Preparation of new 2,4-disubstituted oxazoles from *N*-acylaziridines

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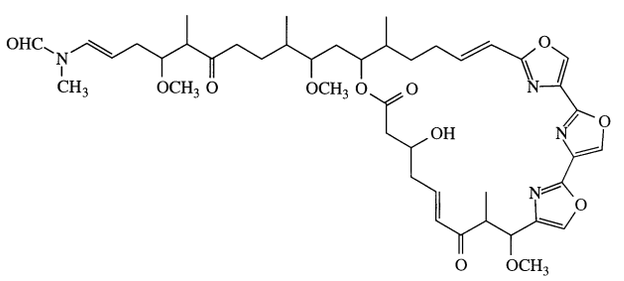
The efficiency of the ring enlargement of 2-substituted *N*-acylaziridines to dihydrooxazoles followed by nickel peroxide oxidation to give 2,4-disubstituted oxazoles as a synthetic route is examined. Sodium iodide-promoted ring enlargements work well for *N*-acylaziridines bearing electron-donating 2-substituents. For *N*-acylaziridines bearing electron-withdrawing 2-substituents, the best results are obtained using acid-promoted rearrangement.

The isolation and structural characterisation of naturally-occurring tris(oxazole)-containing molecules such as halichondramide[1,2] have sparked new interest in the synthesis of 2,4-disubstituted oxazoles. The methods which have been developed may be divided into two main approaches. The first involves the preparation of 2,4-disubstituted oxazoles *via* the corresponding dihydrooxazole derivatives. The most widely used such method employs a coupling reaction between imino ethers and 1,2-amino alcohols.[3] The dihydrooxazoles produced in this way may then be oxidised, usually with nickel peroxide.[4] Alternatively, the intermediate dihydrooxazoles may be prepared by the rearrangement of *N*-acylaziridines.[5] The second approach involves preparation of 2,4-disubstituted oxazoles without the intermediacy of dihydrooxazoles. Apart from the classical method using imino ethers developed by the Cornforths,[6] this approach includes reaction of amides with 2-halogeno ketones,[7–9] rearrangement of 2-acyloxy-*N*,*N*-bis(trimethylsilyl)enamines[10] and the rhodium(II)-promoted coupling of nitriles with dialkyl diazomalonates.[11]



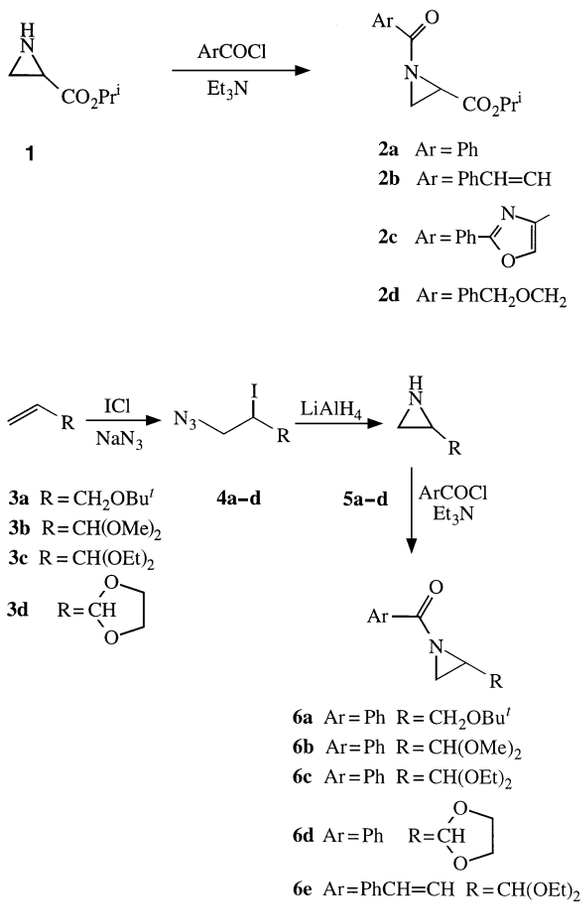
Halichondramide

We were interested in developing the rearrangement of *N*-acylaziridines carrying substituents which would allow the eventual preparation of bis- and tris-(oxazoles). In this paper we provide details of the regioselective preparation of a variety of new 2,4-disubstituted oxazoles bearing such substituents using both iodide- and acid-promoted rearrangement of *N*-acylaziridines.[12] It was found that the iodide-promoted route is very effective with *N*-acylaziridines bearing electron-donating substituents but generates several products when an electron-withdrawing substituent is attached to the aziridine. Acid-promoted ring enlargement provided a useful solution to this problem and yielded 2,4-disubstituted dihydrooxazoles in good yield and with good regioselectivity.

Results and discussion

Preparation of 2-substituted *N*-acylaziridines

The method used for preparing the aziridines in this study was governed by the nature of the aziridine substituent. An isopropyl ester was used as the electron-withdrawing group on the aziridine since isopropyl aziridine-2-carboxylate **1** was readily available from isopropyl acrylate by sequential bromination and treatment with ammonia.[13] For those aziridines bearing an electron-donating group, **5a–d**, azido-iodination[14] of a suitable terminal alkene, **3a-d**, followed by lithium aluminium hydride reduction, was employed. Acylation of all the new aziridines, most of which were not very stable, with benzoyl chloride, cinnamoyl chloride, 2-phenyl-1,3-oxazole-4-carbonyl chloride or benzyloxyacetyl chloride completed the syntheses of the starting materials, **2a–d** and **6a–e**.



Ring enlargement of *N*-acylaziridines bearing an electron-withdrawing substituent at C-2

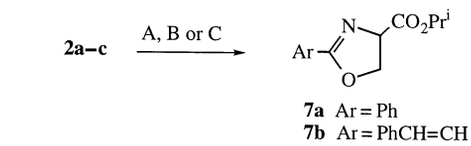
Mente *et al.* have reported that 2-vinyl-*N*-acylaziridines successfully undergo nucleophile-promoted ring enlargement with

Table 1 Ring enlargement of *N*-acylaziridines **2a–d**

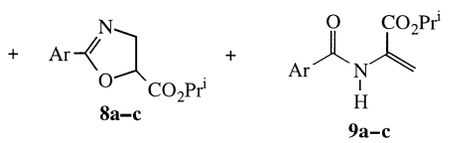
		Method[a]	*t*/h	Yield (%)	Ratio **7**: **8**: **9**
1	**2a**	A	20	89	34:50:16
2		B	20	40	85:15:0[b]
3		C	0.7	79	91:9:0
4	**2b**	A	20	100	25:25:50
5		C	0.5	83	94:6:0
6	**2c**	A	24	94	50:46:4
7	**2d**	A	24	100	0:0:100

[a] Method A: NaI, acetone (**2a**, **2b**, **2d**), DMF (**2c**), room temperature. Method B: H_2SO_4, diethyl ether, room temperature. Method C: CF_3SO_3H, benzene–hexane, room temperature. [b] Isopropyl 2-benzoylamino-3-hydroxypropanoate (17% yield) and isopropyl 3-benzoylamino-2-hydroxypropanoate (10%) were isolated.

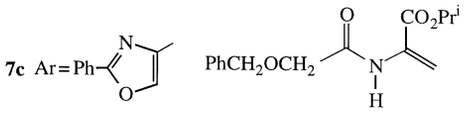
good regioselectivity.[14] Thus we attempted the ring enlargement of **2a** using iodide as the nucleophilic promoter and acetone as solvent (Dewar's conditions[15]) (Table 1, entry 1). This produced a mixture of dihydrooxazole regioisomers (**7a** and **8a**) as



7a Ar = Ph
7b Ar = PhCH=CH



8a–c **9a–c**



9d

well as some ring-opened enamide **9a**. Treatment of **2b** in acetone and of **2c** in dimethylformamide with sodium iodide gave similar results (Table 1, entries 4 and 6). Treatment of **2d** in acetone gave only the enamide **9d** (Table 1, entry 7). In attempts to improve this procedure we employed sodium bromide, chlorotrimethylsilane or iodotrimethylsilane as the nucleophile in a variety of solvents but none of these variations was satisfactory.

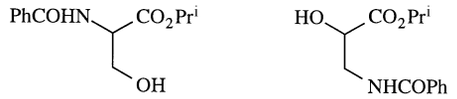
As it is known that acid also promotes the ring enlargement of *N*-acylaziridines,[16] we subjected a solution of **2a** in diethyl ether to concentrated sulfuric acid at room temperature (Table 1, entry 2). A mixture of products was obtained, consisting of **7a** and **8a** as well as the ring-opened products **10** and **11**. Although the ratio of the required isomer **7a** to its regioisomer **8a** was much improved (5.7:1), the yield of **7a** was still unsatisfactory. To avoid any hydrolysis products, attributed to the presence of extraneous water, we attempted the ring enlargement using anhydrous trifluoromethanesulfonic acid. Pleasingly, this modification provided a 10:1 mixture of **7a** and **8a** in excellent yield (Table 1, entry 3). Similar results were obtained for ring enlargement of **2b** (Table 1, entry 5).

Ring enlargement of *N*-acylaziridines bearing an electron-donating substituent at C-2

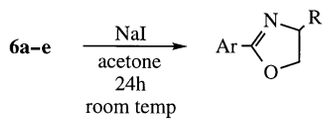
In contrast to the reactions just described, ring enlargements of **6a–e** using sodium iodide in acetone all proceeded with complete regioselectivity, providing oxazolines **12a–e** in excellent yields.

