A New Method for Stereoselective Homoallylic Amine Synthesis

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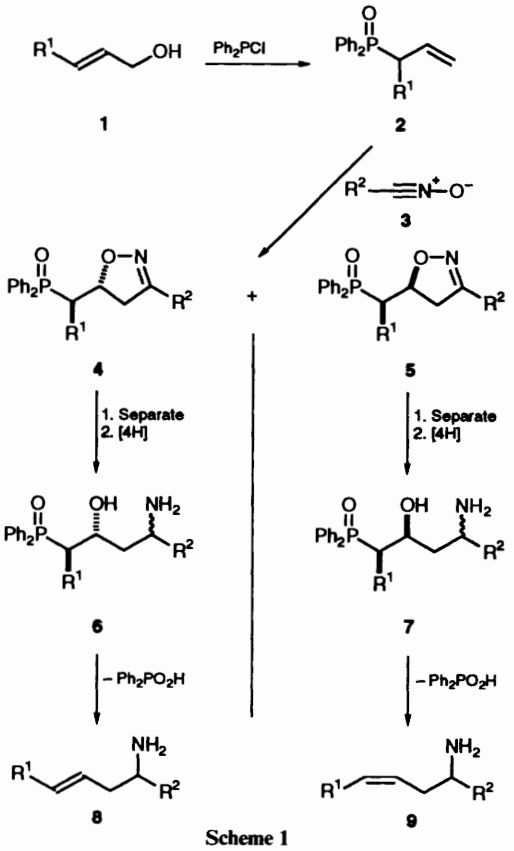
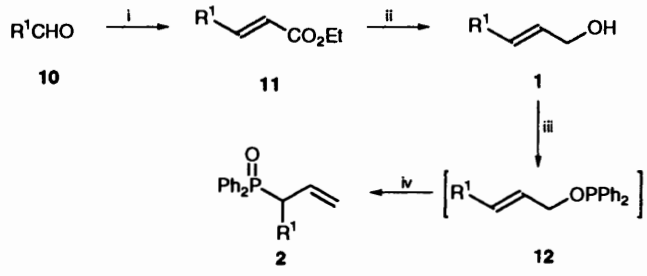
Nitrile oxide cycloadditions to readily available allylic diphenylphosphine oxides **2** proceeded regioselectively and stereoselectively to give 5-(1′-diphenylphosphinoylalkyl)isoxazolines **4** and **5**. These heterocycles were reduced to δ-amino-β-hydroxyalkyldiphenylphosphine oxides **6** and **7** using a combination of sodium borohydride and nickel(II) chloride. Stereospecific elimination of diphenylphosphinic acid from the reduction products using sodium hydride in *N,N*-dimethylformamide gave homoallylic primary amines **8** and **9** of defined stereochemistry.

Homoallylic amines such as **8** and **9** form structural units in a variety of natural products, *e.g.* actinobolin.[1] They have also been used as synthetic precursors to natural products, including the sphingosine bases.[2] There are two main synthetic routes to homoallylic amines in the literature: the addition of allyl metal reagents to imines,[3,4] and Weinreb's hetero-Diels–Alder approach.[1,2] The first, and more widely applied, of these is generally used to make terminal alkenes,[3] although *cis*-1,2-disubstituted alkenes are also available.[4] The second route is more versatile,[2] but neither method gives direct access to unprotected primary homoallylic amines. Our new synthesis[5] converts allylic alcohols **1** in four steps, as outlined in Scheme 1, into the longer-chain homoallylic amines **8** and **9**.



Scheme 1

The allylic alcohol starting materials **1** were efficiently synthesised, where necessary, from aldehydes **10** *via* Horner–Emmons reaction with triethyl phosphonoacetate, and Bu^i_2AlH (DIBAL) reduction of the resulting α,β-unsaturated esters **11**. Treatment of the alcohols **1** with chlorodiphenylphosphine and pyridine in diethyl ether gave alkyl diphenylphosphinites **12**. These were not isolated, but the ether solution was filtered to remove pyridinium chloride and evaporated to dryness under an inert atmosphere. Allylic diphenylphosphine oxides **2** were then obtained in moderate to good yields *via* a [2,3] sigmatropic Arbuzov rearrangement, accomplished by heating alkyl diphenylphosphinites **12** to reflux overnight in toluene (Scheme 2).



Scheme 2 *Reagents and conditions:* i, $(EtO)_2P(O)CH_2CO_2Et$, 80–95%; ii, $(Bu^i)_2AlH$; iii, Ph_2PCl, pyridine, Et_2O; iv, toluene, reflux, 17 h, 26–91% over 2 or 3 steps

The carbon chain elongation was achieved by 1,3-dipolar cycloaddition of nitrile oxides[6] **3** to alkenes **2**. As expected for a monosubstituted, moderately electron-rich double bond, these cycloadditions were totally regioselective, giving exclusively 3,5-disubstituted isoxazolines **4** and **5**.† Several methods were investigated for *in situ* nitrile oxide generation, including the treatment of chloraldoximes with triethylamine,[7] the action of phenyl isocyanate or $POCl_3$ on nitroalkanes,[8] and the action of chloramine-T on aldoximes.[9] The best conditions proved to be aqueous NaOCl (bleach) over a dichloromethane solution of the alkene **2** and an aldoxime as the nitrile oxide precursor. Even under these conditions, the cycloadditions were very slow, typically requiring 1 to 3 weeks for completion. Sonicating the reaction mixture in an ultrasound washing-up bath gave a dramatic, if unexplained, acceleration: under sonication, most reactions reached completion within a few hours or days. Ultrasound has been used to accelerate nitrone cycloadditions.[10] However, if the allylic R^1 substituent in **2** was too large

† Although the term isoxazolines has been used throughout the Discussion section for convenience, such compounds have been named in the Experimental section according to the IUPAC rules of nomenclature for organic compounds as 4,5-dihydroisoxazoles.

Table 1 Results of nitrile oxide cycloadditions

Alkene 2, R^1	Nitrile oxide 3, R^2	Method(s)[a]	4,5-Dihydroisoxazoles 4, 5	Yield (%)	Ratio *anti*-4: *syn*-5[b]
2a, H	**3a**, Et	C (H)	**4** or **5a**	67[c] (71[c])	—
2a	**3b**, Pr	A	**4** or **5b**	96	—
2a	**3c**, Hexyl	A	**4** or **5c**	95	—
2a	**3d**, $C_{11}H_{23}$	E	**4** or **5d**	50	—
2a	**3e**, Ph	A (B)	**4** or **5e**	55 (62)	—
2b, Me	**3f**, Me	A	**4f**	10[c]	—[d]
2b	**3a**	C	**4g**, **5g**	54[c]	84:16
2b	**3b**	B (D)	**4h**, **5h**	84 (41[c])	80:20 (65:35)
2b	**3c**	A	**4i**, **5i**	'107'	71:29
2b	**3d**	A (E)	**4j**, **5j**	66[c] (53)	80:20 (80:20)
2b	**3e**	A (B)	**4k**, **5k**	93 (93)	78:22 (84:16)
2b	**3g**, CO_2Et	F	**4l**, **5l**	44[c]	80:20
2b	**3h**, $(CH_2)_2CO_2Me$	G	**4m**, **5m**	74[c]	83:17
2b	**3i**, $(CH_2)_3CO_2Me$	A	**4n**, **5n**	66[c]	91:9
2c, Et	**3d**	A	**4o**, **5o**	22[c]	78:22
2c	**3i**	A	**4p**, **5p**	20[c]	67:33
2d, Pr	**3d**	A	**4q**, **5q**	33[c]	72:28
2d	**3e**	A	**4r**, **5r**	74[c]	85:15
2d	**3h**	G	**4s**, **5s**	40[c]	85:15
2d	**3i**	A	**4t**, **5t**	24[c]	72:28
2e, Bu^i	**3e**	A (B)	**4u**, **5u**	50[c] (55)[c]	84:16 (84:16)

[a] For detailed methods, see Experimental section. A = oxime + bleach, stirred; B = oxime + bleach, sonicated; C = oxime + Cl_2 gas; D = oxime + chloramine-T; E = oxime + NBS; F = chloroxime + Et_3N; G = nitroalkane + PhNCO; H = modification of method C. [b] Determined by ^1H NMR on crude reaction mixture and/or by product isolation. [c] Some unchanged alkene **2** isolated also. [d] None of minor isomer isolated.

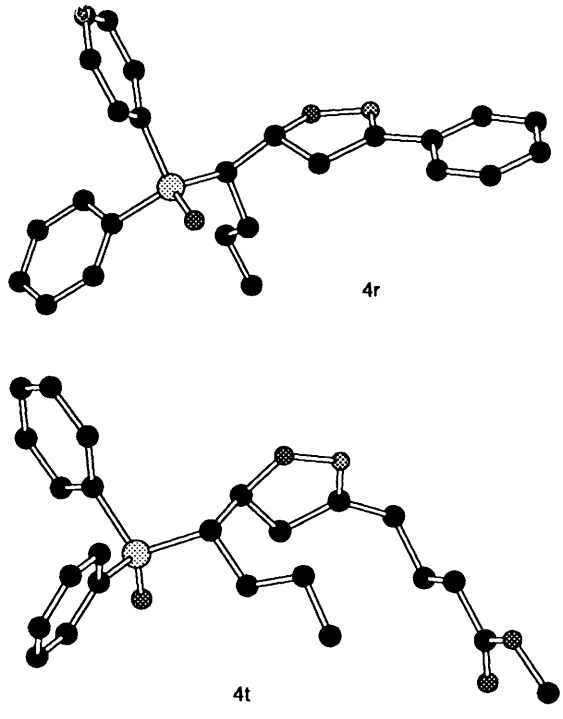


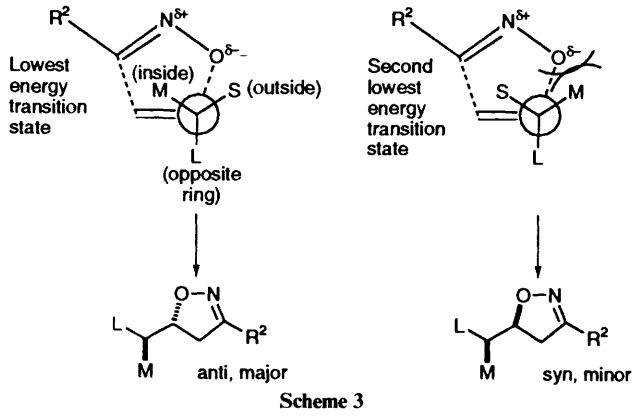
Fig. 1

(*e.g.* R^1 = Pr^i, Ph, or cyclopentyl), no cycloadducts were obtained under any conditions.

The cycloadditions were moderately stereoselective under any of the conditions tested (see Table 1). Generally, the conditions used had very little effect on the selectivity. In almost every case, the diastereoisomeric products could be separated by flash column chromatography, and purified further by recrystallisation if necessary. The cycloadducts **4l** and **5l** from alkene **2b** (R^1 = Me) and nitrile oxide **3g** (R^2 = EtO_2C) could not be separated, however, so this nitrile oxide was used only once. The relative stereochemistries of the cycloadducts were established by NMR correlations to *anti*-**4r** and *anti*-**4t**, whose structures were determined by single-crystal X-ray analysis (Fig. 1).[11] The NMR correlations were based not on chemical shifts, which were less reliable, but on the multiplicities of the ring protons. In particular, the diastereotopic protons on C-4 of the ring appear as two double doublets in the major, *anti*, isoxazoline, and often (but not always) as one doublet in the minor, *syn* isoxazoline (see Experimental section). The multiplicities are clearly governed by the relative sizes of different coupling constants, which, in turn, depend on the conformation of the molecule. It is, therefore, not unreasonable that the relative stereochemistry should be reflected in the coupling constants of the ring protons.

In every case, the *anti*-cycloadduct was the major product. This is consistent with the transition state models of Houk and co-workers (Scheme 3).[12] As other groups have observed,[13] the ground-state conformations of the *anti*-isoxazolines **4r** and **4t**, determined by X-ray analysis, closely resemble the favoured transition-state geometry calculated by Houk. These transition-state models also account for the general observation that the nitrile oxide substituent R^2 has little effect on the stereoselectivity of nitrile oxide cycloadditions.[14] Increasing the steric bulk of the allylic substituent R^1 on the alkene would be expected from these models to improve the stereoselectivity, since a larger alkyl group should show a stronger preference for the 'inside' position over the 'outside' one. Neither of these trends is shown by the data in Table 1. Increasing the size of the allylic substituent R^1 in alkenes **2** from methyl through ethyl and propyl to isobutyl usually reduced the selectivity of the cycloadditions slightly, whereas changing the nitrile oxide substituent often had more effect on the selectivity than changing the allylic substituent. We cannot explain these observations. We assume that the very bulky diphenylphosphinoyl substituent can only occupy the position opposite to the developing ring in Houk's transition state, leaving the R^1 group and the allylic hydrogen to fill the 'inside' and 'outside' positions. A branched allylic substituent such as isopropyl or phenyl is probably too bulky to occupy either of these positions: hence the unreactivity of these alkenes.

