# Ring-opening of *N*-tosyl aziridines by 2-lithiodithianes

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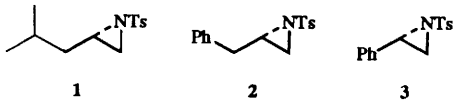
The reaction of lithiated dithianes **6–8** and **15** and **16** with enantiopure *N*-sulfonylated aziridines **1** and **2** leads *via* regiospecific nucleophilic ring-opening to enantiopure *N*-tosyl 2-(2′-dithianyl) secondary amines in good to excellent yields. These compounds may be either desulfonylated or hydrolytically desulfurized to give the corresponding amines **21–24** or carbonyl compounds **25–27** and **28–30** in good yield. In the case of α-silaalkanones **31** and **32** produced by these reactions, oxidation furnishes enantiopure 3-tosylamino acids **33** and **34** in good yield.

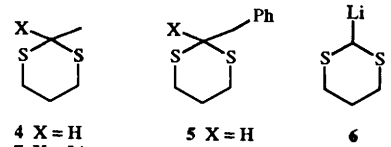
The reactions of aziridines are dominated by ring-opening,[1] in an analogous fashion to the chemistry of epoxides although to a lesser extent. Aziridines have, however, been much less exploited in synthesis than their oxygenated counterparts. During synthetic studies towards the rational design of non-peptide β-turn mimics, we had need of a synthetic route which would allow convenient preparation of enantiopure 3-amino carbonyl compounds; existing preparations of 3-amino carbonyl compounds include the reduction of 3-amino acids, themselves produced by an Arndt-Eistert homologation of α-amino acids,[2] Michael addition of an amine to an enal,[3] or borane addition to an alkyne, followed by oxidation.[4] β-Amino ketones are typically produced *via* Mannich reactions,[5] which in general produce racemic products, or by addition of nitroxides (aminoxyls) to alkenes, followed by electrophilic attack and treatment with a base.[6] We reasoned that the ring-opening of an enantiomerically-pure N-activated aziridine by an acyl anion equivalent would fulfill our desires for preparation of enantiopure materials. We here report in full[7] the details of this previously unexplored synthetic approach.[8]

## Results and discussion

The reactions of lithiodithianes are legion.[9] Thus, we considered the use of these well-documented acyl anion equivalents in our proposed synthetic route. It soon became clear, however, that a notable omission from the synthetic arsenal of these species is the ring-opening of aziridines; in fact, the reaction of *N*-acyl and *N*-carbamoylaziridines with dithiane anions is reported to give products of acyl transfer rather than ring-cleavage,[10] a common and unwanted side-reaction in the reactions of such aziridines with nucleophiles. We presumed that sulfonyl activators would be more robust and, therefore, prepared *N*-tosyl aziridines **1–3** in enantiomerically pure form from (*S*)-leucine, (*S*)-phenylalanine and (*S*)-phenylglycine, respectively, using a one-pot modification of Craig's protocol,[11] and proceeded to the reaction of interest. Anions derived from dithiane itself and alkylated dithianes **4** and **5** were treated separately with aziridines **1–3**.



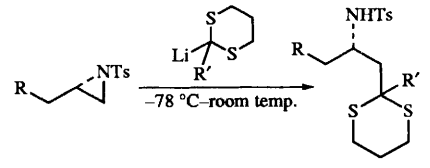

**1** **2** **3**



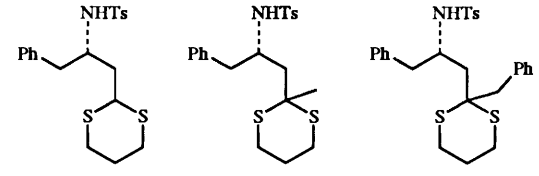

**4** X = H, **7** X = Li; **5** X = H, **8** X = Li; **6**

For aziridines **1** and **2**, the reactions proceeded smoothly at −78–0 °C and regiospecific attack of lithiodithianes **6–8** led to ring-opened products of alkylation **9–14** in good to excellent yield (Table 1). The progress of the reactions was characterized

**Table 1** Ring-opening of *N*-tosyl aziridines by lithiodithianes




Ring-opened products (yield)



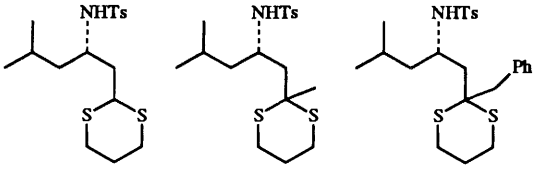

**9** (81%)




**10** (74%)




**11** (59%)



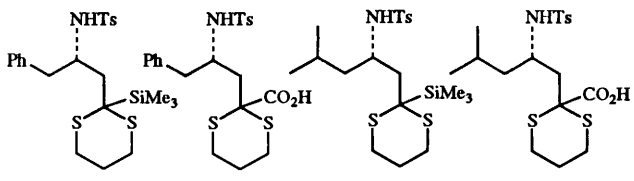

**12** (88%)




**13** (91%)




**14** (68%)

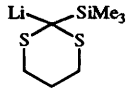



**17** (89%) **18** (89%) **19** (67%) **20** (92%)

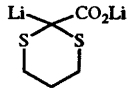
by intense colorations, which aided assessment of the extent of reaction: phenylalanine-derived aziridine **2**, upon reaction at −78 °C with 2-lithiodithiane itself and 2-alkyl-2-lithiodithianes, gave a vivid deep purple coloration which changed to deep red at 0 °C. The leucine-derived aziridine reaction mixtures were golden yellow at low temperature and emerald green at 0 °C.

Phenylglycine-derived aziridine **3** exhibited anomalous reactivity and only racemized **3** and starting dithianes were recovered after reaction under analogous conditions to those described above (*vide infra*).

The anions **15** and **16**, derived from 2-trimethylsilyldithiane



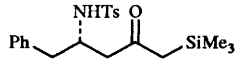
**15**



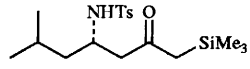
**16**

and 2-carboxydithiane, also effected efficient ring-opening. The 2-(*N*-tosylamino)alkyl dithianes **17**–**20** prepared by this reaction are shown in Table 1. Some of these ring-opened products may be desulfonylated in moderate yield (< 60%) to the aminodithianes **21**–**24** by exposure to sodium naphthalenide. Use of alternative desulfonylating protocols did not furnish the required product, and the trimethylsilyl dithianes **17** and **19** were desilylated under the harsh reaction conditions. Furthermore, benzyl dithianes **11** and **14** and carboxy dithianes **18** and **20** were destroyed by such reaction conditions, yielding neither starting materials nor desired products under any desulfonylating protocol. The stringency of the desulfonylation of sulfonamides leads to serious problems and, therefore, limits the utility of the reaction sequence.

Alternatively, removal of the dithiane group *via* alkylative hydrolysis gave 2-tosylamino carbonyl compounds **25**–**30** in moderate to excellent yield. For the silylated dithianes **17** and **19**, mercury-mediated hydrolysis was found to be most satisfactory, hydrolytic desulfurization liberating the relatively unstable silaketones **31** and **32** which were immediately oxidized to give enantiopure 2-tosyl amino acids **33** and **34** in moderate overall yield (~ 50% from the dithianes). In the case of carboxy dithianes **18** and **20**, attempted hydrolysis neither yielded product, nor returned starting material, probably due to the high water solubility of the 2-keto acids produced.



**31**

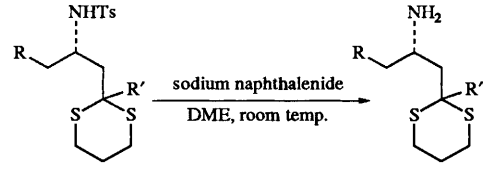


**32**

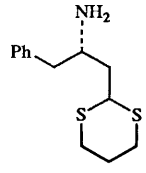
Table 2 shows the amino dithianes prepared in this study, while Table 3 displays the tosylamino carbonyl compounds obtained.