Conversion of dihydrooxazoles to oxazoles

Oxidation of all the dihydrooxazoles described in this work to

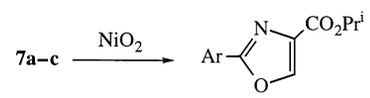


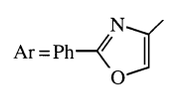
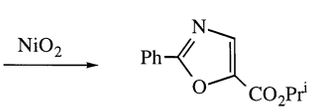
10 **11**



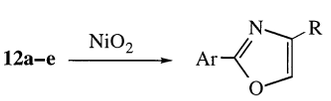
		Yield %
12a	Ar = Ph, R = CH_2OBu^t	95
12b	Ar = Ph, R = $CH(OMe)_2$	98
12c	Ar = Ph, R = $CH(OEt)_2$	93
12d	Ar = Ph, R = 	98
12e	Ar = PhCH=CH, R = $CH(OEt)_2$	83

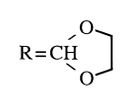
oxazoles was achieved using nickel peroxide as oxidant.[4,17] We briefly examined this procedure and found that significantly improved yields could be obtained by adding the oxidant in portions over several hours and by adding triethylamine to the



		Yield	Oxazoline Recovery
13a	Ar = Ph	74%	
13b	Ar = PhCH=CH	72%	
13c	Ar = Ph 	32%	
8a		39%	24%

14



		Yield	
15a	Ar = Ph R = CH_2OBu^t	27%	
15b	Ar = Ph R = $CH(OMe)_2$	50%	
15c	Ar = Ph R = $CH(OEt)_2$	61%	
15d	Ar = Ph R = 	16%	78%
15e	Ar = PhCH=CH R = $CH(OEt)_2$	85%	

hot reaction mixture immediately prior to work-up (the latter in order to displace any product complexed to the nickel salts). The yields obtained are shown alongside the structures. The yields were not always high but in some experiments the unoxidised oxazoline was recovered and this could, if necessary, be recycled.

Experimental

Melting points (mps) were determined on a Büchi SMP-20 melting point apparatus or a Kofler hotstage and are uncorrected. IR Spectra were recorded on a Perkin-Elmer IR-1600 spectrometer as mull in Nujol unless otherwise stated. Low resolution mass spectra were recorded on a VG Micromass 7070F or a VG TRIO-1 mass spectrometer at 70 eV, with a

source temperature of 200 °C. Chemical ionisation mass spectra (CI) were obtained using methane as the reagent gas. Fast atom bombardment mass spectra (FAB) were performed at the Victorian College of Pharmacy, Monash University. High resolution NMR spectra were obtained either on a Bruker AC-200 spectrometer or on a Bruker AM-300 spectrometer in $CDCl_3$ solution. Chemical shifts (δ) are given in ppm and the coupling constants (J) in Hz. Ether refers to diethyl ether and light petroleum refers to the hydrocarbon fraction bp 60–70 °C.

Isopropyl *N*-benzoylaziridine-2-carboxylate 2a

The following preparation of **2a** illustrates the general method for the acylation of aziridines. To a solution of isopropyl aziridine-2-carboxylate **1** (583 mg, 4.2 mmol) and triethylamine (423 mg, 4.2 mmol) in benzene (35 cm^3) cooled in an ice-water bath was added dropwise a solution of benzoyl chloride (590 mg, 4.2 mmol) in benzene (15 cm^3). The mixture was allowed to warm to room temperature, and then stirred for a further 3 h. The reaction mixture was filtered and the filtrate washed twice with water, dried ($MgSO_4$) and the benzene evaporated *in vacuo* to give a colourless residue (967 mg, 99%) which was purified by flash column chromatography (silica gel, ether–light petroleum, 1:1) to give *aziridine* **2a** (928 mg, 96%) as a colourless oil (Found: C, 66.9; H, 6.2; N, 5.9. $C_{13}H_{15}NO_3$ requires C, 66.9; H, 6.3; N, 6.0%); *m/z* 191 (M − 42, 4.2), 105 (100); ν_{max}/cm^{-1} 1735, 1686, 1233, 1204, 897, 719; δ_H 8.04–7.60 (2 H, m) and 7.58–7.40 (3 H, m, C_6H_5), 4.99 (1 H, septet, J 6.3, C*H*Me_2), 3.24 (1 H, dd, J 5.7 and 3.2, 2-H), 2.76 (1 H, dd, J 3.2 and 1.3, 3-H), 2.66 (1 H, dd, J 5.7 and 1.3, 3-H), 1.18 (3 H, d, J 6.3, Me), 1.15 (3 H, d, J 6.2, Me); δ_C 176.7, 167.6, 133.0, 132.7, 128.9, 128.5, 69.6, 36.2, 30.8, 21.5, 21.7.

Isopropyl *N*-cinnamoylaziridine-2-carboxylate 2b. The reaction of cinnamoyl chloride (334 mg, 2 mmol) with isopropyl aziridine-2-carboxylate **1** (260 mg, 2 mmol) and triethylamine (0.5 cm^3) in benzene gave a light yellow oil (483 mg). Purification of the crude product by preparative radial chromatography (silica gel, ether–light petroleum, 1:2) yielded pure *aziridine* **2b** (471 mg, 91%) as a colourless oil (Found: C, 69.2; H, 6.7; N, 5.6. $C_{15}H_{17}NO_3$ requires C, 69.5; H, 6.6; N, 5.4%); *m/z* 260 (M + 1, 6.4%), 131 (100); ν_{max}/cm^{-1} 1734, 1684, 1692, 1105, 770, 687; δ_H 7.72 (1 H, d, J 16.1, 3′-H), 7.58–7.49 (2 H, m) and 7.46–7.36 (3 H, m, C_6H_5), 6.62 (1 H, d, J 16.1, 2′-H), 5.09 (1 H, septet, J 6.3, C*H*Me_2), 3.20 (1 H, dd, J 5.6 and 3.1, 2-H), 2.69 (1 H, dd, J 3.1 and 1.6, 3-H), 2.58 (1 H, dd, J 5.6 and 1.6, 3-H), 1.27 (3 H, d, J 6.3, CH_3), 1.26 (3 H, d, J 6.3, CH_3); δ_C 175.8, 167.7, 144.3, 134.2, 130.4, 128.9, 128.1, 120.2, 69.7, 35.1, 30.7, 21.7, 21.6.

Isopropyl *N*-(2-phenyl-1,3-oxazol-4-ylcarbonyl)aziridine-2-carboxylate 2c. The reaction of isopropyl aziridine-2-carboxylate **1** (129 mg, 1 mmol) and 2-phenyl-1,3-oxazole-4-carbonyl chloride[18] (220 mg, 1.05 mmol) in the presence of triethylamine gave the crude product (310 mg) as a white solid. The product was dissolved in ether and filtered through a short silica gel column (eluent ether–light petroleum, 1:1) to give pure *aziridine* **2c** (287 mg, 96%) as a white solid, mp 113.5–114 °C (Found: C, 64.2; H, 5.2; N, 9.2. $C_{16}H_{16}N_2O_4$ requires C, 64.0; H, 5.4; N, 9.3%); *m/z* 300 (M^+, 24%), 172 (100); ν_{max}/cm^{-1} 1742, 1693, 1571, 1207, 848, 712, 686; δ_H 8.32 (1 H, s, 5′-H), 8.10–8.05 (2 H, m) and 7.52–7.45 (3 H, m, C_6H_5), 5.01 (1 H, septet, J 6.3, C*H*Me_2), 3.46 (1 H, dd, J 5.2 and 3.2, 2-H), 2.75 (1 H, dd, J 3.2 and 1.1, 3-H), 2.69 (1 H, dd, J 5.2 and 1.1, 3-H), 1.19 (3 H, d, J 6.3, Me), 1.18 (3 H, d, J 6.3, Me); δ_C 169.8, 167.8, 161.8, 142.7, 137.4, 131.1, 128.8, 126.7, 126.5, 69.6, 36.3, 30.3, 21.6, 21.5.

Isopropyl *N*-benzyloxyacetylaziridine-2-carboxylate 2d. Reaction of isopropyl aziridine-2-carboxylate **1** (651 mg, 5 mmol) and 2-benzyloxyacetyl chloride[19] (921 mg, 5 mmol) in the presence of triethylamine (509 mg, 5 mmol) gave a light yellow oil (1.37 g, 99%) as the crude product which was further purified by flash column chromatography (silica, ether–light petroleum, 1:1) to give *aziridine* **2d** (1.17 g, 96%) as a colourless oil (Found: C, 64.9; H, 6.8; N, 5.0. $C_{15}H_{19}NO_4$ requires C, 65.0; H, 6.9; N, 5.1%); *m/z* 278 (M + 1, 6%), 91 (100); ν_{max}/cm^{-1} 1733, 1704, 1455, 1279, 1219, 1183, 1107, 911, 871, 818, 741, 699; δ_H 7.34 (5 H, s, C_6H_5), 5.03 (1 H, septet, J 6.2, C*H*Me_2), 4.61 (2 H, AB q, J 11.8, OCH_2), 4.15 (2 H, AB q, J 16.5, OCH_2), 3.23 (1 H, dd, J 5.3 and 3.1, 2-H), 2.56 (1 H, dd, J 3.1 and 1.3, 3-H), 2.47 (1 H, dd, J 5.3 and 1.3, 3-H), 1.23 (3 H, d, J 6.2, CH_3), 1.20 (3 H, d, J 6.2, CH_3); δ_C 180.3, 167.9, 137.1, 128.4, 127.9, 127.7, 73.4, 70.51, 69.8, 35.2, 29.4, 21.6.

Preparation of 1-azido-3-(1,1-dimethylethoxy)-2-iodopropane 4a

The preparation of **4a** exemplifies the general method employed for the addition of iodo azide to alkenes **3a**–**d**. To a stirred suspension of sodium azide (8.00 g, 125 mmol) in acetonitrile (50 cm^3) cooled in an ethanol–ice bath was added iodine monochloride (9.36 g, 57 mmol) over a 20 min period. The reaction mixture was stirred for an additional 10 min and 3-(1,1-dimethylethoxy)prop-1-ene[20] **3a** (6.57 g, 57 mmol) was added dropwise. The mixture was allowed to warm to room temperature and stirred for 18 h. The red–brown mixture was poured into water (125 cm^3) and extracted with ether. The ether extracts were combined and washed with 5% aqueous sodium thiosulfate to give a colourless solution. This ethereal solution was washed with water and dried ($MgSO_4$). Evaporation of the ether *in vacuo* at room temperature gave a yellow liquid (11.64 g, 73%) whose ^{1}H NMR spectrum displayed a mixture of **4a** and its regioisomer 2-azido-3-(1,1-dimethylethoxy)-1-iodopropane in a ratio of 1:3; ν_{max}/cm^{-1} 2105. 1-*Azido*-3-(1,1-*dimethylethoxy*)-2-*iodopropane* **4a**; δ_H 1.20 (s, Me). Other signals were mixed with those of the regioisomer and not able to be distinguished. δ_C 73.8, 64.6, 55.3, 28.6, 27.5. 2-*Azido*-3-(1,1-*dimethylethoxy*)-1-*iodopropane*; δ_H 3.24 (dd, J 10 and 5.9), 1.22 (s, Me), other signals were mixed with those of **4a** and could not be distinguished. δ_C 73.8, 63.8, 61.5, 27.4, 24.5. These two regioisomers were not separated and were used as such in further reactions.

