), 3.66-3.58 (1H, m, H-3), 3.52-3.33 (2H, m, H-3), 2.30-1.87 (8H, m, H-4), 1.60 (3H, d, J 6.5 Hz, H-1), 1.50 (3H, d, J 6.5 Hz, H-1), 1.43-1.06 (78H, m, 2 x H-1, H-6 - H-14), 0.96-0.83 (30H, m, 2 x *t*-BuSi, 4 x H-15), 0.79 (9H, s, *t*-BuSi), 0.71 (9H, s, *t*-BuSi), 0.14 (3H, s, MeSi), 0.11 (3H, s, MeSi), 0.09 (3H, s, MeSi), 0.08 (3H, s, MeSi), 0.01 (3H, s, MeSi), -0.02 (6H, s, 2 x MeSi), -0.04 (3H, s, MeSi); *m/z* (EI) 545 $[M\text{-}t\text{-}Bu]^+$, 423, 299, 285, 199, 179, 135, 115, 105 (Found: $[M\text{-}t\text{-}Bu]^+$, 545.2757. $C_{34}H_{54}O_5SSi$ requires $[M\text{-}t\text{-}Bu]^+$, 545.2757).

Preparation of 6-benzyloxy-5-(*tert*-butyldimethylsilyloxy)-3-phenylsulfonyl-2-hexanol 2-benzoate (5g).

This was prepared on a 5.13 mmol scale using method D to give, after chromatography (24% ether–petrol), a 1:1:1:1 mixture of diastereomeric benzoates **5g** (67% over two steps from **4g**) as a colourless oil; R_f 0.40, 40% ether–petrol; ν_{max} (film) 2931, 2859, 1722, 1604, 1586, 1472, 1448, 1363, 1308, 1271, 1178, 1105, 1027, 837, 810, 778, 713, 690 cm^{-1}; δ_H (500 MHz) 7.95-7.84 (8H, m, *ortho* protons on $PhSO_2$), 7.84-7.77 (4H, m, *para* protons on $PhSO_2$), 7.74-7.58 (7H, m, *meta* protons on $PhSO_2$), 7.55-7.47 (9H, m, 1 x *meta* proton on $PhSO_2$, 8 x *ortho* protons on Ph), 7.43-7.17 (32H, m, 8 x *ortho*, 16 x *meta* and 8 x *para* protons on Ph), 5.75 (1H, broad quartet, J 6.5 Hz, H-2), 5.63 (1H, dq, J 2.0, 6.5 Hz, H-2), 5.54 (1H, dq, J 3.0, 6.5 Hz, H-2), 5.35 (1H, dq, J 3.5, 6.5 Hz, H-2), 4.65 (1H, d, J 12.0 Hz, $PhCH_2$), 4.57 (1H, d, J 12.0 Hz, $PhCH_2$), 4.54 (2H, s, $PhCH_2$), 4.52-4.43 (3H, m, 1 x H-5, 2 x $PhCH_2$), 4.35 (2H, s, $PhCH_2$), 4.31-4.22 (2H, m, H-5), 4.10 (1H, m, H-5), 3.85 (1H, dt, J 8.5, 3.5 Hz, H-3), 3.82-3.77 (1H, m, H-3), 3.61-3.54 (3H, m, 2 x H-3, 1 x H-6), 3.48 (1H, dd, J 10.0, 5.5 Hz, H-6), 3.45-3.37 (4H, m, H-6), 3.33 (1H, dd, J 10.0, 6.0 Hz, H-6), 3.28 (1H, dd, J 10.0, 5.5 Hz, H-6), 2.48-2.40 (2H, m, 2 x H-4), 2.31-2.26 (2H, m, 2 x H-4), 2.20-2.14 (2H, m, 2 x H-4), 2.06-1.96 (2H, m, 2 x H-4), 1.59 (3H, d, J 6.5 Hz, H-1), 1.47 (3H, d, J 6.5 Hz, H-1), 1.43 (3H, d, J 6.5 Hz, H-1), 1.37 (3H, d, J 6.5 Hz, H-1), 0.90 (9H, s, *t*-BuSi), 0.88 (9H, s, *t*-BuSi), 0.79 (9H, s, *t*-BuSi), 0.72 (9H, s, *t*-BuSi), 0.18 (3H, s, MeSi), 0.12 (6H, s, 2 x MeSi), 0.10 (3H, s, MeSi), 0.03 (3H, s, MeSi), -0.01 (3H, s, MeSi), -0.02 (3H, s, MeSi), -0.04 (3H, s, MeSi); *m/z* (EI) 525 $[M\text{-}t\text{-}Bu]^+$, 403, 339, 319, 291, 199, 179, 169, 135, 122, 117, 105, 91 (Found: $[M\text{-}t\text{-}Bu]^+$, 525.1770. $C_{32}H_{42}O_6SSi$ requires $[M\text{-}t\text{-}Bu]^+$, 525.1773).

Preparation of 5-benzyloxy-4-(*tert*-butyldimethylsilyloxy)-1-(2,4-dimethoxyphenyl)-2-(phenylsulfonyl)pentanol benzoate (5h).

This was prepared on a 1.47 mmol scale using method D to give, after chromatography (30% ether–petrol) a *ca.* 1:1:1:1 mixture of diastereomeric benzoates **5h** (70% over two steps from **4g**) as a white foam; R_f 0.47, 50% ether–petrol (2 elutions); ν_{max} (film) 2936, 2855, 1734, 1617, 1587, 1506, 1466, 1449, 1308, 1259, 1210, 1178, 1147, 1114, 1028, 837, 778, 710 cm^{-1}; δ_H (500 MHz) 8.05-7.20 (60H, m, $PhSO_2$, Ph), 7.15 (1H, d, J 8.5 Hz, H-6'), 7.10 (1H, d, J 8.5 Hz, H-6'), 6.98 (1H, d, J 8.5 Hz, H-6 on $(MeO)_2C_6H_3$), 6.65 (1H, s, H-1), 6.61 (1H, s, H-1), 6.58 (1H, d, J 8.5 Hz, H-6 on $(MeO)_2C_6H_3$), 6.48-6.44 (1H, m, H-5 on $(MeO)_2C_6H_3$), 6.37 (1H, dd, J 8.5, 2.0 Hz, H-5 on $(MeO)_2C_6H_3$), 6.34 (1H, dd, J 8.5, 2.0 Hz, H-6 on $(MeO)_2C_6H_3$), 6.32-6.21 (7H, m, 2 x H-1, 1 x H-5 on $(MeO)_2C_6H_3$, 4 x H-3 on $(MeO)_2C_6H_3$), 4.58 (1H, d, J 12.0 Hz, $PhCH_2$), 4.51 (1H, d, J 12.0 Hz, $PhCH_2$), 4.50 (2H, s, $PhCH_2$), 4.48-4.43 (1H, m, H-4), 4.37 (1H, d, J 12.0 Hz, $PhCH_2$), 4.34 (1H, d, J 12.0 Hz, $PhCH_2$), 4.32 (1H, d, J 12.0 Hz, $PhCH_2$), 4.28-4.23 (1H, m, H-4), 4.23 (1H, d, J 12.0 Hz, $PhCH_2$), 4.15-4.11 (1H, m, H-4), 3.84 (1H, m, H-4), 3.81-3.68 (12H, m, 3 x H-2, 3 x OMe), 3.65 (3H, s, OMe), 3.62 (1H, m, H-2), 3.53 (3H, s, OMe), 3.44 (1H, dd, J 7.0, 5.5 Hz, H-5), 3.42-3.37 (5H, m, 2 x H-5, OMe), 3.35 (1H, dd, J 9.0, 5.5 Hz, H-5), 3.29 (1H, dd, J 9.0, 5.0 Hz, H-5), 3.28 (3H, s, OMe), 3.22 (1H, dd, J 9.0, 5.0 Hz, H-5), 3.21 (3H, s, OMe), 3.14 (1H, dd, J 9.0, 5.0 Hz, H-5), 3.04 (1H, dd, J 9.0, 5.0 Hz, H-5), 2.56 (1H, ddd, J 14.5, 12.0, 2.5 Hz, H-3), 2.44 (2H, t, J 5.5 Hz, H-3), 2.42-2.30 (2H, m, H-3), 2.22-2.17 (1H, m, H-3), 2.04 (1H, m, H-3), 1.88-1.83 (1H, m, H-3), 0.91 (9H, s, *t*-BuSi), 0.85 (9H, s, *t*-BuSi), 0.66 (9H, s, *t*-BuSi), 0.65 (9H, s, *t*-BuSi), 0.07 (3H, s, MeSi), 0.06 (3H, s, MeSi), 0.04 (3H, s, MeSi), 0.02 (3H, s, MeSi), -0.01 (3H, s, MeSi), -0.02 (3H, s, MeSi), -0.03 (3H, s, MeSi), -0.07 (3H, s, MeSi); *m/z* (EI) 647 $[M\text{-}t\text{-}Bu]^+$, 525, 385, 320, 310, 177, 91 (Found: $[M\text{-}t\text{-}Bu]^+$, 647.2135. $C_{39}H_{48}O_8SSi$ requires $[M\text{-}t\text{-}Bu]^+$, 647.2135).

Preparation of 5-(*tert*-butyldimethylsilyloxy)-5-phenyl-3-phenylsulfonyl-2-pentanol 2-benzoate (5i).

This was prepared on a 10.88 mmol scale using method C (without the use of DMPU) to give, after chromatography (18% ether–petrol) a 1:1:1:1 mixture of diastereomeric benzoates **5i** (89%) as a colourless oil; R_f 0.60, 50% ether–petrol; ν_{max} (film) 2953, 2930, 2890, 2855, 1716, 1448, 1306, 1272, 1176, 1148, 1084,

1070, 837 cm^{-1}; δ_H (270 MHz) 8.00-7.04 (60H, m, $PhSO_2$, Ph), 5.75 (1H, dq, J 2.5, 7.5 Hz, H-2), 5.60 (1H, dq, J 3.0, 7.5 Hz, H-2), 5.42-5.27 (2H, m, H-2), 5.17 (1H, dd, J 10.0, 5.0 Hz, H-5), 5.13-4.96 (2H, m, H-5), 4.87 (1H, t, J 7.5 Hz, H-5), 3.87 (1H, m, H-3), 3.55 (1H, m, H-3), 3.45 (1H, m, H-3), 3.07 (1H, m, H-3), 2.64-2.07 (8H, m, H-4), 1.55 (3H, d, J 7.5 Hz, H-1), 1.47 (3H, d, J 7.5 Hz, H-1), 1.44 (3H, d, J 7.5 Hz, H-1), 1.09 (3H, d, J 7.5 Hz, H-1), 0.91 (9H, s, *t*-BuSi), 0.89 (9H, s, *t*-BuSi), 0.81 (9H, s, *t*-BuSi), 0.70 (9H, s, *t*-BuSi), 0.15 (3H, s, MeSi), 0.08 (3H, s, MeSi), -0.02 (3H, s, MeSi), -0.04 (3H, s, MeSi), -0.13 (3H, s, MeSi), -0.15 (3H, s, MeSi), -0.23 (3H, s, MeSi), -0.27 (3H, s, MeSi); *m/z* (EI) 538 $[M]^+$, 523, 481, 221, 199, 135, 105 (Found: C, 67.07; H, 7.19. $C_{30}H_{38}O_5SSi$ requires C, 66.88; H, 7.11%).

Preparation of 4-(*tert*-butyldimethylsilyloxy)-1-(2,4-dimethoxyphenyl)-4-phenyl-2-(phenylsulfonyl)butanol benzoate (5j).

This was prepared on a 7.88 mmol scale using method D to give, after chromatography (35% ether–petrol) a *ca.* 1:1:1:1 mixture of diastereomeric benzoates **5j** (80% over two steps from **4i**) as a white foam; R_f 0.39, 40% ether–petrol (2 elutions); ν_{max} (film) 2957, 2933, 2856, 1729, 1614, 1589, 1560, 1506, 1458, 1308, 1260, 1210, 1148, 1087, 1027, 939, 837, 778, 704 cm^{-1}; δ_H (500 MHz) 8.00-7.90 and 7.78-7.67 and 7.64-6.93 (64H, m, $PhSO_2$, Ph, 4 x H-6 on $(MeO)_2C_6H_3$), 6.64 (1H, s, H-1), 6.52 (1H, d, J 8.5 Hz, H-1), 6.50 (1H, d, J 8.5 Hz, H-1), 6.45 (1H, s, H-1), 6.42 (1H, dd, J 8.5, 2.5 Hz, H-5 on $(MeO)_2C_6H_3$), 6.41 (1H, dd, J 8.5, 2.5 Hz, H-5 on $(MeO)_2C_6H_3$), 6.39 (1H, dd, J 8.5, 2.5 Hz, H-5 on $(MeO)_2C_6H_3$), 6.38 (1H, dd, J 8.5, 2.5 Hz, H-5 on $(MeO)_2C_6H_3$), 6.34 (1H, d, J 2.5 Hz, H-3 on $(MeO)_2C_6H_3$), 6.26 (1H, d, J 2.5 Hz, H-3 on $(MeO)_2C_6H_3$), 6.24 (1H, d, J 2.5 Hz, H-3 on $(MeO)_2C_6H_3$), 6.04 (1H, d, J 2.5 Hz, H-3 on $(MeO)_2C_6H_3$), 5.09 (1H, dd, J 10.5, 3.5 Hz, H-4), 4.79 (1H, dd, J 8.0, 5.5 Hz, H-4), 4.71 (1H, dd, J 8.0, 6.5 Hz, H-4), 4.42 (1H, dd, J 7.5, 5.5 Hz, H-4), 4.11 (1H. m. H-2), 4.05 (1H, m, H-2), 3.82-3.70 (14H, 2 x H-2, 4 x OMe), 3.68 (3H, s, OMe), 3.56 (3H, s, OMe), 3.50 (3H, s, OMe), 3.26 (3H, s, OMe), 2.76-2.62 (2H, m, H-3), 2.55-2.48 (2H, m, H-3), 2.48-2.26 (2H, m, H-3), 2.00-1.90 (1H, m, H-3), 1.84-1.77 (1H, m, H-3), 0.89 (9H, s, *t*-BuSi), 0.84 (9H, s, *t*-BuSi), 0.83 (9H, s, *t*-BuSi), 0.67 (9H, s, *t*-BuSi), 0.01 (9H, s, MeSi), -0.08 (3H, s, MeSi), -0.27 (3H, s, MeSi), -0.29 (3H, s, MeSi), -0.32 (3H, s, MeSi), -0.40 (3H, s, MeSi); *m/z* (EI) 604 $[MH\text{-}t\text{-}Bu]^+$, 603 $[M\text{-}t\text{-}Bu]^+$ 481, 461, 398, 387, 357, 339, 265, 251, 235, 221 (Found: $[M\text{-}t\text{-}Bu]^+$, 603.1873. $C_{37}H_{44}O_7SSi$ requires $[M\text{-}t\text{-}Bu]^+$, 603.1873).