The conversion of ring-opened compounds to the corresponding free amino carbonyl compounds is not feasible, according to our studies. As might be expected, elimination reactions abound when attempts are made to deprotect either of the two classes of partially unmasked intermediates. In particular, the failure to obtain 3-amino acids by desulfonylation of the corresponding *N*-tosyl derivative is a drastic and irritating limitation to this methodology.

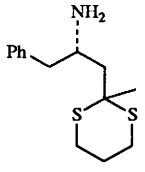
**Table 2** Desulfonylation of *N*-tosyl aminodithianes




Desulfonylated products (yield)

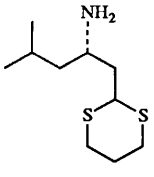


**21**
(59% from **9**)

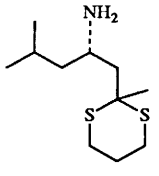


**22**
(51% from **10**)

no product from **11**

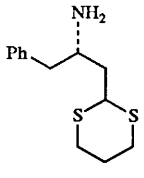


**23**
(42% from **12**)



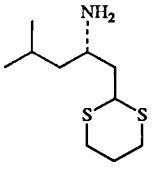
**24**
(48% from **13**)

no product from **14**



**21**
(44% from **17**)*

no product from **18**

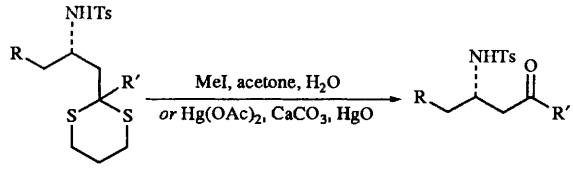


**23**
(53% from **19**)*

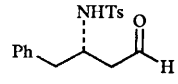
no product from **20**

* Desilylation occurred under reaction conditions (see text).

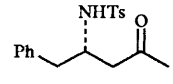
**Table 3** Hydrolytic desulfurization of *N*-tosyl aminodithianes



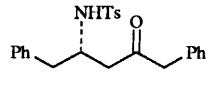

Hydrolytically desulfurized products (yield)



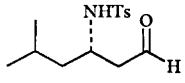
**25**
(100% from **9**)



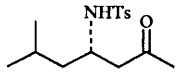
**26**
(100% from **10**)



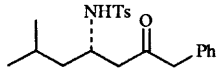
**27**
(42% from **11**)



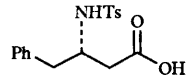
**28**
(85% from **12**)



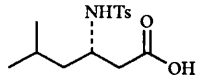
**29**
(78% from **13**)



**30**
(47% from **14**)



**33**
(50% from **17**)*



**34**
(53% from **19**)*

* Yield for two-step desulfurization/oxidation process (see text).

As mentioned earlier, the aziridine derived from phenylglycine is not reactive in the presence of these anions. Indeed, it has previously been postulated that basic nucleophiles (such as α-silylated allylic anions) cause a deprotonation of aziridine **3**, rather than effecting ring-opening.[12]

## Experimental

### General

All organic solvents were distilled prior to use and all reagents were purified by standard procedures.[13] Light petroleum refers to the fraction with boiling range 40–60 °C. Diethyl ether, THF and DME were distilled from sodium benzophenone ketyl; toluene from sodium; dichloromethane, triethylamine, diisopropylamine and acetonitrile from calcium hydride, and pyridine and diisopropylethylamine from potassium hydroxide.

Melting points were recorded on a Kofler hot-stage apparatus and are uncorrected. IR spectra were recorded on a Perkin-Elmer 881 spectrophotometer. Optical rotations were measured using a Perkin-Elmer 241MC polarimeter and are quoted in $10^{-1}$ deg cm$^2$ g$^{-1}$. Mass spectra were recorded on a VG9090 mass spectrometer or on a Fisons Autospec machine. $^1$H and $^{13}$C NMR spectra were recorded on a JEOL GX-270 spectrometer. Unless otherwise stated, deuteriochloroform was used as solvent and tetramethylsilane was used as the internal standard. Chemical shifts in $^1$H NMR spectra are expressed as ppm downfield from tetramethylsilane, and in $^{13}$C NMR, relative to the internal solvent standard. Coupling constants ($J$) are quoted in Hz.

Reactions involving chemicals or intermediates sensitive to air and/or moisture were performed under a nitrogen atmosphere in flame- or oven-dried apparatus. Flash column chromatography[14] was performed using Merck kieselgel 60 or Fluka kieselgel 60 silica. Analytical thin layer chromatography (TLC) was performed on precoated Merck kieselgel 60 $F_{254}$ aluminium backed plates and were visualised under UV conditions at 254 nm, and by staining with an acidic ammonium molybdate spray.

### General method for ring-opening of aziridine with dithiane derivative

To a solution of dithiane (1.1 equiv.), in dry THF, under $N_2$, at −23 °C, was added BuLi (2.4 mol dm$^{-3}$, 1.1 equiv.) and the solution was stirred at −23 °C for 1.3 h. The solution was then cooled to −78 °C and a solution of aziridine (1 equiv.) in THF added dropwise to it. The solution was stirred at −78 °C for 1 h, then at 0 °C until all of the starting material had been consumed, as shown by TLC (typically 2 h). The solution was then quenched with $H_2O$ and extracted with EtOAc, the organic layers washed with brine, dried ($Na_2SO_4$), filtered and the solvent removed under reduced pressure. Purification by chromatography on silica gel eluting with ethyl acetate–light petroleum (1:4) yielded the pure products.

**(*S*)-1-(1,3-Dithian-2-yl)-2-(4-methylbenzenesulfonamido)-3-phenylpropane 9.** Following the general procedure described above, the aziridine **2** (0.5 g, 1.74 mmol) and 2-lithio-1,3-dithiane **6** (0.23 g, 1.92 mmol) were allowed to react at −78 °C for 1 h and then at 0 °C for 3 h to yield the *dithiane* **9** (0.57 g, 81%) as a white solid, $R_f$ 0.4 (ethyl acetate–light petroleum 3:7); mp 125–127 °C (Found: C, 58.5; H, 6.2; N, 3.4; S, 23.8. $C_{20}H_{25}NS_3O_2$ requires C, 58.93; H, 6.18; N, 3.44; S, 23.60%); $[\alpha]_D^{23}$ −6 (*c* 0.2 in $CH_2Cl_2$); $\nu_{max}$(Nujol)/cm$^{-1}$ 3270 (NH), 1601 (arom. C=C), 1493 (S=O), 1413 (S=O), 1334 (S=O), 1164, 1071 (S=O), 810 (arom. C–H); $\delta_H$(270 MHz; $CDCl_3$) 1.76–1.85 and 1.90–2.05 (4 H, m, $SCH_2CH_2CH_2S$ and $PhCH_2CHCH_2CH$), 2.40 (3 H, s, $CCH_3$), 2.53–2.83 (6 H, m, $SCH_2CH_2CH_2S$ + $PhCH_2CH$), 3.76–3.85 (2 H, m, $CHCH_2CH$), 4.93 (1 H, d, *J* 8.6, NH), 7.00–7.27 (7 H, m, ArH) and 7.72 (2 H, d, *J* 8.6, 2 tosyl ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 21.54 ($CCH_3$), 25.72, 29.42, 29.88, 40.02, 41.61 (all $CH_2$), 43.18, 52.24 (both CH) and 126.76, 127.17, 128.61, 129.48, 129.63, 136.44, 137.67 and 143.21 (ArC); *m/z* (EI) 407 ($M^+$, 6%), 316 (5), 133 (30), 119 (85) and 91 (48) (Found: $M^+$, 407.1047. $C_{20}H_{25}NS_3O_2$ requires *M*, 407.1030).