3-Azido-1,1-dimethoxy-2-iodopropane 4b. The reaction of sodium azide (3.00 g, 46 mmol), iodine monochloride (3.80 g, 23 mmol) and prop-2-enal dimethyl acetal **3b** (2.40 g, 23 mmol) yielded a yellow liquid as the crude product (4.65 g, 75%) which was purified by flash column chromatography (ether–light petroleum, 1:10) (R_f 0.36), *m/z* 271 (M^+, 0.26%), 240 (1.9), 184 (6.7), 75 (100); ν_{max}/cm^{-1} 2934, 2834, 2104, 1117, 1066; δ_H 4.31 (1 H, d, J 5.3, 1-H), 4.15 (1 H, q, J 5.9, 2-H), 3.76 (2 H, d, J 5.9, 3-H), 3.46 (6 H, s, 2 × OCH_3); δ_C 104.7, 55.8, 55.4, 54.8, 29.7.

3-Azido-1,1-diethoxy-2-iodopropane 4c. The reaction of sodium azide (8.5 g, 131 mmol), iodine monochloride (10.8 g, 66 mmol) and prop-2-enal diethyl acetal **3c**[21] (8.50 g, 65 mmol) gave **4c** (14.98 g, 77%) as a light yellow liquid which was purified by flash column chromatography (ether–light petroleum, 1:50) (R_f 0.30), *m/z* (FAB) 300 (M + 1, 4%), 286 (28), 274 (6), 240 (18), 228 (22), 200 (17), 183 (13), 129 (37), 114 (13), 103 (100); ν_{max}/cm^{-1} 2978, 2104, 1059; δ_H 4.49 (1 H, d, $J_{1,2}$ 5.2, 1-H), 4.14 (1 H, dt, $J_{2,3,2,1}$ 6.4 and 5.2, 2-H), 3.79–3.69 (4 H, m, OCH and 3-H), 3.63–3.58 (2 H, m, OCH), 1.25 (6 H, t, J 7.0, 2 × CH_3); δ_C 102.7, 64.2, 63.8, 54.8, 31.0, 15.13, 15.10.

2-(2-Azido-1-iodoethyl)-1,3-dioxolane 4d. The reaction of sodium azide (6.60 g, 0.1 mol) and iodine monochloride (8.30 g, 50 mmol) with 2-vinyl-1,3-dioxolane **3d**[22] (5.16 g, 50 mmol) gave 8.41 g of red–brown liquid, which was separated by flash column chromatography (silica gel, ether–light petroleum, 1:5) into two compounds. 2-(2-*Azido*-1-*iodoethyl*)-1,3-*dioxolane* **4d** (R_f 0.42) was obtained as a light yellow liquid (4.84 g, 36%); *m/z* (CI) 269 (M^+, 0.2%), 73 (100); ν_{max}/cm^{-1} 2103; δ_H 4.78 (1 H, d, $J_{2,1'}$ 4, 2-H), 4.17 (1 H, ddd, $J_{1',2',1'}$, $_{2',1',2}$ 7, 6 and 4, 1′-H), 4.13–4.08 (2 H, m, 4-H^a and 5-H^a), 4.03–3.97 (2 H, m, 4-H^b and 5-H^b), 3.79 (2 H, br d, J 7, 2′-H); δ_C 102.7, 65.88, 65.85, 54.5, 31.0. 2′-*Hydroxyethyl* 3-*azido*-2-*iodopropanoate* (R_f 0.02) was

obtained as an orange oil (3.03 g, 22%); *m/z* 268 (M − OH, 2.5%), 45 (100); ν_{max}/cm^{-1} 3406, 2108, 1728; δ_H 4.44 (1 H, dd, *J* 10 and 5, 2-H), 4.34 (2 H, dt, *J* 9 and 5, 2′-H) 3.93 (1 H, dd, *J* 13 and 10, 3-H), 3.86 (2 H, t, *J* 5, 1′-H), 3.65 (1 H, dd, *J* 13 and 5, 3-H), 1.91, (1 H, br s, OH); δ_C 170.0, 67.6, 60.5, 54.5, 14.8.

Preparation of *N*-acylaziridines

The following procedure for the preparation of **6a** from **4a** exemplifies the general method employed for the preparation of *N*-acyl derivatives **6a–e**. (As the aziridine products **5a–d** obtained from the reductions were not very stable, they were immediately acylated.)

***N*-Benzoyl-2-(1,1-dimethylethoxymethyl)aziridine 6a.** To a suspension of $LiAlH_4$ (5.24 g, 0.13 mol) in ether (250 ml) at 0 °C was added dropwise the crude mixture of **4a** and its regioisomer (23.8 g, 0.084 mol). The reaction was allowed to warm to room temperature and stirred for 12 h. A solution of 20% aqueous NaOH (20 cm^3) was added slowly and the mixture was stirred for a further 45 min. The white precipitate was removed by filtration and the filtrate was dried ($MgSO_4$) and concentrated under vacuum to give 9.80 g (90%) of a colourless liquid. The ^{1}H NMR spectrum of the crude product indicated a mixture of 2-(1,1-dimethylethoxymethyl)aziridine **5a** and 2-amino-1-(1,1-dimethylethoxy)propane in a ratio of 5:3. *Aziridine* **5a**; ν_{max}/cm^{-1} 3222, 1364, 1253, 1198, 1079, 858, 668; δ_H 3.38 (1 H, d, *J* 5, 1′-H), 3.40 (1 H, d, *J* 5, 1′-H), 2.13–2.23 (1 H, m, 2-H), 1.77 (1 H, d, *J* 6, 3-H), 1.51 (1 H, d, *J* 4, 3-H), 1.19, (9 H, s, 3 × Me). 2-*Amino*-1-(1,1-*dimethylethoxy*)*propane*; δ_H 3.28 (1 H, dd, *J* 13 and 8, 1-H), 3.10–2.93 (1 H, m, 2-H), 3.02, (1 H, dd, *J* 13 and 8, 1-H), 1.64 (2 H, br s, NH), 1.18 (9 H, s, 3 × Me), 1.03 (3 H, d, *J* 6, 3-H). The crude mixture of 2-(1,1-dimethylethoxymethyl)aziridine **5a** and 2-amino-1-(1,1-dimethylethoxy)propane (1.05 g, 8 mmol) was treated with benzoyl chloride (1.01 g, 8 mmol) in the presence of triethylamine (1.00 g, 10 mmol) to give a light yellow oil (1.89 g, 98%). A portion of the crude mixture (285 mg) was purified by preparative chromatography (silica gel, ether–light petroleum, 1:2). N-*Benzoyl*-2-(1,1-*dimethylethoxymethyl*)*aziridine* **6a** (R_f 0.6) was obtained as a light yellow oil (157 mg, 55%) [Found: (FAB), (M + 1), 234.1509. $C_{14}H_{20}NO_2$ (*M* + 1) requires 243.1494]; *m/z* 232 (M − 1, 0.25%), 105 (100); ν_{max}/cm^{-1} 1677, 1227, 1086, 877, 668; δ_H 8.22–8.17 (2 H, m) and 7.63–7.39 (3 H, m, C_6H_5), 3.56 (2 H, ddd, *J* 10.2, 5.5 and 4.8, 1′-H), 2.78 (1 H, dddd, *J* 5.8, 5.5, 4.8 and 3.6, 2-H), 2.56 (1 H, d, *J* 6.0, 3-H^a), 2.29 (1 H, d, 3.6, 3-H^b), 1.19 (9 H, s, 3 × CH_3); δ_C 178.5, 132.9, 132.5, 129.4, 128.0, 73.2, 62.5, 38.3, 28.5, 27.2. 1-(1,1-*Dimethylethoxy*)-2-*benzoylaminopropane* (R_f 0.53) was obtained as a colourless solid (97 mg, 34%) [Found: (M + 1) 236.165 ± 0.002. $C_{14}H_{22}NO_2$ (*M* + 1) requires 236.1645]; *m/z* 236 (M + 1, 18%), 105 (100); ν_{max}/cm^{-1} 3321, 1637; δ_H 7.79–7.44 (2 H, m) and 7.53–7.37 (3 H, m, C_6H_5), 6.58 (1 H, br d, NH), 4.36–4.27 (1 H, m, 2-H), 3.49 (1 H, dd, *J* 8.9 and 4.1, 1-H^a), 3.39 (1 H, dd, *J* 8.9 and 3.3, 1-H^b), 1.28 (3 H, d, *J* 6.7, 3-H_3), 1.20 (9 H, s, 3 × CH_3); δ_C 166.6, 134.9, 131.1, 128.3, 126.7, 72.76, 64.3, 45.5, 27.4, 17.7.