Preparation of 5-(*tert*-butyldimethylsilyloxy)-7-(2-methyl-1,3-dioxolan-2-yl)-3-phenylsulfonyl-2-heptanol 2-benzoate (5k).

This was prepared on a 6.72 mmol scale using method C (without the use of DMPU) to give, after chromatography (32% ether–petrol) a *ca.* 1:1:1:1 mixture of diastereomeric benzoates **5k** (96%) as a colourless oil; R_f 0.40, 60% ether–petrol; ν_{max} (film) 2955, 2858, 1720, 1604, 1586, 1473, 1448, 1379, 1308, 1273, 1150, 1071, 948, 837, 777, 714, 690 cm^{-1}; δ_H (500 MHz) 7.97-7.80 (12H, m, *ortho* and *para* protons on $PhSO_2$), 7.74-7.28 (28H, m, *meta* protons on $PhSO_2$, *ortho*, *meta* and *para* protons on Ph), 5.65 (1H, dq, J 1.5, 6.5 Hz, H-2), 5.53 (1H, dq, J 2.5, 6.5 Hz, H-2), 4.59 (1H, m, H-5), 4.31 (1H, m, H-5), 4.27-4.21 (1H, m, H-5), 4.20-4.15 (1H, m, H-5), 4.02-3.82 (16H, m, dioxolane protons), 3.78-3.71 (2H, m, H-3), 3.60 (1H, m, H-3), 3.35 (1H, m, H-3), 2.30-1.10 (24H, m, H-4, $CHCH_2CH_2$), 1.62 (3H, s, dioxolane Me), 1.59 (3H, d, J 6.5 Hz, H-1), 1.50 (3H, s, dioxolane Me), 1.37 (3H, s, dioxolane Me), 1.28 (3H, d, J 6.5 Hz, H-1), 1.27 (3H, s, dioxolane Me), 1.22 (3H, d, J 6.5 Hz, H-1), 1.19 (3H, d, J 6.5 Hz, H-1), 0.89 (9H, s, *t*-BuSi), 0.87 (9H, s, *t*-BuSi), 0.80 (9H, s, *t*-BuSi), 0.72 (9H, s, *t*-BuSi), 0.15 (3H, s, MeSi), 0.13 (3H, s, MeSi), 0.05 (3H, s, MeSi), 0.04 (3H, s, MeSi), 0.03 (3H, s, MeSi), 0.01 (3H, s, MeSi), -0.01 (3H, s, MeSi), -0.02 (3H, s, MeSi); *m/z* (EI) 561, 519, 483, 475, 455, 445, 429, 417, 401, 323, 279, 259, 199, 179, 137, 125, 105, 87, 73, 43 (Found: $[M\text{-}Me]^+$, 561.2342. $C_{30}H_{44}O_7SSi$ requires $[M\text{-}Me]^+$, 561.2351).

Preparation of *threo*-enriched 1-(*tert*-butyldimethylsilyloxy)-1-phenyl-3-phenylsulfonyl-4-pentanol (6l).

To a stirred solution of silyl ether **4i** (3 g, 7.68 mmol, 1.0 equiv) under nitrogen at -78°C in THF (38 ml) was added *n*-BuLi (3.4 ml of a 2.5 M solution in hexanes, 8.45 mmol, 1.1 equiv). After 5 min acetaldehyde (1.7 ml of a 4.87 M solution in THF, 8.06 mmol, 1.05 equiv) was added to the bright yellow solution, causing the discharge of most of the colour. Acetic acid (7.7 ml of a 1 M solution in THF, 7.68 mmol, 1.0 equiv) was added and the mixture allowed to warm to rt. After addition of water the organic phase was separated and the aqueous layer extracted with ether (3 x 250 ml). The combined organic layers were washed with water (150 ml) and brine (150 ml), dried ($MgSO_4$) and concentrated under reduced pressure to yield a yellow oil which was purified by chromatography (20% ether–petrol) to give a 1:1:1:1 mixture of diastereomeric hydroxysulfones **6l** (2.9 g, 87%). A portion of this material (1.4 g, 3.22 mmol, 1.0 equiv) was dissolved in CH_2Cl_2 (32 ml) and added to a mixture of powdered 4Å activated molecular sieves (3.2 g) and PDC (1.8 g, 4.83 mmol, 1.5 equiv) under nitrogen at room temperature. After 3 h the brown mixture was diluted with ether and filtered through silica gel. The filtrate was concentrated under reduced pressure to yield a yellow oil which was purified by chromatography (10% EtOAc–petrol) to give a 1:1 mixture of diastereomeric ketones **7l** (1.3 g, 90%) as a colourless oil. To a mixture of $CeCl_3 \cdot 7H_2O$ (1.0 g, 2.77 mmol, 1.0 equiv) and ketones **7l** (1.2 g, 2.77 mmol, 1.0 equiv) in MeOH (8 ml) at rt was added $NaBH_4$ (210 mg, 5.54 mmol, 2.0 equiv) in one portion. Gas and heat were evolved. After 25 min the mixture was poured into ether (30 ml) and washed with aqueous HCl (0.1 M, 30 ml). The organic phase was separated and the aqueous phase extracted with ether (4 x 30 ml). The combined organic layers were washed with water (2 x 50 ml) and brine (2 x 50 ml). The organic phase was dried ($MgSO_4$) and concentrated under reduced pressure to yield a yellow oil which was purified by chromatography (20% EtOAc–petrol) to give a 3:3:1:1 mixture of diastereomeric alcohols **6l** (0.8 g, 67%; 51% over three steps from **4i**) as a colourless oil; R_f 0.31, 50% ether–petrol; ν_{max} (film) 3510, 2929, 1447, 1304, 1146, 1082, 836, 777, 701 cm^{-1}; δ_H (270 MHz) 7.92-7.80 (4H, dd, J 8.5, 2.0 Hz, *ortho* protons on $PhSO_2$, minor diastereomer), 7.90-7.82 (4H, dd, J 8.5, 2.0 Hz, *ortho* protons on $PhSO_2$, major diastereomer), 7.70-7.40 (12H, m, *meta* and *para* protons on $PhSO_2$, major and minor diastereomer), 7.30-7.00 (20H, m, Ph, major and minor diastereomer), 4.95 (1H, t, J 5.5 Hz, H-1, major diastereomer), 4.79 (1H, t, J 8.5 Hz, H-1, minor diastereomer), 4.60-4.50 (2H, m, H-1, major and minor diastereomer), 4.40-4.30 (2H, m, H-4, major diastereomer), 4.22-4.12 (2H, m, H-4, minor diastereomer), 4.10 (1H, d, J 10.0 Hz, OH, major diastereomer), 3.38-3.30 (1H, m, H-3, major diastereomer), 3.25-3.19 (1H, m, H-3, major diastereomer), 3.08 (1H, m, H-3, minor diastereomer), 2.95-2.88 (1H, m, H-3, minor diastereomer), 2.40-2.00 (8H, m, H-2, major and minor diastereomer), 1.62 (1H, br s, OH, minor diastereomer), 0.99 (1H, d, J 6.5 Hz, OH major diastereomer), 0.80 (49H, m, H-5, OH minor diast and *t*-BuSi, major and minor diastereomer), 0.02 (3H, s, MeSi, major diastereomer), 0.00 (3H, s, MeSi, minor diastereomer), -0.01 (6H, s, MeSi, major and minor diastereomer), -0.16 (3H, s, MeSi, major diastereomer), -0.24 (3H, s, MeSi, minor diastereomer), -0.31 (3H, s, MeSi, major diastereomer), -0.32 (3H, s, MeSi, minor diastereomer); *m/z* (EI) 377, 333, 235, 221, 199, 181, 161, 149, 143, 135, 117, 107, 91, 75, 57 (Found: [M-*t*-Bu]$^+$, 377.1228. $C_{23}H_{34}O_4SSi$ requires [M-*t*-Bu]$^+$, 377.1243).

Preparation of *threo*-enriched 1-(*tert*-butyldimethylsilyloxy)-1-phenyl-3-phenylsulfonyl-5-methyl-4-hexanol (6m).

This was prepared analogously to *threo*-enriched **6l** on a 7.6 mmol scale to give, after chromatography (20% EtOAc–petrol), a 7:7:1:1 mixture of diastereomeric alcohols **6m** (74% over three steps from **4i**) as a colourless oil; R_f 0.28, 10% ether–petrol; ν_{max} (film) 3525, 2928, 1300, 1140, 1082, 836, 777 cm^{-1}; major diastereomers δ_H (270 MHz) 7.98-7.45 (10H, m, $PhSO_2$), 7.33-7.08 (10H, m, Ph), 4.80 (1H, dd, J 5.5, 4.5 Hz, H-1), 4.70 (1H, dd, J 9.0, 3.0 Hz, H-1), 3.60-3.40 (2H, m, H-4), 3.40-3.23 (2H, m, H-3), 3.22 (1H, d, J 9.0 Hz, OH), 2.20-1.90 (6H, m, H-2 and H-5), 1.70 (1H, br s, OH), 0.82-0.70 (30H, m, *t*-BuSi and H-6), 0.02 (3H, s, MeSi), 0.00 (3H, s, MeSi), -0.22 (6H, s, 2 x MeSi); *m/z* (EI) 447, 420, 405, 333, 303, 287, 263, 247, 221, 207, 199, 189, 181, 171, 163, 145, 135, 125, 117, 105, 97, 91, 83, 75, 57 (Found: [M-Me]$^+$, 447.2011. $C_{25}H_{38}O_4SSi$ requires [M-Me]$^+$, 447.2025).

Preparation of *threo*-enriched 1-(*tert*-butyldimethylsilyloxy)-1-phenyl-3-phenylsulfonyl-6-methyl-4-heptanol (6n).

This was prepared analogously to *threo*-enriched **6l** on a 5.48 mmol scale to give, after chromatography (10% EtOAc–petrol), a 3:3:1:1 mixture of diastereomeric alcohols **6n** (83% over three steps from **4i**) as a colourless oil; R_f 0.30, 10% EtOAc–petrol; ν_{max} (film) 3520, 2955, 2857, 1471, 1478, 1367, 1304, 1257, 1147, 1084, 1006, 937, 837, 778, 701 cm^{-1}; δ_H (270 MHz) 7.98-7.90 (4H, m, *ortho* protons on $PhSO_2$, 2 x major and 2 x minor diastereomer), 7.80-7.50 (16H, m, *ortho* protons on $PhSO_2$, 2 x major and 2 x minor diast and *meta* and *para* on $PhSO_2$ major and minor diastereomer), 7.30-7.05 (20H, m, Ph, major and minor diastereomer), 4.99 (1H, t, J 5.5 Hz, H-1, major diastereomer), 4.85-4.80 (1H, m, H-1, minor diastereomer), 4.70 (1H, dd, J 9.0, 6.5 Hz, H-1, minor diastereomer), 4.60 (1H, dd, J 9.0, 6.5 Hz, H-1, major diastereomer), 4.30-4.18 (2H, m, H-4, major diastereomer), 4.10-4.00 (2H, m, H-4, minor diastereomer), 3.80 (1H, d, J 9.0 Hz, OH, major diastereomer), 3.42-3.40 (1H, m, H-3, major diastereomer), 3.38-3.36 (1H, m, H-3, minor diastereomer), 3.30 (1H, dt, J 9.0, 1.0 Hz, H-3, major diastereomer), 2.93-2.89 (1H, m, H-3 minor diastereomer), 2.40-1.80 (8H, m, H-2, major and minor diastereomer), 1.78-1.42 (12H, m, H-6 and H-5, major and minor diastereomer), 1.00-0.75 (61H, m, H-7 and H-6 Me and *t*-BuSi, major and minor diast and OH, major diastereomer), 0.82 (1H, d, J 7.0 Hz, OH, major diastereomer), 0.70 (1H, d, J 7.0 Hz, OH, minor diastereomer), 0.62 (1H, d, J 7.0 Hz, OH, minor diastereomer), 0.10 (6H, s, 2 x MeSi, major and minor diastereomer), 0.08 (3H, s, MeSi, minor diastereomer), 0.62 (3H, s, MeSi, major diastereomer), -0.06 (3H, s, MeSi, major diastereomer), -0.16 (3H, s, MeSi, minor diastereomer), -0.22 (3H, s, MeSi, major diastereomer), -0.24 (3H, s, MeSi, minor diastereomer); *m/z* (EI) 419, 401, 333, 317, 277, 221, 199, 185, 163, 149, 135, 117, 91, 75, 57 (Found: $[M-t\text{-}Bu]^+$, 419.1732. $C_{26}H_{40}O_4SSi$ requires $[M-t\text{-}Bu]^+$, 419.1712).

Preparation of *threo*-enriched 1-benzyloxy-2-(*tert*-butyldimethylsilyloxy)-5-cyclohexyl-4-phenylsulfonyl-5-pentanol (6o).