**(*S*)-1-(2-Methyl-1,3-dithian-2-yl)-2-(4-methylbenzenesulfonamido)-3-phenylpropane 10.** Following the general procedure described above, the aziridine **2** (0.5 g, 1.74 mmol) and 2-lithio-2-methyl-1,3-dithiane **7** (0.25 g, 1.92 mmol) were allowed to react at −78 °C for 1 h and then at 0 °C for 3 h to yield the *dithiane* **10** (0.54 g, 74%) as a white solid, $R_f$ 0.10 (ethyl acetate–light petroleum 1:9); mp 122–123 °C (Found: C, 59.0; H, 6.6; N, 3.2. $C_{21}H_{27}NS_3O_2 \cdot 0.3H_2O$ requires C, 59.06; H, 6.51; N, 3.28%); $[\alpha]_D^{23}$ −22 (*c* 3 in $CH_2Cl_2$); $\nu_{max}$($CCl_4$)/cm$^{-1}$ 2924 (NH), 1416 (S=O), 1337 (S=O), 1191 (S=O), 952 (arom. C–H); $\delta_H$(270 MHz; $CDCl_3$) 1.30 [3 H, s, $CH_3C(SCH_2CH_2CH_2S)$], 1.70–1.90 and 2.12–2.38 (4 H, m, $SCH_2CH_2CH_2S$ and $CHCH_2CH$), 2.40 (3 H, s, $CCH_3$), 2.52–2.96 (6 H, m, $SCH_2CH_2CH_2S$ + $PhCH_2$), 3.66–3.69 (1 H, m, CH), 5.25 (1 H, d, *J* 6.4, NH) and 7.02–7.81 (9 H, m, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 21.46 ($CCH_3$), 24.44, 26.01, 26.49 (all $CH_2$), 27.73 ($CCH_3$), 42.60, 43.78 (both $CH_2$), 53.24 (CH) and 47.16 [$CH_2C$(Me)]; *m/z* (EI) 421 ($M^+$, 2%), 330 (7), 316 (4), 272 (22), 155 (30), 133 (100) and 91 (81) (Found: $M^+$, 421.1204. $C_{21}H_{27}NS_3O_2$ requires *M*, 421.1204).

**(*S*)-1-(2-Benzyl-1,3-dithian-2-yl)-2-(4-methylbenzenesulfonamido)-3-phenylpropane 11.** Following the general procedure described above, the aziridine **2** (0.1 g, 0.35 mmol) and 2-benzyl-2-lithio-1,3-dithiane **8** (0.08 g, 0.38 mmol) were allowed to react at −78 °C for 1 h and then at 0 °C for 1 h to yield the *dithiane* **11** (0.11 g, 59%) as a pale yellow oil, $R_f$ 0.21 (ethyl acetate–light petroleum 1:4); $[\alpha]_D^{23}$ −15.06 (*c* 1.7 in $CH_2Cl_2$); $\nu_{max}$($CCl_4$)/cm$^{-1}$ 3264 (NH), 2931 (alkyl), 1600 (C=C), 1453, 1334, 1160 and 1093 (S=O); $\delta_H$(270 MHz; $CDCl_3$) 1.65–1.79 (2 H, m, $SCH_2CH_2CH_2S$), 1.97 (1 H, dd, *J* 8.1, 15.5, C*H* of $PhCH_2CHCH_2$), 2.07 (1 H, dd, *J* 3.9 and 15.5, C*H* of $PhCH_2CHCH_2$), 2.37 (3 H, s, $CCH_3$), 2.50–2.68 (4 H, m, $SCH_2CH_2CH_2S$), 2.76 (1 H, dd, *J* 5.1, 13.7, C*H* of $PhCH_2$), 2.84 (2 H, s, $PhCH_2$), 2.98 (1 H, dd, *J* 4.5 and 13.7, C*H* of $PhCH_2$), 3.71–3.84 (1 H, m, $PhCH_2CH$), 5.53 (1 H, d, *J* 5.4, N*H*), 7.00–7.55 (12 H, m, ArH) and 7.81 (2 H, d, *J* 8.1, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 21.38 ($CCH_3$), 23.98, 25.82, 26.30, 41.73, 42.84 and 45.63 (all $CH_2$), 52.05 (C), 53.09 (CH) and 126.49, 126.78, 127.45, 127.51, 127.76, 128.40, 129.50, 129.64, 130.92, 135.11, 137.23 and 143.37 (ArC); *m/z* (EI) 406 [$(M - 91)^+$, 7%], 274 (28), 119 (100) and 91 (87) (Found: $M^+$, 406.0963. $C_{20}H_{24}NS_3O_2$ requires *M*, 406.0969).

**(*S*)-1-(2-Trimethylsilyl-1,3-dithian-2-yl)-2-(4-methylbenzenesulfonamido)-3-phenylpropane 17.** Following the general procedure described above, the aziridine **2** (0.1 g, 0.35 mmol) and 2-lithio-2-trimethylsilyl-1,3-dithiane **15** (0.07 g, 0.38 mmol) were allowed to react at −78 °C for 1 h and then at 0 °C for 3 h to yield the *dithiane* **17** (0.15 g, 90%) as a yellow oil, $R_f$ 0.25 (ethyl acetate–light petroleum 1:4); $[\alpha]_D^{23}$ −11.8 (*c* 1 in $CH_2Cl_2$); $\nu_{max}$(neat liquid)/cm$^{-1}$ 3300 (NH), 2940 (alkyl), 1600 (C=C), 1480, 1260 and 1180 (S=O); $\delta_H$(270 MHz; $CDCl_3$) −0.23 (9 H, s, $SiMe_3$), 1.69–2.06 (4 H, m, $PhCH_2CHCH_2$ and $SCH_2CH_2CH_2S$), 2.30 (3 H, s, $CCH_3$), 2.44–3.02 (6 H, m, $PhCH_2CH$ and $SCH_2CH_2CH_2$), 3.30–3.55 (1 H, m, $PhCH_2CH$), 6.93 (1 H, d, *J* 6.8, N*H*), 6.99–7.11 (7 H, m, ArH) and 7.60 (2 H, d, *J* 8.1, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) −3.00 ($SiMe_3$), 21.41 ($ArCH_3$), 23.73, 23.87 and 26.08 (all $CH_2$), 36.76 (C), 39.79 and 41.29 (both $SCH_2$), 55.54 (CH) and 126.51, 127.16, 128.43, 129.46, 129.57, 137.05, 137.72 and 143.18 (ArC); *m/z* (EI) 479 ($M^+$, 4%), 274 (37), 155 (28), 91 (100) and 73 (72) (Found: $M^+$, 479.1443. $C_{23}H_{33}NO_2SiS_3$ requires *M*, 479.1444).

**(*S*)-1-(2-Carboxy-1,3-dithian-2-yl)-2-(4-methylbenzenesulfonamido)-3-phenylpropane 18.** Following the general procedure described above, the aziridine **2** (0.1 g, 0.35 mmol) and dianion **16**, derived from 1,3-dithiane-2-carboxylic acid (0.06 g, 0.38 mmol), were allowed to react at −78 °C for 1 h and then at 0 °C to room temperature overnight to yield the *dithiane* **18** (0.14 g, 89%) as a yellow oil (crude), $\nu_{max}$(neat liquid)/cm$^{-1}$ 3294 (OH), 2925 (NH), 1731 (C=O), 1599 (C=C), 1496, 1420, 1291 and 1161 (S=O); $\delta_H$(270 MHz; $CDCl_3$) 1.70–2.39 (4 H, m, $SCH_2CH_2CH_2S$ and $PhCH_2CHCH_2$), 2.39 (3 H, s, $CCH_3$), 2.53–3.46 (6 H, m, $SCH_2CH_2CH_2S$ and $PhCH_2$), 3.77–3.99 (1 H, m, $PhCH_2CH$), 5.40 (1 H, d, *J* 7.9, NH), 6.97–7.60 (7 H, m, ArH), 7.75 (2 H, d, *J* 8.3, ArH) and 10.14 (1 H, s br, OH); *m*/*z* (EI) 433 (M − 18, 5%), 119 (100), 91 (55) and 45 (62) (Found: M$^+$, 433.0843. $C_{21}H_{23}NS_3O_3$ requires *M*, 433.0840).