The isoxazolines **4** and **5** proved unexpectedly resistant to reduction by a variety of reducing agents, including sodium borohydride, DIBAL, alane, lithium aluminium hydride, $Na(MeOCH_2CH_2O)_2AlH_2$ (Red-Al), sodium in ethanol, and hydrogenation over Raney nickel, palladium, rhodium, or



Scheme 3

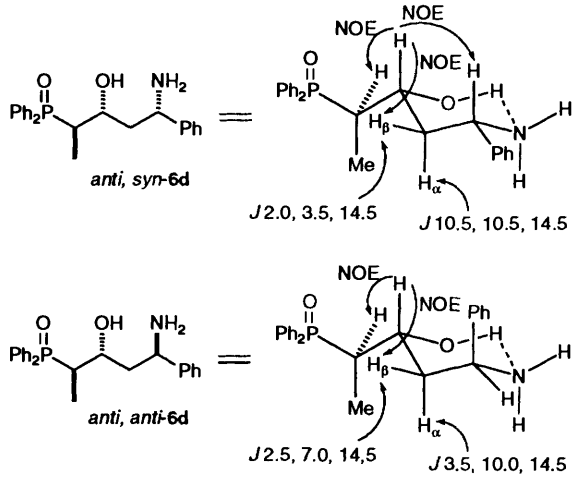
Table 2 Results of reductions using $NaBH_4$ and $NiCl_2 \cdot 6H_2O$

4,5-Dihydroisoxazole 4 or 5	Amino alcohols 6 or 7	% Yield of 6 or 7	Product ratio[a,b]
4 or **5b**	6 or **7a**	90.5	60:40
4 or **5b**	6 or **7a**	—[c]	50:50[d]
4 or **5e**	6 or **7b**	76	71:29
4 or **5e**	6 or **7b**	—[c]	55:45[d]
4h	**6c**	84	55:45
5h	**7c**	86	66:34
4k	**6d**	85	82:18
4k	**6d**	—[c]	83:17[e]
4k	**6d**	—[c]	67:33[e]
5k	**7d**	84	67:33
4r	**6e**	94	83:17
4u	**6f**	64	71:29
5u	**7f**	89	67:33

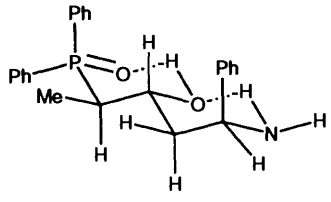
[a] Reactions performed at −30 °C unless otherwise stated. [b] Ratios of *anti,anti*-**6** to *anti,syn*-**6** or *syn,anti*-**7** to *syn,syn*-**7**. [c] Yield not measured. [d] Reaction performed at room temp. [e] Reaction performed at −78 °C.

platinum oxide. Reduction of **4** and **5** to the amino alcohols **6** and **7**, respectively, was achieved cleanly and in high yield by using sodium borohydride with either $NiCl_2 \cdot 6H_2O$ or $CoCl_2 \cdot 6H_2O$.[15] At room temperature the reaction was barely stereoselective, but moderate selectivities could be obtained with the nickel system at −30 °C (see Table 2). Reducing the temperature to −78 °C had almost no further effect on the stereoselectivity, but did introduce a significant induction period for the reaction. This induction period was observed with the cobalt system even at −20 °C, making the nickel system preferable. Although other transition metal salts, notably $TiCl_4$, gave better selectivity, the extent of reduction was very low (< 12%) unless either Ni^{II} or Co^{II} was used. Sodium borohydride alone was totally ineffective.

Separation of the diastereoisomeric reduction products was considerably harder than separation of the diastereoisomeric cycloadducts **4** and **5**, and total separation was achieved in only one case: *anti,anti*-**6d** and *anti,syn*-**6d** were completely separated by flash column chromatography. Since the diastereoisomeric amino alcohols *anti,anti*-**6** and *anti,syn*-**6** give the same homoallylic amines **8** after elimination (see below), their separation was not important, and was, therefore, not attempted in many cases. Neither *anti,anti*-**6d** nor *anti,syn*-**6d** formed crystals suitable for X-ray analysis, but their relative stereochemistries were investigated by NOE studies. Both NMR coupling constants and, to a lesser extent, IR stretching frequencies support the suggestion that these 1,3-amino alcohols adopt a cyclic, hydrogen-bonded conformation (Scheme 4). It has been suggested[16] that in view of the strong hydrogen bonding potential of the phosphine oxide oxygen, a



Scheme 4



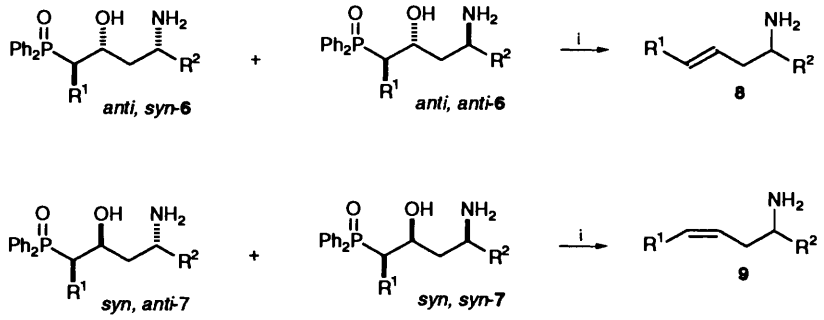
13

Scheme 5

pseudo-decalin structure such as **13** (for *anti,anti*-**6d**) might be more appropriate. This is not consistent with the observed NOEs between OC*H* and PC*H*, however. Based on the monocyclic conformation, the NOE data shown in Scheme 4 suggest that the major reduction product was *anti,anti*-**6d**, and the minor product *anti,syn*-**6d**. These assignments are tentative, however, and related NOE studies on the amino alcohols **6f** provided no support for them. If correct, they imply that the major product *anti*, *anti*-**6d** is formed by reduction from the more hindered face of the ring: the hydride is delivered to the face bearing the diphenylphosphinoylalkyl group. This presumably occurs by co-ordination of the reducing agent to the phosphine oxide, but the structure of the reducing agent in these systems is not known.[17]

Stereospecific elimination of diphenylphosphinic acid from the amino alcohols **6** and **7** proceeded as expected under our usual conditions of sodium hydride in *N,N*-dimethylformamide (DMF).[18] The homoallylic amine products **8** and **9** were best isolated as their hydrochloride salts, although these tended to decompose on attempted recrystallisation. The configuration of the alkene products is decided by the relative stereochemistry of the chiral centres bearing phosphorus and oxygen in the amino alcohols **6** and **7**. These chiral centres were formed in the nitrile oxide cycloaddition, and the *syn* and *anti* diastereoisomers immediately separated, so that *E*-**8** and *Z*-**9** were formed quite separately. The stereochemistry of the third centre was unimportant in these cases, since in the products **8** and **9** it was the only chiral centre. Thus, both *anti,anti*- and *anti,syn*-isomers of the amino alcohols **6** give the same *E* alkenes **8**, while both *syn,anti*- and *syn,syn*-isomers of the amino alcohols **7** give the same *Z* alkenes **9** (Scheme 6). Since the major products of the cycloaddition had *anti* stereochemistry, the *E* alkenes were the more readily available by this route.

In summary, we have developed a new route, outlined in Scheme 1, to the homoallylic amines **8** and **9** of defined geometry. The route leads directly to unprotected primary amines, and the *E* and *Z* alkenes are produced in different reactions, avoiding the need for isomer separation.



Scheme 6 *Reagents and conditions:* i, (a) NaH, DMF; (b) HCl, H_2O: R = H, 28–45%; R ≠ H, 73–81%

Experimental

Column chromatography was carried out at slightly greater than atmospheric pressure using Merck Kieselgel 60 (230–400 mesh). High performance liquid chromatography was performed using a Dynamax prepacked silica column (21.4 mm i.d. × 25 cm), with a Gilson model 303 pump operating at 10 ml min^{-1} and a Cecil Instruments CE 212A u.v. detection system measuring the absorbance at 254 nm. Thin layer chromatography (TLC) was carried out on commercially available pre-coated plates (Merck silica Kieselgel $60F_{254}$). All solvents were distilled before use. Tetrahydrofuran (THF) was freshly distilled from potassium using benzophenone radical as an indicator. Dry diethyl ether (Et_2O) was dried by distillation from calcium hydride. Dimethylformamide (DMF) was dried with, and stored over, activated molecular sieves (4 Å). RT stands for room temperature.

M.p.s were measured on a Reichart hot-stage microscope and are uncorrected. IR spectra were recorded on a Perkin-Elmer 297 grating spectrophotometer. ^1H NMR spectra were recorded on a Varian EM 390 (90 MHz) continuous wave spectrometer or on Bruker WP 80 (80 MHz), WM 250 (250 MHz) and WM 400 (400 MHz) Fourier transform spectrometers. ^1H NMR spectra were recorded at 250 MHz unless otherwise stated. ^{13}C NMR were recorded on a Bruker WM 400 (100 MHz) spectrometer. Chemical shifts are quoted in parts per million relative to tetramethylsilane (δ 0.00 ppm) or chloroform (δ 7.25 ppm) for ^1H spectra, and relative to chloroform (δ 77.0 ppm) for ^{13}C spectra. *J* Values are given in Hz. Mass spectra were recorded on an AEI Kratos MS30 machine using a DS503 data system for high resolution analysis. Microanalyses were carried out using Carlo Erba 1106 or Perkin-Elmer 240 automatic analysers.

Hex-1-en-3-yldiphenylphosphine Oxide **2d**.—Chlorodiphenylphosphine (8.1 cm^3, 45 mmol) in Et_2O (80 cm^3) was added slowly to a stirred solution of hex-2-en-1-ol (5.3 cm^3, 45 mmol) and pyridine (3.6 cm^3, 45 mmol) in Et_2O (60 cm^3) under Ar at 0 °C, and the mixture stirred at RT for 1 h. The mixture was filtered under Ar, and the Et_2O removed under reduced pressure of Ar. Toluene (40 cm^3) was added to the residue and the solution heated to reflux under Ar for 18 h. The toluene was removed under reduced pressure and the residue purified by column chromatography on SiO_2, eluting with 5% MeOH in CH_2Cl_2 to give the impure phosphine oxide. This was recrystallised from EtOAc–hexane to give the *phosphine oxide* **2d** (5.992 g, 47%) as needles, m.p. 105–109 °C (Found: M^+, 284.1327. $C_{18}H_{21}OP$ requires *M*, 284.1330); ν_{max}/cm^{-1}($CHCl_3$) 1630 (C=C), 995 and 920 (=CH_2); δ_H($CDCl_3$) 0.83 (3 H, t, *J* 7.2, Me), 1.14–1.28 (1 H, m, CH_AH_BMe), 1.41–1.54 (1 H, m, CH_AH_BMe), 1.59–1.71 (2 H, m, PCHCH_2), 2.95–3.08 (1 H, m, PCH), 4.98 (1 H, ddd, *J* 0.8, 3.5, 17.0, CH=CH_AH_B), 5.12 (1 H, ddd, *J* 1.4, 3.5, 10.2, CH=CH_AH_B), 5.60–5.77 (1 H, m, CH=CH_2), 7.38–7.55 (6 H, m, Ph_2P) and 7.70–7.86 (4 H, m, Ph_2P); δ_C($CDCl_3$) 13.5 (Me), 20.7 (d, *J* 13.2, CH_2Me), 28.85 (CH_2CHP), 44.9 (d, *J* 69.0, PCH), 119.9, 120.1, 128.1, 128.25, 128.4, 128.55, 131.1, 131.2, 131.3, 131.4, 131.5, 131.6, 132.4, 132.9 and 133.0; *m/z* 284 (M^+, 15%), 242 (M − C_3H_6, 8), 201 (Ph_2PO, 100), 83 (M − Ph_2PO, 18) and 77 (Ph, 20).

5-Methylhex-1-en-3-yldiphenylphosphine Oxide **2e**.—In the same way, chlorodiphenylphosphine (6.3 cm^3, 35 mmol) and 5-methylhex-2-en-1-ol (4.0 g, 35 mmol) gave the *phosphine oxide* **2e** (7.92 g, 76%) as needles, m.p. 153–155 °C (Found: M^+, 298.1490. $C_{19}H_{23}OP$ requires *M*, 298.1486); R_F (EtOAc–hexane, 3:1) 0.34; ν_{max}/cm^{-1} 3100–2800 (C–H), 1635 (C=C), 1600 (Ph), 1440 (P–Ph) and 1165 (P=O); δ_H($CDCl_3$) 0.80 (3 H, d, *J* 6.5, CMe_AMe_B), 0.85 (3 H, d, *J* 6.5, CMe_AMe_B), 1.33 (1 H, dtd, *J* 2.8, 9.0 and 11.8, PC–CH_AH_B), 1.80–1.58 (2 H, m, $Me_2CHCH_AH_B$), 3.11 (1 H, dq, *J* 2.4 and 9.7, PCH), 4.96 (1 H, ddd, *J* 0.8, 4.6 and 17.0, CH=CH_AH_B), 5.11 (1 H, ddd, *J* 1.3, 3.8 and 10.0, CH=CH_AH_B), 5.68 (1 H, dtd, *J* 5.3, 9.8 and 17.0, CH=CH_2), 7.39–7.53 (6 H, m, Ph_2PO) and 7.70–7.85 (4 H, m, Ph_2PO); δ_C($CDCl_3$) 20.4 (CMe_AMe_B), 23.6 (CMe_AMe_B), 25.3 (d, *J* 12, CH), 35.5 (CH_2), 43.3 (d, *J* 68, PCH), 120.0 (d, *J* 12, CH=CH_2), 128.2, 128.3, 128.5, 128.6, 131.1, 131.2, 131.4, 131.6, 132.0 (d, *J* 90, *ipso*-C), 132.8 and 132.9; *m/z* 298 (M^+, 8%), 255 (M^+ − Pr, 4), 242 (M^+ − C_4H_8, 10), 202 (Ph_2POH, 48) and 201 (Ph_2PO, 100).