This was prepared analogously to *threo*-enriched **6l** on a 6.06 mmol scale to give, after chromatography (25% EtOAc–petrol), a 5:5:1:1 mixture of diastereomeric alcohols **6o** (73% over three steps from **4g**) as a colourless oil; R_f 0.43, 25% EtOAc–petrol; ν_{max} (film) 3518, 2928, 2855, 1448, 1301, 1255, 1137, 1084, 837, 778, 734, 690, 665 cm^{-1}; major diastereomers δ_H (270 MHz) 7.95-7.90 (4H, d, J 8.0 Hz, *ortho* protons on $PhSO_2$), 7.70-7.42 (6H, m, *meta* and *para* protons on $PhSO_2$), 7.40-7.30 (10H, m, Ph), 4.58-4.42 (4H, m, H-2'), 4.18-4.08 (1H, m, H-2), 4.03-3.95 (1H, m, H-2), 3.80-3.21 (8H, m, H-1, H-4 and H-5), 2.21-1.41 (15H, m, 11 x cyclohexyl protons and H-3), 1.40-1.00 (11H, m, 11 x cyclohexyl protons), 0.93 (9H, s, *t*-BuSi), 0.91 (9H, s, *t*-BuSi), 0.18 (3H, s, MeSi), 0.13 (3H, s, MeSi), 0.07 (3H, s, MeSi), 0.03 (3H, s, MeSi); *m/z* (CI) 564 $[M+NH_4]^+$, 547 $[M+H]^+$, 529, 489, 452, 435, 415, 407, 389, 381, 372, 317, 310, 299, 283, 273, 255, 239, 199, 181, 167, 151, 132, 117, 108, 91, 78, 65 (Found: $[M+H]^+$, 547.3047. $C_{30}H_{46}O_5SSi$ requires $[M+H]^+$, 547.2914).

Preparation of (*E*)-4-phenylsulfonyl-4-hexen-2-ol (3a).

To a stirred solution of benzoates **5a** (2.63 g, 5.52 mmol, 1.0 equiv) in THF (80 ml) under argon at rt was added, portionwise *t*-BuOK (6.35 ml of a 1.0M solution in THF, 6.35 mmol, 1.15 equiv). The addition caused a transient yellow colour and the formation of a white precipitate, and towards the end of the addition the solution became pale yellow in colour. The reaction was quenched by the addition of saturated aqueous NH_4Cl (15 ml). The organic phase was separated and the aqueous layer was extracted with CH_2Cl_2 (3 x 100 ml). The combined organic layers were washed with water (75 ml), dried ($MgSO_4$) and concentrated under reduced pressure to give an orange oil. Chromatography (17% ether–petrol) gave the *E*- vinylic sulfone (1.83 g, 94%) as a colourless oil. To a portion of this material (1.61 g, 4.53 mmol, 1 equiv) dissolved in MeCN (45 ml) at rt was added HF (1.9 ml of a 48% w/v solution in water, 45.3 mmol, 10 equiv). After 1 h the reaction was quenched carefully with solid $NaHCO_3$. After addition of water, the organic phase was separated and the aqueous layer was extracted with CH_2Cl_2 (3 x 25 ml). The combined organic layers were washed with saturated aqueous $NaHCO_3$ (50 ml), water (50 ml), dried ($MgSO_4$) and concentrated under reduced pressure to give a colourless

solid. Chromatography (80% ether–petrol) gave **3a** (1.07 g, 98%; 92 % over two steps from **5a**) as a colourless oil; R_f 0.14, 60% ether–petrol; ν_{max} (film) 3517, 2969, 1648, 1458, 1448, 1376, 1305, 1132, 1082, 933, 738, 690 cm^{-1}; δ_H (250 MHz) 7.90-7.82 (2H, m, *ortho* protons on $PhSO_2$), 7.67-7.49 (3H, m, *meta* and *para* protons on $PhSO_2$), 7.14 (1H, q, J 7.0 Hz, H-5), 4.03 (1H, m, H-2), 2.63 (1H, d, J 4.0 Hz, OH), 2.35 (2H, d, J 6.0 Hz, H-3), 1.90 (3H, d, J 7.0 Hz, H-6) 1.19 (3H, d, J 6.0 Hz, H-1); *m/z* (EI) 225 $[M-Me]^+$, 196, 143, 77 (Found: C, 60.20; H, 6.50. $C_{12}H_{16}O_3S$ requires C, 60.00; H, 6.71%).

Preparation of (*E*)- and (*Z*)-6-methyl-4-phenylsulfonyl-4-hepten-2-ol (3b).

These were prepared analogously to **3a** on a 1.7 mmol scale to give, after chromatography (68% ether–petrol) (*E*)-**3b** and (*Z*)-**3b** (38:62 ratio; 80% combined yield over two steps from **5b**) as colourless oils; (*E*)-**3b**: R_f 0.31, 70% ether–petrol; ν_{max} (film) 3508, 2963, 2927, 2868, 1635, 1445, 1302, 1180, 1140, 1082, 998, 765, 743, 689, 611 cm^{-1}; δ_H (250 MHz) 7.92-7.78 (2H, m, *ortho* protons on $PhSO_2$), 7.65-7.46 (3H, m, *meta* and *para* protons on $PhSO_2$), 6.83 (1H, d, J 10.5 Hz, H-5), 4.0 (1H, m, H-2), 2.76 (1H, d, J 4.0 Hz, OH), 2.65 (1H, dheptet, J 10.5, 6.5 Hz, H-6), 2.29 (2H, d, J 6.0 Hz, H-3), 1.16 (3H, d, J 6.0 Hz, H-1), 1.05 (3H, d, J 6.5 Hz, H-7), 1.04 (3H, d, J 6.5 Hz, H-7); *m/z* (EI) 268, 253, 250, 238, 224, 143, 125, 109, 82, 77, 67, 43 (Found: $[M-MeCHO]^+$, 224.0876. $C_{14}H_{20}O_3S$ requires $[M-MeCHO]^+$, 224.0871); (*Z*)-**3b**: R_f 0.25, 70% ether–petrol; ν_{max} (film) 3498, 2965, 2927, 1629, 1445, 1372, 1286, 1140, 1083, 936, 759, 734, 690, 670, 632 cm^{-1}; δ_H (250 MHz) 7.96 (2H, m, *ortho* protons on $PhSO_2$), 7.66-7.47 (3H, m, *meta* and *para* protons on $PhSO_2$), 5.90 (1H, d, J 11.0 Hz, H-5), 4.05 (1H, broad s, H-2), 3.48 (1H, dheptet, J 11.0, 6.5 Hz, H-6), 2.47 (1H, dd, J 14.5, 4.0 Hz, H-3), 2.40 (1H, broad doublet, OH), 2.30 (1H, dd, J 14.5, 8.0 Hz, H-3), 1.17 (3H, d, J 6.0 Hz, H-1), 0.92 (3H, d, J 6.5 Hz, H-7), 0.89 (3H, d, J 6.5 Hz, H-7); m / z (EI) 268, 253, 250, 238, 224, 143, 125, 109, 82, 77, 67, 43 (Found: $[M-MeCHO]^+$, 224.0876. $C_{14}H_{20}O_3S$ requires $[M-MeCHO]^+$, 224.0871).

Preparation of (*E*)- and (*Z*)-6-benzyloxy-4-phenylsulfonyl-4-hexen-2-ol (3c).

These were prepared analogously to **3a**, but carrying out the elimination reaction at -78°C on a 1.85 mmol scale to give, after chromatography (75% ether–petrol) (*E*)-**3c** and (*Z*)-**3c** (75:25 ratio; 65% combined yield over two steps from **5c**) as colourless oils; (*E*)-**3c**: R_f 0.26, 75% ether–petrol; ν_{max} (film) 3524, 2972, 2866, 1586, 1561, 1540, 1498, 1448, 1363, 1305, 1152, 1127, 1083, 1028, 933, 740, 690 cm^{-1}; δ_H (250 MHz) 7.92-7.84 (2H, m, *ortho* protons on $PhSO_2$), 7.69-7.50 (3H, m, *meta* and *para* protons on $PhSO_2$), 7.47-7.20 (5H, m, Ph), 7.13 (1H, t, J 6.0 Hz, H-5), 4.54 (2H, s, $PhCH_2$), 4.26 (2H, d, J 6.0 Hz, H-6), 3.90 (1H, q, J 6.0 Hz, H-2), 2.42 (1H, broad s, OH), 2.33 (2H, d, J 6.0 Hz, H-3), 1.12 (3H, d, J 6.0 Hz, H-1); *m/z* (EI) 302, 240, 222, 211, 195, 160, 143, 125, 110, 91, 77 (Found: $[M-MeCHO]^+$, 302.0977. $C_{19}H_{22}O_4S$ requires $[M-MeCHO]^+$, 302.0974); (*Z*)-**3c**: R_f 0.19, 75% ether–petrol; ν_{max} (film) 3503, 3064, 3031, 2971, 2928, 1644, 1586, 1498, 1448, 1360, 1305, 1207, 1150, 1081, 1029, 999, 932, 803, 739, 690 cm^{-1}; δ_H (250 MHz) 7.90-7.79 (2H, m, *ortho* protons on $PhSO_2$), 7.70-7.48 (3H, m, *meta* and *para* protons on $PhSO_2$), 7.45-7.27 (5H, m, Ph), 6.37 (1H, t, J 5.0 Hz, H-5), 4.71 (2H, d, J 5.0 Hz, H-6), 4.55 (2H, s, $PhCH_2$), 4.00 (1H, m, H-2), 2.32 (2H, m, H-3), 1.17 (3H, d, J 6.0 Hz, H-1); *m/z* (EI) 302, 271, 255, 253, 240, 222, 143, 125, 108, 91, 77 (Found: $[M-PhCH_2]^+$, 255.0690. $C_{19}H_{22}O_4S$ requires $[M-PhCH_2]^+$, 255.0691).

Preparation of (*E*)- and (*Z*)-5-phenyl-4-phenylsulfonyl-4-penten-2-ol (3d).

These were prepared analogously to **3a** on a 3.09 mmol scale to give, after chromatography (60% ether–petrol) (*E*)-**3d** and (*Z*)-**3d** (86:14 ratio; 85% combined yield over two steps from **5d**) as colourless oils; (*E*)-**3d**: R_f 0.27, 50% ether–petrol; ν_{max} (film) 3515, 1624, 1586, 1448, 1374, 1305, 1206, 1147, 1082, 1008, 941, 839, 739, 690, 624 cm^{-1}; δ_H (250 MHz) 8.00-7.90 (3H, m, *ortho* protons on $PhSO_2$, H-5). 7.70-7.34 (8H, m, *meta* and *para* protons on $PhSO_2$, *ortho*, *meta* and *para* protons on Ph), 4.30-4.12 (1H, m, H-2), 2.67-2.49 (2H, m, H-3), 0.08 (3H, d, J 6.0 Hz, H-1); *m/z* (EI) 302 $[M]^+$, 258, 116 (Found: $[M-MeCHO]^+$, 258.0720. $C_{17}H_{18}O_3S$ requires $[M-MeCHO]^+$, 258.0715); (*Z*)-**3d**: R_f 0.09, 50% ether–petrol; ν_{max} (film) 3494, 3060, 2972, 2929, 1625, 1493, 1448, 1303, 1145, 1081, 938, 748, 689, 639 cm^{-1}; δ_H (250 MHz) 7.55-7.45 (2H, m, *ortho*

protons on $PhSO_2$), 7.45-7.34 (1H, m, *para* proton on $PhSO_2$), 7.30-7.08 (8H, m, *meta* protons on $PhSO_2$, *ortho*, *meta* and *para* protons on Ph, H-5), 4.26 (1H, m, H-2), 2.83 (1H, dd, J 14.0, 3.5 Hz, H-3), 2.62 (1H, dd, J 14.0, 8.0 Hz, H-3), 2.45 (1H, br s, OH), 2.33 (3H, d, J 6.0 Hz, H-1); *m/z* (EI) 302 $[M]^+$, 258, 116, 77 (Found: $[M\text{-}MeCHO]^+$, 258.0720. $C_{17}H_{18}O_3S$ requires $[M\text{-}MeCHO]^+$, 258.0715).

Preparation of (*E*)- and (*Z*)-5-(2,4-dimethoxyphenyl)-4-phenylsulfonyl-4-penten-2-ol (3e).

These were prepared analogously to **3a** on a 3.99 mmol scale to give, after chromatography (75% ether–petrol) (*E*)-**3e** and (*Z*)-**3e** (83:17 ratio; 94% combined yield over two steps from **5e**) as colourless oils; (*E*)-**3e**: R_f 0.20, 75% ether–petrol; ν_{max} (film) 3502, 2971, 2840, 1653, 1611, 1577, 1506, 1447, 1307, 1210, 1145, 1082, 1030, 767, 750, 728, 689 cm^{-1}; δ_H (500 MHz) 8.17 (1H, s, H-5), 7.92 (2H, d, J 7.5 Hz, *ortho* protons on $PhSO_2$), 7.63-7.57 (1H, m, *para* proton on $PhSO_2$), 7.53 (2H, t, J 7.5 Hz, *meta* protons on $PhSO_2$), 7.45 (1H, d, J 8.5 Hz, H-6 on $(MeO)_2C_6H_3$), 6.49 (1H, dd, J 8.5, 2.5 Hz, H-5 on $(MeO)_2C_6H_3$), 6.45 (1H, d, J 2.5 Hz, H-3 on $(MeO)_2C_6H_3$), 4.18 (1H, m, H-2), 3.83 (3H, s, OMe), 3.81 (3H, s, OMe), 2.97 (1H, s, OH), 2.54 (1H, dd, J 15.0, 8.5 Hz, H-3), 2.48 (1H, dd, J 15.0, 4.0 Hz, H-3), 1.16 (3H, d, J 6.5 Hz, H-1); *m/z* (EI) 362 $[M]^+$, 318, 176, 161 (Found: $[M\text{-}MeCHO]^+$, 318.0917. $C_{19}H_{22}O_5S$ requires $[M\text{-}MeCHO]^+$, 318.0925); (*Z*)-**3e**: R_f 0.14, 75% ether–petrol; ν_{max} (film) 3504, 2931, 1655, 1612, 1579, 1506, 1458, 1448, 1418, 1289, 1210, 1145, 1081, 1033, 834, 738 cm^{-1}; δ_H (500 MHz) 7.54-7.50 (2H, m, *ortho* protons on $PhSO_2$), 7.42-7.37 (2H, m, *para* protons on $PhSO_2$, H-6 on $(MeO)_2C_6H_3$), 7.28-7.22 (2H, m, *meta* protons on $PhSO_2$), 7.01 (1H, s, H-5), 6.43 (1H, dd, J 8.0, 2.5 Hz, H-5 on $(MeO)_2C_6H_3$), 6.08 (1H, d, J 2.5 Hz, H-3 on $(MeO)_2C_6H_3$), 4.23 (1H, m, H-2), 3.79 (3H, s, OMe), 3.52 (3H, s, OMe), 2.88 (1H, dd, J 13.5, 3.5 Hz, H-3), 2.58 (1H, dd, J 13.5, 8.0 Hz, H-3), 2.42 (1H, d, J 4.0 Hz, OH), 1.33 (3H, d, J 5.5 Hz, H-1); *m/z* (EI) 362, 318, 220, 176, 161 (Found: $[M]^+$, 362.1196. $C_{19}H_{22}O_5S$ requires $[M]^+$, 362.1188).