***N*-Benzoyl-2-(dimethoxymethyl)aziridine 6b.** Using the same procedure as that described for **5a**, reduction of 3-azido-1,1-dimethoxy-2-iodopropane **4b** (1.40 g) with $LiAlH_4$ (325 mg) in ether gave 479 mg (80% of crude product) of a colourless liquid. The ^{1}H NMR spectrum displayed signals of a mixture which contained the desired aziridine **5b** as the major product, *m/z* (CI) 118 (M + 1, 5%), 86 (100); ν_{max}/cm^{-1} 3300, 1458, 1274, 1213, 1193, 1115, 1057, 844; δ_H 4.31 (1 H, *J* 3.7, 1′-H), 3.41 (3 H, s, OMe), 3.39 (3 H, s, OMe), 2.22–2.15 (1 H, m, 2-H), 1.73 (1 H, d, *J* 5.7, 3-H), 1.66 (1 H, d, *J* 3.4, 3-H), 1.46 (1 H, br s, NH); δ_C 103.3, 53.6, 53.3, 30.7, 21.2. The reaction of benzoyl chloride (548 mg, 3.9 mmol) and crude 2-(dimethoxymethyl) azidirine **5b** (458 mg) in the presence of triethylamine (450 mg) gave a light yellow liquid (831 mg) whose ^{1}H NMR spectrum showed a mixture of aziridine **6b** and (*E*)-3-benzoylamino-1-methoxyprop-1-ene in a ratio of 5:1. Purification of the crude product by chromatography (silica gel, ether–light petroleum, 1:5) gave two products. N-*Benzoyl*-2-(*dimethoxymethyl*)-*aziridine* **6b** (R_f 0.35) (482 mg) (Found: C, 65.3; H, 7.0; N, 6.2. $C_{12}H_{15}NO_3$ requires C, 65.1; H, 6.8; N, 6.3%); *m/z* 221 (M$^+$, 0.68%), 220 (M − 1, 1.5), 75 (100); ν_{max}/cm^{-1} 1681, 1324, 1228, 1070, 862, 714, 689; δ_H 8.12–8.07 (2 H, m) and 7.60–7.41 (3 H, m, C_6H_5), 4.43 (1 H, d, *J* 4.4, 1′-H), 3.44 (3 H, s, OCH_3), 3.41 (3 H, s, OCH_3), 2.88 (1 H, ddd, *J* 6.0, 4.4 and 3.6, 2-H), 2.53–2.49 (2 H, m, 3-H); δ_C 178.5, 132.8, 132.7, 129.2, 128.3, 102.4, 54.4, 53.1, 37.6, 28.4. (*E*)-3-Benzoylamino-1-methoxyprop-1-ene (R_f 0.2) (80 mg) [Found: (M + 1), 192.1015. $C_{11}H_{14}NO_2$ requires (*M* + 1) 192.1025.1538]; *m/z* 191 (M$^+$, 11%), 105 (100); ν_{max}/cm^{-1} 3318, 3066, 2935, 1640, 1603, 1578, 1490, 1213, 940, 804, 712, 689; δ_H 7.80–7.74 (2 H, m) and 7.48–7.36 (3 H, m, C_6H_5), 6.55 (1 H, d, *J* 12.6, 1-H), 6.40 (1 H, br s, NH), 4.88 (1 H, dt, *J* 12.6 and 7.5, 2-H), 3.96 (2 H, ddd, *J* 6.5, 5.5 and 0.94, 3-H_2), 3.53 (3 H, s, Me); δ_C 167.2, 150.7, 134.5, 131.3, 128.4, 126.8, 98.5, 55.9, 38.4.

***N*-Benzoyl-2-(diethoxymethyl)aziridine 6c.** Using the same procedure as that described for the preparation of **5a**, 3-azido-1,1-diethoxymethyl-2-iodopropane **4c** (3.00 g, 0.01 mol) was reduced with $LiAlH_4$ (625 mg, 0.016 mol) in ether (40 cm^3) to afford a colourless liquid (1.19 g, 82%). The ^{1}H NMR spectrum of the crude product indicated a mixture which contained mainly 2-(diethoxymethyl)aziridine **5c**; ν_{max}/cm^{-1} 3300, 2976, 2930, 1227, 1060, 668; δ_H 4.43 (1 H, d, *J* 4.7, 1′-H), 3.83–3.46 (4 H, m, 2 × OCH_2), 2.21–2.15 (1 H, m, 2-H), 1.70 (1 H, d, *J* 5.5, 3-H), 1.66 (1 H, d, *J* 3.5, 3-H), 1.221 (3 H, t, *J* 7.0, CH_3), 1.219 (3 H, t, *J* 7.0, CH_3); δ_C 101.7, 62.0, 61.6, 31.5, 21.4, 15.2. Benzoyl chloride (548 mg, 3.9 mmol) was treated with crude 2-(diethoxymethyl)aziridine **5c** (566 mg, 3.9 mmol) in the presence of triethylamine (450 mg, 4.5 mmol) to give a light yellow oil (970 mg) whose ^{1}H NMR spectrum showed a mixture of the desired aziridine **6c** and (*E*)-3-benzoylamino-1-ethoxyprop-1-ene. Separation by flash column chromatography (ether–light petroleum, 1:10) gave the *aziridine* **6c** (R_f 0.32) as a colourless oil (622 mg, 64%) (Found: C, 67.7; H, 7.6; N, 5.7. $C_{14}H_{19}NO_3$ requires C, 67.5; H, 7.7; N, 5.6%); *m/z* (CI) 250 (M + 1, 1.5%), 105 (100); ν_{max}/cm^{-1} 2976, 1680, 1321, 1277, 1062, 875, 715, 689; δ_H(300 MHz) 8.15– 8.11 (2 H, m), 7.58–7.52 (1 H, m) and 7.46–7.41 (2 H, m, C_6H_5), 4.52 (1 H, d, 1′-H), 3.82–3.50 (4 H, m, 2 × OCH_2), 2.87 (1 H, ddd, *J* 6.1, 4.5 and 3.6, 2-H), 2.52 (1 H, d, *J* 6.1, 3-H^a), 2.50 (1 H, d, *J* 3.6, 3-H^b), 1.26 (3 H, t, *J* 7.0, CH_3), 1.22 (3 H, t, *J* 7.0, CH_3); δ_C 178.4, 132.8, 132.7, 129.3, 128.2, 101.2, 62.7, 61.8, 38.6, 28.1, 15.2.

***N*-Benzoyl-2-(1,3-dioxolan-2-yl)aziridine 6d.** Using the same procedure as that described for the preparation of **5a**, 2-(2-azido-1-iodoethyl)-1,3-dioxolane **4d** (4.20 g, 15.6 mmol) was reduced with $LiAlH_4$ (1.20 g, 31 mmol) in ether (45 cm^3) to give 1.245 g (69%) of light yellow liquid as the crude product which contained *ca.* 80% of 2-(1,3-dioxolan-2-yl)aziridine **5d** according to the ^{1}H NMR spectrum; ν_{max}/cm^{-1} 3299, 1233, 868, 668; δ_H 4.72 (1 H, d, *J* 4, 2′-H), 4.06–3.87 (4 H, m, 2 × OCH_2), 2.75 (1 H, br s, NH), 2.25 (1 H, ddd, *J* 6, 4 and 4, 2-H), 1.82 (1 H, d, *J* 6, 3-H), 1.68 (1 H, d, *J* 3.5, 3-H); δ_C 104.5, 65.1, 30.9, 21.3. Benzoyl chloride (1.40 g, 9.8 mmol) was treated with the crude mixture of 2-(1,3-dioxolan-2-yl)aziridine **5d** (1.10 g, 9.6 mmol) in the presence of triethylamine (1.00 g, 10 mmol) to yield 1.87 g of a yellow oil. The crude product was separated by flash column chromatography (silica gel, ether–light petroleum, 1:1) to give *title compound* **6d** (R_f, 0.31) (1.05 g, 49%) (Found: C, 66.0; H, 5.8; N, 6.8. $C_{12}H_{13}NO_3$ requires C, 65.7; H, 6.0; N, 6.4%); *m/z* 218 (M − 1, 2%), 105 (100); ν_{max}/cm^{-1} 2893, 1674, 1223, 858, 713, 688, 659; δ_H 8.18–8.13 (2 H, m) and 7.57–7.42 (3 H, m, C_6H_5), 4.94 (1 H, d, *J* 4.6, 2′-H), 4.09–3.94 (4 H, m, 2 × OCH_2), 2.80 (1 H, ddd, *J* 6.3, 4.6 and 3.5, 2-H), 2.57 (1 H, d, *J* 6.3, 3-H^a), 2.45 (1 H, d, *J* 3.5, 3-H^b); δ_C 178.4, 132.9, 132.5, 129.4, 128.4, 103.5, 65.5, 65.2, 38.5, 27.8.

***N*-Cinnamoyl-2-(diethoxymethyl)aziridine 6e.** From the reaction of cinnamoyl chloride (632 mg, 3.58 mmol) and crude

2-(diethoxymethyl)aziridine **5c** (500 mg) in the presence of triethylamine (700 mg) in benzene, a yellow oil (992 mg) was obtained. Separation by flash column chromatography (silica, ether–light petroleum, 1:10) of the crude product gave *aziridine* **6e** as a colourless oil (R_f 0.38) (676 mg, 69%) (Found: C, 69.4; H, 7.5; N, 5.0. $C_{16}H_{21}NO_3$ requires C, 69.8; H, 7.7; N, 5.1%); *m/z* (CI) 276 (M + 1, 12%), 103 (100); ν_{max}/cm^{-1} 2976, 1677, 1628, 1337, 1258, 1062, 884, 770, 688; δ_H 7.76 (1 H, d, *J* 16.0, 3″-H), 7.57–7.51 (2 H, m) and 7.42–7.35 (3 H, m, C_6H_5), 6.75 (1 H, d, *J* 16.0, 2″-H), 4.43 (1 H, d, *J* 5.0, 1′-H), 3.91–3.53 (4 H, m, 2 × OCH_2), 2.79 (1 H, ddd, *J* 6.0, 5.0 and 3.4, 2-H), 2.50 (1 H, d, *J* 6.0, 3-H[a]), 2.39 (1 H, d, *J* 3.4, 3-H[b]), 1.29 (3 H, t, *J* 7.1, CH_3), 1.24 (3 H, t, *J* 7.1, CH_3); δ_C 177.5, 143.5, 134.4, 130.1, 128.7, 127.9, 120.5, 101.6, 62.6, 62.5, 38.1, 27.7, 15.2, 15.1.

General method for the iodide-promoted ring expansion of *N*-acylaziridines

Aziridines **2a–d** and **6a–e** were mixed with sodium iodide in acetone or dimethylformamide (DMF). The reaction was stirred at room temperature for 2–24 h. The solvent was removed *in vacuo* and the residue extracted with ether where acetone was used, or where DMF was used as reaction solvent, the reaction mixture was partitioned between water and benzene. The organic phase was dried ($MgSO_4$) and concentrated to give crude products which were purified by chromatography.