4-Methylpent-1-en-3-yldiphenylphosphine Oxide **2f**.—In the same way, chlorodiphenylphosphine (0.90 cm^3, 5.0 mmol) and 4-methylpent-2-en-1-ol (0.50 g, 5.0 mmol) gave the *phosphine oxide* **2f** as needles, m.p. (from EtOAc–hexane) 164–165 °C (Found: M^+, 284.1343. $C_{18}H_{21}OP$ requires *M*, 284.1338); R_F (EtOAc–hexane, 1:1) 0.13; ν_{max}/cm^{-1} ($CHCl_3$) 2940 (CH), 1720 (C=C), 1430 (P–Ph) and 1140 (P=O); δ_H($CDCl_3$) 0.91 (3 H, d, *J* 6.7, $CHMe_AMe_B$), 1.03 (3 H, d, *J* 6.9, $CHMe_AMe_B$), 2.21 (1 H, m, Me_2CH), 2.88 (1 H, ddd, *J* 2.6, 8.3 and 10.7, PCH), 4.95 (1 H, ddd, *J* 1.5, 4.0 and 17.0, CH=CH_AH_B), 5.16 (1 H, td, *J* 2.1 and 10.2, CH=CH_AH_B), 5.91 (1 H, dtd, *J* 6.4, 10.3 and 16.9, CH=CH_2), 7.36–7.54 (6 H, m, Ph_2PO) and 7.71–7.88 (4 H, m, Ph_2PO); δ_C($CDCl_3$) 18.6 (Me), 22.9 (d, *J* 13, $CHMe_2$), 27.4 (Me), 51.1 (d, *J* 69, PCH), 121.6 (d, *J* 13, CH=CH_2), 127.9, 128.0, 128.7, 128.8, 129.7, 129.8, 130.7, 130.8, 131.1, 131.3, 131.4, 131.5, 132.8 (d, *J* 96.4 Hz, *ipso*-C) and 133.0 (d, *J* 93.9, *ipso*-C); *m/z* 284 (M^+, 8%), 241 (M^+ − Pr), 202 (Ph_2POH, 50), 201 (Ph_2PO, 100) and 77 (Ph, 17).

1-Cyclopentylprop-2-enyldiphenylphosphine Oxide **2g**.—In the same way, chlorodiphenylphosphine (1.2 cm^3, 6.8 mmol) and 3-cyclopentylprop-2-en-1-ol (0.85 g, 6.8 mmol) gave the *phosphine oxide* **2g** (613 mg, 29%) as needles, m.p. 162–164 °C (Found: M^+, 310.1511. $C_{20}H_{23}OP$ requires *M*, 310.1486); R_F (EtOAc) 0.42; ν_{max}/cm^{-1}($CDCl_3$) 3070 (aryl CH), 3000–2800 (CH), 1600 (Ph), 1435 (P–Ph), and 1175 (P=O); δ_H($CDCl_3$) 1.15 (1 H, m), 1.20–1.63 (6 H, m), 1.73 (1 H, m), 2.28 [1 H, br septet, *J* *ca.* 7, $(CH_2)_4CH$], 3.07 (1 H, dt, *J* 5.9 and 9.5, PCH), 4.94 (1 H, ddd, *J* 1.3, 4.4 and 17.1, CH=CH_AH_B) 5.10 (1 H, ddd, *J* 1.6, 2.8 and 10.2, CH=CH_AH_B) 5.82 (1 H, dtd, *J* 5.9, 10.5 and 17.0,

C*H*=CH_2), 7.38–7.50 (6 H, m, Ph_2PO) and 7.73–7.88 (4 H, m, Ph_2PO); δ_C($CDCl_3$) 24.7, 24.9, 29.6 (d, *J* 5), 31.8 (d, *J* 8), 38.4 [$(CH_2)_4CH$], 49.4 (d, *J* 68, PCH), 120.6 (d, *J* 12, CH=CH_2), 128.1, 128.2, 128.4, 128.5, 130.9, 131.0, 131.2, 131.3, 131.4, 131.6, 131.6, 132.6 (d, 95, *ipso*-C), and 133.3 (d, *J* 92, *ipso*-C); *m/z* 310 (M^+, 8%), 242 [$Ph_2P(O)C_3H_5$, 17], 202 (Ph_2POH, 72), 201 (Ph_2PO, 100) and 77 (Ph, 42).

Other alkenyldiphenylphosphine oxides were prepared in the same way.

Methyl 5-Hydroxyiminopentanoate.—A solution of hydroxylamine hydrochloride (1.60 g, 23.1 mmol) and sodium acetate (1.89 g, 23.1 mmol) in water (20 cm^3) was added to a stirred solution of methyl 5-oxopentanoate (1.0 g, 7.7 mmol) in ethanol (7 cm^3). The reaction mixture was stirred at room temperature for 24 h, poured into brine (20 cm^3) and extracted with ether (3 × 50 cm^3). The combined organic extracts were washed with brine (50 cm^3), dried (Na_2SO_4) and the solvent was removed under reduced pressure to give the imino ester (previously prepared[19] by the nitration of methoxycyclopentane) as a pale yellow oil (1.05 g, 94%), ν_{max}/cm^{-1}(film) 3350br (OH), 1730 s (C=O) and 1650 (C=N); δ_H($CDCl_3$) 1.74–2.09 (4 H, m, CH_2CH_2CO of both isomers), 2.25 (2 H, dt, *J* 7.3, 5.7, CH_2CHN of *cis* isomer), 2.33–2.80 (6 H, m, CH_2CHN of *trans* isomer and CH_2CO of both isomers), 3.65 (3 H, s, Me of *trans* isomer), 3.67 (3 H, s, Me of *cis* isomer), 6.71 (1 H, t, *J* 5.7, CHN of *cis* isomer), 7.40 (1 H, t, *J* 6.0, CHN of *trans* isomer) and 7.5 (2 H, br s, OH of both isomers); *m/z* 129 (M − O, 8%), 128 (M − OH, 40), 114 (M − NOH and M − OMe, 40), 113 (M − MeOH, 100) and 96 (M − MeOH, OH, 92). Other oximes were commercially available, or were prepared in the same way.

Methods used to carry out 1,3-*Dipolar Cycloadditions.*—*Method A.* Aqueous sodium hypochlorite (2 mol dm^{-3}; 1.2 equiv.) was added dropwise to a vigorously stirred solution of the oxime and the alkene **2** (0.5–1 equiv.) in dichloromethane (20 cm^3/mmol oxime) at 0 °C. The solution was stirred at room temperature for the desired period and poured into water. The organic layer was removed and the aqueous layer extracted with dichloromethane. The combined organic extracts were washed with brine, dried ($MgSO_4$), and the solvent was removed under reduced pressure to give the crude product.

Method B. NaOCl (2 mol dm^{-3} aqueous solution; 2.4 equiv.) was added to a solution of the alkene **2** (1 equiv.) and the oxime (2 equiv.) in CH_2Cl_2 (10 cm^3 per mmol of alkene) and the mixture sonicated in an ultrasonic washing-up tank until the reaction was complete by TLC, more oxime (2 equiv.) and NaOCl (2.4 equiv.) being added at intervals. The mixture was poured into water and separated, and the aqueous layer extracted three times with CH_2Cl_2. The combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude reduction product, which was purified by column chromatography on SiO_2.

Method C. Chlorine gas was passed through a stirred solution of the oxime in ether or chloroform (depending on solubility) at −60 °C. After 15 min the blue solution turned blue–green and was evaporated to dryness under reduced pressure at −5 °C to give the imidoyl chloride. Triethylamine (1 equiv.) in chloroform or ether was added dropwise to a stirred solution of the imidoyl chloride and the alkene **2** (1–4 equiv.) in ether or chloroform at −10 °C. The solution was stirred at room temperature for 1–2 days and then evaporated under reduced pressure. Water was added and the solution was extracted. The combined organic extracts were dried ($MgSO_4$) and then evaporated under reduced pressure to give the crude product.

Method D. An equimolar mixture of the alkene **2**, the oxime, and chloramine-T trihydrate in EtOH (15 cm^3 per mmol of reagents) was heated to reflux for a suitable period. At intervals, the mixture was cooled and more oxime and chloramine-T added. After the desired reflux period, the mixture was concentrated under reduced pressure and extracted with EtOAc. The extract was filtered, and the solvent removed under reduced pressure to give the crude reaction product, which was purified by column chromatography on SiO_2.

Method E. A mixture of the oxime and 2 equiv. of NBS in dry DMF (10 cm^3/mmol of oxime) was stirred at −20 °C for 1 h and then at 0 °C for 30 min. The mixture was then diluted with ether (5 cm^3 $mmol^{-1}$), and a solution of the alkene **2** and 1 equiv. of triethylamine in ether was added slowly. The reaction was stirred at room temperature for 48 h, poured into water and extracted with dichloromethane. The combined organic extracts were washed with brine, dried ($MgSO_4$), and the solvent was removed under reduced pressure to give the crude product.

Method F. Triethylamine (0.11 cm^3, 0.8 mmol) in THF (2 cm^3) was added dropwise in portions over 3 h to a stirred solution of the alkene **2** (0.39 mmol) and ethyl chlorooximidoacetate (121 mg, 0.8 mmol) in THF (5 cm^3) and the solution stirred for 8 d, with more oxime and triethylamine added after 3.5 d. Water was added, and the mixture extracted into EtOAc (2 × 15 cm^3). The combined organic extracts were dried (Na_2SO_4) and evaporated under reduced pressure to give the crude product.

Method G. A solution of the primary nitroalkane and triethylamine (5–10 drops) in toluene (2 cm^3 $mmol^{-1}$ nitroalkane) was added dropwise to a solution of phenyl isocyanate (2 equiv.) and the alkene **2** (1–2 equiv.) in toluene. After being stirred at room temperature for 1 h, the solution was heated at 80 °C for 24 h. If TLC indicated the presence of alkene **2** a further addition of phenyl isocyanate and nitroalkane was made and heating was continued for a further 24 h. The reaction mixture was allowed to cool, diluted with water and the organic layer was separated. The aqueous layer was extracted with dichloromethane and the combined organic extracts were washed with 2 mol dm^{-3} hydrochloric acid and brine, dried ($MgSO_4$), and the solvent was removed under reduced pressure to give the crude product.

Method H. As method C, but the chloraldoxime and the alkene were heated together in toluene at reflux, in the absence of triethylamine.

5-Diphenylphosphinoylmethyl-3-ethyl-4,5-dihydroisoxazole **4** *or* **5a**.—*By Method C.* Propanal oxime (230 mg, 3.1 mmol) and the phosphine oxide **2a** (0.5 g, 2.1 mmol) gave a pale yellow solid. This was purified by flash column chromatography on silica (75 g) eluting with ethyl acetate. The first compound to be eluted was the phosphine oxide **2a** (0.15 g, 30% recovery). The second compound to be eluted was the *dihydroisoxazole* (**4** or **5a**) (430 mg, 67%), as needles, m.p. 132–136 °C (from EtOAc) (Found: M^+, 313.1234. $C_{18}H_{20}NO_2P$ requires *M*, 313.1231); ν_{max}/cm^{-1}($CHCl_3$) 1585 (C=N); δ_H($CDCl_3$) 1.12 (3 H, t, *J* 7.5, Me), 2.33 (2 H, q, *J* 7.5, CH_2Me), 2.56 (1 H, dt, *J* 14.5, 10.2, PCH_AH_B), 2.86 (1 H, ddd, *J* 3.7, 9.0, 14.5, PCH_AH_B), 2.99 (1 H, dd, *J* 8.2, 17.3, 4-CH_AH_B), 3.07 (1 H, dd, *J* 9.4, 17.3, 4-CH_AH_B), 4.67–4.79 (1 H, m, OCH), 7.42–7.58 (6 H, m, Ph_2P) and 7.67–7.81 (4 H, m, Ph_2P); *m/z* 313 (M^+, 2%), 258 (M − EtCN, 10), 257 (M − Et, HCN, 8), 243 (M − C_3H_8CN, 18), 216 [$Ph_2P(O)Me$, 42], 215 [$Ph_2P(O)CH_2$, 100] 201 (Ph_2PO, 27) and 77 (Ph, 12).

By Method H. Propanal oxime (300 mg, 4.1 mmol) was converted as before into the chloroaldoxime. This and the phosphine oxide **2a** (0.50 g, 2.1 mmol) were heated together in toluene at reflux to give a brown solid. Flash column chromatography of this on silica (60 g) eluting with ethyl acetate gave the phosphine oxide **2a** (140 mg, 28% recovery) and the dihydroisoxazole (**4** or **5a**) (460 mg, 71%), as a white solid.