Preparation of (*E*)-3-phenylsulfonyl-2-pentadecen-5-ol (3f).

This was prepared analogously to **3a** on a 7.57 mmol scale to give, after chromatography (45% ether–petrol) (*E*)-**3f** (68% yield over two steps from **5f**) as a colourless solid, mp 48°C; R_f 0.17, 40% ether–petrol; ν_{max} (film) 3506, 2925, 2855, 1655, 1646, 1448, 1379, 1305, 1151, 1085, 761, 735, 689 cm^{-1}; δ_H (500 MHz) 7.88-7.83 (2H, m, *ortho* protons on $PhSO_2$), 7.65-7.60 (1H, m, *para* protons on $PhSO_2$), 7.57-7.52 (2H, m, *meta* protons on $PhSO_2$), 7.13 (1H, q, J 7.0 Hz, H-2), 3.80 (1H, m, H-5), 2.54 (1H, d, J 4.0 Hz, OH), 2.37 (1H, dd, J 15.0, 3.5 Hz, H-4), 2.31 (1H, dd, J 15.0, 9.0 Hz, H-4), 1.90 (3H, d, J 7.0 Hz, H-1), 1.50-1.20 (18H, m, C_9H_{18}), 0.88 (3H, t, J 7.0 Hz, $C_9H_{18}CH_3$); *m/z* (EI) 366 $[M]^+$, 278, 247, 196, 143, 125, 110, 78, 55, 43 (Found: C, 68.50; H, 9.62. $C_{21}H_{34}O_3S$ requires C, 68.81; H, 9.35%).

Preparation of (*E*)-1-benzyloxy-4-phenylsulfonyl-4-hexen-2-ol (3g).

This was prepared analogously to **3a** on a 3.17 mmol scale to give, after chromatography (72% ether–petrol) (*E*)-**3g** (85% over two steps from **5g**) as a colourless oil; R_f 0.19, 60% ether–petrol; ν_{max} (film) 3493, 2859, 1643, 1496, 1478, 1448, 1359, 1305, 1214, 1152, 1131, 1085, 1027, 738, 690 cm^{-1}; δ_H (500 MHz) 7.87-7.82 (2H, m, *ortho* protons on $PhSO_2$), 7.63-7.57 (1H, m, *para* protons on $PhSO_2$), 7.55-7.48 (2H, m, *meta* protons on $PhSO_2$), 7.38-7.24 (5H, m, Ph), 7.13 (1H, q, J 7.5 Hz, H-5), 4.53 (2H, s, $PhCH_2$), 4.00 (1H, m, H-2), 3.45 (1H, dd, J 9.5, 5.0 Hz, H-1), 3.42 (1H, dd, J 10.0, 5.0 Hz, H-1), 2.86 (1H, d, J 4.5 Hz, OH), 2.51 (1H, dd, J 15.0, 5.0 Hz, H-3), 2.45 (1H, dd, J 15.0, 7.5 Hz, H-3), 1.90 (3H, d, J 7.5 Hz, H-6); *m/z* (EI) 255 $[M\text{-}PhCH_2]^+$, 237, 225, 143, 125, 91, 77 (Found: C, 66.01; H, 6.71. $C_{19}H_{22}O_4S$ requires C, 65.87; H, 6.40%).

Preparation of (*E*)- and (*Z*)-1-benzyloxy-5-(2,4-dimethoxyphenyl)-4-phenylsulfonyl-4-penten-2-ol (3h).

These were prepared analogously to **3a** on a 0.9 mmol scale to give, after chromatography (74% ether–petrol) (*E*)-**3h** as a colourless solid and (*Z*)-**3h** (86:14 ratio; 82% combined yield over two steps from **5h**); (*E*)-**3h**: mp 94°C; R_f 0.42, 90% ether–petrol; ν_{max} (film) 3471, 2865, 1607, 1577, 1502, 1462, 1302, 1211, 1144, 1031,

835, 750, 694 cm^{-1}; δ_H (250 MHz) 8.19 (1H, s, H-5), 7.98 (2H, m, *ortho* protons on $PhSO_2$), 7.65-7.47 (4H, m, *meta* and *para* protons on $PhSO_2$, , H-6 on $(MeO)_2C_6H_3$), 7.39-7.23 (5H, m, Ph), 6.43 (1H, d, J 2.5 Hz, H-3 on $(MeO)_2C_6H_3$), 6.25 (1H, dd, J 8.5, 2.5 Hz, , H-5 on $(MeO)_2C_6H_3$), 4.48 (2H, s, $PhCH_2$), 4.21 (1H, m, H-2), 3.83 (3H, s, OMe), 3.76 (3H, s, OMe), 3.56-3.40 (2H, m, H-1), 3.30 (1H, d, J 3.5 Hz, OH), 2.81 (1H, dd, J 15.5, 4.0 Hz, H-3), 2.57 (1H, dd, J 15.5, 8.5 Hz, H-3); *m/z* (EI) 468 $[M]^+$, 347, 326, 317, 176, 161, 91 (Found: $[M]^+$, 468.1608. $C_{26}H_{28}O_6S$ requires $[M]^+$, 468.1606). Nmr data for (*Z*)-**3h** *inter alia*: δ_H (250 MHz) 7.06 (1H, s, H-5), 6.40 (1H, d, J 2.5 Hz, H-3'), 6.25 (1H, dd, J 8.5, 2.5 Hz, H-5'), 4.59 (2H, s, $PhCH_2$), 3.78 (3H, s, OMe), 3.65 (1H, dd, J 9.5, 4.0 Hz, H-1), 3.57 (1H, dd, J 9.5, 6.0 Hz, H-1), 3.51 (3H, s, OMe).

Preparation of (*E*)-1-phenyl-3-phenylsulfonyl-3-penten-1-ol (3i).

This was prepared analogously to **3a** on a 8.88 mmol scale to give, after chromatography (50 % ether–petrol) (*E*)-**3i** (55% over two steps from **5i**) as a colourless solid, mp 75-80°C; R_f 0.18, 40% ether–petrol; ν_{max} (film) 3477, 1640, 1446, 1302, 1146, 1128, 1084 cm^{-1}; δ_H (250 MHz) 7.95-7.22 (10H, m, Ph), 7.13 (1H, q, J 6.5 Hz, H-4), 4.97 (1H, ddd, J 3.5, 5.0, 7.5 Hz, H-1), 2.98 (1H, d, J 3.5 Hz, OH), 2.64 (1H, dd, J 15.0, 7.5 Hz, H-2), 2.55 (1H, dd, J 15.0, 5.0 Hz, H-2), 1.64 (3H, d, J 6.6 Hz, H-5); *m/z* (EI) 302 $[M]^+$, 196, 143, 125, 107, 77 $[Ph]^+$ (Found: C, 67.60; H, 6.02. $C_{17}H_{18}O_3S$ requires C, 67.52; H, 6.00%).

Preparation of (*E*)- and (*Z*)-4-(2,4-dimethoxyphenyl)-1-phenyl-3-phenylsulfonyl-3-buten-1-ol (3j).

These were prepared analogously to **3a** on a 5.41 mmol scale to give, after chromatography (65% ether–petrol) (*E*)-**3j** and (*Z*)-**3j** (80:20 ratio; 55% combined yield over two steps from **5j**); (*E*)-**3j**: R_f 0.33, 75% ether–petrol; ν_{max} (film) 3497, 2973, 1606, 1578, 1506, 1458, 1419, 1301, 1212, 1142, 1090, 1031, 836, 747, 727, 705, 608 cm^{-1}; δ_H (250 MHz) 8.18 (1H, s, H-4), 8.01-7.93 (2H, m, *ortho* protons on $PhSO_2$), 7.66-7.50 (4H, m, *meta* and *para* protons on $PhSO_2$, H-6 on $(MeO)_2C_6H_3$), 7.33-7.18 (5H, m, *ortho*, *meta* and *para* protons on Ph), 6.52-6.43 (2H, m, H-3 on $(MeO)_2C_6H_3$, H-5 on $(MeO)_2C_6H_3$), 5.12 (1H, m, H-1), 3.84 (3H, s, OMe), 3.83 (3H, S, OMe), 3.13 (1H, d, J 3.5 Hz, OH), 2.85 (1H, dd, J 15.0, 9.0 Hz, H-2), 2.73 (1H, dd, J 15.0, 3.5 Hz, H-2); *m/z* (EI) 406, 318, 199, 176, 161, 77 (Found: $[M-H_2O]^+$, 406.1239. $C_{24}H_{24}O_5S$ requires $[M-H_2O]^+$, 406.1239). Nmr data for (*Z*)-**3h** *inter alia*: δ_H (250 MHz) 6.90 (1H, s, H-4), 6.08 (1H, d, J 2.5 Hz, H-3'), 3.80 (3H, s, OMe), 3.52 (3H, s, OMe).

Preparation of (*E*)-7-(2-methyl-1,3-dioxolan-2-yl)-3-phenylsulfonyl-2-hepten-5-ol (3k).

This was prepared analogously to **3a** but carrying out the deprotection reaction with TBAF on a 4.61 mmol scale to give, after chromatography (ether) (*E*)-**3k** (1.22 g, 78%) as a colourless oil; R_f 0.28, ether; ν_{max} (film) 3491, 2957, 2886, 1646, 1479, 1448, 1378, 1304, 1221, 1153, 1070, 857, 737, 690 cm^{-1}; δ_H (250 MHz) 7.90-7.80 (2H, m, *ortho* protons on $PhSO_2$), 7.67-7.47 (3H, m, *para* and *meta* protons on $PhSO_2$), 7.13 (1H, q, J 7.0 Hz, H-2), 4.01-3.71 (5H, m, H-1', H-2', H-5), 2.92 (1H, d, J 4.0 Hz, OH), 2.35 (2H, d, J 6.5 Hz, H-4), 1.90 (3H, d, J 7.0 Hz, H-1), 1.87-1.48 (4H, m, H-6, H-7), 1.30 (3H, s, H-9); *m/z* (EI) 325 $[M-Me]^+$, 279, 237, 196, 156, 145, 137, 125, 93, 87, 83, 77, 55, 43 (Found: $[M-Me]^+$, 325.1110. $C_{17}H_{24}O_5S$ requires $[M-Me]^+$, 325.1110).

Preparation of (*E*)- and (*Z*)-1-(*tert*-butyldimethylsilyloxy)-1-phenyl-3-phenylsulfonyl-3-penten-1-ol (3i).

To a stirred solution of *threo*-enriched hydroxy sulfones **6l** (1 g, 2.30 mmol, 1.0 equiv) in THF (11.5 ml) under nitrogen at 0°C was added *n*-BuLi (1 ml of a 2.30M solution in hexanes, 2.30 mmol, 1.0 equiv) causing the mixture to become yellow in colour. After stirring for 2 min, TsCl (0.7 g, 3.45 mmol, 1.5 equiv) in THF was added *via* cannula resulting in the disappearance of the yellow colour. Saturated aqueous NH_4Cl was added, the organic phase was separated and the aqueous phase extracted with EtOAc (4 x 75 ml). The combined organic layers were washed with water (75 ml), brine (75 ml), dried ($MgSO_4$) and concentrated under reduced pressure

to yield a 3:3:1:1 mixture of diastereomeric tosylates as a colourless oil. To a stirred solution of the crude tosylates in EtOH (24 ml) at rt was added NaOEt (4.76 ml of a 1 M solution in EtOH, 4.76 mmol, 2.0 equiv), causing the mixture to become yellow in colour. After 30 min saturated aqueous NH_4Cl (5 ml) was added, the organic phase was separated and the aqueous phase extracted with CH_2Cl_2 (4 x 50 ml). The combined organic layers were washed with brine (2 x 50 ml), dried ($MgSO_4$) and concentrated under reduced pressure to yield a colourless oil which was purified by chromatography (20% ether–petrol) to give a 1:1 mixture of vinylic sulfone isomers (680 mg, 71%). To a stirred solution of the vinylic sulfones (0.68 g, 1.63 mmol) in CH_3CN (20 ml) was added HF (48% w/v aqueous solution) dropwise until tlc revealed complete reaction. Solid $NaHCO_3$ was added carefully and the organic phase separated. The aqueous phase was extracted with CH_2Cl_2 (4 x 30 ml). The combined organic layers were washed with water (30 ml), brine (30 ml), water (30 ml), saturated aqueous $NaHCO_3$ (30 ml), water (30 ml), dried ($MgSO_4$) and concentrated under reduced pressure to yield a colourless oil which was purified by chromatography (50% ether–petrol) to give (*E*)-**3i** and (*Z*-**3i** (50:50 ratio; 51% combined yield over three steps from *threo*-enriched **6l**) as a colourless oil. Nmr data for (*Z*)-**3i** *inter alia*: δ_H (270 MHz) 6.22 (1H, q, J 8.0 Hz, H-4); (*E*)-**3i** showed ^1H nmr characteristics identical with those of the compound prepared from benzoate **5i**.

Preparation of (*Z*)- and (*E*)-5-methyl-1-phenyl-3-phenylsulfonyl-3-hexen-1-ol (3m).