Reaction of isopropyl *N*-benzoylaziridine-2-carboxylate 2a. Treatment of isopropyl *N*-benzoylaziridine-2-carboxylate **2a** (2.38 g, 10.23 mmol) with sodium iodide (19.19 g, 130 mmol) in acetone (250 cm^3) gave a yellow oil. The ^{1}H NMR spectrum of the crude product indicated a mixture of isomers **7a**, **8a** and **9a** in a ratio of 1.7:3.4:1. The mixture was separated by flash chromatography (silica gel, ether–light petroleum, 1:1) into three compounds. Isopropyl 2-phenyl-4,5-dihydro-1,3-oxazole-4-carboxylate **7a** (R_f 0.34) (733 mg, 31%) crystallised from light petroleum as colourless crystals, mp 41.8–42 °C (lit.,[23] 40–42 °C). *Isopropyl* 2-*phenyl*-4,5-*dihydro*-1,3-*oxazole*-5-*carboxylate* **8a** (R_f 0.26) (1.048 g, 44%) crystallised from light petroleum as colourless crystals, mp 67.2–67.8 °C (Found: C, 66.9; H, 6.3; N, 6.2. $C_{13}H_{15}NO_3$ requires C, 66.9; H, 6.5; N, 6.0%); *m/z* 234 (M + 1, 35%), 57 (100); ν_{max}/cm^{-1} 1739, 1658, 1580, 1222, 1109, 1062, 1023, 986, 899, 780, 698, 681; δ_H 8.01–7.90 (2 H, m) and 7.54–7.38 (3 H, m, C_6H_5), 5.12 (1 H, septet, *J* 6.3, C*H*Me_2), 5.04 (1 H, dd, *J* 10.8 and 7.2, 5-H), 4.36 (1 H, dd, *J* 15.1 and 10.8, 4-H[a]), 4.12 (1 H, dd, *J* 15.1 and 7.2, 4-H[b]), 1.29 (6 H, d, *J* 6.3, 2 × CH_3); δ_C 170.1, 164.1, 131.6, 128.4, 127.0, 75.9, 69.4, 59.4, 21.7. *Isopropyl* 2-*benzamidopropenoate* **9a** (R_f 0.6) was obtained as a pale yellow oil (340 mg, 14%) (Found: M^+, 233.105 ± 0.002. $C_{13}H_{15}NO_3$ requires *M*, 233.1048); *m/z* 233 (M^+, 32%), 105 (100); ν_{max}/cm^{-1} 3408, 1710, 1678, 1637, 1602, 1581, 1518, 1363, 1319, 1195, 1105, 905, 828, 807, 758, 698; δ_H 8.60 (1 H, br s, NH), 7.88–7.82 (2 H, m) and 7.58–7.42 (3 H, m, C_6H_5), 6.76 (1 H, s, 3-H_{cis}), 5.98 (1 H, d, *J* 13.3, 3-H_{trans}), 5.16 (1 H, septet, *J* 6.3, C*H*Me_2), 1.34 (6 H, d, *J* 6.3, 2 × CH_3); δ_C 165.7, 163.8, 134.3, 132.0, 131.5, 128.8, 126.9, 108.3, 70.3, 21.7.

Reaction of isopropyl *N*-cinnamoylaziridine-2-carboxylate 2b. Aziridine **2b** (25 mg) was treated with sodium iodide (20 mg) in acetone (1 cm^3) to give a light yellow oil as the crude product (27 mg). The ^{1}H NMR spectrum of the crude mixture displayed all the distinguishing signals for isomeric products **7b**, **8b** and **9b** in a ratio of 1 : 1 : 2. The same reaction in DMF gave a crude mixture of **7b**, **8b** and **9b** in a ratio of 1.6 : 1.5 : 1. *Isopropyl* 2-(*cinnamoylamino*)*propenoate* **9b**; δ_H 7.96 (1 H, br s), 7.71–7.50 (2 H, m, C_6H_5), 7.69 (1 H, d, *J* 15.5, 3′-H), 7.40–7.35 (3 H, m, C_6H_5), 6.50 (1 H, d, *J* 15.5, 2′-H), 6.72 (1 H, s, 3-H_{cis}), 5.93 (1 H, d, *J* 1.4, 3-H_{trans}), 5.15 (1 H, septet, *J* 6.2, C*H*Me_2), 1.34 (6 H, d, *J* 6.2, 2 × CH_3). (For the analytical data of oxazoline isomers **7b** and **8b**, see the following part of this section.)

Reaction of isopropyl *N*-(2-phenyl-1,3-oxazol-4-ylcarbonyl)-aziridine-2-carboxylate 2c. The reaction of aziridine **2c** (53 mg, 0.18 mmol) with sodium iodide (50 mg, 0.33 mmol) in DMF (1.5 cm^3) gave a white solid product. The ^{1}H NMR spectrum displayed signals for isomers **7c**, **8c** and **9c** in a ratio of 9 : 8.3 : 1. Separation by preparative TLC (silica gel, ether–light petroleum, 1:1) gave the three isomeric products as white solids. *Isopropyl* 2-(2-*phenyl*-1,3-*oxazol*-4-*ylcarbonylamino*)*propenoate* **9c** (R_f 0.5) (2 mg, 4%), mp 86–89 °C (Found: M^+, 300.112 ± 0.003. $C_{16}H_{16}N_2O_4$ requires *M*, 300.1108); *m/z* 300 (M^+, 23%), 105 (100); ν_{max}/cm^{-1} 3366, 1717, 1684, 1588, 1516, 1321, 1197, 1107, 854, 779, 705; δ_H 9.43 (1 H, br s, NH), 8.28 (1 H, s, 5′-H), 8.12–8.07 (2 H, m) and 7.53–7.46 (3 H, m, C_6H_5), 6.73 (1 H, s, 3-H_{cis}, 5.99 (1 H, d, *J* 1.6, 3-H_{trans}), 5.20 (1 H, septet, *J* 6.3, C*H*Me_2), 1.38 (6 H, d, *J* 6.3, 2 × CH_3); δ_C 163.3, 161.5, 159.2, 141.2, 137.3, 131.4, 128.9, 131.2, 126.8, 126.4, 108.8, 70.2, 21.7. *Isopropyl* 2-(2-*phenyl*-1,3-*oxazol*-4-*yl*)-4,5-*dihydro*-1,3-*oxazole*-4-*carboxylate* **7c** (R_f 0.3) (25 mg, 47%), mp 126–127 °C (Found: C, 64.0; H, 5.2; 9.3. $C_{16}H_{16}N_2O_4$ requires C, 64.0; H, 5.4; N, 9.3%); *m/z* 300 (M^+, 10%), 213 (100); ν_{max}/cm^{-1} 1734, 1677, 1560, 1108, 987, 954, 889; δ_H 8.24 (1 H, s, 5′-H), 8.21–8.08 (2 H, m) and 7.53–7.41 (3 H, m, C_6H_5), 5.11 (1 H, septet *J* 6.3, C*H*Me_2), 4.92 (1 H, dd, *J* 10.6 and 7.9, 4-H), 4.56–4.72 (2 H, m, 5-H_2), 1.31 (3 H, d, *J* 6.3, Me), 1.30 (3 H, d, *J* 6.3, CH_3); δ_C 170.2, 162.5, 160.0, 141.2, 131.3, 131.0, 128.7, 126.8, 126.4, 69.9, 69.5, 68.8, 21.7, 21.66. *Isopropyl* 2-(2-*phenyl*-1,3-*oxazol*-4-*yl*)-4,5-*dihydro*-1,3-*oxazole*-5-*carboxylate* **8c** (R_f 0.22) (23 mg, 43%), mp 122.5–123.5 °C (Found: C, 64.0; H, 5.4; N, 9.3. $C_{16}H_{16}N_2O_4$ required C, 64.0; H, 5.4; N, 9.3%); *m/z* 300 (M^+, 22%), 213 (100); ν_{max}/cm^{-1} 1747, 1682, 1563, 1225, 1107, 888, 856, 776, 706, 689; δ_H 8.24 (1 H, s, 5′-H) 8.21–8.09 (2 H, m) and 7.53–7.41 (3 H, m, C_6H_5), 5.13 (1 H, septet, *J* 6.3, C*H*Me_2), 5.06 (1 H, dd, *J* 10.8 and 7.2, 5-H), 4.39 (1 H, dd, *J* 15.3 and 10.8, 4-H[a]), 4.14 (1 H, dd, *J* 15.3 and 7.2, 4-H[b]), 1.29 (6 H, d, *J* 6.3, 2 × CH_3); δ_C 169.7, 160.6, 157.8, 140.9, 131.1, 131.0, 128.8, 126.8, 126.5, 76.0, 69.6, 59.3, 21.6. Reaction of aziridine **2c** (15 mg) and sodium iodide (15 mg) in $[^2H]_6$acetone (0.5 cm^3) provided **7c**, **8c** and **9c** in a ratio of 2 : 2 : 1.

Reaction of isopropyl *N*-benzyloxyacetylaziridine-2-carboxylate 2d. The ester **2d** (277 mg, 1 mmol) and sodium iodide (1.871 g, 12.5 mmol) were dissolved in dry acetone (25 cm^3) and the mixture was stirred at room temperature for 24 h. The solvent was evaporated *in vacuo* and the residue was extracted with warm benzene (10 cm^3). The extract was dried ($MgSO_4$), filtered and the benzene evaporated to give isopropyl 2-(benzyloxyacetylamino)propenoate **9d** as a pale yellow liquid (216 mg, 78%) (Found: C, 64.8; H, 7.2; N, 5.1. $C_{15}H_{19}NO_4$ requires C, 65.0; H, 6.9; N, 5.1%); *m/z* 277 (M^+, 0.3%), 218 (1.5), 171 (24), 129 (19), 111 (35), 91 (100); ν_{max}/cm^{-1} 3377, 1785, 1695, 1634, 1521, 1107; δ_H 8.94 (1 H, br s, NH), 7.37 (5 H, s, C_6H_5), 6.60 (1 H, s, =CH), 5.92 (1 H, d, *J* 1.6, =CH), 5.13 (1 H, septet, *J* 6.3, C*H*Me_2), 4.63 (2 H, s, $PhCH_2O$), 4.04 (2 H, s, OCH_2CO), 1.31 (6 H, d, *J* 6.3, 2 × CH_3); δ_C 168.33, 163.10, 136.56, 130.99, 128.62, 128.23, 127.86, 108.84, 73.55, 70.00, 69.45, 21.68.