**(*S*)-1-(1,3-Dithian-2-yl)-2-(4-methylbenzenesulfonamido)-4-methylpentane 12.** Following the general procedure described above, the aziridine **1** (0.1 g, 0.39 mmol) and 2-lithio-1,3-dithiane **6** (0.05 g, 0.44 mmol) were allowed to react at −78 °C for 1 h and then at 0 °C for 2.5 h to yield the *dithiane* **12** (0.13 g, 88%) as a white solid, $R_f$ 0.44 (ethyl acetate–light petroleum 1:4); mp 130–132 °C (Found: C, 54.5; H, 7.5; N, 3.7; S, 25.8. $C_{17}H_{27}NS_3O_2$ requires C, 54.65; H, 7.28; N, 3.75; S, 25.75%); $[\alpha]_D^{23}$ −18 (*c* 0.83 in $CH_2Cl_2$); $\nu_{max}$($CCl_4$)/cm$^{-1}$ 2900 (NH), 1598 (C=C), 1430 and 1180 (S=O); $\delta_H$(270 MHz; $CDCl_3$) 0.73 and 0.79 (6 H, 2 × d, *J* 6.5, $Me_2CH$), 1.17–2.18 (7 H, m, $Me_2CHCH_2CHCH_2$ and $SCH_2CH_2CH_2S$), 2.43 (3 H, s, $CCH_3$), 2.57–2.85 (4 H, m, $SCH_2CH_2CH_2S$), 3.49–3.59 (1 H, m, $Me_2CHCH_2CHCH_2$), 3.86 (1 H, dd, *J* 5.1 and 9.4, SCHS), 4.48 (1 H, d, *J* 8.5, NH), 7.31 (2 H, d, *J* 8.0, ArH) and 7.80 (2 H, d, *J* 8.0, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 21.44 (C*Me*), 22.22 (C*Me*), 22.36 (C*Me*), 24.57 ($Me_2CH$), 25.70, 29.59, 30.00 and 41.05 (all $CH_2$), 43.17 (CH), 45.08 ($CH_2S$), 49.95 (CH) and 127.24, 129.59, 143.24 and 138.00 (Ar*C*); *m*/*z* (EI) 373 (M$^+$, 4%), 155 (23), 119 (100) and 86 (71) (Found: M$^+$, 373.1207. $C_{17}H_{27}NS_3O_2$ requires *M*, 373.1204).

**(*S*)-1-(2-Methyl-1,3-dithian-2-yl)-2-(4-methylbenzenesulfonamido)-4-methylpentane 13.** Following the general procedure described above, the aziridine **1** (0.1 g, 0.40 mmol) and 2-lithio-2-methyl-1,3-dithiane **7** (0.06 g, 0.44 mmol) were allowed to react at −78 °C for 1 h and then at 0 °C for 4 h to yield the *dithiane* **13** (0.14 g, 91%) as a clear oil, $R_f$ 0.25 (ethyl acetate–light petroleum 1:4); $[\alpha]_D^{23}$ −16 (*c* 0.5 in $CH_2Cl_2$); $\nu_{max}$(neat liquid)/cm$^{-1}$ 3270 (NH), 2930 (CH), 1599 (C=C), 1423, 1330, 1161, 1080 ($SO_2$); $\delta_H$(270 MHz; $CDCl_3$) 0.71 and 0.82 (6 H, 2 × d, *J* 6.4, $Me_2CH$), 1.40 (3 H, s, CMe), 1.23–2.03 (6 H, m, $Me_2CHCH_2$ and $SCH_2CH_2CH_2S$ and CH of $CH_2CCH_3$), 2.25 (1 H, dd, *J* 6.8 and 15.0, CH of $CH_2CCH_3$), 2.43 (3 H, s, CMe), 2.69–2.98 (4 H, m, $SCH_2CH_2CH_2S$), 3.40–3.47 (1 H, m, $Me_2CHCH_2CH$), 5.13 (1 H, d, *J* 6.4, NH), 7.31 (2 H, d, *J* 8.0, ArH) and 7.79 (2 H, d, *J* 8.0, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 21.47 and 22.33 (both C*Me*), 22.43 (C*Me*), 24.63 ($CH_2$), 24.74 (CH), 25.19 ($CH_2$), 28.01 ($CCH_3$), 30.63 ($CHCH_2CMe$), 42.90 ($SCH_2$), 45.79 ($SCH_2$), 47.21 (C), 50.35 (CHN) and 127.45, 129.50, 137.59 and 143.29 (Ar*C*); *m*/*z* (EI) 387 (M$^+$, 5%), 240 (98), 155 (62), 133 (75) and 91 (100) (Found: M$^+$, 387.1355. $C_{18}H_{29}NO_2S_3$ requires *M*, 387.1360).

**(*S*)-1-(2-Benzyl-1,3-dithian-2-yl)-2-(4-methylbenzenesulfonamido)-4-methylpentane 14.** Following the general procedure described above, the aziridine **1** (0.1 g, 0.40 mmol) and 2-benzyl-2-lithio-1,3-dithiane **8** (0.09 g, 0.44 mmol) were allowed to react at −78 °C for 1 h and then at 0 °C for 2 h to yield the *dithiane* **14** (0.15 g, 73%) as a clear oil, $R_f$ 0.29 (ethyl acetate–light petroleum 1:4); mp 72–74 °C (Found: C, 62.0; H, 7.3; N, 3.05. $C_{24}H_{33}NS_3O_2$ requires C, 62.16; H, 7.17; N, 3.05%); $[\alpha]_D^{23}$ −6.5 (*c* 7 in $CH_2Cl_2$); $\nu_{max}$(neat liquid)/cm$^{-1}$ 2960 (NH), 1600 (C=C), 1490, 1420, 1345, 1160, 1080 (S=O) and 920 (ArH); $\delta_H$(270 MHz; $CDCl_3$) 0.76 and 0.80 (6 H, 2 × d, *J* 6.1, $Me_2CH$), 1.25–1.87 (5 H, m, $SCH_2CH_2CH_2S$ and $Me_2CHCH_2$), 1.92 (1 H, dd, *J* 4.7 and 15.4, CH of $CH_2CCH_2Ph$), 2.12 (1 H, dd, *J* 7.4 and 15.4, CH of $CH_2CCH_2Ph$), 2.39 (3 H, s, $CCH_3$), 2.73–2.85 (4 H, m, $SCH_2CH_2CH_2S$), 2.95 (2 H, s, $PhCH_2$), 3.57–3.59 (1 H, m, $Me_2CHCH_2CH$), 5.41 (1 H, d, *J* 5.3, NH), 7.13–7.31 (7 H, m, ArH) and 7.81 (2 H, d, *J* 8.3, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 21.43, 22.30 and 22.70 (all C*Me*), 24.08 ($CH_2$), 24.68 ($Me_2CH$), 26.24, 26.44, 43.68, 45.92 and 45.95 (all $CH_2$), 50.28 (CH), 52.06 (C) and 126.89, 127.54, 127.61, 129.43, 131.03, 135.43, 137.62 and 143.21 (ArC); *m*/*z* (EI) 372 [(M − 91)$^+$, 12%], 240 (72), 133 (23), 119 (52), 115 (11), 65 (15), 47 (12) and 41 (50) (Found: M$^+$, 372.1129. $C_{17}H_{26}NS_3O_2$ requires *M*, 372.1126).