5-Diphenylphosphinoylmethyl-3-propyl-4,5-dihydroisoxazole **4** *or* **5b**.—*By Method A.* The phosphine oxide **2a** (0.243 g, 1.0 mmol), butyraldehyde oxime (0.176 g, 2.0 mmol), CH_2Cl_2 (40 cm^3), and aqueous NaOCl (2 mol dm^{-3}; 1.2 cm^3, 2.4 mmol) were stirred for 10 d, with more oxime and NaOCl added after 4 d. The crude mixture was purified by column chromatography on SiO_2, eluting with EtOAc–hexane (3:1) then EtOAc, to give the *dihydroisoxazole* **4** or **5b** (0.315 g, 96%) as needles, m.p. 111–113 °C (EtOAc–hexane) (Found: C, 69.6; H, 6.8; N, 4.4; P, 9.5%; M^+ − PrCN, 258.0804. $C_{19}H_{22}NO_2P$ requires C, 69.7; H, 6.8; N, 4.3; P, 9.5%; M − PrCN, 258.0810); R_F (EtOAc–hexane, 3:1) 0.14; ν_{max}/cm^{-1}($CHCl_3$) 3000–2800 (CH), 1595 (Ph), 1355 (P–Ph), 1185 (P=O) and 1120 (C–O); δ_H($CDCl_3$) 0.92 (3 H, t, *J* 7.4, Me), 1.54 (2 H, sextet, *J* 7.4, 3″-H_2), 2.28 (2 H, t, *J* 7.4, 3′-H_2), 2.55 (1 H, dt, *J* 10.2 and 14.3, PCH_AH_B), 2.86 (1 H, ddd, *J* 3.7, 9.1, and 14.6, PCH_AH_B), 2.97 (1 H, dd, *J* 8.0 and 17.4, 4-H_AH_B), 3.05 (1 H, dd, *J* 9.4 and 17.4, 4-H_AH_B), 4.72 (1 H, m, 5-H), 7.42–7.58 (6 H, m, Ph_2PO) and 7.67–7.80 (4 H, m, Ph_2PO); δ_C($CDCl_3$) 13.7 (Me), 19.6, 29.6, 35.4 (d, *J* 67, PCH_2), 42.8, 74.8 (C-5), 128.7, 128.8, 128.8, 128.9, 130.4, 130.4, 130.8, 130.9, 131.8 (d, *J* 99, *ipso*-C), 132.1, 133.3 (d, *J* 100, *ipso*-C) and 159.8 (C=N); *m/z* 258 (M^+ − PrCN, 2.3%), 243 [$Ph_2P(O)C_2H_2O$, 2.5], 215 [$Ph_2P(O)CH_2$, 100], 201 (Ph_2PO, 25) and 77 (Ph, 34).

5-Diphenylphosphinoylmethyl-3-hexyl-4,5-dihydroisoxazole **4** *or* **5c**.—*By Method A.* The phosphine oxide **2a** (246 mg, 1 mmol), heptanal oxime (259 mg, 2 mmol), CH_2Cl_2 (40 cm^3), and aqueous NaOCl (2 mol dm^{-3}; 1.2 cm^3, 2.4 mmol) were stirred together for 10 d, with more oxime and NaOCl added after 2 and 7 d. The residue was purified by column chromatography on SiO_2, eluting with EtOAc, to give the *dihydroisoxazole* **4** or **5c** (356 mg, 95%) as needles, m.p. 66–68 °C (EtOAc–hexane) (Found: C, 71.7; H, 7.95; N, 3.75; P, 8.5%; M^+ − Bu, 312.1155. $C_{22}H_{28}NO_2P$ requires C, 71.5; H, 7.6; N, 3.8; P, 8.4%; M − Bu, 312.1154); R_F (EtOAc–hexane, 3:1) 0.28; ν_{max}/cm^{-1}($CHCl_3$) 3100–2800 (C–H), 1675 (C=N), 1595 (Ph), 1440 (P–Ph), 1170 (P=O), and 1125 (C–O); δ_H($CDCl_3$) 0.85 (3 H, t, *J* 6.5, Me), 1.25–1.32 [6 H, m, $(CH_2)_3$Me], 1.50 (2 H, br quintet, *J ca.* 6.5, 3″-H_2), 2.29 (2 H, t, *J* 7.5, 3′-H_2), 2.55 (1 H, td, *J* 10.1 and 14.5, PCH_AH_B), 2.86 (1 H, ddd, *J* 3.7, 9.1 and 14.5, PCH_AH_B), 2.96 (1 H, dd, *J* 7.8 and 17.2, 4-H_AH_B), 3.06 (1 H, dd, *J* 9.5 and 17.2, 4-H_AH_B), 4.92 (1 H, m, OCH), 7.42–7.58 (6 H, m, Ph_2PO) and 7.67–7.80 (4 H, m, Ph_2PO); δ_C($CDCl_3$) 14.0 (Me), 22.4, 26.2, 27.7, 28.9, 31.4, 35.4 (d, *J* 67, PCH_2), 42.9, 74.8 (OC), 128.7, 128.8, 128.9, 128.9, 130.4, 130.4, 130.8, 130.9, 131.7 (d, *J ca.* 100, *ipso* C), 132.1, 133.2 (d, *J* 100, *ipso* C) and 160.0 (C=N); *m/z* 312 (M^+ − Bu, 0.35%), 299 (M^+ − C_5H_{10}, 0.5), 258 [$Ph_2P(O)C_3H_6$, 2.7], 216 [$Ph_2P(O)Me$, 56], 215 [$Ph_2P(O)CH_2$, 100], 202 (Ph_2POH, 6), 201 (Ph_2PO, 22) and 77 (Ph, 16).

5-Diphenylphosphinoylmethyl-3-undecyl-4,5-dihydroisoxazole **4** *or* **5d**.—*By Method E.* Dodecanal oxime (7.30 g, 36.6 mmol), the phosphine oxide **2a** (4.43 g, 18.3 mmol) and NBS (13.0 g, 73.2 mmol) gave a brown gum. Flash column chromatography on silica (1000 g) eluting with ether gave the *dihydroisoxazole* **4** or **5d** (4.0 g, 50%) as needles, m.p. 64–66 °C (from EtOAc–hexane) (Found: M^+, 439.2601. $C_{27}H_{38}NO_2P$ requires *M*, 439.2640); ν_{max}/cm^{-1}($CHCl_3$) 1590w (C=N), 1430 (P–Ph), and 1175 (P=O); δ_H($CDCl_3$) 0.86 (3 H, t, *J* 6.4, Me), 1.13–1.33 [16 H, m, $(CH_2)_8$Me], 1.47–1.53 (2 H, m, CH_2CH_2CN), 2.29 (2 H, t, *J* 7.5, CH_2CH_2CN), 2.55 (1 H, dt, *J* 10.2, 14.5, PCH_AH_B), 2.86 (1 H, ddd, *J* 3.7, 9.0, 14.5, PCH_AH_B), 2.98 (1 H, dd, *J* 7.8, 17.1, 4-CH_AH_B), 3.05 (1 H, dd, *J* 9.3, 17.1, 4-CH_AH_B), 4.62–4.83 (1 H, m, CHO), 7.43–7.54 (6 H, m, Ph_2P) and 7.67–7.81 (4 H, m, Ph_2P); δ_C($CDCl_3$) 14.0 (Me), 22.6, 26.2, 27.6, 29.1, 29.2, 29.4, 29.5, 29.55, 31.8, 35.35 (d, *J* 68, PCH_2), 74.7 (CHO), 128.7, 128.75, 128.8, 128.9, 130.3, 130.4, 130.8, 130.9, 131.1, 132.05, 133.6 and 160.0 (C=N); *m/z* 440 (M + H, 5%), 439 (M^+, 4), 438 (M − H, 3), 312 (M − C_9H_{19}, 8), 299 (M − $C_{10}H_{20}$, 12), 258 (M − $C_{11}H_{23}CN$, 20), 243 [$Ph_2P(O)CH_2CO$, 25], 216 [$Ph_2P(O)Me$, 85], 215 [$Ph_2P(O)CH_2$, 100] and 201 (Ph_2PO, 30).

5-Diphenylphosphinoylmethyl-3-phenyl-4,5-dihydroisoxazole **4** *or* **5e**.—*By Method A.* The phosphine oxide **2a** (242 mg, 1 mmol), benzaldehyde oxime (0.17 cm^3, 2 mmol), CH_2Cl_2 (10 cm^3) and aqueous NaOCl (2 mol dm^{-3}; 1.5 cm^3, 3 mmol) were stirred together for 10 d, with more oxime and NaOCl added after 4 and 6 d. The residue was purified by column chromatography on SiO_2, eluting with EtOAc to give the *dihydroisoxazole* **4** or **5e**, which recrystallised from EtOAc–hexane as needles (199 mg, 55%), m.p. 145–147 °C (Found: C, 73.2; H, 5.7; N, 4.0; P, 8.7%; M^+, 361.1248. $C_{22}H_{20}NO_2P$ requires C, 73.1; H, 5.6; N, 3.9; P, 8.6%; M, 361.1232); R_F (EtOAc–hexane, 9:1) 0.26; ν_{max}/cm^{-1}($CDCl_3$) 3100–3000 (aryl CH), 3000–2800 (CH), 1730 (C=N), 1600 (Ph), 1440 (P–Ph), 1185 (P=O) and 1120 (C–O); δ_H($CDCl_3$) 2.67 (1 H, dt, *J* 10.3 and 14.3, PCH_AH_B), 2.95 (1 H, ddd, *J* 3.7, 9.1 and 14.6, PCH_AH_B), 3.42 (1 H, dd, *J* 8.2 and 16.5, 4-H_AH_B), 3.50 (1 H, dd, *J* 9.4 and 16.5, 4-H_AH_B), 4.95 (1 H, m, OCH) and 7.34–7.85 (15 H, m, Ph_2PO and PhCN); δ_C($CDCl_3$) 35.5 (d, *J* 68, PCH_2), 40.7 (C-4), 76.1 (OC), 126.7, 128.6, 128.7, 128.8, 128.9, 128.9, 129.2 (N=C-C_{aryl}), 130.2, 130.3, 130.4, 130.5 (d, *J* 110, *ipso* C), 130.8, 130.9, 131.1, 132.1, 132.2, 133.1 (d, *J* 100, *ipso* C) and 157.3 (C=N); *m/z* 361 (M^+, 1%), 258 (M^+ − PhCN, 0.2), 216 [$Ph_2P(O)Me$, 63], 215 [$Ph_2P(O)CH_2$, 100)] 202 (Ph_2POH, 3), 201 (Ph_2PO, 20) and 77 (Ph, 27).

By Method B. Aqueous NaOCl (2 mol dm^{-3}; 1.2 cm^3, 2.4 mmol) was added to a solution of the phosphine oxide **2a** (242 mg, 1 mmol) and benzaldehyde oxime (242 mg, *ca.* 2 mmol) in CH_2Cl_2 (10 cm^3) at 0 °C, and the mixture sonicated for 40 h over 8 d. After work-up, the residue was purified by column chromatography on SiO_2, eluting with EtOAc to give the dihydroisoxazole **4** or **5e** as needles (224 mg, 62%).

(1′R*,5R*)-5-(1′-*Diphenylphosphinoylethyl*)-3-*methyl*-4,5-*dihydroisoxazole* **4f**.—*By method A.* The phosphine oxide **2b** (251 mg, 1 mmol), acetaldehyde oxime (1.2 cm^3, 20 mmol), CH_2Cl_2 (10 cm^3), and aqueous NaOCl (2 mol dm^{-3}; 1.5 cm^3, 3 mmol) were stirred together for 20 d, with more NaOCl added after 5, 10 and 15 d. The residue was purified by column chromatography on SiO_2, eluting with 10% hexane in EtOAc to give recovered phosphine oxide **2b** (225 mg, 88%) and the anti-*dihydroisoxazole* **4f** (30 mg, 10%) as needles, m.p. 181–183 °C (Found: C, 69.2; H, 6.5; N, 4.3; P, 9.7%; M^+ − MeCN, 272.0988. $C_{18}H_{20}NO_2P$ requires C, 69.0; H, 6.4; N, 4.5; P, 9.9%; *M* − MeCN, 272.0966); R_F (EtOAc–hexane, 9:1) 0.17; ν_{max}/cm^{-1}($CDCl_3$) 3100–3040 (aryl CH), 3000–2800 (CH), 1725 (C=N), 1600 (Ph), 1435 (P–Ph), 1190 (P=O) and 1115 (C–O); δ_H($CDCl_3$) 1.14 (3 H, dd, *J* 7.1 and 15.7, PCMe), 1.93 (3 H, s, 3-Me), 2.87 (1 H, dd, *J* 11.2 and 18.2, 4-H_AH_B), 2.9 (1 H, partially obscured m, PCH), 3.24 (1 H, dd, *J* 8.4 and 18.0, 4-H_AH_B), 4.70 (1 H, tdd, *J* 3.5, 8.3 and 11.0, OCH), 7.44–7.55 (6 H, m, Ph_2PO) and 7.75–7.85 (4 H, m, Ph_2PO); δ_C($CDCl_3$) 5.7 (Me), 12.9 (Me), 35.3 (d, *J* 68, PCH), 39.3 (C-4), 78.2 (d, *J* 4, OCH), 128.7, 128.8, 128.9, 130.5, 130.6, 130.7, 131.6 (d, *J* 98 *ipso* C), 131.8 (d, *J* 94 *ipso* C), 131.8, 131.9 and 156.2 (C=N); *m/z* 272 (M^+ − MeCN, 2%), 230 [$Ph_2P(O)Et$, 100], 229 [$Ph_2P(O)C_2H_4$, 56], 202 (Ph_2POH, 79), 201 (Ph_2PO, 50) and 77 (Ph, 48).