Reaction of *N*-benzoyl-2-(1,1-dimethylethoxymethyl)aziridine 6a. The reaction of *N*-benzoyl-2-(1,1-dimethylethoxymethyl)-aziridine **6a** (201 mg, 0.86 mmol) and sodium iodide (263 mg, 1.75 mmol) in acetone (15 cm^3) for 24 h followed by ether extraction gave a yellow oil (201 mg, 100%). Purification by preparative TLC (silica gel, ether–light petroleum, 1:1, R_f 0.39) gave 4-(1,1-*dimethylethoxymethyl*)-2-*phenyl*-4,5-*dihydro*-1,3-*oxazole* **12a** (190 mg, 95%) as a light yellow oil (Found: M^+, 233.142 ± 0.002. $C_{14}H_{19}NO_2$ requires *M*, 233.1411); *m/z* 233 (M^+, 0.6%), 146 (100); ν_{max}/cm^{-1} 1649, 1604, 1581, 1195, 1085, 946, 883, 782, 696; δ_H(300 MHz) 7.96–7.93 (2 H, m) and 7.50–7.37 (3 H, m, C_6H_5), 4.51–4.46 (1 H, m, 5-H[a]), 4.44–4.37 (1 H, m, 4-H), 4.29 (1 H, dd, *J* 7.2 and 6.4, 5-H[b]), 3.76 (1 H, dd, *J* 8.7 and 4.2, 1′-H[a]), 3.27 (1 H, t, *J* 8.5, 1′-H[b]), 1.20 (9 H, s, 3 × CH_3); δ_C 164.7, 131.3, 128.2, 127.7, 73.1, 71.5, 66.8, 64.5, 27.5.

Reaction of *N*-benzoyl-2-(dimethoxymethyl)aziridine 6b. The reaction of aziridine **6b** (430 mg, 1.95 mmol) and sodium iodide (300 mg, 2 mmol) in acetone (20 cm^3) for 24 h followed by ether

extraction gave pure 4-(*dimethoxymethyl*)-2-*phenyl*-4,5-*dihydro*-1,3-*oxazole* **12b** (421 mg, 98%) as a yellow oil (Found: C, 65.2; H, 7.2; N, 6.1. $C_{12}H_{15}NO_3$, requires C, 65.1; H, 6.8; N, 6.3%); *m/z* (CI) 222 (M + 1, 6%), 75 (100); ν_{max}/cm^{-1} 1650, 1358, 1090, 1067, 697; δ_H 8.00–7.95 (2 H, m) and 7.49–7.40 (3 H, m, C_6H_5), 4.47–4.41 (4 H, m, 4-H, 5-H_2, 1′-H), 3.50 (3 H, s, OCH_3), 3.45 (3 H, s, OCH_3); δ_C 165.4, 131.4, 128.4, 128.2, 127.6, 106.0, 69.1, 68.4, 56.1, 55.0.

Reaction of *N*-benzoyl-2-(diethoxymethyl)aziridine 6c. The reaction of aziridine **6c** (468 mg, 1.88 mmol) with sodium iodide (282 mg, 1.88 mmol) in acetone (20 cm^3) gave reasonably pure 4-(*diethoxymethyl*)-2-*phenyl*-4,5-*dihydro*-1,3-*oxazole* **12c** (433 mg, 93%) as a yellow oil. Further purification for the microanalytical sample was achieved by radial chromatography (silica gel, ether–light petroleum, 1:3, R_f 0.34) (Found: C, 67.6; H, 7.9; N, 6.0. $C_{14}H_{19}NO_3$ requires C, 67.5; H, 7.7; N, 5.6%); *m/z* (CI) 250 (M + 1, 40%), 103 (100); ν_{max}/cm^{-1} 1649, 1088, 1064, 697; δ_H 7.99–7.94 (2 H, m) and 7.52–7.36 (3 H, m, C_6H_5), 4.61 (1 H, dd, *J* 2.4 and 1.5, 1′-H), 4.52–4.41 (3 H, m, 4-H, 5-H_2), 3.86–3.50 (4 H, m, 2 × OCH_2), 1.26 (3 H, t, *J* 7.1, CH_3), 1.14 (3 H, t, *J* 7.1, CH_3); δ_C 165.3, 131.3, 128.3, 128.2, 127.7, 103.62, 69.8, 68.4, 64.6, 63.1, 15.3, 15.2.

Reaction of *N*-benzoyl-2-(1,3-dioxolan-2-yl)aziridine 6d

The reaction of aziridine **6d** (900 mg, 4.1 mmol) with sodium iodide (1.3 g, 8.6 mmol) in acetone (60 cm^3) gave 928 mg of a yellow oil as crude product which was purified in the same manner as the previous dihydrooxazole to give 4-(1,3-*dioxan*-2-*yl*)-2-*phenyl*-4,5-*dihydro*-1,3-*oxazole* **12d** (878 mg, 98%) as a light yellow oil [Found: (FAB), (M + 1) 220.096 94; $C_{12}H_{14}NO_3$ requires (*M* + 1) 220.097 37]; *m/z* 219 (M^+, 5%), 73 (100); ν_{max}/cm^{-1} 1646, 1604, 1579, 1364, 1289, 1050, 1026, 936, 695; δ_H(300 MHz) 8.01–7.96 (2 H, m) and 7.51–7.37 (3 H, m, C_6H_5), 5.08 (1 H, d, *J* 3.6, 2′-H); 4.52 (1 H, td, *J* 8.5 and 3.6, after irradiation at 5.08, this group of peaks collapsed into a triplet, *J* 8.4, 4-H), 4.45 (1 H, overlapping dd, *J* 12.1 and 8.1, 5-H^b), 4.41 (1 H, overlapping dd, *J* 12.1 and 8.3, 5-H^a), 4.08–4.03 (2 H, m, 4′-H^a and 5′-H^a), 4.00-3.92 (2 H, m, 4′-H^b and 5′-H^b); δ_C 165.6, 131.5, 128.5, 128.2, 127.2, 103.9, 69.2, 67.8, 65.5.

Reaction of *N*-cinnamoyl-2-(diethoxymethyl)aziridine 6e

The reaction of aziridine **6e** (350 mg, 1.3 mmol) and sodium iodide (250 mg, 1.4 mmol) in acetone (15 cm^3) for 20 h gave 400 mg of yellow oil. Purification of the crude product by radial chromatography (silica, ether–light petroleum, 1:2) gave pure 4-(*diethoxymethyl*)-2-(2-*phenylvinyl*)-4,5-*dihydro*-1,3-*oxazole* **12e** (290 mg, 83%) as a colourless oil which became solid while being stored in a freezer, mp 39–40 °C (Found: C, 70.0; H, 7.7; N, 5.0. $C_{16}H_{21}NO_3$ requires C, 69.8; H, 7.7; N, 5.1%); *m/z* (CI) 276 (M + 1, 14%), 230 (17), 103 (100), 75 (23); ν_{max}/cm^{-1} 2976, 1655, 1609, 1363, 1064, 760, 697; δ_C 7.51–7.42 (2 H, m) and 7.41–7.32 (4 H, m, C_6H_5, 2″-H), 6.66 (1 H, d, *J* 16.3, 1″-H), 4.54 (1 H, d, *J* 4.0, 1′-H), 4.45–4.31 (3 H, m, 4-H, 5-H_2), 3.85–3.51 (4 H, m, 2 × OCH_2), 1.26 (3 H, t, *J* 7.0, CH_3), 1.18 (3 H, t, *J* 7.0, CH_3); δ_C 164.9, 140.1, 135.1, 129.4, 128.7, 127.4, 115.0, 103.5, 69.4, 68.1, 64.2, 62.4, 15.3, 15.2.

Reaction of isopropyl *N*-benzoylaziridine-2-carboxylate 2a with concentrated sulfuric acid

Concentrated sulfuric acid (40 mm^3) was added dropwise with a microsyringe to a solution of isopropyl *N*-benzoylaziridine-2-carboxylate **2a** (150 mg) in anhydrous ether (20 cm^3). After being stirred at room temperature for 20 h the solution was washed with aqueous sodium carbonate (2 × 5 cm^3) and water (2 × 5 cm^3). The ethereal solution was dried ($MgSO_4$) and concentrated *in vacuo* to give 128 mg of a colourless oil. The ^{1}H NMR spectrum showed four compounds to be present. Separation of the crude product by radial chromatography (silica, ether–light petroleum, 1:1, changed to 2:1 and then pure ether at the end) gave three fractions. *Fraction A*, as identified by ^{1}H NMR spectroscopy, was a mixture of 4-isopropoxycarbonyl- **7a** and 5-isopropoxycarbonyl-2-phenyl-4,5-dihydro-1,3-oxazole **8a** in a ratio of 5.7:1 (60 mg, 40%). *Fraction B*, a colourless solid was identified as isopropyl 2-benzoylamino-3-hydroxypropanoate (27 mg, 17%) [Found: (M + 1) 252.123 ± 0.002. $C_{13}H_{18}NO_4$ (*M* + 1) requires 252.1236]; *m/z* 252 (M + 1, 6%), 221 (9), 164 (32), 122 (22), 105 (100), 77 (78), 51 (24); ν_{max}/cm^{-1} 3406, 3333, 1742, 1639, 1533, 827, 800, 720; δ_H 7.86–7.54 (2 H, m) and 7.53–7.36 (3 H, m, C_6H_5), 7.23 (1 H, br d, *J* 6.7, NH), 5.11 (1 H, septet, *J* 6.3, C*H*Me_2), 4.80 (1 H, dt, *J* 7.0 and 3.6, 2-H), 4.03 (2 H, d, *J* 3.6, 3-H_2), 3.09 (1 H, br s, OH), 1.30 (3 H, d, *J* 6.3, CH_3) and 1.28 (3 H, d, *J* 6.3, CH_3); δ_C 170.0, 167.7, 133.5, 131.9, 128.6, 127.1, 69.9, 63.7, 55.4, 21.7. *Fraction C* was identified as isopropyl 3-benzoylamino-2-hydroxypropanoate **11** and was obtained as an oil (16 mg, 10%) [Found: (M^+) 251.116 ± 0.002. $C_{13}H_{17}NO_4$ requires *M*, 251.1157]; *m/z* 251 (M^+, 9%), 192 (9), 164 (12), 134 (23), 105 (100), 77 (36), 51 (12); ν_{max}/cm^{-1}, 3334, 1734, 1646, 1540, 1105, 713, 690, 669; δ_H 7.86–7.73 (2 H, m) and 7.54–7.29 (3 H, m, C_6H_5), 5.08 (1 H, septet, *J* 6.3, C*H*Me_2), 4.36 (1 H, t, $J_{2,3}$ 4.9, 2-H), 3.82 (2 H, dd *J* 5.7 and 4.9, 3-H_2), 3.21 (1 H, br s, OH), 1.27 (3 H, d, *J* 6.3, CH_3), 1.26 (3 H, d, *J* 6.3, CH_3); δ_C 172.6, 167.9, 134.1, 131.6, 128.5, 126.9, 70.3, 70.0, 43.0, 21.6.