These were prepared analogously to (*Z*)- and (*E*)-**3i** on a 5.28 mmol scale to give, after chromatography (50% ether–petrol) (*Z*)-**3m** and (*E*)-**3m** (90:10 ratio; 66% combined yield over three steps from *threo*-enriched **6m**) as a colourless oil; R_f 0.33, 50% ether–petrol; ν_{max} (film) 3500, 2963, 1635, 1446, 1287, 1140, 1086, 757, 733, 690 cm^{-1}; δ_H (270 MHz) 7.99-7.88 (4H, m, *ortho* protons on $PhSO_2$ (*Z*)- and (*E*)-), 7.62-7.50 (6H, m, *meta* and *para* protons on $PhSO_2$ (*Z*)- and (*E*)-), 7.38-7.22 (10H, m, Ph (*Z*)- and (*E*)-), 6.82 (1H, d, J 11.0 Hz, H-4 vinylic proton on *E*-isomer), 5.60 (1H, d, J 11.0 Hz, H-4 vinylic proton on *Z*-isomer), 4.99 (2H, m, H-1 (*Z*)- and (*E*)-), 3.42 (2H, m, H-5 (*Z*)- and (*E*)-), 2.62-2.50 (4H, m, H-2 (*Z*)- and (*E*)-), 1.22 (3H, d, J 8.0 Hz, H-6 (*E*)-), 1.00 (3H, d, J 8.0 Hz, H-6 (*E*)-), 0.80 (3H, d, J 8.0 Hz, H-6 (*Z*)-), 0.80 (3H, d, J 8.0 Hz, H-6 (*Z*)-); *m/z* (EI) 330 $[M]^+$, 301, 224, 205, 180, 164, 144, 126, 105, 91, 77, 55 (Found: $[M]^+$, 330.1301. $C_{19}H_{22}O_3S$ requires $[M]^+$, 330.1290).

Preparation of (*Z*)- and (*E*)-1-phenyl-3-phenylsulfonyl-6-methyl-3-hepten-1-ol (3n).

These were prepared analogously to (*Z*)- and (*E*)-**3i** on a 4.22 mmol scale to give, after chromatography (50% ether–petrol), (*Z*)-**3n** and (*E*)-**3n** (75:25 ratio; 65% combined yield over three steps from *threo*-enriched **6n**) as a colourless oil; R_f 0.18, 50% ether–petrol; ν_{max} (film) 3499, 3065, 3030, 2956, 2928, 2895, 1386, 1368, 1350, 1302, 1197, 1131, 1085, 1057, 1001, 1004, 758, 737, 701, 690, 636, 601 cm^{-1}; δ_H (270 MHz) 8.00-7.92 (4H, m, *ortho* protons on $PhSO_2$ (*Z*)- and (*E*)-), 7.70-7.59 (6H, m, *meta* and *para* protons on $PhSO_2$ (*Z*)- and (*E*)-), 7.40-7.22 (10H, m, Ph), 7.12 (1H, t, J 7.0 Hz, H-4 vinylic proton on *E* isomer), 6.10 (1H, t, J 7.0 Hz, H-4 vinylic proton on Z isomer), 5.02 (2H, m, H-1 (*Z*)- and (*E*)-), 3.10 (1H, d, J 3.0 Hz, OH (*E*)-), 2.80-2.60 (6H, m, H-2 (*Z*)- and (*E*)- and H-5 (*E*)-), 2.50 (2H, m, H-5 (*Z*)-), 2.00 (1H, octet, J 8.0 Hz, H-6 (*E*)-), 1.80-1.55 (1H, m, H-6 (*Z*)-), 0.92-0.83 (12H, m, H-7 (*Z*)- and (*E*)-); *m/z* (CI) 362 $[M+NH_4]^+$, 344, 327, 268, 256, 220, 204, 185, 175, 160, 142, 125, 106, 94, 78, 58 (Found: $[M+NH_4]^+$, 362.1789 $C_{20}H_{24}O_3S$ requires $[M+NH_4]^+$, 362.1790).

Preparation of (*Z*)- and *E*)-1-benzyloxy-5-cyclohexyl-4-phenylsulfonyl-4-penten-2-ol (3o).

This was prepared analogously to (*Z*)- and (*E*)-**3i** on a 4.35 mmol scale to give, after chromatography (50% ether–petrol) (*Z*)-**3o** and (*E*)-**3o** (70:30 ratio; 66% combined yield over three steps from *threo*-enriched **6o**) as a colourless oil; R_f 0.17, 50% ether–petrol; ν_{max} (film) 3494, 2925, 2851, 1451, 1305, 1288, 1141, 1086, 1027, 738, 695, 588 cm^{-1}; (*Z*)-**3o**: δ_H (270 MHz) 7.91 (2H, dd, J 7.50, 1.25 Hz, *ortho* protons on $PhSO_2$), 7.60-7.48 (3H, m, *meta* and *para* protons on $PhSO_2$), 7.32 (5H, m, Ph), 5.95 (1H, d, J 11.0 Hz, H-5 vinylic proton on *Z* isomer), 4.55 (2H, s, $PhCH_2$), 4.10-3.97 (1H, m, H-2), 3.50 (1H, dd, J 10.0, 5.0 Hz, H-1), 3.42 (1H, dd, J 10.0, 5.5 Hz, H-1), 3.21-3.08 (1H, m, cyclohexyl C*H*), 2.60-2.32 (3H, m, H-3 and OH), 1.72-1.41 (10H, m,

cyclohexyl protons); (*E*)-**3o**: δ_H (270 MHz) 7.88-7.80 (2H, dd, J 7.50, 1.25 Hz, *ortho* protons on $PhSO_2$), 7.62-7.41 (3H, m, *meta* and *para* protons on $PhSO_2$), 7.40-7.22 (5H, m, Ph), 6.85 (1H, d, J 11.0 Hz, H-5 vinylic proton on *E* isomer), 4.55 (1H, d, J 10.0 Hz, $PhCH_2$), 4.49 (1H, d, J 10.0 Hz, $PhCH_2$), 3.95 (1H, m, H-2), 3.45 (2H, d, J 5.0 Hz, H-1), 2.91 (1H, d, J 4.5 Hz, OH), 2.55-2.22 (3H, m, H-3 and cyclohexyl C*H*), 1.80-1.52 and 1.40-1.10 (10H, m, cyclohexyl protons); *m/z* (CI) 432 $[M+NH_4]^+$, 415 $[M+H]^+$, 397, 340, 323, 310, 290, 273, 263, 212, 181, 165, 149, 133, 125, 108, 91, 78, 65, 55 (Found: $[M+NH_4]^+$, 432.2172. $C_{24}H_{30}O_4S$ requires $[M+NH_4]^+$, 432.2209) (Found: C, 69.73; H, 6.80. $C_{24}H_{30}O_4S$ requires C, 69.70 ; H, 7.08%).

Cyclisation reaction of (*E*)-3a.

To a stirred solution of alcohol (*E*)-**3a** (1.50 g, 6.24 mmol, 1.0 equiv) in THF (200 ml) containing *t*-BuOH (2.87 ml, 31.2 mmol, 5 equiv: *conditions A*) under argon at 25°C was added *t*-BuOK (6.24 ml of a 1.0M solution in THF, 6.24 mmol, 1.0 equiv), causing a bright yellow colouration. After 40 min at rt the reaction was quenched with acetic acid (357 µl, 6.24 mmol, 1.0 equiv). Water was added, the organic phase was separated and the aqueous layer was extracted with CH_2Cl_2 (4 x 150 ml). The combined organic layers were washed with water (3 x 200 ml), dried ($MgSO_4$), and concentrated under reduced pressure to give a pale yellow oil. This was purified using chromatography (45% ether–petrol) to give *syn*-**8a** (693 mg, 46%) and *anti*-**8a** (518 mg, 35%), both as crystalline solids; *syn*-**8a**: mp 87°C; R_f 0.47, 75% ether–petrol; ν_{max} (film) 2973, 2933, 2872, 1654, 1541, 1448, 1306, 1148, 1118, 1086, 951, 879, 746, 719, 691 cm^{-1}; δ_H (250 MHz) 7.97-7.87 (2H, m, *ortho* protons on $PhSO_2$), 7.75-7.54 (3H, m, *meta* and *para* protons on $PhSO_2$), 4.29 (1H, quintet, J 6.5 Hz, H-2), 4.00 (1H, m, H-5), 3.30 (1H, ddd, J 10.5, 7.0, 3.5 Hz, H-3), 2.47 (1H, ddd, J 13.5, 5.5, 3.5 Hz, H-4), 1.74 (1H, ddd, J 13.5, 10.5, 10.0 Hz, H-4), 1.24 (3H, d, J 6.0 Hz, C-5 Me), 1.18 (3H, d, J 6.0 Hz, C-2 Me); *m/z* (EI) 240 $[M]^+$, 225 $[M-Me]^+$, 196, 183, 98, 83, 77, 43 (Found C, 59.72; H, 6.76. $C_{12}H_{16}O_3S$ requires C, 59.97; H, 6.71%); *anti*-**8a**: mp 76-80°C; R_f 0.40, 75% ether–petrol; ν_{max} (film) 2977, 2933, 2870, 1684, 1541, 1507, 1448, 1388, 1303, 1252, 1153, 1086, 998, 945, 880, 766, 720, 694 cm^{-1}; δ_H (500 MHz) 7.98-7.86 (2H, m, *ortho* protons on $PhSO_2$), 7.75-7.53 (3H, m, *meta* and *para* protons on $PhSO_2$), 4.52 (1H, quintet, J 6.5 Hz, H-2), 4.15 (1H, m, H-5), 3.38 (1H, ddd, J 9.0, 8.5, 6.5 Hz, H-3), 2.24 (1H, ddd, J 13.0, 8.5, 5.5 Hz, H-4), 1.99 (1H, dt, J 12.5, 9.0 Hz, H-4), 1.23 (3H, d, J 6.0 Hz, C-5 Me), 1.19 (3H, d, J 6.0 Hz, C-2 Me); *m/z* 240 $[M]^+$, 225 $[M-Me]^+$, 196, 98, 83, 77, 43 (Found: C, 59.97; H, 6.81. $C_{12}H_{16}O_3S$ requires C, 59.97; H, 6.71%).

Cyclisation reaction of (*Z*)-3b.

This was carried out analogously to the reaction of (*E*)-**3a** on a 0.373 mmol scale (10 min reaction time) to give, after chromatography (45% ether–petrol) a mixture of *syn*-**8b** and *anti*-**8b** (11:89 ratio; 86% combined yield); *anti*-**8b**: mp 51°C; R_f 0.48, 70% ether–petrol; ν_{max} (film) 2966, 2903, 2872, 1464, 1445, 1385, 1365, 1305, 1291, 1148, 1108, 1086, 1026, 1000, 758, 721, 690 cm^{-1}; δ_H (500 MHz), 7.95-7.90 (2H, m, *ortho* protons on $PhSO_2$), 7.70-7.65 (1H, m, *para* proton on $PhSO_2$), 7.62-7.55 (2H, m, *meta* protons on $PhSO_2$), 4.15 (1H, dd, J 7.0, 5.0 Hz, H-2), 4.02 (1H, m, H-5), 3.58 (1H, ddd, J 9.0, 8.0, 5.0 Hz, H-3), 2.22 (1H, ddd, J 13.0, 9.0, 5.5 Hz, H-4), 1.98 (1H, ddd, J 13.0, 9.0, 8.0 Hz, H-4), 1.63 (1H, m, $CH(CH_3)_2$), 1.22 (3H, d, J 6.0 Hz, C-2 Me), 0.88 (3H, d, J 6.5 Hz, $CH(CH_3)_2$), 0.81 (3H, d, J 6.5 Hz, $CH(CH_3)_2$); *m/z* (EI) 269 $[MH]^+$, 225, 143, 126, 111, 99, 71, 55, 43 (Found: $[M+NH_4]^+$, 286.1477. $C_{14}H_{20}O_3S$ requires $[M+NH_4]^+$, 286.1477).

Cyclisation reaction of (*E*)-3d.

This was carried out analogously to the reaction of (*E*)-**3a** on a 1.79 mmol scale (15 min reaction time) to give, after chromatography (75% CH_2Cl_2–petrol) *syn*-**8d** (18%) and vinylic sulfone **11** (Ar = Ph) (42%), both as crystalline solids; *syn*-**8d**: mp 125-126°C; R_f 0.13, 75% CH_2Cl_2–petrol; ν_{max} (film) 2973, 2955, 2923, 2871, 1601, 1558, 1441, 1301, 1288, 1160, 1146, 1083, 1022, 785, 761, 750, 719, 699, 624, 610 cm^{-1}; δ_H (250 MHz) 7.93-7.82 (2H, m, *ortho* protons on $PhSO_2$), 7.70-7.59 (1H, m, *para* proton on $PhSO_2$), 7.59-7.47 (2H, m, *meta* protons on $PhSO_2$), 7.29-7.17 (3H, m, *ortho* and *para* protons on Ph), 7.17-7.07 (2H, m, *meta*

protons on Ph), 5.26 (1H, d, J 6.0 Hz, H-2), 4.32 (1H, m, H-5), 3.67 (1H, ddd, J 10.0, 6.0, 2.5 Hz, H-3), 2.59 (1H, ddd, J 14.0, 5.0, 2.5 Hz, H-4), 1.89 (1H, dt, J 14.0, 10.0 Hz, H-4), 1.40 (3H, d, J 6.0 Hz, H-6); *m/z* (EI) 301 $[M-H]^+$, 245, 197, 160, 105, 91, 77, 57 (Found: C, 67.42; H, 6.00. $C_{17}H_{18}O_3S$ requires C, 67.52; H, 6.01%); **11** (Ar = Ph): mp 90-91°C; R_f 0.35, 75% CH_2Cl_2–petrol; ν_{max} (film) 1635, 1443, 1303, 1150, 1108, 1071, 777, 736, 686 cm^{-1}; δ_H (250 MHz) 7.98-7.89 (2H, m, *ortho* protons on $PhSO_2$), 7.83 (1H, d, J 1.5 Hz, PhC*H*), 7.67-7.50 (3H, m, *meta* and *para* protons on $PhSO_2$), 7.44-7.35 (5H, m, Ph), 2.12 (3H, d, J 1.5 Hz, Me); *m/z* (EI) 258 $[M]^+$, 133, 125, 116 (Found: C, 69.67; H, 5.33. $C_{15}H_{14}O_2S$ requires C, 69.74; H, 5.46%).

Cyclisation reaction of (*E*)-3e.