(1′R*,5R*)- *and* (1′R*,5S*)-5-(1′-*Diphenylphosphinoylethyl*)-3-*ethyl*-4,5-*dihydroisoxazoles* **4g** *and* **5g**.—*By method C.* Propanal oxime (0.43 g, 5.9 mmol) and the phosphine oxide **2b** (1.0 g, 3.9 mmol) gave an off-white solid which was purified by flash column chromatography on silica (150 g) eluting with ethyl

acetate. The first compound to be eluted was 3,4-diethylfurazan 2-oxide (140 mg, 33%), as a yellow oil (Found: M^+, 142.0732. $C_6H_{10}N_2O_2$ requires *M*, 142.0742); ν_{max}/cm^{-1}($CHCl_3$) 1600 and 955 (lit.,[20] 1600, 1142, 1037, 955 and 843 cm^{-1}); δ_H($CDCl_3$) 1.20 (3 H, t, *J* 7.6, 3-CCH_2Me), 1.33 (3 H, t, *J* 7.5, 4-CCH_2Me), 2.54 (2 H, q, *J* 7.6, 3-CCH_2) and 2.66 (2 H, q, *J* 7.5, 4-CCH_2); δ_C($CDCl_3$) 9.6 (4-CCH_2Me), 10.8 (3-CCH_2Me), 15.8 (4-CCH_2), 19.2 (3-CCH_2), 116.7 (4-C) and 158.7 (C=N); *m/z* 142 (M^+, 20%), 112 (M − NO, 17), 81 (M − N_2O_2, H, 35) and 67 (EtCCN or $EtCCCH_2$, 100). The second compound to be eluted was the phosphine oxide **2b** (370 mg, 37% recovery). The third compound to be eluted was the anti-4,5-*dihydroisoxazole* **4g** (580 mg, 45%), as needles, m.p. 137–140 °C (from EtOAc–hexane) (Found: M^+, 327.1388. $C_{19}H_{32}NO_2P$ requires 327.1387); ν_{max}/cm^{-1}($CHCl_3$) 1595 (C=N) and 1118; δ_H($CDCl_3$) 1.09 (3 H, t, *J* 7.5, CH_2Me), 1.10 (3 H, dd, *J* 7.1, 15.8, CH*Me*), 2.28 (2 H, q, *J* 7.5, CH_2Me), 2.85 (1 H, dd, *J* 11.0, 18.0, 4-CH_AH_B), 2.94 (1 H, ddq, *J* 7.3, 3.5, 7.1, PCH), 3.23 (1 H, dd, *J* 8.2, 18.0, 4-CH_AH_B), 4.67 (1 H, dddd, *J* 3.5, 8.2, 11.0, 14.5, CHO), 7.41–7.47 (6 H, m, Ph_2P) and 7.73–7.83 (4 H, m, Ph_2P); δ_C($CDCl_3$) 5.65 (d, *J* 2, PCH*Me*), 10.7 (CH_2Me), 21.0 (CH_2Me), 35.4 (d, *J* 68. PCH), 37.5 ($CHCH_2$), 77.9 (d, *J* 5, CHO), 128.3, 128.4, 128.6, 128.7, 128.8, 130.4, 130.5, 130.6, 130.8, 130.9, 131.1, 131.3, 131.69, 131.71, 131.78, 131.81, 132.1, 132.3 and 160.6 (C=N); *m/z* 327 (M^+, 5%), 310 (M − OH, 5), 272 (M − EtCN, 60), 257 (M − Me, EtCN, 35), 230 [$Ph_2P(O)Et$, 100)], 229 [$Ph_2P(O)C_2H_4$, 50], 202 (Ph_2POH, 65), 201 (Ph_2PO, 60) and 77 (Ph, 20). The fourth compound to be eluted was the syn-4,5-*dihydroisoxazole* **5g** (111 mg, 9%), as needles, m.p. 114–116 °C (from EtOAc–hexane); ν_{max}/cm^{-1}($CHCl_3$) 1595 (C=N) and 1120; δ_H($CDCl_3$) 1.03 (3 H, t, *J* 7.5, CH_2Me), 1.20 (3 H, dd, *J* 7.2, 16.7, CH*Me*), 2.22 (2 H, q, *J* 7.5, CH_2Me), 2.70 (1 H, ddq, *J* 7.3, 11.1, 7.2, PCH), 2.82 (2 H, d, *J* 9.4, CH_2CO), 4.68 (1 H, ddt, *J* 7.3, 8.2, 9.4, CHO), 7.44–7.56 (6 H, m, Ph_2P) and 7.75–7.86 (4 H, m, Ph_2P); δ_C($CDCl_3$) 10.6, 11.05, 21.0 (CH_2Me), 38.3 (d, *J* 69, PCH), 41.1 (d, *J* 2.5, $CHCH_2$), 79.3 (CHO), 128.4, 128.47, 128.5, 128.6, 130.45, 130.9, 131.0, 131.2, 131.3, 131.4, 131.6, 131.7, 131.8, 132.5 and 160.6 (C=N); *m/z* 230 [$Ph_2P(O)Et$, 100], 229 [$Ph_2P(O)C_2H_4$, 65], 202 (Ph_2POH, 95), 201 (Ph_2PO, 60) and 77 (Ph, 50).

(1'R*,5R*)- *and* (1'R*,5S*)-5-(1'-*Diphenylphosphinoylethyl*)-3-*propyl*-4,5-*dihydroisoxazoles* **4h** *and* **5h**.—*By method B.* The phosphine oxide **2b** (257 mg, 1 mmol), butyraldehyde oxime (0.17 cm^3, 2 mmol), CH_2Cl_2 (10 cm^3) and aqueous NaOCl (2 mol dm^{-3}; 1.5 cm^3, 3 mmol) were sonicated together for 11 h over 2 d. The residue was purified by column chromatography on SiO_2, eluting with EtOAc. The first compound isolated was the anti-4,5-*dihydroisoxazole* **4h** (239 mg, 70%) as needles, m.p. 139–141 °C (Found: C, 70.4; H, 7.1; N, 4.0; P, 9.1%; M^+ − PrCN, 272.0387. $C_{20}H_{24}NO_2P$ requires C, 70.4; H, 7.1; N, 4.1; P, 9.1%; M − PrCN, 272.0366); R_F (EtOAc–hexane, 3:1) 0.24; ν_{max}/cm^{-1}($CHCl_3$) 2920 (CH), 1660 (C=N), 1580 (Ph), 1450 (P–Ph), 1300 (P=O) and 1130 (C–O); δ_H($CDCl_3$) 0.91 (3 H, t, *J* 7.4, $MeCH_2$), 1.13 (3 H, dd, *J* 7.1 and 15.8, *Me*CH), 1.55 (2 H, sextet, *J* 7.4, $MeCH_2$), 2.26 (2 H, t, *J* 7.5, $EtCH_2$), 2.86 (1 H, dd, *J* 11.0 and 17.9, 4-H_AH_B), 2.9 (1 H, partially obscured m, PCH), 3.23 (1 H, dd, *J* 7.8 and 17.9, 4-H_AH_B), 4.69 (1 H, tdd, *J* 3.5, 8.1 and 11.2, OCH), 7.43–7.55 (6 H, m, Ph_2PO) and 7.74–7.85 (4 H, m, Ph_2PO); δ_C($CDCl_3$) 5.7 (d, *J* 2, CH*Me*), 13.7 (CH_2Me), 19.6 (CH_2), 29.5 (CH_2), 35.5 (d, *J* 68, PCH), 37.8 (CH_2), 77.9 (OC), 128.7, 128.9, 129.0, 130.5, 130.6, 130.7, 131.7 (d, *J* 100, *ipso* C), 131.8, 131.9, 132.0 (d, *J* 90, *ipso* C) and 159.7 (C=N); *m/z* 272 (M^+ − PrCN, 1%), 257 [$Ph_2P(O)C_3H_4O$, 0.5], 230 [$Ph_2P(O)Et$, 100], 229 [$Ph_2P(O)C_2H_4$, 65], 202 (Ph_2POH, 88), 201 (Ph_2PO, 60) and 77 (Ph, 76). The second product to be isolated was the *syn*-4,5-dihydroisoxazole **5h** (48 mg, 14%), which was, unfortunately, not characterised, but was identified by its ^1H NMR; δ_H($CDCl_3$) 0.9 (3 H, t, *J* 7.0, CH_2Me), 1.22 (3 H, dd, *J* 7.2 and 16.7, CH*Me*), 1.47 (2 H, sextet, *J* 7.5, $MeCH_2$), 2.21 (2 H, t, *J* 7.0, 3'-H_2), 2.71 (1 H, quintet of doublets, *J* 7.2 and 11.2, PCH), 2.83 (2 H, d, *J* 9.4, 4-H_2), 4.70 (1 H, quintet, *J* 8.0, OCH), 7.4–7.6 (6 H, m, Ph_2PO) and 7.7–7.9 (4 H, m, Ph_2PO).

By method D. The phosphine oxide **2b** (130 mg, 0.5 mmol), butyraldehyde oxime (43 mg, 0.5 mmol), and chloramine-T (141 mg, 0.6 mmol) were dissolved in EtOH (10 ml) and heated at reflux for 6 d, with more reagents added after 3 d. Work-up gave a residue which was purified by column chromatography on SiO_2, eluting with 25% hexane in EtOAc, to give the *anti*-4,5-dihydroisoxazole **4h** (47 mg, 27%), the phosphine oxide **2b** (71 mg, 55%) and the *syn*-4,5-dihydroisoxazole **5h** (25 mg, 14%), which were all recognised by their ^1H NMR spectra.

(1'R*,5R*)- *and* (1'R*,5S*)-5-(1'-*Diphenylphosphinoylethyl*)-3-*hexyl*-4,5-*dihydroisoxazoles* **4i** and **5i**.—*By method A.* The phosphine oxide **2b** (132 mg, 0.52 mmol), heptanal oxime (130 mg, 1 mmol), CH_2Cl_2 (20 cm^3) and aqueous NaOCl (2 mol dm^{-3}; 0.8 cm^3, 1.6 mmol) were stirred together for 7 d, with more oxime and NaOCl added after 6 d. The residue was purified by column chromatography on SiO_2, eluting with EtOAc–hexane (3:1). The first compound isolated was the anti-4,5-*dihydroisoxazole* **4i** (152 mg, 77%) as needles, m.p. (EtOAc–hexane) 112–114 °C (Found: C, 72.2; H, 8.1; N, 3.6; P, 7.9%; M^+ − C_5H_{10}, 313.1238. $C_{23}H_{30}NO_2P$ requires C, 72.0; H, 7.9; N, 3.65; P, 8.1%; M − C_5H_{10}, 313.1232); R_F (EtOAc–hexane, 3:1) 0.31, ν_{max}/cm^{-1}($CHBr_3$) 3000–2800 (CH), 1626 (C=N), 1591 (Ph), 1438 (P–Ph), 1200 (P=O) and 1071 (C–O); δ_H($CDCl_3$) 0.85 (3 H, t, *J* 6.5, CH_2Me), 1.14 (3 H, dd, *J* 7.1 and 15.8, CH*Me*), 1.21–1.38 [6 H, m, $(CH_2)_3$Me], 1.51 (2 H, quintet, *J* 7.5, 3''-H_2), 2.27 (2 H, t, *J* 7.5, 3'-H_2), 2.87 (1 H, dd, *J* 11.0 and 17.9, 4-H_AH_B), 2.9 (1 H, partially obscured m, PCH), 3.2 (1 H, dd, *J* 8.2 and 18.0, 4-H_AH_B), 4.69 (1 H, tdd, *J* 3.4, 8.1 and 11.1, OCH), 7.44–7.55 (6 H, m, Ph_2PO) and 7.75–7.86 (4 H, m, Ph_2PO); δ_C($CDCl_3$) 5.7 (d, *J* 3, CH*Me*), 14.0 (CH_2Me), 22.4 (CH_2), 26.2 (CH_2), 27.6 (CH_2), 28.8 (CH_2), 31.4 (CH_2), 35.5 (d, *J* 68, PCH), 37.8 (CH_2), 77.9 (d, *J* 5, OC), 128.7, 128.8, 129.0, 130.6, 130.6, 130.7, 131.7 (d, *J* 98, *ipso* C), 131.8, 131.9, 131.9 (d, *J* 95, *ipso* C) and 159.9 (C=N); *m/z* 313 (M^+ − C_5H_{10}, 0.6%), 272 [$Ph_2P(O)C_4H_7O$, 2.4] 257 [$Ph_2P(O)C_3H_4O$, 1.4], 230 [$Ph_2P(O)Et$, 100], 202 (Ph_2POH, 38) and 201 (Ph_2PO, 32). The second compound isolated was the syn-4,5-*dihydroisoxazole* **5i** (60 mg, 30%) as needles, m.p. (EtOAc–hexane) 131–132 °C (Found: C, 71.8; H, 7.85; N, 3.5; P, 7.85%; M^+ − C_5H_{10}, 313.1228. $C_{23}H_{30}NO_2P$ requires C, 72.0; H, 7.9; N, 3.65; P, 8.1%; *M* − C_5H_{10}, 313.1232); R_F (3:1:EtOAc:hexane) 0.15, ν_{max}/cm^{-1}($CDCl_3$) 3060 (aryl CH), 3000–2800 (C–H), 1670 (C=N), 1590 (Ph), 1435 (P–Ph), 1180 (P=O) and 1115 (C–O); δ_H($CDCl_3$) 0.86 (3 H, t, *J* 6.5, CH_2Me), 1.22 (3 H, dd, *J* 7.2 and 16.6, CH*Me*), 1.1–1.3 [6 H, m, $(CH_2)_3$Me], 1.4 (2 H, poorly resolved quintet, *J ca.* 7, 3''-H_2), 2.22 (2 H, t, *J* 7.5, 3'-H_2), 2.70 (1 H, quintuplet d, *J* 7.3 and 11.3, PCH), 2.83 (2 H, d, *J* 9.5, 4-H_2), 4.69 (1 H, br quintet, *J ca.* 8.5, OCH), 7.43–7.57 (6 H, m, Ph_2PO) and 7.74–7.85 (4 H, m, Ph_2PO); δ_C($CDCl_3$) 11.4 (Me), 14.0 (Me), 22.5 (CH_2), 26.1 (CH_2), 27.6 (CH_2), 28.9 (CH_2), 31.4 (CH_2), 38.5 (d, *J* 68, PCH), 41.1 (CH_2), 79.4 (OC), 128.5, 128.6, 128.7, 128.7, 131.0 (d, *J* 92, *ipso* C), 131.1, 131.2, 131.4, 131.5, 131.9, 131.9, 132.2 (d, *J* 96, *ipso* C) and 160.0 (C=N); *m/z* 313 (M^+ − C_5H_{10}, 0.5%), 272 [$Ph_2P(O)C_4H_7O$, 2.4], 258 [$Ph_2P(O)C_3H_5O$, 1.0], 257 [$Ph_2P(O)C_3H_4O$, 2], 230 [$Ph_2P(O)Et$, 100], 202 (Ph_2POH, 40) and 201 (Ph_2PO, 34).