Reaction of isopropyl *N*-benzoylaziridine-2-carboxylate 2a with trifluoromethanesulfonic acid

Trifluoromethanesulfonic acid (140 mm^3) was added dropwise *via* a microsyringe into a solution of isopropyl *N*-benzoylaziridine-2-carboxylate **2a** (250 mg, 1.07 mmol) in hexane (24 cm^3) and benzene (8 cm^3) at room temperature and the reaction was stirred for 40 min. Triethylamine (0.5 cm^3) was then added and the reaction was stirred for a further 40 min. The reaction mixture was washed with saturated aqueous NaCl (3 × 10 cm^3) and dried ($MgSO_4$). After filtration and concentration of the solution *in vacuo* the crude product was obtained as a yellow oil (220 mg). Purification of the crude product (210 mg) by radial chromatography gave two fractions. The higher R_f fraction, identified as isopropyl 2-phenyl-4,5-dihydro-1,3-oxazole-4-carboxylate **7a**, was obtained as colourless crystals (171 mg, 72%), mp 39.5–40.5 °C. The NMR spectral signals matched the literature data. The lower R_f fraction, isopropyl 2-phenyl-4,5-dihydro-1,3-oxazole-5-carboxylate **8a**, was obtained as colourless crystals (18 mg, 7%), mp 66–67 °C. All the NMR spectral signals matched the previous data for the compound.

Reaction of isopropyl *N*-cinnamoylaziridine-2-carboxylate 2b with trifluoromethanesulfonic acid

Trifluoromethanesulfonic acid (160 mm^3) was added dropwise *via* a microsyringe to a solution of isopropyl *N*-cinnamoylaziridine-2-carboxylate **2b** (322 mg, 1.24 mmol) in light petroleum (30 cm^3)–benzene (10 cm^3) at room temperature and the reaction was stirred for 30 min. Triethylamine (0.6 cm^3) was added and the reaction was stirred for 1 h. After being worked up as described in the previous experiment, the crude product (298 mg) was obtained as a light yellow solid as a mixture of 2,4- and 2,5-disubstituted 4,5-dihydro-1,3-oxazoles in a ratio of 6.5 : 1. The crude product (286 mg) was purified by radial chromatography (silica, ether–light petroleum, 1:3). *Isopropyl* 2-(2-*phenylvinyl*)-4,5-*dihydro*-1,3-*oxazole*-4-*carboxylate* **7b** (R_f 0.35) was obtained as colourless crystals (246 mg, 78%), mp 93–94.5 °C (Found: C, 69.4; H, 6.6; N, 5.3. $C_{15}H_{17}NO_3$ requires C, 69.5; H, 6.6; N, 5.4%); *m/z* (CI) 260 (M + 1, 87%), 218 (29), 172 (100), 144 (21), 115 (30); ν_{max}/cm^{-1} 1734, 1650, 1596, 1465, 1026, 1106, 999, 979, 764; δ_H(300 MHz) 7.50–7.46 (2 H, m) and 7.40–7.31 (3 H, m, C_6H_5), 7.41 (1 H, d, *J* 16.3, 2′-H), 6.67 (1 H, d, *J* 16.3, 1′-H), 5.11 (1 H, septet, *J* 6.3, C*H*Me_2), 4.83 (1 H, dd, *J* 10.5 and 7.9, 4-H), 4.59–4.46 (2 H, m, 5-H_2), 1.31 (3 H, d, *J* 6.2, CH_3), 1.30 (3 H, d, *J* 6.3 CH_3); δ_C 170.6, 165.7, 69.2, 69.3, 114.5, 141.1, 134.9, 129.7, 128.8,

127.6, 68.8, 21.71, 21.69. *Isopropyl* 2-(2-*phenylvinyl*)-4,5-*dihydro*-1,3-*oxazole*-5-*carboxylate* **8b** (R_f 0.28) was obtained as colourless crystals (16 mg, 5%), mp 105–108 °C [Found: (M − 1) 258.112 ± 0.002. $C_{15}H_{16}NO_3$ requires (M − 1) 258.1130]; *m/z* 259 (M^+, 13%), 258 (24), 216 (100), 172 (75), 144 (27), 131 (68), 115 (87), 103 (28), 77 (34); ν_{max}/cm^{-1} 1752, 1656, 1613, 1215, 1108, 1061, 995, 762, 697; δ_H 7.63–7.45 (3 H, m) and 7.41–7.34 (3 H, m, C_6H_5 and 2′-H), 6.64 (1 H, d, *J* 16.3, 1′-H), 5.12 (1 H, septet, *J* 6.2, C*H*Me$_2$), 4.96 (1 H, dd, *J* 10.9 and 7.1, 5-H), 4.29 (1 H, dd, *J* 15.3 and 10.9, 4-H[a]) and 4.04 (1 H, dd, *J* 15.3 and 7.1, 4-H[b]), 1.30 (3 H, d, *J* 6.2, CH_3), 1.29 (3 H, d, *J* 6.2, CH_3); δ_C 171.0, 169.8, 140.8, 135.0, 129.5, 128.8, 127.5, 114.2, 75.47, 69.4, 59.3, 21.6.

Isopropyl 2-phenyl-1,3-oxazole-4-carboxylate 13a

Isopropyl 2-phenyl-4,5-dihydro-1,3-oxazole-4-carboxylate **7a** (170 mg, 0.7 mmol) and nickel peroxide NiO_2 (170 mg) were mixed in benzene (20 cm^3) and the mixture was heated at reflux for 9 h. More nickel peroxide (170 mg) was added and the reaction was heated for a further 19 h. Triethylamine (0.3 cm^3) was added to the reaction and the mixture was heated for 1 h. After being filtered, the solution was concentrated *in vacuo* to give the crude product as a solid (160 mg) which was purified by radial chromatography (silica gel, ether–light petroleum, 1 : 3) to give *oxazole* **13a** as colourless crystals (125 mg, 74%), mp 55–56 °C (Found: C, 67.5; H, 6.0; N, 6.2. $C_{13}H_{13}NO_3$ requires C, 67.5; H, 5.7; N, 6.1%); *m/z* 231 (M^+, 14%), 105 (100); ν_{max}/cm^{-1} 1732, 1564, 1155, 1111, 1059, 985, 824, 837, 786, 714, 692; δ_H 8.24 (1 H, s, 5-H), 8.22–8.07 (2 H, m) and 7.53–7.41 (3 H, m, C_6H_5), 5.31 (1 H, septet, *J* 6.3, C*H*Me$_2$), 1.39 (6 H, d, *J* 6.3, 2 × CH_3); δ_C 162.4, 160.9, 143.4, 134.9, 131.0, 128.7, 126.8, 126.5, 68.9, 21.8. Hydrolysis of **13a** in aqueous NaOH followed by acidifying to pH 4.0 gave 2-phenyl-1,3-oxazole-4-carboxylic acid in 90% yield, mp 210 °C (lit.,[24] 210 °C).

Isopropyl 2-(2-phenylvinyl)-1,3-oxazole-4-carboxylate 13b

Isopropyl 2-(2-phenylvinyl)-4,5-dihydro-1,3-oxazole-4-carboxylate **7b** (150 mg, 0.58 mmol) and nickel peroxide (250 mg) were mixed in anhydrous benzene (20 cm^3). The mixture was heated at reflux for 16 h. Triethylamine (0.3 cm^3) was then added to the reaction mixture which was then refluxed for a further 10 min. After being worked up as described above the crude product was obtained as a light yellow solid (151 mg). Purification by radial chromatography (silica gel, ether–light petroleum, 1 : 4) gave *oxazole* **13b** (108 mg, 72%) as colourless crystals, mp 89.5–90 °C (Found: C, 70.0; H, 5.8; N, 5.3. $C_{15}H_{15}NO_3$ requires C, 70.0; H, 5.9; N, 5.4%); *m/z* 258 (M + 1, 76%), 257 (M^+, 68), 214 (100); ν_{max}/cm^{-1} 1725, 1644, 1540, 1316, 1155, 1105, 986, 965; δ_H(300 MHz) 8.17 (1 H, s, 5-H), 7.61 (1 H, d, *J* 16.4, 2′-H), 7.54–7.51 (2 H, m) and 7.42–7.35 (3 H, m, C_6H_5), 6.97 (1 H, d, *J* 16.4, 1′-H), 5.29 (1 H, septet, *J* 6.1, C*H*Me$_2$), 1.39 (6 H, d, *J* 6.1, 2 × CH_3); δ_C 162.1, 160.9, 143.1, 138.1, 135.0, 129.6, 128.9, 127.4, 113.0, 68.9, 21.9.

Isopropyl 2-(2-phenyl-1,3-oxazol-4-yl)-1,3-oxazole-4-carboxylate 13c

2-(2-Phenyl-1,3-oxazol-4-yl)-4,5-dihydro-1,3-oxazole-4-carboxylate **7c** (25 mg, 0.083 mmol) was mixed with nickel peroxide (20 mg) in benzene (8 cm^3). The mixture was heated at reflux for 5 h and tested by TLC. More nickel peroxide was added to the reaction and the reaction was kept at 75–80 °C (bath) for 10 h. The TLC displayed the same fractions as before. Triethylamine (30 mg) was added to the reaction and the mixture was stirred for 30 min. The mixture was filtered and the filtrate evaporated to give the crude product as a solid (21 mg) which was purified by preparative TLC (silica gel, ethyl acetate–light petroleum, 1 : 3). The *bis*(*oxazole*) **13c** (R_f 0.45) was obtained as a colourless solid (8 mg, 32%), mp 164 °C [Found: (M + 1) 299.102 76. $C_{16}H_{15}N_2O_4$ requires (*M* + 1) 299.103 18]; *m/z* 298 (M^+, 25%), 172 (100); ν_{max}/cm^{-1} 3140, 2925, 1719, 1633, 1559, 1528, 1161, 1100, 987, 964, 914, 836, 774, 712, 689, 666; δ_H 8.43 (1 H, s, 5′-H), 8.30 (1 H, s, 5-H), 8.12–8.18 (2 H, m) and 7.45–7.54 (3 H, m, C_6H_5), 5.31 (1 H, septet, *J* 6.3, C*H*Me$_2$), 1.39 (6 H, d, *J* 6.3, 2 × CH_3); δ_C 162.8, 160.6, 155.8, 143.5, 139.4, 135.0, 131.2, 131.0, 128.9, 126.8, 126.3, 69.2, 21.9. Starting material **7c** (3 mg) was recovered.