This was carried out analogously to the reaction of (*E*)-**3a** on a 1.62 mmol scale (16 min reaction time) to give, after chromatography (4% EtOAc–CH_2Cl_2) a mixture of *syn*-**8e** and *anti*-**8e** (80:20 ratio; 60% combined yield), and vinylic sulfone **11** (Ar = 2,4-$(MeO)_2C_6H_3$) (27%), both as crystalline solids; mixture of *syn*-**8e** and *anti*-**8e**: R_f 0.42, 75% ether–petrol; ν_{max} (film) 2927, 2853, 1614, 1590, 1508, 1459, 1448, 1306, 1209, 1148, 1087, 1037, 835, 755, 722, 690 cm^{-1}; *syn*-**8e**: δ_H (250 MHz) 7.87-7.77 (2H, m, *ortho* protons on $PhSO_2$), 7.61-7.52 (1H, m, *para* proton on $PhSO_2$), 7.52-7.41 (2H, m, *meta* protons on $PhSO_2$), 6.94 (1H, d, J 9.0 Hz, H-6 on $(MeO)_2C_6H_3$), 6.35-6.24 (2H, m, H-3 on $(MeO)_2C_6H_3$, H-5 on $(MeO)_2C_6H_3$), 5.27 (1H, d, J 6.0 Hz, H-2), 4.28 (1H, m, H-5), 3.98 (1H, ddd, J 10.0, 6.0, 2.5 Hz, H-3), 3.75 (3H, s, OMe), 3.62 (3H, s, OMe), 2.70 (1H, ddd, J 13.5, 5.5, 2.5 Hz, H-4), 2.01 (1H, dt, J 13.5, 10.0 Hz, H-4), 1.36 (3H, d, J 6.0 Hz, C-5 Me); *anti*-**8e**: δ_H (250 MHz) 7.82 (2H, d, J 8.0 Hz, *ortho* protons on $PhSO_2$), 7.61-7.39 (3H, m, *meta* and *para* protons on $PhSO_2$), 6.99-6.90 (1H, m, H-6 on $(MeO)_2C_6H_3$), 6.35-6.25 (2H, m, H-3 on($MeO)_2C_6H_3$, H-5 on $(MeO)_2C_6H_3$), 5.40 (1H, d, J 6.5 Hz, H-2), 4.47 (1H, m, H-5), 4.25 (1H, m, H-3), 3.75 (3H, s, OMe), 3.64 (3H, s, OMe), 2.49 (1H, m, H-4), 2.26 (1H, dt, J 13.0, 8.5 Hz, H-4), 1.33 (3H, d, J 6.0 Hz, C-5 Me); mixture of *syn*-**8e** and *anti*-**8e**: *m/z* (EI) 362, 318, 220, 205, 176, 165, 147, 77, 32, 28 (Found: $[MH]^+$, 363.1266. $C_{19}H_{22}O_5S$ requires $[MH]^+$, 363.1266); **11** (Ar = 2,4-$(MeO)_2C_6H_3$): mp 106°C; R_f 0.47, 75% Et_2O–petrol; ν_{max} (film) 3067, 3005, 2944, 2840, 1610, 1578, 1506, 1448, 1419, 1304, 1211, 1153, 1131, 1105, 1074, 1031, 970, 837, 769, 750, 727, 690, 608 cm^{-1}; δ_H (250 MHz) 8.01 (1H, s, ArC*H*), 7.98-7.90 (2H, m, *ortho* protons on $PhSO_2$), 7.66-7.50 (3H, m, *meta* and *para* protons on $PhSO_2$), 7.26-7.20 (1H, m, Ar H-6), 6.54-6.46 (2H, m, Ar H-3, Ar H-5), 3.87 (3H, s, OMe), 3.85 (3H, s, OMe), 2.06 (3H, d, J 1.5 Hz, $PhSO_2CMe$); *m/z* (EI) 318, 176, 161, 147, 77 (Found: C, 64.13; H, 5.63. $C_{17}H_{18}O_4S$ requires C, 64.13; H, 5.70%).

Cyclisation reaction of (*E*)-3f.

This was carried out analogously to the reaction of (*E*)-**3a** on a 2.0 mmol scale (16 min reaction time) to give, after chromatography (25% ether–petrol) *syn*-**8f** (46%) and *anti*-**8f** (35%) as crystalline solids; *syn*-**8f**: mp 56°C; R_f 0.57, 50% ether–petrol; ν_{max} (film) 2929, 2855, 1449, 1380, 1308, 1149, 1087, 746, 720, 690 cm^{-1}; δ_H (500 MHz) 7.94-7.88 (2H, m, *ortho* protons on $PhSO_2$), 7.71-7.65 (1H, m, *para* protons on $PhSO_2$), 7.62-7.57 (2H, m, *meta* protons on $PhSO_2$), 4.27 (1H, quintet, J 6.0 Hz, H-2), 3.85 (1H, m, H-5), 3.26 (1H, ddd, J 11.0, 6.0, 4.0 Hz, H-3), 2.45 (1H, ddd, J 13.5, 6.0, 4.0 Hz, H-4), 1.75 (1H, m, H-4), 1.50-1.20 (18H, m, C_9H_{18}), 1.17 (3H, d, J 6.0 Hz, C-2 Me), 0.87 (3H, t, J 7.0 Hz, $C_9H_{18}CH_3$); *m/z* (EI) 367, 323, 241, 223, 206, 169, 143, 135, 125, 98, 83, 77, 55, 43 (Found: C, 68.60; H, 9.50. $C_{21}H_{34}O_3S$ requires C, 68.81; H, 9.35%); *anti*-**8f**: mp 56°C; R_f 0.49, 50% ether–petrol; ν_{max} (film) 2928, 2855, 1448, 1378, 1308, 1148, 1089, 999, 898, 751, 721, 690 cm^{-1}; δ_H (500 MHz) 7.93-7.88 (2H, m, *ortho* protons on $PhSO_2$), 7.70-7.65 (1H, m, *para* proton on $PhSO_2$), 7.62-7.55 (2H, m, *meta* protons on $PhSO_2$), 4.47 (1H, quintet, J 6.5 Hz, H-2), 3.97 (1H, m, H-5), 3.36 (1H, m, H-3), 2.22 (1H, ddd, J 13.0, 8.5, 5.5 Hz, H-4), 2.01 (1H, dt, J 13.0, 9.0 Hz, H-4), 1.48-1.20 (18H, m, C_9H_{18}), 1.19 (3H, d, J 6.5 Hz, C-2 Me), 0.88 (3H, t, J 7.0 Hz, $C_9H_{18}CH_3$); *m/z* (EI) 367, 323, 224, 206, 166, 143, 135, 125, 98, 83, 77, 55, 43, 28 (Found: C, 68.96; H, 9.20. $C_{21}H_{34}O_3S$ requires C, 68.81; H, 9.35%).

Cyclisation reaction of (*E*)-3g.

This was carried out analogously to the reaction of (*E*)-**3a** on a 1.44 mmol scale (23 min reaction time) to give, after chromatography (50% ether–petrol) a mixture of *syn*-**8g** and *anti*-**8g** (64:36 ratio; 86% combined yield) as a colourless oil; *syn*-**8g**: R_f 0.32, 60% ether–petrol; ν_{max} (film) 3064, 3031, 2978, 2869, 1496, 1443, 1361, 1149, 1086, 1028, 999, 943, 880, 744, 720, 690 cm^{-1}; δ_H (250 MHz) 7.95-7.87 (2H, m, *ortho* protons on $PhSO_2$), 7.73-7.54 (3H, m, *para* and *meta* protons on $PhSO_2$), 7.38-7.23 (5H, m, Ph), 4.54 (2H, s, $PhCH_2$), 4.35 (1H, m, H-2), 4.14 (1H, m, H-5), 3.52 (1H, dd, J 10.0, 4.0 Hz, CH_2OBn), 3.45 (1H, dd, J 10.0, 5.0 Hz, CH_2OBn), 3.33 (1H, ddd, J 10.0, 7.5, 5.0 Hz, H-3), 2.42 (1H, ddd, J 13.0, 6.5, 5.0 Hz, H-4), 2.00 (1H, ddd, J 13.0, 10.0, 8.0 Hz, H-4), 1.23 (3H, d, J 6.5 Hz, C-2 Me); *m/z* (EI) 346 $[M]^+$, 255, 240, 204, 143, 91, 83, 77 (Found: $[M]^+$, 346.1239. $C_{19}H_{22}O_4S$ requires $[M]^+$, 346.1239); *anti*-**8g**: R_f 0.26, 60% ether–petrol; ν_{max} (film) 3064, 3031, 2977, 2872, 1586, 1496, 1448, 1377, 1307, 1207, 1150, 1087, 1028, 999, 940, 879, 753, 721, 691 cm^{-1}; δ_H (250 MHz) 7.91-7.87 (2H, m, *ortho* protons on $PhSO_2$), 7.70-7.64 (1H, m, *para* proton on $PhSO_2$), 7.60-7.54 (2H, m, *meta* protons on $PhSO_2$), 7.37-7.24 (5H, m, Ph), 4.57 (1H, d, J 12.0 Hz, $PhCH_2$), 4.51 (1H, d, J 12.0 Hz, $PhCH_2$), 4.48 (1H, q, J 6.5 Hz, H-2), 4.24 (1H, m, H-5), 3.50 (1H, dd, J 10.0, 6.5 Hz, CH_2OBn), 3.42 (1H, dd, J 10.0, 5.0 Hz, CH_2OBn), 3.37 (1H, dt, J 9.0, 8.0 Hz, H-3), 2.27-2.15 (2H, m, H-4), 1.24 (3H, d, J 6.5 Hz, C-2 Me); *m/z* (EI) 346, 255, 240, 204, 187, 143, 91, 83, 77, 44 (Found: $[M]^+$, 346.1240. $C_{19}H_{22}O_4S$ requires $[M]^+$, 346.1239).

Cyclisation reaction of (*E*)-3h.

This was carried out analogously to the reaction of (*E*)-**3a** on a 0.136 mmol scale (90 min reaction time) to give, after chromatography (65% ether–petrol) *syn*-**8h** (52%) and *anti*-**8h** (24%) as colourless oils; *syn*-**8h**: R_f 0.34, 70% ether–petrol; ν_{max} (film) 2927, 1684, 1654, 1612, 1506, 1464, 1457, 1306, 1209, 1148, 1086, 1032, 721, 690 cm^{-1}; δ_H (250 MHz) 7.86-7.78 (2H, m, *ortho* protons on $PhSO_2$), 7.62-7.40 (3H, m, *meta* and *para* protons on $PhSO_2$), 7.38-7.27 (5H, m, Ph), 7.05 (1H, d, J 9.0 Hz, H-6 on $(MeO)C_6H_3$), 6.30-6.21 (2H, m, H-3 on $(MeO)_2C_6H_3$, H-5 on $(MeO)_2C_6H_3$), 5.36 (1H, d, J 5.5 Hz, H-2), 4.58 (2H, s, $PhCH_2$), 4.42 (1H, m, H-5), 3.97 (1H, ddd, J 9.5, 5.5, 3.5 Hz, H-3), 3.87-3.58 (2H, m, CH_2OBn), 3.73 (3H, s, OMe), 3.54 (3H, s, OMe), 2.65 (1H, ddd, J 13.5, 6.0, 3.5 Hz, H-4), 2.34 (1H, dt, J 13.5, 9.5 Hz, H-4); *m/z* (EI) 468 $[M]^+$, 377, 347, 326, 235, 205, 176, 91 (Found: $[M]^+$, 468.1608. $C_{26}H_{28}O_6S$ requires $[M]^+$, 468.1607); *anti*-**8h**: R_f 0.25, 70% ether–petrol; ν_{max} (film) 2934, 1655, 1613, 1587, 1508, 1466, 1458, 1308, 1210, 1147, 1087, 1033, 722, 689 cm^{-1}; δ_H (250 MHz) 7.85-7.79 (2H, m, *ortho* protons on $PhSO_2$), 7.55 (1H, m, *para* protons on $PhSO_2$), 7.50-7.41 (2H, m, *meta* protons on $PhSO_2$), 7.38-7.27 (5H, m, Ph), 6.96 (1H, d, J 8.5 Hz, H-6 on $(MeO)_2C_6H_3$), 6.30 (1H, dd, J 8.5, 2.5 Hz, H-5 on $(MeO)_2C_6H_3$), 6.28 (1H, d, J 2.5 Hz, H-3 on $(MeO)_2C_6H_3$), 5.39 (1H, d, J 6.0 Hz, H-2), 4.61 (1H, d, J 12.0 Hz, $PhCH_2$), 4.57 (1H, d, J 12.0 Hz, $PhCH_2$), 4.54 (1H, m, H-5), 4.12 (1H, dt, J 6.0, 8.0 Hz, H-3), 3.75 (3H, s, OMe), 3.66 (1H, dd, J 10.0, 6.0 Hz, CH_2OBn), 3.61 (3H, s, OMe), 3.56 (1H, dd, J 10.0, 5.0 Hz, CH_2OBn), 2.47 (2H, t, J 8.0 Hz, H-4); *m/z* (EI) 468 $[M]^+$, 377, 347, 326, 235, 205, 177, 91 (Found: $[M]^+$, 468.1608. $C_{26}H_{28}O_6S$ requires $[M]^+$, 468.1607).

Cyclisation reaction of (*E*)-3i.