(1'R*,5R*)- *and* (1'R*,5S*)-5-(1'-*Diphenylphosphinoylethyl*)-3-*undecyl*-4,5-*dihydroisoxazoles* **4j** *and* **5j**.—*By method E.* Dodecanal oxime (1.75 g, 17.6 mmol) and the phosphine oxide **2b** (1.5 g, 5.9 mmol) gave an oil which was purified by flash column chromatography on silica (400 g) eluting with ether.

The first compound to be eluted was the anti-4,5-*dihydroisoxazole* **4j** (1.12 g, 42%), as needles, m.p. 103–106 °C (from EtOAc–hexane) (Found: C, 74.1; H, 8.95; N, 3.0; P, 6.6%; M^+, 453.2788. $C_{28}H_{40}NO_2P$ requires C, 74.1; H, 8.9; N, 3.0; P, 6.8%; *M*, 453.2792), $\nu_{max}/cm^{-1}(CDCl_3)$ 1595 (C=N), 1435 (P–Ph) and 1185 (P=O), $\delta_H(CDCl_3)$ 0.86 (3 H, t, *J* 6.4, CH_2Me), 1.13 (3 H, dd, *J* 7.1, 15.8, CH*Me*), 1.18–1.27 [16H, m, $(CH_2)_8Me$], 1.48–1.54 (2 H, m, CH_2CH_2CN), 2.28 (2 H, t, *J* 7.5, CH_2CH_2CN), 2.86 (1 H, dd, *J* 11.0, 18.0, 4-CH_AH_B), 2.92–3.02 (1 H, m, PCH), 3.23 (1 H, dd, *J* 8.3, 18.0, 4-CH_AH_B), 4.65–4.72 (1 H, m, CHO), 7.44–7.55 (6 H, m, Ph_2P) and 7.75–7.84 (4 H, m, Ph_2P); *m/z* 453 (M^+, 8%), 452 (M − H, 8), 326 (M − C_9H_{19}, 8), 313 (M − $C_{10}H_{20}$, 20), 272 (M − $C_{10}H_{21}CN$, 40), 230 [$Ph_2P(O)Et$, 100], 229 [$Ph_2P(O)C_2H_4$, 20], 202 (Ph_2POH, 30), 201 (Ph_2PO, 27) and 77 (Ph, 10). The second fraction to be eluted was found by NMR to contain the phosphine oxide **2b** and the dihydroisoxazole **5j** in a ratio of 2:1. Separation by HPLC eluting with dichloromethane–methanol (50:1) gave **2b** (450 mg, 30% recovery) and the syn-4,5-*dihydroisoxazole* **5j** (280 mg, 11%), as needles, m.p. 98–99 °C (from EtOAc–hexane) (Found: C, 74.35; H, 8.8; N, 3.1; P, 7.1%; M^+, 453.2815. $C_{28}H_{40}NO_2P$ requires C, 74.1; H, 8.9; N, 3.0; P, 6.8%; *M*, 453.2792); $\nu_{max}/cm^{-1}(CDCl_3)$ 1605 (C=N), 1440 (P–Ph) and 1175 (P=O); $\delta_H(CDCl_3)$ 0.87 (3 H, t, *J* 6.3, CH_2Me), 1.18–1.33 [16 H, m, $(CH_2)_8Me$], 1.23 (3 H, dd, *J* 7.2, 16.6, CH*Me*), 1.40–1.47 (2 H, m, CH_2CH_2CN), 2.22 (2 H, t, *J* 7.6, CH_2CH_2CN), 2.69–2.73 (1 H, d quintet, *J* 11, 7, PCH), 2.84 (2 H, d, *J* 9.4, 4-CH_2), 4.66–4.73 (1 H, m, CHO), 7.44–7.56 (6 H, m, Ph_2P) and 7.75–7.85 (4 H, m, Ph_2P); *m/z* 454 (M + H, 5%), 453 (M^+, 10), 452 (M − H, 8), 438 (M − Me, 3), 436 (M − OH, 5), 435 (M − H_2O, 10), 326 (M − C_9H_{19}, 10), 313 (M − $C_{10}H_{20}$, 30), 272 (M − $C_{11}H_{23}CN$, 50), 257 [$Ph_2P(O)CH(Me)CO$, 40], 253 (M + H, − Ph_2PO, 40), 252 (M − Ph_2PO, 38), 230 [$Ph_2P(O)Et$, 85], 229 [$Ph_2P(O)C_2H_4$, 100], 202 (Ph_2POH, 60), 201 (Ph_2PO, 55) and 77 (Ph, 15).

By method A. Dodecanal oxime (0.47 g, 2.3 mmol) and the phosphine oxide **2b** (0.5 g, 2.0 mmol) gave a white solid. ^1H NMR showed that the ratio of the two diastereoisomers was 4:1. Flash column chromatography on silica (100 g) eluting with ether gave the *anti*-4,5-dihydroisoxazole **4j** (470 mg, 53%).

(1'R*,5R*)- *and* (1'R*,5S*)-5-(1'-*Diphenylphosphinoylethyl*)-3-*phenyl*-4,5-*dihydroisoxazoles* **4k** *and* **5k**.—*By method B.* The phosphine oxide **2b** 5.005 g, 19.5 mmol), benzaldehyde oxime (2.6 cm^3, 30 mmol), CH_2Cl_2 (150 cm^3), and aqueous NaOCl (2 mol dm^{-3}; 25 cm^3, 50 mmol) were sonicated for 11 h. The residue was purified by column chromatography on SiO_2, eluting with EtOAc–hexane (85:15) then EtOAc. The first compound isolated was the anti-*dihydroisoxazole* **4k** (5.718 g, 78%) as needles, m.p. (from EtOAc–hexane) 228–230 °C (Found: C, 73.3; H, 5.9; N, 4.0; P, 8.25. $C_{23}H_{22}NO_2P$ requires C, 73.6; H, 5.9; N, 3.9; P, 8.3%); R_F (EtOAc) 0.37; $\nu_{max}/cm^{-1}(CDCl_3)$ 3100–3000 (aryl CH), 3000–2800 (CH), 1670 (C=N), 1590 (Ph), 1435 (P–Ph), 1190 (P=O) and 1110 (C–O); $\delta_H(CDCl_3)$ 1.18 (3 H, dd, *J* 7.1 and 15.8, Me), 3.06 (1 H, dqd, *J* 3.3, 7.1 and 8.6, PCH), 3.29 (1 H, dd, *J* 11.2 and 17.4, 4-H_AH_B), 3.66 (1 H, dd, *J* 8.7 and 17.8, 4-H_AH_B), 4.89 (1 H, tdd, *J* 3.4, 8.6 and 11.3, OCH), 7.35–7.57 (9 H, m, Ph_2PO and PhCN), 7.65–7.70 (2 H, m, Ph_2PO and PhCN) and 7.78–7.90 (4 H, m, Ph_2PO and PhCN); $\delta_C(CDCl_3)$ 5.8 (Me), 35.6 (d, *J* 68, PCH), 35.6 (CH_2), 79.4 (d, *J* 5, OC), 126.8, 127.4, 128.6, 128.7, 128.8, 128.9, 129.0, 129.1, 129.2 (NC-C_{aryl}), 130.1, 130.6, 130.7, 130.8, 131.8 (d, *J* 95, *ipso* C), 131.9, 132.0 and 157.4 (C=N); *m/z* 230 [$Ph_2P(O)Et$, 18], 202 (Ph_2POH, 14), 201 (Ph_2PO, 20), 121 ($PhCH_2NO$, 49), 105 ($PhCH_2N$, 70) and 77 (Ph, 100). The second compound isolated was the syn-4,5-*dihydroisoxazole* **5k** (1.120 g, 15%) as needles, m.p. (EtOAc–hexane) 169–170 °C (Found: M^+, 375.1395. $C_{23}H_{22}NO_2P$ requires *M*, 375.1388); R_F (EtOAc) 0.22; $\nu_{max}/cm^{-1}(CDCl_3)$ 3100–3000 (aryl CH), 3000–2800 (CH), 1600 (Ph), 1435 (P–Ph), 1185 (P=O) and 1120 (C–O); $\delta_H(CDCl_3)$ 1.29 (3 H, dd, *J* 7.1 and 16.6, Me), 2.82 (1 H, quintuplet d, *J* 7.3 and 11.3, PCH), 3.26 (2 H, d, *J* 9.5, 4-H_2), 4.92 (1 H, br quintet, *J ca.* 8, OCH), 7.32–7.38 (3 H, m, Ph_2PO and PhCN), 7.48–7.58 (8 H, m, Ph_2PO and PhCN) and 7.78–7.86 (4 H, m, Ph_2PO and PhCN); $\delta_C(CDCl_3)$ 11.1 (Me), 38.5 (d, *J* 68, PCH), 39.2 (CH_2), 80.5 (OCH), 126.5, 128.5, 128.6, 128.7, 129.7 (d, *J* 117, *ipso* C), 129.9 (NC-C_{aryl}), 131.0, 131.1, 131.3, 131.4, 131.8, 132.1 (d, *J* 96, *ipso* C) and 157.2 (C=N); *m/z* 375 (M^+, 0.4%), 272 (M^+ − PhCN, 0.4), 230 [$Ph_2(P(O)Et$, 100], 229 [$Ph_2P(O)C_2H_4$, 45], 202 (Ph_2POH, 52), 201 (Ph_2PO, 32) and 77 (Ph, 49).

By method A. Aqueous NaOCl (2 mol dm^{-3}; 1.5 cm^3, 3 mmol) was added to a stirred solution of the phosphine oxide **2b** (215 mg, 0.84 mmol) and benzaldehyde oxime (0.15 cm^3) in CH_2Cl_2 (10 cm^3), and the mixture stirred for 10 d, with more oxime and bleach added after 4 and after 6 d. Work-up gave a residue which was purified by column chromatography on SiO_2, eluting with 15% hexane in EtOAc to give the *anti*-4,5-dihydroisoxazole **4k** (228 mg, 72%) and the *syn*-4,5-dihydroisoxazole **5k** (66 mg, 21%).

(1'R*,5R*)- *and* (1'R*,5S*)-5-(1'-*Diphenylphosphinoylethyl*)-3-*ethoxycarbonyl*-4,5-*dihydroisoxazoles* **4l** *and* **5l**.—*By method F.* Triethylamine (0.11 cm^3, 0.8 mmol), the phosphine oxide **2b** (100 mg, 0.39 mmol), and ethyl chlorooximidoacetate (121 mg, 0.8 mmol) gave an oil which was purified by column chromatography on SiO_2, eluting with EtOAc–hexane (3:1). The first fraction isolated contained the 4,5-*dihydroisoxazoles* **4l** *and* **5l** (64 mg, 44%) as an 80:20 mixture of diastereoisomers **4l** and **5l**, respectively, as a pale yellow oil which slowly crystallised (Found: M^+, 371.1281. $C_{20}H_{22}NO_4P$ requires *M*, 371.1287); R_F (EtOAc–hexane, 3:1) 0.31; $\nu_{max}/cm^{-1}(CHCl_3)$ 2970–2780 (CH), 1715 (C=O), 1590 (Ph), 1460 (P–Ph), 1185 (P=O) and 1115 (C–O); $\delta_H(CDCl_3)$ 1.15 (3 H_{4l}, dd, *J* 7 and 15.5, *Me*CH), c. 1.2 (3 H_{5l}, largely obscured by **4l**, *Me*CH), 1.33 (3 H_{4l}, t, *J* 7.2, $MeCH_2$), 1.39 (3 H_{5l}, t, *J* 7, $MeCH_2$), 2.96–3.11 (1 $H_{4l\ and\ 5l}$, m, PCH), 3.15 (1 H_{4l}, dd, *J* 11.5 and 18.7, 4-H_AH_B), c. 3.18 (1 H_{5l}, dd largely obscured by **4l**, smaller *J* 7.5, 4-H_AH_B), c. 3.4 (1 H_{5l}, dd partially obscured by **4l**, smaller *J* 4, 4-H_AH_B), 3.47 (1 H_{4l}, dd, *J* 9.3 and 18.6, 4-H_AH_B), 4.31 (2 H_{4l}, q, *J* 7.2, $MeCH_2$), 4.42 (2 H_{5l}, q, *J* 7.2, $MeCH_2$), 4.94 (1 $H_{4l\ and\ 5l}$, **5l** obscured by **4l**, **4l** tdd, *J* 4.0, 9.2 and 11.7, OCH), 7.45–7.58 (6 $H_{4l\ and\ 5l}$, m, Ph_2PO) and 7.68–7.86 (4 $H_{4l\ and\ 5l}$, m, Ph_2PO); $\delta_C(CDCl_3)$ 6.0 (*Me*CH **4l**), 11.4 (*Me*CH **5l**), 14.0 ($MeCH_2$ **5l**), 14.1 ($MeCH_2$ **4l**), 28.8 (C-4 **5l**), 34.3 (C-4 **4l**), 35.5 (d, *J* 68, OCH **4l**), 37.0 (d, *J* 68, PCH **5l**), 62.0 (CH_2Me **4l**), 62.7 (CH_2Me **5l**), 70.8 (C–O **5l**), 82.3 (d, *J* 4, C–O **4l**), 128.6, 128.7, 128.8, 128.9, 129.0, 129.1, 130.6, 130.7, 130.7, 130.8, 130.9, 131.0, 131.7, 131.8, 132.1, 132.1, 152.5 (C=O **4l**), and 160.2 (C=N **4l**); *m/z* 371 (M^+, 1.5%), 298 (M^+ − CO_2Et, 27), 272 (M^+ − $NCCO_2Et$, 6), 256 [$Ph_2P(O)C_4H_7$, 6)], 230 [$Ph_2P(O)Et$, 100], 202 (Ph_2POH, 86), 201 (Ph_2PO, 97) and 77 (Ph, 42). The second fraction was the phosphine oxide **2b** (63 mg, 63%, not recrystallised).