Isopropyl 2-phenyl-1,3-oxazole-5-carboxylate 14

Isopropyl 2-phenyl-4,5-dihydro-1,3-oxazole-5-carboxylate **8a** (111 mg, 0.48 mmol) and nickel peroxide NiO_2 (263 mg) were mixed in toluene (11 cm^3) and the mixture was heated at reflux for 24 h. After being filtered, the solution was concentrated and the residue was purified by flash chromatography (silica gel, ether–light petroleum, 1 : 1). The recovery of the starting material was 27 mg (24%). *Oxazole* **14** was obtained as colourless crystals from light petroleum (43 mg, 39%), mp 81–81.5 °C (Found: C, 67.6; H, 5.9; N, 6.3. $C_{13}H_{13}NO_3$ requires C, 67.5; H, 5.7; N, 6.1%); *m/z* 231 (M^+, 28%), 116 (100); ν_{max}/cm^{-1} 1714, 1578, 1535, 985, 836; δ_H 8.14–8.12 (2 H, m) and 7.53–7.47 (3 H, m, C_6H_5), 7.82 (1 H, s, 4-H) 5.29 (1 H, septet, *J* 6.3, C*H*Me$_2$), 1.39 (6 H, d, *J* 6.3, 2 × CH_3); δ_C 164.1, 157.5, 142.6, 135.1, 128.9, 127.2, 131.5, 126.4, 69.3, 21.9.

4-(1,1-Dimethylethoxymethyl)-2-phenyl-1,3-oxazole 15a

4-(1,1-Dimethylethoxymethyl)-2-phenyl-4,5-dihydro-1,3-oxazole **12a** (220 mg, 0.94 mmol) and nickel peroxide (230 mg) were mixed in dry benzene (15 cm^3). After the mixture was heated at reflux for 18 h, 250 mg of nickel peroxide was added and the mixture was heated for a further 22 h. Another portion of 230 mg of nickel peroxide was added and the mixture was heated for 30 h. The reaction was tested by TLC before each addition of nickel peroxide. The mixture was filtered and the solid was washed with ether (15 cm^3). Evaporation of the solvent gave 168 mg of crude product whose ^{1}H NMR spectrum indicated the oxazole and starting material in a ratio of 1 : 1.6. Separation by preparative chromatography (silica, ether–light petroleum, 1 : 3) gave recovered starting material (80 mg, 36%) and the *oxazole* **15a** (R_f 0.4) (58 mg, 27%) (Found: M^+, 231.126 ± 0.002. $C_{14}H_{17}NO_2$ requires *M*, 231.1255); *m/z* 231 (M^+, 22%), 158 (100); ν_{max}/cm^{-1} 3133, 3067, 2974, 1554, 1095, 1063, 1026, 932, 891, 779, 714, 692, 668; δ_H 8.04–7.99 (2 H, m) and 7.44–7.40 (3 H, m, C_6H_5), 7.61 (1 H, t, *J* 1.2, 5-H), 4.46 (2 H, d, *J* 1.2, 1′-H), 1.29 (9 H, s, 3 × CH_3); δ_C 161.9, 140.9, 135.6, 130.2, 128.6, 127.5, 126.3, 73.8, 57.2, 27.5.

4-(Dimethoxymethyl)-2-phenyl-1,3-oxazole 15b

4-(Dimethoxymethyl)-2-phenyl-4,5-dihydro-1,3-oxazole **12b** (320 mg, 1.45 mmol) and nickel peroxide (325 mg) were mixed in benzene (20 cm^3). The mixture was heated in an oil bath at reflux for 24 h, 150 mg of nickel peroxide was added and the mixture was heated for a further 24 h. The reaction mixture was filtered and the solid was washed with ether (10 cm^3). Evaporation of the solvent gave 260 mg of crude product whose ^{1}H NMR spectrum showed a mixture of the desired oxazole and the starting material in a ratio of 2 : 1. Purification of the crude product with preparative chromatography (silica, ether–light petroleum, 1 : 3) gave *oxazole* **15b** (R_f 0.3) as a colourless oil (158 mg, 50%) (Found: C, 65.7; H, 5.8; N, 6.4. $C_{12}H_{13}NO_3$ requires C, 65.7; H, 6.0; N, 6.4%); *m/z* (CI) 220 (M + 1, 11%), 219 (M^+, 14), 188 (100); ν_{max}/cm^{-1} 3144, 2983, 1589, 1556, 1102, 1061, 981, 909, 854, 781, 717, 693; δ_H 8.10–8.05 (2 H, m) and 7.46–7.42 (3 H, m, C_6H_5), 7.72 (1 H, d, *J* 1.0, 5-H), 5.51 (1 H, d, *J* 1.0, 1′-H) 3.41 (6 H, s, 2 × OCH_3); δ_C 162.0, 139.5, 136.8, 130.4, 128.6, 127.2, 126.4, 98.3, 52.7.

4-(Diethoxymethyl)-2-phenyl-1,3-oxazole 15c

4-(Diethoxymethyl)-2-phenyl-4,5-dihydro-1,3-oxazole **12c** (350 mg, 1.4 mmol) and nickel peroxide (350 mg) were mixed in benzene (20 cm^3). The mixture was heated in an oil bath at reflux for 24 h, 150 mg of nickel peroxide was added and the

mixture was heated for a further 24 h. Another portion of nickel peroxide (50 mg) was added and the reaction was refluxed overnight (16 h). The reaction mixture was then filtered and the solid was washed with ether (10 cm^3). Evaporation of the solvent gave 278 mg of crude product whose ^1H NMR spectrum showed a mixture of the oxazole and the starting material in a ratio of 5:1. After separation of the crude product by preparative chromatography (ether–light petroleum, 1:3), *oxazole* **15c** (R_f 0.4) was obtained as a colourless oil (212 mg, 61%) (Found: C, 67.9; H, 6.8; N, 6.0. $C_{14}H_{17}NO_3$ requires C, 68.0; H, 6.9; N, 5.7%); *m/z* (CI) 248 (M + 1, 3.6%), 247 (M^+, 3), 202 (100); ν_{max}/cm^{-1} 2976, 1589, 1555, 1059, 993, 848, 780, 716, 692; δ_H 8.09–8.04 (2 H, m) and 7.47–7.41 (3 H, m, C_6H_5), 7.72 (1 H, d, *J* 1.0, 5-H), 5.60 (1 H, d, *J* 1.0, 1′-H), 3.77–3.60 (4 H, m, 2 × OCH_2), 1.26 (6 H, t, *J* 7.0, 2 × CH_3); δ_C 161.9, 140.7, 136.5, 130.3, 128.6, 127.4, 126.5, 97.0, 61.4, 15.2.

4-(1,3-Dioxolan-2-yl)-2-phenyl-1,3-oxazole 15d

4-(1,3-dioxolan-2-yl)-2-phenyl-4,5-dihydro-1,3-oxazole **12d** (90 mg, 0.41 mmol) was mixed with nickel peroxide (200 mg) in benzene (8 cm^3). The mixture was heated at reflux for 48 h. The reaction mixture was filtered and the residue was washed with ether. After being concentrated, the crude product was separated by preparative thin layer chromatography (silica gel, ether–light petroleum, 2:1) to give recovered starting material (70 mg, 78%) and *oxazole* **15d** (14 mg, 16%) (Found: C, 66.0; H, 5.2; N, 6.3. $C_{12}H_{11}NO_3$ requires C, 66.35; H, 5.1; N, 6.5%); *m/z* 217 (M^+, 23%), 174 (100); ν_{max}/cm^{-1} 2891, 1556, 1486, 1450, 1094, 942, 817, 782, 713, 693; δ_H 8.09–8.04 (2 H, m) and 7.43–7.47 (3 H, m, C_6H_5), 7.76 (1 H, br d, *J* 0.53, 5-H), 5.99 (1 H, br s, 2′-H), 4.12–4.21 (2 H, m, 4′-H^a and 5′-H^a), 4.04–4.10 (2 H, m, 4′-H^b and 5′-H^b); δ_C 162.5, 140.0, 136.3, 130.5, 128.7, 127.1, 126.6, 98.2, 65.2.

4-(Diethoxymethyl)-2-(2-phenylvinyl)-1,3-oxazole 15e

4-(Diethoxymethyl)-2-(2-phenylvinyl)-4,5-dihydro-1,3-oxazole **12e** (180 mg, 0.65 mmol) and nickel peroxide (360 mg) were mixed in anhydrous benzene (20 cm^3). The mixture was refluxed for 24 h. Extra nickel peroxide (200 mg) was added in two portions during the 24 h time period. Triethylamine (0.5 cm^3) was added to the reaction mixture and the reaction was refluxed for a further 10 min. After being worked up as described above the crude product was obtained as a yellow oil (169 mg). Purification by radial chromatography (ether–light petroleum, 1:4) gave pure *oxazole* **15e** (R_f 0.36) (151 mg, 85%) as a colourless solid, mp 43.5–44 °C (Found: C, 70.4; H, 7.1; N, 5.0. $C_{16}H_{19}NO_3$ requires C, 70.3; H, 7.0; N, 5.1%); *m/z* (CI) 273 (M^+, 19%), 228 (100); ν_{max}/cm^{-1} 3060, 2975, 1644, 1579, 1530, 1098, 1058, 967, 911, 850, 755, 689; δ_H 7.64 (1 H, d, *J* 0.7, 5-H), 7.52 (1 H, d, *J* 16.4, 2′-H), 7.54–7.49 (2 H, m) and 7.43–7.32 (3 H, m, C_6H_5), 6.94 (1 H, d, *J* 16.5, 1′-H), 5.56 [1 H, d, *J* 0.9, C*H*$(OEt)_2$], 3.79–3.55 (4 H, m, 2 × OCH_2), 1.26 (6 H, t, *J* 7.1, 2 × CH_3); δ_C 161.7, 140.7, 136.3, 136.1, 135.3, 129.1, 128.8, 127.1, 113.8, 96.8, 61.3, 15.1.

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