This was carried out analogously to the reaction of (*E*)-**3a** on a 0.826 mmol scale (6 min reaction time) to give, after chromatography (33% ether–petrol) *syn*-**8i** (52%) and *anti*-**8i** (24%) as crystalline solids; *syn*-**8i**: mp 93-97°C; R_f 0.49, 50% ether–petrol (2 elutions); ν_{max} (film) 2979, 2935, 2883, 1447, 1306, 1148, 1027, 944, 901, 744, 719, 690 cm^{-1}; δ_H (250 MHz) 7.98-7.88 (2H, m, *ortho* protons on $PhSO_2$), 7.73-7.53 (2H, m, *meta* and *para* protons on $PhSO_2$), 7.37-7.18 (5H, m, Ph), 4.92 (1H, dd, J 10.0, 6.0 Hz, H-5), 4.48 (1H, quintet, J 6.5 Hz, H-2), 3.41 (1H, ddd, J 10.5, 6.5, 4.0 Hz, H-3), 2.76 (1H, ddd, J 13.5, 6.0, 4.0 Hz, H-4), 2.07 (1H, dt, J 13.5, 10.0 Hz, H-4), 1.29 (3H, d, J 7.0 Hz, C-2 Me); *m/z* (EI) 302 $[M]^+$, 160, 117, 105, 77, 43 (Found: C, 67.34; H, 5.97. $C_{17}H_{18}O_3S$ requires C, 67.52; H, 6.00%); *syn*-**8i**: mp 86°C; R_f 0.36, 50% ether–petrol (2 elutions); ν_{max} (film) 2975, 1496, 1447, 1337, 1307, 1149, 1086, 1001, 933, 900, 752, 721, 701, 639, 604 cm^{-1}; δ_H (250 MHz) 7.95-7.87 (2H, m, *ortho* protons on $PhSO_2$), 7.72-7.63 (1H, m, *para* proton on $PhSO_2$), 7.63-

7.52 (1H, m, *meta* protons on $PhSO_2$), 7.37-7.23 (5H, m, Ph), 4.98 (1H, dd, J 10.0, 6.0 Hz, H-5), 4.79 (1H, quintet, J 7.0 Hz, H-2), 3.62-3.45 (1H, m, H-3), 2.55-2.26 (2H, m, H-4), 1.34 (3H, d, J 7.0 Hz, C-2 Me); *m/z* (EI) 302 $[M]^+$, 223, 160, 149 (Found: C, 67.39; H, 5.91. $C_{17}H_{18}O_3S$ requires C, 67.52; H, 6.00%).

Cyclisation reaction of (*E*)-3j.

This was carried out analogously to the reaction of (*E*)-**3a** on a 0.236 mmol scale (11 min reaction time) to give, after chromatography (0.25% EtOAc–CH_2Cl_2) *syn*-**8j** and *anti*-**8j** (80:20 ratio; 19% combined yield) as a colourless oil, and **11** (Ar = 2,4-$(MeO)_2C_6H_3$) (74%) as a crystalline solid identical in all respects with the material obtained in the cyclisation reaction of (*E*)-**3e**; mixture of *syn*-**8j** and *anti*-**8j**: R_f 0.18, 0.25% EtOAc–CH_2Cl_2; ν_{max} (film) 2937, 2841, 1612, 1540, 1448, 1423, 1305, 1211, 1148, 1087, 1033, 833, 752, 720, 690 cm^{-1}; *syn*-**8j**: δ_H (500 MHz) 8.04-7.78 (2H, m, *ortho* protons on $PhSO_2$), 7.65-7.20 (8H, *meta* and *para* protons on $PhSO_2$, Ph), 6.92 (1H, d, J 8.0 Hz, H-6 on $(MeO)_2C_6H_3$), 6.40-6.25 (2H, m, H-3 and H-5 on $(MeO)_2C_6H_3$), 5.39 (1H, d, J 6.0 Hz, H-2), 5.16 (1H, dd, J 10.5, 6.0 Hz, H-5), 4.14 (1H, ddd, J 12.5 Hz, 10.5, 6.0, H-3), 3.75 (3H, s, OMe), 3.70 (3H, s, OMe), 2.97 (1H, ddd, J 13.5, 6.0, 2.5 Hz, H-4), 2.41 (1H, dt, J 13.5, 10.5 Hz, H-4); nmr data for *anti*-**8j** inter alia: δ_H (500 MHz) 7.05 (1H, d, J 9.0 Hz, H-6 on $(MeO)_2C_6H_3$), 5.63 (1H, d, J 7.0 Hz, H-2), 5.29 (1H, dd, J 9.0, 7.0 Hz, H-5), 4.45 (1H, m, H-3), 3.77 (3H, s, OMe), 3.73 (3H, s, OMe), 2.83-2.52 (2H, m, H-4); *m/z* (EI) 424, 407, 354, 318, 282, 176, 166, 161, 149, 135, 115, 107, 91, 77 (Found: $[M]^+$, 424.1347. $C_{24}H_{24}O_5S$ requires $[M]^+$, 424.1345).

Cyclisation reaction of (*E*)-3k.

This was carried out analogously to the reaction of (*E*)-**3a** on a 0.93 mmol scale (15 min reaction time) to give, after chromatography (75% ether–petrol) *syn*-**8k** and *anti*-**8k** (50:50 ratio; 61% combined yield) as a colourless oil; *syn*-**8k**: R_f 0.49, 90% ether–petrol; ν_{max} (film) 3061, 2977, 2875, 1584, 1477, 1445, 1376, 1305, 1252, 1219, 1147, 1087, 1063, 998, 948, 897, 863, 777, 748, 719, 690 cm^{-1}; δ_H (500 MHz) 7.91-7.87 (2H, m, *ortho* protons on $PhSO_2$), 7.70-7.63 (1H, m, *para* proton on $PhSO_2$), 7.60-7.54 (2H, m, *meta* protons on $PhSO_2$), 4.27 (1H, q, J 6.0 Hz, H-2), 3.97-3.80 (5H, m, H-5, dioxolane protons), 3.26 (1H, ddd, J 11.0, 6.5, 4.0 Hz, H-3), 2.44 (1H, ddd, J 13.5, 6.0, 4.0 Hz, H-4), 1.82-1.53 (5H, m, H-4, $CHCH_2CH_2$), 1.28 (3H, s, dioxolane Me), 1.17 (3H, d, J 6.0 Hz, C-2 Me); *m/z* (EI) 325 $[M\text{-}Me]^+$, 223, 199, 183, 156, 149, 96, 87, 77, 43 (Found: C, 59.98; H, 7.11. $C_{17}H_{24}O_5S$ requires C, 59.98; H, 7.11%); *anti*-**8k**: R_f 0.38, 90% ether–petrol; ν_{max} (film) 2985, 2881, 1654, 1558, 1540, 1448, 1377, 1149, 1038, 948, 894, 865, 756, 721, 691 cm^{-1}; δ_H (500 MHz) 7.93-7.88 (2H, m, *ortho* protons on $PhSO_2$), 7.70-7.65 (1H, m, *para* proton on $PhSO_2$), 7.61-7.57 (2H, m, *meta* protons on $PhSO_2$), 4.48 (1H, quintet, J 6.5 Hz, H-2), 4.02-3.97 (1H, m, H-5), 3.97-3.87 (4H, m, dioxolane protons), 3.37 (1H, ddd, J 9.0, 8.5, 6.5 Hz, H-3), 2.22 (1H, ddd, J 13.0, 8.5, 5.5 Hz, H-4), 2.02 (1H, dt, J 13.0, 9.0 Hz, H-4), 1.80-1.42 (4H, m, $CHCH_2CH_2$), 1.29 (3H, s, dioxolane Me), 1.19 (3H, d, J 6.5 Hz, C-2 Me); *m/z* (EI) 340, 325, 199, 183, 143, 136, 125, 96, 87, 55, 43 (Found: $[M\text{-}Me]^+$, 325.1110. $C_{17}H_{24}O_5S$ requires $[M\text{-}Me]^+$, 325.1110).

Cyclisation reaction of (*Z*)-3m.

This was carried out analogously to the reaction of (*E*)-**3a** on a 0.091 mmol scale but using 10 equiv of *t*-BuOH (*conditions B*) to give, after chromatography (50% ether–petrol) *syn*-**8m** and *anti*-**8m** (10:90 ratio; 83% combined yield) as a colourless oil; mixture of *syn*-**8m** and *anti*-**8m**: ν_{max} (film) 3062, 2961, 2920, 2874, 2851, 2360, 1447, 1306, 1291, 1149, 1086, 1064, 1025 cm^{-1}; *anti*-**8m**: δ_H (500 MHz) 7.92 (2H, dd, J 8.0, 1.0 Hz, *ortho* protons on $PhSO_2$), 7.65 (1H, m, *para* proton on $PhSO_2$), 7.57 (2H, m, *meta* protons on $PhSO_2$), 7.32-7.23 (5H, m, Ph), 4.85 (1H, dd, J 10.0, 6.0, H-5), 4.40 (1H, dd, J 7.0, 5.0, H-2), 3.72 (1H, ddd, J 13.5, 8.5, 5.0 Hz, H-3), 2.49 (1H, m, H-4), 2.32 (1H, m, H-4), 1.80 (1H, octet, J 7.0 Hz, $CH(CH_3)_2$), 1.00 (3H, d, J 7.0 Hz, $CH(CH_3)_2$), 0.92 (3H, d, J 7.0 Hz, $CH(CH_3)_2$); *m/z* (CI) 678 $[2M+NH_4]^+$, 348 $[M+NH_4]^+$, 331 $[M+H]^+$, 313, 287, 259, 206, 188, 171, 160, 145, 131, 117, 91 (Found: $[M+NH_4]^+$, 348.1632. $C_{19}H_{22}O_3S$ requires $[M+NH_4]^+$, 348.1633); *syn*-**8m**: δ_H (500 MHz) 8.00-7.96 (2H, dd, J 7.0, 5.5 Hz, *ortho* protons on $PhSO_2$), 7.68-7.62 (1H, m, *para* proton on $PhSO_2$), 7.60-7.55 (2H, m, *meta* protons on $PhSO_2$), 7.33-7.22

(5H, m, Ph), 5.10 (1H, dd, J 11.0, 5.0 Hz, H-5), 4.38 (1H, t, J 5.0 Hz, H-2), 3.57 (1H, ddd, J 6.5, 5.0, 1.5 Hz, H-3), 2.72 (1H, ddd, J 13.0, 9.0, 1.5 Hz, H-4), 1.95 (1H, m, H-4), 1.72 (1H, octet, J 5.0 Hz, $CH(CH_3)_2$), 0.93 (3H, d, J 4.5 Hz, $CH(CH_3)_2$), 0.91 (3H, d, J 4.5 Hz, $CH(CH_3)_2$); *m/z* (CI) 348 $[M+NH_4]^+$, 330, 313, 189, 171, 160, 145, 125, 117, 105, 91, 83, 78, 71, 58 (Found: $[M+NH_4]^+$, 348.1635. $C_{19}H_{22}O_3S$ requires $[M+NH_4]^+$, 348.1633).

Cyclisation reaction of (*Z*)-3n.

This was carried out analogously to the reaction of (*Z*)-**3m** on a 0.022 mmol scale to give, after chromatography (50% ether–petrol) *syn*-**8n** and *anti*-**8n** (67:33 ratio; 53% combined yield) as a colourless oil; mixture of *syn*-**8n** and *anti*-**8n**: ν_{max} (film) 2956, 2921, 2851, 2360, 1737, 1463, 1378, 1307, 1290, 1261, 1149, 1087, 1024, 803, 756, 721, 700, 690 cm^{-1}; δ_H (500 MHz) 7.95 (2H, dd, J 9.0, 1.0 Hz, *ortho* protons on $PhSO_2$ *syn*-), 7.90 (2H, d, J 9.0 Hz, *ortho* protons on $PhSO_2$ *anti*-), 7.72-7.65 (2H, m, *para* protons on $PhSO_2$ *syn*- and *anti*-), 7.62-7.56 (4H, m, *meta* protons on $PhSO_2$ *syn*- and *anti*-), 7.35-7.26 (10H, m, Ph *syn*- and *anti*-), 4.96 (1H, dd, J 9.0, 6.0 Hz, H-5 *syn*-), 4.91 (1H, dd, J 9.0, 6.0 Hz, H-5 *anti*-), 4.70 (1H, m, H-2 *anti*-), 4.42 (1H, ddd, J 9.5, 6.5, 3.0 Hz, H-2 *syn*-), 3.55 (1H, ddd, J 9.5, 8.5, 5.5 Hz, H-3 *anti*-), 3.41 (1H, ddd, J 10.0, 6.5, 3.0 Hz H-3 *syn*-), 2.78 (1H, ddd, J 11.0, 6.0, 3.0 Hz, H-4 *syn*-), 2.48 (1H, ddd, J 13.0, 8.0, 5.5 Hz, H-4 *anti*-), 2.32 (1H, m, H-4 *anti*-), 2.05 (1H, m, H-4 *syn*-), 1.80 (2H, m, $CH_2CH(CH_3)_2$ *anti*-), 1.61-1.52 (2H, m, $CH_2CH(CH_3)_2$ *syn*-), 1.22-1.18 (1H, m, $CH_2CH(CH_3)_2$ *anti*-), 1.15 (1H, ddd, J 10.0, 6.5, 3.5, $CH_2CH(CH_3)_2$ *syn*-), 0.89 (3H, d, J 6.5 Hz, $CH_2CH(CH_3)_2$ *anti*-), 0.88 (3H, d, J 6.5 Hz, $CH_2CH(CH_3)_2$ *anti*-), 0.86 (3H, d, J 6.5 Hz, $CH_2CH(CH_3)_2$ *syn*-), 0.85 (3H, d, J 6.5 Hz, $CH_2CH(CH_3)_2$ *syn*-); *m/z* (CI) 391, 362 $[M+NH_4]^+$, 344, 327, 279, 219, 203, 185, 175, 167, 160, 145, 133, 121, 117, 110, 105, 97, 91, 85, 78, 69, 58 (Found: $[M+NH_4]^+$, 362.1800. $C_{20}H_{24}O_3S$ requires $[M+NH_4]^+$, 362.1800).

Cyclisation reaction of (*Z*)-3o.