**(*S*)-1-(2-Trimethylsilyl-1,3-dithian-2-yl)-2-(4-methylbenzenesulfonamido)-4-methylpentane 19.** Following the general procedure described above, the aziridine **1** (0.1 g, 0.40 mmol) and 2-lithio-2-trimethylsilyl-1,3-dithiane **15** (0.08 g, 0.44 mmol) were allowed to react at −78 °C for 1 h and then at 0 °C for 1.5 h to yield the *dithiane* **19** (0.12 g, 67%) as a clear oil, $R_f$ 0.27 (ethyl acetate–light petroleum 1:4) (Found: C, 53.1; H, 8.0; N, 3.05. $C_{20}H_{35}NS_3O_2Si{\cdot}0.3H_2O$ requires C, 53.24; H, 7.95; N, 3.10%); $[\alpha]_D^{23}$ −6.0 (*c* 0.8 in $CH_2Cl_2$); $\nu_{max}$($CCl_4$)/cm$^{-1}$ 2929 (NH), 1250 and 1155 (S=O); $\delta_H$(270 MHz; $CDCl_3$) −0.14 (9 H, s, $SiMe_3$), 0.76 and 0.82 (6 H, 2 × d, *J* 6.4, $Me_2CH$), 1.18–2.14 (7 H, m, $Me_2CHCH_2CHCH_2$ and $SCH_2CH_2CH_2S$), 2.37 (3 H, s, CMe), 2.38–2.49 and 2.90–3.05 (4 H, m, $SCH_2CH_2CH_2S$), 3.50–3.64 (1 H, m, $Me_2CHCH_2CH$), 5.87 (1 H, d, *J* 3.9, NH), 7.22 (2 H, d, *J* 8.3, ArH) and 7.71 (2 H, d, *J* 8.3, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) −2.61 [$Si(CH_3)_3$], 21.25 (C*Me*), 22.33 (C*Me*), 22.59 (C*Me*), 24.08 ($CH_2$), 24.09 ($Me_2CH$), 26.24 and 26.44 (both $CH_2$), 36.51 (C), 42.68 ($SCH_2$), 44.48 ($SCH_2$), 52.08 (CH) and 127.03, 129.19, 138.59 and 142.78 (ArC); *m*/*z* (EI) 445 (M$^+$, 7%), 240 (68), 205 (18), 155 (54), 91 (100) and 73 (77) (Found: M$^+$, 445.1592. $C_{20}H_{35}NS_3O_2Si$ requires *M*, 445.1599).

**(*S*)-1-(2-Carboxy-1,3-dithian-2-yl)-2-(4-methylbenzenesulfonamido)-4-methylpentane 20.** Following the general procedure described above, the aziridine **1** (0.1 g, 0.39 mmol) and the dianion **16**, derived from 1,3-dithiane-2-carboxylic acid (0.07 g, 0.43 mmol), were reacted at −78 °C for 1 h and then at 0 °C to room temperature overnight to yield the *dithiane* **20** (0.15 g, 92%) as a yellow oil (crude), $\nu_{max}$(neat liquid)/cm$^{-1}$ 3754–3200 (OH), 2927 (alkyl), 1731 (C=O), 1695 (C=C), 1456, 1286, 1192 and 1073 (S=O); $\delta_H$(270 MHz; $CDCl_3$) 0.73 and 0.80 (6 H, 2 × d, *J* 6.4, $Me_2CH$), 1.23–2.38 (7 H, m, $Me_2CHCH_2CHCH_2$ and $SCH_2CH_2CH_2S$), 2.40 (3 H, s, $CCH_3$), 2.51–3.46 (4 H, m, $SCH_2CH_2CH_2S$), 3.67–3.78 (1 H, m, $Me_2CHCH_2CHCH_2$), 5.51 (1 H, d, *J* 9.0, NH), 7.34 (2 H, d, *J* 8.0, ArH), 7.79 (2 H, d, *J* 8.0, ArH) and 9.82 (1 H, s br, OH); *m*/*z* (EI) 399 [(M − OH)$^+$, 10%], 244 (100) and 91 (81) (Found: M$^+$, 399.0994. $C_{18}H_{25}NS_3O_3$ requires *M*, 399.0997).

**General procedure for desulfonylation**

To sodium (6 equiv.) and naphthalene (7 equiv.) in a flame-dried flask, under $N_2$, was added dry DME.[15] The solution was then stirred at room temperature for 1 h, resulting in the formation of a deep green solution. This solution was then added to a solution of the dithiane compound in DME until the green colour persisted (typically 3–5 equiv. were required). The solution was then stirred at room temperature for 4 h, before being acidified by the addition of 4 mol dm$^{-3}$ aqueous HCl. The solution was extracted with $CH_2Cl_2$, the aqueous layer basified by the addition of $NaHCO_3$, the aqueous layer extracted with $CH_2Cl_2$ (3 ×), the organic layers washed with brine, dried ($Na_2SO_4$), filtered, and the solvent removed under reduced pressure to leave the deprotected compound as a yellow oil.

**(*S*)-1-(1,3-Dithian-2-yl)-2-amino-3-phenylpropane 21.** Following the general method described above the *N*-tosyl dithiane **9**

(0.06 g, 0.15 mmol) in DME (10 $cm^3$) was deprotected with sodium naphthalenide (4 equiv.) in DME (2 $cm^3$) to yield the *aminodithiane* **21** (0.022 g, 59%) as a pale yellow oil, $R_f$ 0.1 (ethyl acetate); $\nu_{max}(CCl_4)/cm^{-1}$ 3386 (NH), 2900 (CH), 1407 and 750 (arom.); $\delta_H$(270 MHz; $CDCl_3$) 1.55–2.97 (12 H, m, $SCH_2CH_2$-$CH_2S$ and $PhCH_2$ and $CHCH_2CH$ and $NH_2$), 3.29–3.40 (1 H, m, $CHNH_2$), 4.28 [1 H, dd, *J* 5.3 and 9.2, $CH(NH_2)CH_2CH$] and 7.00–7.86 (5 H, m, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 26.00, 30.22, 30.54, 30.90, 42.94, 44.80, 49.55, 126.40, 128.51, 129.30 and 133.42; *m/z* (EI) 253 ($M^+$, 2%), 162 (22), 145 (26), 121 (11), 120 (64) and 119 (100) (Found: $M^+$, 253.0951. $C_{13}H_{19}NS_2$ requires *M*, 253.0959).

Deprotection of the *N*-tosyl dithiane **9** (0.11 g, 0.23 mmol) in DME (10 $cm^3$) with sodium naphthalenide (3 equiv.) in DME (3 $cm^3$) also produced the aminodithiane **21** (0.026 g, 44%) as a yellow oil, the analytical data for which were identical to those recorded above.

**(*S*)-1-(2-methyl-1,3-dithianyl)-2-amino-3-phenylpropane 22.** Following the general method described above the *N*-tosyl dithiane **10** (0.06 g, 0.15 mmol) in DME (10 $cm^3$) was deprotected with sodium naphthalenide (4 equiv.) in DME (2 $cm^3$) to yield the *aminodithiane* **22** as a pale yellow oil (0.02 g, 51%), $R_f$ 0.1 (ethyl acetate); $\nu_{max}(CCl_4)/cm^{-1}$ 3200 (NH), 2850 (CH), 1397 and 770 (arom.); $\delta_H$(270 MHz; $CDCl_3$) 1.63 (3 H, s, $CCH_3$), 1.81–2.30 [6 H, m, $SCH_2CH_2CH_2S$ and $CHCH_2C(Me)$ and $NH_2$], 2.60–2.98 (6 H, m, $PhCH_2$ and $SCH_2CH_2CH_2S$), 3.30–3.51 (1 H, m, CH) and 7.11–7.35 (7 H, m, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 24.87, 26.59, 28.74, 30.90, 45.25, 48.00, 48.27, 50.30, 126.46, 128.51, 129.37 and 138.75 (ArC); *m/z* (EI) 176 ($M - PhCH_2$, 19%), 133 (100), 120 (81) and 91 (67) (Found: $M^+$, 176.0562. $C_7H_{14}NS_2$ requires *M*, 176.0568).