(1'R*,5R*)- *and* (1'R*,5S*)-5-(1'-*Diphenylphosphinoylethyl*)-3-*methoxycarbonylethyl*-4,5-*dihydroisoxazoles* **4m** *and* **5m**.—*By method G.* Methyl 4-nitrobutyrate[21] (0.86 g, 5.9 mmol), the phosphine oxide **2b** (0.5 g, 2.0 mmol) and phenyl isocyanate (1.74 g, 1.6 cm^3, 14.6 mmol) gave a brown gum. Attempted purification by flash column chromatography on silica (200 g) eluting with ethyl acetate–hexane (2:1) failed to separate the two diastereoisomers. The product mixture was recolumned on silica (20 g) eluting with ethyl acetate. The first product to be eluted was the anti-4,5-*dihydroisoxazole* **4m** (460 mg, 61%), as a gum (Found: M − OMe, 354.1277. $C_{20}H_{21}NO_3P$ requires 354.1259); ν_{max}/cm^{-1} ($CHCl_3$) 1725 (C=O), 1595 (C=N), and

1440 (P–Ph); $\delta_H(CDCl_3)$ 1.12 (3 H, dd, *J* 7.1, 15.7, CH*Me*), 2.58–2.62 (4 H, m, CH_2CH_2CO), 2.88 (1 H, dd, *J* 11.0, 17.9, 4-CH_AH_B), 2.87–3.05 (1 H, m, PCH), 3.25 (1 H, dd, *J* 8.3, 17.9, 4-CH_AH_B), 3.66 (3 H, s, OMe), 7.45–7.50 (6 H, m, Ph_2P) and 7.74–7.84 (4 H, m, Ph_2P); *m/z* 354 (M − OMe, 7%), 230 [$Ph_2P(O)Et$, 100], 229 [$Ph_2P(O)CHMe$, 30], 201 (Ph_2PO, 50) and 77 (Ph, 20). The second compound to be eluted was the syn-4,5-*dihydroisoxazole* **5m** (95 mg, 13%), as a gum (Found: M − OMe, 354.1265. $C_{20}H_{21}NO_3P$ requires 354.1259); ν_{max}/cm^{-1} ($CHCl_3$) 1730 (C=O), 1595 (C=N) and 1440 (P–Ph); $\delta_H(CDCl_3)$ 1.21 (3 H, dd, *J* 7.2, 16.6, CH*Me*), 2.49–2.60 (4 H, m, CH_2CH_2), 2.61–2.77 (1 H, m, PCH), 2.86 (2 H, d, *J* 9.5, CH_2CHO), 3.66 (3 H, s, OMe), 4.72 (1 H, dq, *J* 7.5, 9.5, CHO), 7.44–7.57 (6 H, m, Ph_2P) and 7.74–7.85 (4 H, m, Ph_2P); *m/z* 354 (*M* − OMe, 7%), 230 [$Ph_2P(O)Et$, 100], 201 (Ph_2PO, 5) and 77 (Ph, 20).

(1′R*,5R*)- *and* (1′R*,5S*)-5-(1′-*Diphenylphosphinoylethyl*)-3-*methoxycarbonylpropyl*-4,5-*dihydroisoxazoles* **4n** *and* **5n**.—*By method A*. Methyl 5-hydroxyiminopentanoate (1.35 g, 7.8 mmol) and the phosphine oxide **2b** (1.0 g, 4.0 mmol) gave a pale yellow oil which was purified by flash column chromatography on silica (200 g) eluting with ethyl acetate. The first fraction was the anti-4,5-*dihydroisoxazole* **4n** (855 mg, 55%), as needles, m.p. 109–110 °C (from EtOAc) (Found: M − OMe, 368.1384. $C_{21}H_{23}NO_3P$ requires 368.1416); ν_{max}/cm^{-1} ($CDCl_3$) 1735 (C=O), 1605 (C=N), 1430 (P–Ph) and 1190 (P=O); $\delta_H(CDCl_3)$ 1.13 (3 H, dd, *J* 7.1, 15.7, CH*Me*), 1.89 (2 H, quintet, *J* 7.4, $NCCH_2CH_2$), 2.33 (2 H, t, *J* 7.4, $NCCH_2CH_2$ or CH_2CO_2), 2.34 (2 H, t, *J* 7.4, $NCCH_2CH_2$ or CH_2CO_2), 2.87 (1 H, dd, *J* 10.8, 17.8, 4-CH_AH_B), 2.86–2.95 (1 H, m, PCH), 3.23 (1 H, dd, *J* 8.0, 17.8, 4.CH_AH_B), 3.65 (3 H, s, OMe), 4.69–4.73 (1 H, m, CHO), 7.45–7.55 (6 H, m, Ph_2P) and 7.74–7.85 (4 H, m, Ph_2P); *m/z* 368 (M − OMe, 45%), 326 (M − OMe, CO, CH_2, 15), 298 (M − $C_3H_6CO_2Me$, 3), 272 [M − $NC(CH_2)_3CO_2Me$, 25], 257 [$Ph_2P(O)C_3H_4O$, 20], 256 [$Ph_2P(O)CH(Me)CHCH_2$, 25], 230 [$Ph_2P(O)Et$, 100], 229 [$Ph_2P(O)C_2H_4$, 55], 202 (Ph_2POH, 35), 201, (Ph_2PO, 35) and 77 (Ph, 35). The second fraction to be eluted contained a mixture of the two diastereoisomers **4n** and **5n** in a ratio of 1:1 by ^1H NMR. This mixture was separated by HPLC eluting with chloroform–methanol (50:1) to give the anti-4,5-*dihydroisoxazole* **4n** (60 mg, 4%), and the syn-4,5-*dihydroisoxazole* **5n** (86 mg, 6%), as needles, m.p. 133.5–134.5 °C (from EtOAc) (Found: *M*$^+$, 399.1574. $C_{22}H_{26}NO_4P$ requires *M*, 399.1599); ν_{max}/cm^{-1} ($CDCl_3$) 1730 (C=O), 1605 (C=N), 1430 (P–Ph) and 1180 (P=O); $\delta_H(CDCl_3)$ 1.22 (3 H, dd, *J* 7.3, 16.5, CH*Me*), 1.82 (2 H, br quintet, *J* 7, $NCCH_2CH_2$), 2.28 (2 H, t, *J* 7.1, $NCCH_2CH_2$ or CH_2CO_2), 2.33 (2 H, t, *J* 7.1, $NCCH_2CH_2$ or CH_2CO_2), 2.69–2.79 (1 H, m, PCH), 2.86 (2 H, d, *J* 9.5, 4-CH_2), 3.66 (3 H, s, OMe), 4.69–4.73 (1 H, m, CHO), 7.45-7.57 (6 H, m, Ph_2P) and 7.75–7.86 (4 H, m, Ph_2P); *m/z* 400 (M + H, 7%), 399 (M$^+$, 4), 368 (M − OMe, 5), 272 [M − $NC(CH_2)_3CO_2Me$, 2], 230 [$Ph_2P(O)Et$, 100], 229 [$Ph_2P(O)C_2H_4$, 35], 202 (Ph_2POH, 60), 201 (Ph_2PO, 40) and 77 (Ph, 30).

(1′R*,5R*)- *and* (1′R*,5S*)-5-(1′-*Diphenylphosphinoylpropyl*)-3-*undecyl*-4,5-*dihydroisoxazoles* **4o** *and* **5o**.—*By method A*. Dodecanal oxime (1.50 g, 7.5 mmol) and the phosphine oxide **2c** (1.50 g, 5.5 mmol) gave a yellow oily solid which was purified by flash column chromatography on silica (300 g) eluting with ethyl acetate–dichloromethane (1:1). The first compound to be eluted was the phosphine oxide **2c** (912 mg, 61% recovery). The second fraction to be eluted contained a mixture of the two 4,5-dihydroisoxazoles. Separation by HPLC eluting with chloroform–methanol (100:1) gave the anti-4,5-*dihydroisoxazole* **4o** (434 mg, 17%), as needles, m.p. 92–94 °C (from EtOAc) (Found: C, 74.3; H, 9.0; N, 3.2; P, 6.3%; M$^+$, 467.2915. $C_{29}H_{42}NO_2P$ requires C, 74.5; H, 9.05; N, 3.0; P, 6.6%; *M*, 467.2953); ν_{max}/cm^{-1} ($CDCl_3$) 1595 (C=N), 1430 (P–Ph) and 1190 (P=O); $\delta_H(CDCl_3)$ 0.81 (3 H, t, *J* 7.5, $PCHCH_2Me$), 0.86 [3 H, t, *J* 6.2, $(CH_2)_{10}Me$], 1.2–1.3 [16 H, m, $(CH_2)_8Me$], 1.48–1.54 (2 H, m, CH_2CH_2CN), 1.67–1.82 (2 H, m, $PCHCH_2Me$), 2.28 (2 H, t, *J* 7.6, CH_2CH_2CN), 2.78–2.89 (2 H, m, PCH and 4-CH_AH_B), 3.19 (1 H, dd, *J* 9.4, 17.9, 4-CH_AH_B), 4.63–4.71 (1 H, m, CHO), 7.43–7.54 (6 H, m, Ph_2P) and 7.78–7.89 (4 H, m, Ph_2P); *m/z* 467 (M$^+$, 5%), 466 (M − H, 5), 452 (M − Me, 2), 450 (M − OH, 4), 449 (M − H_2O, 4), 438 (M − Et, 3), 340 (M − C_9H_{19}, 5), 327 (M − $C_{10}H_{20}$, 15), 312 (M − $C_{11}H_{23}$, 8), 286 (M − $C_{11}H_{23}CN$, 10), 266 (M − Ph_2PO, 30), 258 [$Ph_2P(O)C_3H_5O$, 50], 244 [$Ph_2P(O)C_3H_7$, 100], 229 [$Ph_2P(O)C_2H_4$, 90], 202 (Ph_2POH, 30), 201 (Ph_2PO, 40) and 77 (Ph, 15); and the syn 4,5-*dihydroisoxazole* **5o** (120 mg, 5%), as needles, m.p. 71–72 °C (from EtOAc–hexane) (Found: C, 74.4; H, 9.3; N, 3.1; P, 6.85%; M$^+$, 467. 2962. $C_{29}H_{42}NO_2P$ requires C, 74.5; H, 9.05; N, 3.0; P, 6.6%; M, 467.2953); ν_{max}/cm^{-1} ($CDCl_3$) 1 595 (C=N), 1 430 (P–Ph) and 1 185 (P=O); $\delta_H(CDCl_3)$ 0.87 [3 H, t, *J* 6.4, $(CH_2)_{10}Me$], 0.98 (3 H, t, *J* 7.4, $PCHCH_2Me$), 1.01–1.43 [18 H, m, $(CH_2)_9Me$], 1.6–1.7 (2 H, m, $PCHCH_2Me$), 2.18 (2 H, t, *J* 7.5, CH_2CH_2CN), 2.5–2.6 (1 H, m, PCH), 2.79 (1 H, dd, *J* 10.3, 18.1, 4-CH_AH_B), 2.96 (1 H, dd, *J* 9.1, 18.1, 4-CH_AH_B), 4.72–4.91 (1 H, m, CHO), 7.46–7.53 (6 H, m, Ph_2P) and 7.76–7.85 (4 H, m, Ph_2P); *M/z* 467 (M$^+$, 2%), 466 (M − H, 2), 340 (M − C_9H_{19}, 2), 327 (M − $C_{10}H_{20}$, 4), 312 (M − $C_{11}H_{23}$, 3), 286 (M − $C_{11}H_{23}CN$, 40), 271 (M − $C_{11}H_{23}CN$, Me, 20), 266 (M − Ph_2PO, 25), 258 [$Ph_2P(O)C_3H_5O$, 30], 244 [$Ph_2P(O)C_3H_7$, 80], 229 [$Ph_2P(O)C_2H_4$, 70], 202 (Ph_2POH, 35), 201 (Ph_2PO, 50), 77 (Ph, 30) and 57 (C_4H_9, 100).