This was carried out analogously to the reaction of (*Z*)-**3m** on a 0.073 mmol scale to give, after chromatography (50% ether–petrol) *syn*-**8o** and *anti*-**8o** (10:90 ratio; 87% combined yield) as a colourless oil; mixture of *syn*-**8o** and *anti*-**8o**: ν_{max} (film) 2925, 2856, 1306, 1146, 1091, 736 cm^{-1}; *anti*-**8o**: δ_H (500 MHz) 7.90 (2H, dd, J 8.0, 1.0 Hz, *ortho* protons on $PhSO_2$), 7.68-7.62 (1H, m, *para* proton on $PhSO_2$), 7.59-7.51 (2H, m, *meta* protons on $PhSO_2$), 7.33-7.20 (5H, m, Ph), 4.56 (1H, d, J 12.0 Hz, $PhCH_2$), 4.50 (1H, d, J 12.0 Hz, $PhCH_2$), 4.20 (1H, dd, J 6.0, 5.5 Hz, H-2), 4.10 (1H, m, H-5), 3.62 (1H, ddd, J 14.0, 7.5, 5.0 Hz, H-3), 3.51 (1H, dd, J 11.0, 6.0 Hz, CH_2OBn), 3.45 (1H, dd, J 10.0, 5.0 Hz, CH_2OBn), 2.18 (2H, m, H-4), 1.75-1.51 and 1.40-0.81 (11H, m, cyclohexyl protons); *m/z* (CI) 432 $[M+NH_4]^+$, 415 $[M+H]^+$, 391, 340, 323, 307, 292, 273, 255, 243, 223, 202, 181, 175, 167, 151, 142, 135, 108, 98, 91, 78, 65, 58, 44 (Found: $[M+NH_4]^+$, 432.2202. $C_{24}H_{30}O_4S$ requires $[M+NH_4]^+$, 432.2209); *syn*-**8o**: δ_H (500 MHz) 7.91 (2H, dd, J 8.0, 0.5 Hz, *ortho* protons on $PhSO_2$), 7.65 (1H, m, *para* protons on $PhSO_2$), 7.60 (2H, m, *meta* protons on $PhSO_2$), 7.36-7.22 (5H, m, Ph), 4.56 (1H, d, J 13.0 Hz, $PhCH_2$), 4.51 (1H, d, J 13.0 Hz, $PhCH_2$), 4.22 (1H, t, J 5.0 Hz, H-2), 4.18 (1H, m, H-5), 3.55-3.48 (3H, m, H-3 and CH_2OBn), 2.35 (1H, ddd, J 14.0, 5.5, 2.0 Hz, H-4), 1.91 (1H, ddd, J 14.0, 9.0, 8.5 Hz, H-4), 1.70-1.55 and 1.38-0.82 (11H, m, cyclohexyl protons); *m/z* (CI) 432 $[M+NH_4]^+$, 415 $[M+H]^+$, 391, 361, 342, 323, 292, 279, 272, 189, 181, 166, 151, 135, 125, 111, 91, 78, 69, 55 (Found: $[M+NH_4]^+$, 432.2217. $C_{24}H_{30}O_4S$ requires $[M+NH_4]^+$, 432.2209).

Preparation of [2*R,3*S**,5*S**]-2,5-dimethyl-3-phenylsulfenyl-3-(phenylsulfonyl)-tetrahydrofuran (12).**

To a stirred solution of *syn*-**8a** (500 mg, 2.08 mmol, 1.0 equiv) in THF (10 ml) under argon at -93°C was added, dropwise via syringe *n*-BuLi (1 ml of a 2.3M solution in hexanes, 2.30 mmol, 1.1 equiv) causing a bright yellow colouration. After 10 min at -93°C DMPU (1.5 ml in 3.5 ml of THF, 10% v/v) was added followed by Ph_2S_2 (700 mg in 10 ml THF, 3.3 mmol, 1.5 equiv), both via cannula, causing some discharge of the colour. The reaction was allowed to warm to -74°C and quenched by the addition of acetic acid (1.32 ml of a 1.75M solution in THF, 2.29 mmol, 1.1 equiv). After the addition of water the organic layer was separated and

the aqueous layer was extracted with CH_2Cl_2 (4 x 60 ml). The combined organic layers were washed with water (2 x 60 ml), dried ($MgSO_4$) and concentrated under reduced pressure to give a yellow oil. This was purified by chromatography (30% ether–petrol) to give a >20:1 mixture of diastereomeric tetrahydrofurans (640 mg, 88%) as a colourless solid. The major diastereomer was **12**, mp 111°C; R_f 0.31, 40% ether–petrol; ν_{max} (film) 3064, 2978, 2935, 2878, 1585, 1476, 1448, 1395, 1378, 1342, 1301, 1225, 1150, 1081, 1024, 999, 878, 749, 719, 706, 690 cm^{-1}; δ_H (500 MHz) 8.12-8.07 (2H, m, *ortho* protons on $PhSO_2$), 7.75-7.50 (1H, m, *para* proton on $PhSO_2$), 7.62-7.58 (2H, m, *meta* protons on $PhSO_2$), 7.58-7.52 (2H, m, *ortho* protons on PhS), 7.41-7.36 (1H, m, *para* proton on PhS), 7.36-7.30 (2H, m, *meta* proton on PhS), 4.57 (1H, q, J 6.0 Hz, H-2), 4.02 (1H, m, H-5), 2.70 (1H, dd, J 14.5, 6.5 Hz, H-4), 1.63 (1H, dd, J 14.5, 9.0 Hz, H-4), 1.15 (3H, d, J 6.0 Hz, H-6 or H-7), 1.12 (3H, d, J 6.0 Hz, H-7 or H-6); *m/z* (EI) 333 $[M\text{-}Me]^+$, 218, 207, 189, 165, 148, 135, 110, 97, 77, 66, 51, 43, 32, 28 (Found: C, 61.75; H, 5.76. $C_{18}H_{20}O_3S_2$ requires C, 62.04; H, 5.78%).

Preparation of [2*R,5*S**]-2,5-dimethyl-3-(phenylsulfonyl)-2,5-dihydrofuran (13) and [2*R**,5*S**]-2,5-dimethyl-3,3-bis(phenylsulfonyl)tetrahydrofuran (14).**

To a stirred solution of **12** (10 mg, 0.029 mmol, 1 equiv) in CH_2Cl_2 (0.5 ml) at rt was added peracetic acid (35 wt % solution in acetic acid; 1 drop in 5 drops water). Further peracetic acid (1 drop in 5 drops water) was added after 5 h. The reaction was quenched after 14 h by the addition of saturated aqueous $NaHCO_3$ and the aqueous layer extracted with CH_2Cl_2 (3 x 4 ml). The combined organic layers were washed with saturated aqueous sodium thiosulfate (4 ml), saturated aqueous $NaHCO_3$ (4 ml), water (4 ml), dried ($MgSO_4$) and concentrated under reduced pressure to give a colourless oil (15.4 mg). Analysis by ^1H nmr showed a 5:1 mixture of sulfones **13** and **14**; R_f 0.44, 70% ether–petrol; δ_H (500 MHz) 8.16-8.10 (4H, m, *ortho* protons on $PhSO_2$, **14**), 7.94-7.90 (2H, M, *ortho* protons on $PhSO_2$, **13**), 7.80-7.55 (9H, m, *meta* and *para* protons on $PhSO_2$, **13** and **14**), 6.71 (1H, m, H-4, **13**), 4.97-4.91 (1H, m, H-2 or H-5, **13**), 4.90-4.84 (1H, m, H-5 or H-2, **13**), 4.56 (1H, q, J 6.5 Hz, H-2, **14**), 4.07 (1H, m, H-5, **14**), 2.91 (1H, dd, J 14.5, 6.5 Hz, H-4, **14**), 2.35 (1H, dd, J 14.5, 9.5 Hz, H-4, **14**), 1.42 (3H, d, J 6.0 Hz, Me, **14**), 1.37 (3H, d, J 6.5 Hz, Me, **13**), 1.35 (6H, d, J 6.5 Hz, Me, **13** and Me, **14**).

Preparation of [2*R,3*S**,5R*]-2,5-dimethyl-2-ethyl-3-(phenylsulfenyl)tetrahydrofuran (15) and [2*R**,3*S**,5*R**]-2,5-dimethyl-3-(phenylsulfenyl)-2-(2-propenyl)tetrahydrofuran (16).**

To a stirred solution of **12** (20 mg, 0.057 mmol, 1.0 equiv) and allyltrimethylsilane (10.0 µl, 0.063 mmol, 1.1 equiv) in CH_2Cl_2 (0.6 ml) under argon at 0°C was added Et_2AlCl (32.0 µl of a 1.8M solution in toluene, 0.057 mmol, 1.0 equiv). Tlc after 4 min indicated the formation of a new, less polar component; the solution was quenched by the addition of saturated aqueous $NaHCO_3$ and allowed to warm to rt. The organic phase was separated and the aqueous layer extracted with CH_2Cl_2 (4 x 5 ml). The combined organic layers were washed with water (5 ml), dried ($MgSO_4$) and concentrated under reduced pressure to give **15** and **16** (4:1 mixture by ^1H nmr; 11.9 mg) as a pale yellow oil. Data for the mixture; compound **15**: δ_H (250 MHz) 7.50-7.20 (5H, m, Ph), 3.98 (1H, m, H-5), 3.52 (1H, dd, J 11.0, 7.0 Hz, H-3), 2.44 (1H, ddd, J 12.5, 7.5, 5.5 Hz, H-4), 1.74 (1H, ddd, J 12.5, 11.0, 10.5 Hz, H-4), 1.66-1.50 (2H, m, CH_2CH_3), 1.32 (3H, d, J 6.5 Hz, C-5 CH_3), 1.24 (3H, s, C-2 CH_3), 0.91 (3H, t, J 7.5 Hz, CH_2CH_3); compound **16**: δ_H (250 MHz) 7.50-7.20 (5H, m, Ph), 5.85 (1H, m, CH:CH_2), 5.10-4.93 (2H, m, CH:CH_2), 3.98 (1H, m, H-5), 3.59 (1H, dd, J 11.5, 7.0 Hz, H-3), 2.48-1.16 (4H, m, H-4, CH_2CH:CH_2), 1.28-1.23 (6H, m, C-2 and C-5 CH_3).

Preparation of [2*R,5*S**]-2,5-dimethyl-3-(phenylsulfenyl)-2-(2-propenyl)tetrahydrofuran (16).**

To a stirred solution of **12** (20.0 mg, 0.057 mmol, 1.0 equiv) and allyltrimethylsilane (10.0 µl, 0.063 mmol, 1.1 equiv) in CH_2Cl_2 (0.6 ml) under argon at -78°C was added $AlCl_3$ (63.0 µl of a 1M solution in nitrobenzene, 0.063 mmol, 1.1 equiv). Tlc after 5 min indicated complete consumption of starting material and the solution was quenched with saturated aqueous $NaHCO_3$ and allowed to warm to rt. The organic phase was separated and the aqueous layer extracted using CH_2Cl_2 (4 x 5 ml).The combined organic layers were washed with water (5

ml), then dried ($MgSO_4$) and concentrated under reduced pressure to give **16** (11.8 mg, 84%) as a pale oil which showed ^1H nmr characteristics identical with those of the material generated in the Et_2AlCl reaction.

5. ACKNOWLEDGEMENTS

We thank the SERC (Quota Studentship to A. M. S.), SERC/EPSRC and Wellcome Research Laboratories (Earmarked/CASE Studentship to N. J. I.), and ICI plc (Strategic Research Initiative) for financial support of this research. We acknowledge support from the Wolfson Foundation for establishing the Wolfson Centre for Organic Chemistry in Medical Science. We thank Ms Hilary O'Callaghan (Imperial College) for carrying out elemental combustion analyses. We gratefully acknowledge the SERC Mass Spectrometry Service Centre, University College of Swansea for providing some of the high-resolution mass spectra.

6. REFERENCES AND NOTES

1. For reviews, see: (i) Boivin, T. L. B. *Tetrahedron* **1987**, *43*, 3309-3362; (ii) Harmange, J.-C.; Figadère, B. *Tetrahedron: Asymmetry* **1993**, *4*, 1711-1754.
2. Auvray, P.; Knochel, P.; Normant, J.-F. *Tetrahedron Lett.* **1985**, *26*, 4455-4458.
3. Baldwin, J. E. *J. Chem. Soc., Chem. Commun.* **1976**, 734-736; Baldwin, J. E.; Cutting, J.; Dupont, W.; Kruse, L.; Silberman, L.; Thomas, R. C. *J. Chem. Soc., Chem. Commun.* **1976**, 736-738. For some recent examples of the use of 5-*endo-trig* reactions in heterocycle synthesis, see: Minamikawa, J.; Nishi, T. *Bioorg. Med. Chem. Lett.* **1997**, *7*, 1267-1268; Andrey, O.; Ducry, L.; Landais, Y.; Planchenault, D.; Weber, V. *Tetrahedron* **1997**, *53*, 4339-4352; Jones, A. D.; Knight, D. W. *J. Chem. Soc., Chem. Commun.* **1996**, 915-916.
4. Preliminary communications: (i) Craig, D.; Smith, A. M. *Tetrahedron Lett.* **1992**, *33*, 695-698; (ii) Craig, D.; Ikin, N. J.; Mathews, N.; Smith, A. M. *Tetrahedron Lett.* **1995**, *36*, 7531-7534.
5. Julia, M.; Launay, M.; Stacino, J.-P.; Verpeaux, J.-N. *Tetrahedron Lett.* **1982**, *23*, 2465-2468.
6. The *threo*-selectivity may be rationalised using the Cram or Felkin–Anh models, treating the sulfonyl group as the largest α-substituent.
7. The use of $NaBH_4$–$CeCl_3$ consistently gave cleaner, more rapid reduction reactions than $NaBH_4$ alone. L-Selectride®[5] was effective only for substrates having R^2 = Me.
8. We thank Mr Dick Sheppard and Mr Paul Hammerton of this Department for these determinations.
9. We presume that the unusually low temperature at which the *syn*-elimination took place stems from relief of steric crowding in the putative intermediate sulfoxide.
10. Jones and Liotta have reported that on the basis of MNDO calculations phenylthio-substituted cyclic oxonium ions derived from pyrans are viable alternatives to the postulated episulfonium species in the substitution–rearrangement reactions of some phenylthiopyranosides. See: Jones, D. K.; Liotta, D. C. *Tetrahedron Lett.* **1993**, *34*, 7209-7212.
11. Craig, D.; Lawrence, R. M.; Tapolczay, D. J. *Synlett* **1997**, 1001-1003.
12. Berry, M. B.; Craig, D.; Jones, P. S.; Rowlands, G. J. *Chem. Commun.* **1997**, 2141-2142; Craig, D.; Jones, P. S.; Rowlands, G. J. *Synlett* **1997**, 1423-1425.
13. Perrin, D. D.; Armarego, W. L. F. *Purification of Laboratory Chemicals*, 3rd edn.; Pergamon: Oxford, 1988.