**(*S*)-1-(1,3-Dithian-2-yl)-2-amino-4-methylpentane 23.** Following the general method described above the *N*-tosyl dithiane **12** (0.10 g, 0.27 mmol) in DME (10 $cm^3$) was deprotected with sodium naphthalenide (5 equiv.) in DME (2 $cm^3$) to yield the *aminodithiane* **23** (0.025 g, 42%) as a pale yellow oil, $R_f$ 0.1 (ethyl acetate); $\nu_{max}(CCl_4)/cm^{-1}$ 3386 (NH) and 2928 (CH); $\delta_H$(270 MHz; $CDCl_3$) 0.75 and 0.82 (6 H, 2 × d, *J* 6.5, $Me_2CH$), 1.20–2.98 [13 H, m, $Me_2CHCH_2$ and $CH(NH_2)CH_2CH$ and $SCH_2CH_2CH_2S$], 3.01–3.20 (1 H, m, $CHNH_2$), 4.30 [1 H, dd, *J* 5.0 and 8.9, $CH(NH_2)CH_2CH$]; $\delta_C$(67.5 MHz; $CDCl_3$) 22.11, 23.16, 24.71, 26.03, 30.30, 30.62, 43.81, 44.78, 46.01 and 47.92; *m/z* (EI) 219 ($M^+$, 4%), 202 (32), 156 (17), 145 (45), 119 (65), 113 (54), 98 (20), 86 (100), 70 (93), 56 (28), 44 (63), 41 (50) and 30 (64) (Found: $M^+$, 219.1107. $C_{10}H_{21}NS_2$ requires *M*, 219.1115).

Deprotection of the *N*-tosyl dithiane **12** (0.10 g, 0.23 mmol) in DME (10 $cm^3$) with sodium naphthalenide (3 equiv.) in DME (3 $cm^3$) also produced the amine **23** (0.027 g, 53%), the analytical data for which were identical to those recorded above.

**(*S*)-1-(2-Methyl-1,3-dithian-2-yl)-2-amino-4-methylpentane 24.** Following the general method described above the *N*-tosyl dithiane **13** (0.09 g, 0.22 mmol) in DME (10 $cm^3$) was deprotected with sodium naphthalenide (3 equiv.) in DME (3 $cm^3$) to yield the *aminodithiane* **24** (0.025 g, 48%) as a pale yellow oil, $\nu_{max}(CCl_4)/cm^{-1}$ 3600 (NH) and 2957 (CH); $\delta_H$(270 MHz; $CDCl_3$) 0.66 and 0.79 (6 H, 2 × d, *J* 6.5, $Me_2CH$) and 1.20–3.20 [17 H, m, $CHCH_2CH(NH_2)CH_2$ and $C(Me)SCH_2$-$CH_2CH_2S$]; *m/z* 234 (M + 1, 19%), 128 (39) and 86 (100) (Found: $M^+$, 234.1351. $C_{11}H_{24}NS_2$ requires *M*, 234.1350).

### General method for the desulfurative hydrolysis of dithianes

To a solution of the dithiane in acetone was added MeI[16] (excess) and the solution heated under reflux for 1 h. A few drops of $H_2O$ were then added to it and the solution heated under reflux for a further 3 h, after which time the solution was partitioned between EtOAc and $H_2O$, the organic layers washed with brine, dried ($Na_2SO_4$), filtered, and the solvent removed under reduced pressure to yield the carbonyl compounds which were purified by column chromatography on silica gel eluting with ethyl acetate–light petroleum (1 : 4).

**(*S*)-3-(4-Methylbenzenesulfonamido)-4-phenylbutan-1-al 25.** Following the general procedure described above the dithiane **9** (0.1 g, 0.25 mmol) and MeI (excess) in aqueous acetone (10 $cm^3$) were heated under reflux to produce the *aldehyde* **25** (0.07 g, 100%) as a clear oil, $R_f$ 0.1 (ethyl acetate); $[\alpha]_D^{23}$ −18 (*c* 0.6 in $CH_2Cl_2$); $\nu_{max}$(neat liquid)/$cm^{-1}$ 3273 (NH), 2732 (aldehyde C–H), 1721 (C=O), 1597 (arom. C=C), 1454 (S=O), 1328 (S=O), 1093 (S=O), 816 (arom. C–H) and 750 (arom. C–H); $\delta_H$(270 MHz; $CDCl_3$) 2.40 (3 H, s, $CCH_3$), 2.63–2.83 (4 H, m, $PhCH_2$, $CH_2CHO$), 3.81–3.88 (1 H, m, $CH_2CHCH_2$), 5.34 (1 H, d, *J* 8.1, NH), 6.95–7.20 (7 H, m, ArH), 7.71 (2 H, d, *J* 8.3, ArH) and 9.61 (1 H, t, *J* 1.3, CHO); $\delta_C$(67.5 MHz; $CDCl_3$) 21.47 ($CCH_3$), 40.68 ($CH_2$), 47.54 ($CH_2$), 50.62 (CH), 127.16, 127.44, 128.87, 129.63, 130.01, 136.49, 137.00 and 143.38 (arom. C) and 200.59 (CHO); *m/z* (EI) 274 ($M - CH_2CHO$, 6%), 240 (8), 226 (57), 155 (67), 142 (14), 121 (11), 91 (100), 75 (37) and 65 (16) (Found: $M^+$, 226.0548. $C_{10}H_{12}NSO_3$ requires *M*, 226.0538).

**(*S*)-4-(4-Methylbenzenesulfonamido)-5-phenylpentan-2-one 26.** Following the general procedure described above the dithiane **10** (0.1 g, 0.24 mmol) and MeI (excess) in aqueous acetone (10 $cm^3$) were heated under reflux to produce the *ketone* **26** (0.08 g, 100%) as a white solid, $R_f$ 0.34 (EtOAc); mp 141–141.5 °C (Found: C, 65.2; H, 6.1; N, 3.9; S, 9.3. $C_{18}H_{21}NSO_3 \cdot 0.25H_2O$ requires C, 65.23; H, 6.39; N, 4.23; S, 9.67%); $[\alpha]_D^{23}$ −15 (*c* 1 in $CH_2Cl_2$); $\nu_{max}$(neat liquid)/$cm^{-1}$ 3280 (NH), 1713 (C=O), 1495 (S=O), 1453 (S=O), 1324 (S=O), 1160 (S–N–C), 1090 (S–N–C), 814, 787, 702 and 663 (arom. C–H); $\delta_H$(270 MHz; $CDCl_3$) 2.04 (3 H, s, $CCH_3$), 2.40 (3 H, s, $CCH_3$), 2.57 (1 H, dd, *J* 6.0 and 18.0, CH of $CH_2CO$), 2.65 (1 H, dd, *J* 4.5 and 18.0, CH of $CH_2CO$), 2.72 (1 H, dd, *J* 7.3 and 13.7, CH of $CH_2Ph$), 2.81 (1 H, dd, *J* 7.5 and 13.7, CH of $CH_2Ph$), 3.69–3.76 (1 H, m, CH), 5.35 (1 H, d, *J* 8, NH), 6.95–7.64 (7 H, m, ArH) and 7.82 (2 H, d, *J* 8.3, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 21.48 ($CCH_3$), 30.59 ($CH_3$), 40.30, 46.37 ($CH_2$), 51.48 (CH), 126.45, 127.25, 128.15, 129.12, 129.66, 137.18, 137.28 and 143.28, (ArC) and 207.58 (C=O); *m/z* (EI) 305 (M − 16, 23%), 240 (21), 198 (19), 155 (30), 91 (100) and 43 (26) (Found: $M^+$, 240.0696. $C_{11}H_{14}NSO_3$ requires *M*, 240.0694).

**(*S*)-4-(4-Methylbenzenesulfonamido)-1,5-diphenylpentan-2-one 27.** Following the general procedure described above the dithiane **11** (0.1 g, 0.20 mmol) and MeI (excess) in aqueous acetone (10 $cm^3$) were heated under reflux to produce the ketone **27** (0.03 g, 42%) as a clear oil, $R_f$ 0.24 (ethyl acetate–light petroleum 1:4); $[\alpha]_D^{23}$ −25 (*c* 2 in $CH_2Cl_2$); $\nu_{max}$ $(CCl_4)/cm^{-1}$ 2957 (NH), 1688 (C=O), 1254, 1138, 1006 (S=O) and 843 (arom.); $\delta_H$(270 MHz; $CDCl_3$) 2.40 (3 H, s, $CCH_3$), 2.59–2.71 (4 H, m, $PhCH_2CHCH_2$), 3.56 (2 H, s, $COCH_2Ph$), 3.73–3.77 (1 H, m, $PhCH_2CHCH_2$), 5.12 (1 H, d, *J* 8.1, NH), 7.09–7.34 (12 H, m, ArH) and 7.55 (2 H, d, *J* 8.3, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 21.51 ($CCH_3$), 40.16 ($CH_2$), 44.57 ($CH_2$), 50.60 ($CH_2$), 51.49 (CH), 126.38, 126.67, 127.19, 127.24, 128.56, 128.61, 129.00, 129.40, 133.30, 136.97, 137.23 and 143.19; *m/z* (EI) 316 (M − 91, 29%), 240 (21) and 91 (100) (Found: $M^+$, 316.0997. $C_{17}H_{18}NSO_3$ requires *M*, 316.1007).

**(*S*)-3-(4-Methylbenzenesulfonamido)-5-methylhexan-1-al 28.** Following the general procedure described above the dithiane **12** (0.1 g, 0.27 mmol) and MeI (excess) in aqueous acetone (10 $cm^3$) were heated under reflux to produce the *aldehyde* **28** (0.06 g, 85%) as a pale yellow gum, $R_f$ 0.1 (ethyl acetate) (Found: C, 57.55; H, 7.65; N, 4.5. $C_{14}H_{21}NSO_3 \cdot 0.5H_2O$ requires C, 57.51; H, 7.58; N, 4.79%). $[\alpha]_D^{23}$ −18.8 (*c* 0.1 in $CH_2Cl_2$); $\nu_{max}(CCl_4)/cm^{-1}$ 3271 (NH), 2925 (alkyl), 1724 (C=O), 1598 (C=C), 1461, 1200, 1150, 1092 and 1037 (S=O); $\delta_H$(270 MHz; $CDCl_3$) 0.66 and 0.77 (6 H, 2 × d, *J* 6.4, $Me_2CH$), 1.09–1.59 (3 H, m, $Me_2CHCH_2$), 2.43 (3 H, s, $CCH_3$), 2.60 (2 H, dd, *J* 1.3

and 5.5, $CH_2CHO$), 3.62–3.71 (1 H, m, $Me_2CHCH_2CH$), 5.26 (1 H, d, *J* 8.6, NH), 7.31 (2 H, d, *J* 8.3, ArH), 7.75 (2 H, d, *J* 8.3, ArH) and 9.64 (1 H, t, *J* 1.3, CHO); $\delta_C$(67.5 MHz; $CDCl_3$) 21.49, 21.56 and 22.64 (all *Me*C), 24.51 (CH), 44.35, 47.78 ($CH_2$), 48.96 (CH), 127.09, 129.72, 137.79 and 143.53 (ArC) and 200.90 (C=O); *m*/*z* (CI) 284 (M + 1, 3%), 240 (M − 43, 100), 172 (57) and 155 (38) (Found: $M^+$, 240.1053. $C_{12}H_{18}NSO_2$ requires *M*, 240.1058).

**(*S*)-4-(4-Methylbenzenesulfonamido)-6-methylheptan-2-one 29.** Following the general procedure described above the dithiane **13** (0.08 g, 0.21 mmol) and MeI (excess) in aqueous acetone (10 $cm^3$) were heated under reflux to produce the *ketone* **29** (0.05 g, 78%) as a clear oil, $R_f$ 0.20 (ethyl acetate–light petroleum 1:4) (Found: C, 60.4; H, 7.9; N, 4.65; S, 10.7. $C_{15}H_{23}NSO_3$ requires C, 60.58; H, 7.79; N, 4.71; S, 10.78%); $[\alpha]_D^{23}$ −14 (*c* 2 in $CH_2Cl_2$); $\nu_{max}(CCl_4)/cm^{-1}$ 3200 (NH), 2900 (alkyl), 1715 (C=O), 1600 (C=C), 1420, 1340, 1180 and 1090 (S=O); $\delta_H$(270 MHz; $CDCl_3$) 0.66 and 0.79 (6 H, 2 × d, *J* 6.5, $Me_2CH$), 1.15–1.22 (1 H, m, $Me_2CH$), 1.34–1.55 (2 H, m, $Me_2CHCH_2$), 2.02 (3 H, s, MeC=O), 2.43 (3 H, s, $CCH_3$), 2.48 [1 H, dd, *J* 6.0 and 17.5, *H* of $CH_2C(O)Me$], 2.58 [1 H, dd, *J* 4.0 and 17.5, *CH* of $CH_2C(O)Me$], 3.51–3.59 (1 H, m, $Me_2CHCH_2CH$), 5.30 (1 H, d, *J* 8.6, NH), 7.28 (2 H, d, *J* 8.0, ArH) and 7.74 (2 H, d, *J* 8.0, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 21.46, 21.51, 22.65, 24.49 (Me and CH), 30.65 (*Me*C=O), 43.86, 47.60 ($CH_2$), 48.52 (*CH*), 127.07, 129.54, 138.08 and 143.23 (ArC) and 207.55 (C=O); *m*/*z* (CI) 298 (M + 1, 10%), 240 (M − 57, 100) and 142 (37) (Found: $M^+$, 298.1477. $C_{15}H_{24}NO_3S$ requires *M*, 298.1471).

**(*S*)-6-Methyl-4-(4-methylbenzenesulfonamido)-1-phenylheptan-2-one 30.** Following the general procedure described above the dithiane **14** (0.1 g, 0.22 mmol) and MeI (excess) in aqueous acetone (10 $cm^3$) were heated under reflux to produce the *ketone* **30** (0.04 g, 47%) as a clear oil, $R_f$ 0.24 (ethyl acetate–light petroleum 1:4) (Found: C, 66.95; H, 7.25; N, 3.6. $C_{21}H_{27}NSO_3 \cdot 0.2H_2O$ requires C, 66.88; H, 7.32; N, 3.71%); $[\alpha]_D^{23}$ −28 (*c* 4.6 in $CH_2Cl_2$); $\nu_{max}$(oil)/$cm^{-1}$ 2954 (NH), 1682 (C=O), 1454, 1266 and 1138 (S=O); $\delta_H$(270 MHz; $CDCl_3$) 0.61 and 0.73 (6 H, 2 × d, *J* 6.4, $Me_2CH$), 1.06–1.13 (1 H, m, $Me_2CH$), 1.27–1.44 (2 H, m, $Me_2CHCH_2$), 2.45 (3 H, s, $CCH_3$), 2.49 (1 H, dd, *J* 6.0 and 18.0, CH of $CHCH_2C$=O), 2.62 (1 H, dd, *J* 3.9 and 18.0, CH of $CHCH_2C$=O), 3.54 (2 H, s, $PhCH_2C$=O), 3.50–3.53 (1 H, m, $Me_2CHCH_2CH$), 5.09 (1 H, d, *J* 9.2, NH), 7.07–7.35 (7 H, m, ArH) and 7.71 (2 H, d, *J* 8.3, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 21.49, 21.50, 22.65, 24.49 (Me and CH), 43.79 and 45.76 (both $CH_2$), 48.62 (CHNH), 50.75 ($CH_2$), 127.07, 127.16, 128.75, 129.37, 129.62, 133.38, 138.08 and 143.26 (ArC) and 207.42 (C=O); *m*/*z* (CI) 374 (M + 1, 16%) and 240 (100) (Found: $M^+$, 374.1790. $C_{21}H_{28}NSO_3$ requires *M*, 374.1791).

### General procedure for the desulfurative hydrolysis of dithianylacyl silanes 31 and 32[17]

To a solution of the 2-trimethylsilyl-1,3-dithiane **17** or **19** in acetone was added $HgCl_2$ (10 equiv.), $CaCO_3$ (2.2 equiv.) and HgO (1.5 equiv.). The suspension was then heated under reflux for 4 h after which time it was filtered through Celite and partitioned between EtOAc and $H_2O$. The organic layer was washed with brine, dried ($Na_2SO_4$), filtered and the solvent removed under reduced pressure to leave the crude acyl silane as an oil, which was used without further purification.

**(*S*)-2,2-Dimethyl-5-(4-methylbenzenesulfonamido)-6-phenyl-2-silahexane-3-one 31.** Following the general procedure described above the dithiane **17** (0.15 g, 0.31 mmol), $HgCl_2$ (0.85 g, 3.1 mmol), $CaCO_3$ (0.06 g, 0.62 mmol) and HgO (0.11 g, 0.47 mmol) in aqueous acetone (10 $cm^3$) were heated under reflux to produce the *silaketone* **31** as an oil, which was used without further purification, $R_f$ 0.30 (ethyl acetate–light petroleum 1:4); $\nu_{max}$(neat liquid)/$cm^{-1}$ 3300 (NH), 2956 (alkyl), 1649 (C=O), 1250 and 1180 (S=O); $\delta_H$(270 MHz; $CDCl_3$) 0.11 (9 H, s, $SiMe_3$), 2.41 (3 H, s, $CCH_3$), 2.65–2.98 (4 H, m, $PhCH_2CHCH_2$), 3.74–3.97 (1 H, m, $PhCH_2CHCH_2$), 5.19–5.22 (1 H, m, NH) and 6.93–7.83 (9 H, m, ArH); *m*/*z* (EI) 316 (M − TMS, 1%), 202 (16), 155 (17), 139 (61), 91 (87) and 73 (100).

**(*S*)-2,2,7-Trimethyl-5-(4-methylbenzenesulfonamido-2-silaoctan-3-one 32.** Following the general procedure described above the dithiane **19** (0.1 g, 0.23 mmol), $HgCl_2$ (0.62 g, 2.3 mmol), $CaCO_3$ (0.06 g, 0.66 mmol) and HgO (0.08 g, 0.36 mmol) in aqueous acetone (10 $cm^3$) were heated under reflux to produce the *silaketone* **32** as an oil, which was used without further purification, $R_f$ 0.38 [ethyl acetate–light petroleum (1:4)]; $\nu_{max}$(neat liquid)/$cm^{-1}$ 3274 (NH), 2959 (alkyl), 1640 (C=O), 1496, 1335, 1184 and 1095 (S=O); $\delta_H$(270 MHz; $CDCl_3$) 0.12 (9 H, s, $SiMe_3$), 0.79 and 0.89 (6 H, 2 × d, *J* 6.6, $Me_2CH$), 1.06–1.68 (3 H, m, $Me_2CHCH_2$), 2.42 (3 H, s, $ArCH_3$), 2.60 (1 H, dd, *J* 6.6 and 18.8, CH of $CH_2COSiMe_3$), 2.81 (1 H, dd, *J* 2.2 and 18.8, CH of $CH_2COSiMe_3$), 3.47–3.60 (1 H, m, $Me_2CHCH_2CH$), 5.08 (1 H, d, *J* 8.8, NH), 7.31 (2 H, d, *J* 8.3, ArH) and 7.73 (2 H, d, *J* 8.3, ArH); *m*/*z* (EI) 282 (M − TMS, 3%), 155 (60) and 91 (100).

### General method for oxidation of 5-(4-methylbenzenesulfonamido)-2-silaalkan-2-ones[18]

To a solution of the silaketones in THF was added aqueous NaOH (3 mol $dm^{-3}$, 1.2 equiv.), and the solution was heated to 35–40 °C. $H_2O_2$ (30%, 1 equiv.) was then added dropwise, taking care to maintain the temperature below 50 °C. The solution was heated at this temperature for 3 h, after which it was cooled to room temperature and extracted with EtOAc. The solution was then cooled to 0 °C and acidified to pH 1 by the addition of HCl, and extracted with EtOAc (3 × 25 $cm^3$). The combined organic extracts were washed with brine, dried ($Na_2SO_4$), filtered and the solvent removed under reduced pressure to give the β-amino acids in the yields stated.

**(*S*)-3-(4-Methylbenzenesulfonamido)-4-phenylbutanoic acid 33.** Following the general procedure described above the silaketone **31** (0.12 g, 0.3 mmol) was treated with aqueous 3 mol $dm^{-3}$ NaOH (0.12 $cm^3$, 0.36 mmol) and $H_2O_2$ (0.07 $cm^3$, 0.30 mmol) to yield the 3-tosyl amino carboxylic acid **33** (0.05 g, 50% from **19**) as a clear oil, $[\alpha]_D^{23}$ −14.56 (*c* 0.9 in $CH_2Cl_2$); $\nu_{max}(CCl_4)/cm^{-1}$ 3300 (OH), 2900 (NH), 1715 (C=O) and 1180 (tosyl); $\delta_H$(270 MHz; $CDCl_3$) 2.40 (3 H, s, $ArCH_3$), 2.53 (2 H, d, *J* 5.6, $CH_2CO_2H$), 2.77 (1 H, dd, *J* 6.8 and 13.7, CH of $CH_2Ph$), 2.85 (1 H, dd, *J* 7.7 and 13.7, CH of $CH_2Ph$), 3.64–3.72 (1 H, m, $PhCH_2CH$), 4.90–5.27 (1 H, s, br, OH), 5.45 (1 H, d, *J* 8.6, NH), 6.92–7.27 (7 H, m, ArH) and 7.55 (2 H, d, *J* 8.3, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 21.47 ($CCH_3$), 37.36, 40.55 ($CH_2$), 51.73 (CH), 126.86, 126.94, 128.70, 129.20, 129.67, 136.70, 137.28 and 143.41 (ArC) and 175.60 (C=O); *m*/*z* (EI) 242 (M − Ph, 66%), 155 (52) and 91 (100) (Found: $M^+$, 242.0494. $C_{10}H_{12}NSO_4$ requires *M*, 242.0487).

**(*S*)-3-(4-Methylbenzenesulfonamido)-5-methylhexanoic acid 34.** Following the general procedure described above the silaketone **32** (0.07 g, 0.2 mmol) was treated with aqueous 3 mol $dm^{-3}$ NaOH (0.10 $cm^3$, 0.32 mmol) and 30% $H_2O_2$ (0.04 $cm^3$, 0.33 mmol) to yield the 3-tosylaminocarboxylic acid **34** (0.04 g, 53% from **20**) as a white solid, mp 137–138 °C (Found: C, 52.89; H, 7.1; N, 4.5. $C_{14}H_{21}NSO_4 \cdot H_2O$ requires C, 53.00; H, 7.26; N, 4.42%); $[\alpha]_D^{23}$ −12.5 (*c* 2.4 in $CH_2Cl_2$); $\nu_{max}(CCl_4)/cm^{-1}$ 3250 (OH), 2960 (NH), 1705 (C=O), 1420 and 1140 (tosyl); $\delta_H$(270 MHz; $CDCl_3$) 0.64 and 0.75 (6 H, 2 × d, *J* 6.4, $Me_2CH$), 1.07–1.65 (3 H, m, $Me_2CHCH_2$), 2.31–2.40 (5 H, m, $ArCH_3$ and $CH_2CO_2H$), 3.39–3.56 (1 H, m, $Me_2CHCH_2CH$), 5.14 (1 H, d, *J* 5.1, NH), 7.25 (2 H, d, *J* 8.3, ArH) and 7.74 (2 H, d, *J* 8.3, ArH); $\delta_C$(67.5 MHz; $CDCl_3$) 21.52, 21.62, 22.68, 24.49 (Me and

$Me_2CH$), 38.60 and 43.76 (both $CH_2$), 48.49 (CHNH), 126.43, 129.72, 137.82, 143.51 and 176.32; *m/z* (CI) 800 (M + 1, 7%), 242 (M − 57, 22), 155 (50) and 91 (100) (Found: $M^+$, 242.0490. $C_{10}H_{12}NSO_4$ requires *M*, 242.0487).

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