(1′R*, 5R*)- *and* (1′R*, 5S*)-5-(1′-*Diphenylphosphinoylpropyl*)-3-*methoxycarbonylpropyl*-4,5-*dihydroisoxazoles* **4p** *and* **5p**. —*By method A*. Methyl 5-hydroxyiminopentanoate (1.1 g, 7.4 mmol) and the phosphine oxide **2c** (1.0 g, 3.6 mmol) gave a brown oil which was purified by flash column chromatography on silica (100 g) eluting with ethyl acetate. The first fraction to be eluted was the phosphine oxide **2c** (470 mg, 47% recovery). The second fraction to be eluted contained a mixture of **4p** and **5p** and the phosphine oxide **2c**. This fraction was purified by HPLC eluting with chloroform–methanol (50:1) to give the anti-4,5-*dihydroisoxazole* **4p** (184 mg, 12%), as needles, m.p. 101–102 °C (from EtOAc) (Found: M$^+$, 413.1741. $C_{23}H_{28}NO_4P$ requires *M*, 413.1776); ν_{max}/cm^{-1}($CDCl_3$) 1735 (C=O), 1605 (C=N), 1435 (P-Ph) and 1190 (P=O); $\delta_H(CDCl_3)$ 0.81 (3 H, t, *J* 7.5, CH_2Me), 1.63–1.82 (2 H, m, CH_2Me), 1.88 (2 H, br quintet, *J* 7.4, CH_2CH_2CO), 2.33 (2 H, t, *J* 7.4, CH_2CO_2 or CH_2CH_2CN), 2.35 (2 H, t, *J* 7.4, CH_2CO_2 or CH_2CH_2CN), 2.76–2.85 (1 H, m, PCH), 2.84 (1 H, dd, *J* 11.2, 18.0, 4-CH_AH_B), 3.20 (1 H, dd, *J* 9.5, 18.0, 4-CH_AH_B), 3.65 (3 H, s, OMe), 4.62–4.74 (1 H, m, CHO), 7.43–7.55 (6 H, m, Ph_2P) and 7.78–7.87 (4 H, m, Ph_2P); *m/z* 414 (M + H, 30%), 413 (M$^+$, 30), 412 (M − H, 20), 396 (M − OH, 25), 382 (M − OMe, 70), 340 (M − CH_2CO_2Me, 15), 312 [M − $(CH_2)_3CO_2Me$, 5], 271 [$Ph_2P(O)C_5H_{10}$, 15], 244 [$Ph_2P(O)C_3H_7$, 75], 229 [$Ph_2P(O)C_2H_4$, 100], 202 (Ph_2POH, 60), 201 (Ph_2PO, 80) and 77 (Ph, 30); and a mixture of the phosphine oxide **2c** and the syn-4,5-*dihydroisoxazole* **5p** in the ratio of 2:1 (310 mg, 21% of **2c** and 7% of **5p**) as a white solid (Found: M − OMe, 382.1543. $C_{22}H_{25}NO_3P$ requires 382.1572). The mixture had ν_{max}/cm^{-1}-($CDCl_3$) 1730 (C=O), 1600 (C=N), 1435 (P–Ph) and 1180 (P=O); $\delta_H(CDCl_3)$ 0.92 (3 H, t, *J* 7.4, Me of alkene), 0.95 (3 H, t, *J* 7.4, CH_2Me of 4,5-dihydroisoxazole), 1.56–1.91 (6 H, m, CH_2Me of both compounds and CH_2CH_2CN of 4,5-dihydroisoxazole), 2.24 (2 H, t, *J* 7.4, CH_2CH_2CN or CH_2CO_2 of 4,5-dihydroisoxazole), 2.31 (2 H, t, *J* 7.3, CH_2CH_2CN or CH_2CO_2 of 4,5-dihydroisoxazole), 2.54–2.65 (1 H, m, PCH of 4,5-dihydroisoxazole), 2.79 (1 H, dd, *J* 10.5, 17.5, 4-CH_AH_B of 4,5-dihydroisoxazole), 2.82–2.94 (1 H, m, PCH of alkene), 3.00

(1 H, dd, *J* 9.1, 17.5, 4-CH_AH_B of 4,5-dihydroisoxazole), 3.65 (3 H, s, OMe of 4,5-dihydroisoxazole), 4.76–4.92 (1 H, m, CHO of 4,5-dihydroisoxazole), 4.96–5.05 (1 H, m, CH=CH_AH_B of alkene), 5.11–5.28 (1 H, m, CH=CH_AH_B of alkene), 5.60–5.77 (1 H, m, C*H*=CH_2 of alkene), 7.38–7.57 (12 H, m, Ph_2P of both compounds) and 7.67–7.89 (8 H, m, Ph_2P of both compounds).

(1'R*,5R*)- *and* (1'R*,5S*)-5-(1'-*Diphenylphosphinoylbutyl*)-3-*undecyl*-4,5-*dihydroisoxazoles* **4q** *and* **5q**.—*By method A*. Dodecanal oxime (1.05 g, 5.2 mmol) and the phosphine oxide **2d** (1.0 g, 3.6 mmol) gave a white solid which was purified by flash column chromatography on silica (100 g) eluting with ethyl acetate. The first fraction to be eluted gave a clear gum which was tentatively identified by ^1H NMR as 3,4-diundecylfurazan 2-oxide. The second fraction contained a mixture of the two isoxazolines. The third fraction contained the phosphine oxide **2d** (0.7 g, 70% recovery). The mixed fraction was separated by HPLC eluting with chloroform–methanol (200:1) to give the anti-4,5-*dihydroisoxazole* **4q** (370 mg, 22%), as needles, m.p. 92–94.5 °C (from EtOAc) (Found: C, 75.0; H, 9.5; N, 3.0; P, 6.7%; M^+, 481.3070. $C_{30}H_{44}NO_2P$ requires C, 74.8; H, 9.2; N, 2.9; P, 6.4%; M, 481.3109); ν_{max}/cm^{-1}($CDCl_3$) 1610 (C=N), 1440 (P–Ph) and 1190 (P=O); δ_H($CDCl_3$) 0.72 [3 H, t, *J* 7.2, PCH$(CH_2)_2$*Me*], 0.86 [3H, t, *J* 6.6, $(CH_2)_{10}$*Me*], 1.03–1.23 [16 H, m, $(CH_2)_8$Me], 1.34–1.77 (6 H, m, PCHCH_2CH_2 and CH_2CH_2CN), 2.28 (2 H, t, *J* 7.5, CH_2CH_2CN), 2.82 (1 H, dd, *J* 11.0, 17.9, 4-CH_AH_B), 2.81–2.91 (1 H, m, PCH), 3.20 (1 H, dd, *J* 9.4, 17.9, 4-CH_AH_B), 4.62–4.70 (1 H, m, CHO), 7.42–7.54 (6 H, m, Ph_2P) and 7.77–7.86 (4 H, m, Ph_2P); *m/z* 482 (M + H, 6%), 481 (M^+, 5), 480 (M – H, 10), 452 (M – Et, 10), 439 (M – C_3H_6, 5), 438 (M – C_3H_7, 4), 396 (M – C_6H_{13}, 2), 354 (M – C_9H_{19}, 10), 341 (M – $C_{10}H_{20}$, 15), 326 (M – $C_{11}H_{23}$, 6), 300 (M – $C_{11}H_{23}CN$, 13), 299 (M – $C_{11}H_{24}CN$, 15), 280 (M – Ph_2PO, 50), 258 [$Ph_2P(O)C_4H_9$, 60], 229 [$Ph_2P(O)C_2H_4$, 100], 201 (Ph_2PO, 25), and 77 (Ph, 6); and the syn-4,5-*dihydroisoxazole* **5q** (180 mg, 11%), as needles, m.p. 88–92 °C (from EtOAc) (Found: C, 74.5; H, 9.2; N, 2.7; P, 6.6. $C_{30}H_{44}NO_2P$ requires C, 74.8; H, 9.2; N, 2.9; P, 6.4%); ν_{max}/cm^{-1}($CDCl_3$) 1610 (C=N), 1435 (P–Ph) and 1185 (P=O); δ_H($CDCl_3$) 0.73 [3 H, t, *J* 7.1, PCH$(CH_2)_2$*Me*], 0.87 [3 H, t, *J* 6.8, $(CH_2)_{10}$*Me*], 1.24–1.75 [22 H, m, $(CH_2)_9$Me), and PCHCH_2CH_2], 2.18 (2 H, t, *J* 7.5, CH_2CH_2CN), 2.60–2.71 (1 H, m, PCH), 2.81 (1 H, dd, *J* 10.4, 17.5, 4-CH_AH_B), 2.99 (1 H, dd, *J* 9.1, 17.5, 4-CH_AH_B), 4.7–4.9 (1 H, m, CHO), 7.42–7.55 (6 H, m, Ph_2P) and 7.76–7.86 (4 H, m, Ph_2P); *m/z* 482 (M + H, 10%), 481 (M^+, 7), 480 (M – H, 15), 465 (M – O, 5), 464 (M – OH, 3), 463 (M – H_2O, 4), 452 (M – Et, 7), 439 (M – C_3H_6, 5), 354 (M – C_9H_{19}, 5), 341 (M – $C_{10}H_{20}$, 20), 326 (M – $C_{11}H_{23}$, 10), 300 (M – $C_{11}H_{23}CN$, 20), 299 (M – $C_{11}H_{24}$ CN, 22), 280 (M – Ph_2PO, 75), 271 [$Ph_2P(O)C_5H_{10}$, 30], 258 [$Ph_2P(O)C_4H_9$, 60], 229 [$Ph_2P(O)C_2H_4$, 100)] 201 (Ph_2PO, 20) and 77 (Ph, 15) (Found: M^+ – H, 480.3054. $C_{30}H_{43}NO_2P$ requires 480.3031).

(1'R*,5R*)- *and* (1'R*,5S*)-5-(1'-*Diphenylphosphinoylbutyl*)-3-*phenyl*-4,5-*dihydroisoxazoles* **4r** *and* **5r**.—*By method A*. The phosphine oxide **2d** (281 mg, 1 mmol), benzaldehyde oxime (0.17 cm^3, 2 mmol), CH_2Cl_2 (10 cm^3), and aqueous NaOCl (2 mol dm^{-3}; 1.5 cm^3, 3 mmol) were stirred together for 19 d, with more oxime and NaOCl added after 5, 11 and 15 d. The residue was purified by column chromatography on SiO_2, eluting with EtOAc–hexane (85:15). The first compound isolated was the anti-4,5-*dihydroisoxazole* **4r** (249 mg, 62%) as transparent prisms, m.p. (from EtOAc–hexane) 200–202 °C (Found: C, 74.1; H, 6.5; N, 3.5%; M^+ – Et, 374.1337. $C_{25}H_{26}NO_2P$ requires C, 74.4; H, 6.5; N, 3.5%; M – Et, 374.1310); R_F (EtOAc–hexane, 9:1) 0.43; ν_{max}/cm^{-1}($CDCl_3$) 3080–2960 (aryl CH), 2960–2750 (CH), 1580 (Ph), 1420 (P-Ph), 1175 (P=O) and 1100 (C-O); δ_H($CDCl_3$) 0.71 (3 H, t *J* 7.3, Me), 1.00–1.15 (1 H, m), 1.25–1.39 (1 H, m), 1.62–1.80 (2 H, m), 2.99 (1 H, dtd, *J* 3.2, 5.8 and 9.1, PCH), 3.26 (1 H, dd, *J* 11.1 and 17.5, 4-H_AH_B), 3.61 (1 H, dd, *J* 10.1 and 17.7, 4-H_AH_B), 4.86 (1 H, dddd, *J* 3.4, 4.2, 10.0 and 11.0, OCH), 7.36–7.39 (3 H, m, Ph_2PO and PhCN), 7.40–7.52 (6 H, m, Ph_2PO and PhCN, 7.65–7.69 (2 H, m, Ph_2PO and PhCN) and 7.81–7.96 (4 H, m, Ph_2PO and PhCN); δ_C($CDCl_3$) 14.2 (Me), 22.8 (d, *J* 6, CH_2Me), 24.5 (CH_2), 36.4 (CH_2), 40.3 (d, *J* 7, PCH), 80.24 (d, *J* 5, OCH), 126.7, 128.7, 128.8, 128.9, 129.0, 129.3 (NC-C_{aryl}), 130.1, 130.6, 130.7, 130.7, 130.8, 131.9, 132.2 (d, *J* 94, *ipso* C) and 157.7 (C=N); *m/z* 374 (M^+ – Et, 0.3%), 271 (M^+ – Et – PhCN, 1), 258 [$Ph_2P(O)C_3H_5O$, 38], 229 [$Ph_2P(O)C_2H_4$, 100], 202 (Ph_2POH, 17), 201 (Ph_2PO, 28) and 77 (Ph, 29). The second fraction isolated was a mixture of the phosphine oxide **2d** (22.5 mg, 8%) and the syn-4,5-*dihydroisoxazole* **5r** (11.5%). The latter was purified by HPLC eluting with EtOAc to give needles, m.p. 202–204 °C (Found: M^+ – C_3H_6, 361.1236. $C_{25}H_{26}NO_2P$ requires M – C_3H_6, 361.1232); R_F (EtOAc) 0.42; ν_{max}/cm^{-1}($CDCl_3$) 3100–3000 (aryl CH), 3000–2800 (CH), 1720 (C=N), 1590 (Ph), 1430 (P–Ph), 1180 (P=O) and 1110 (C–O); δ_H($CDCl_3$) 0.76 (3 H, t, *J* 7.2, Me), 1.30–1.39 (1 H, m), 1.53–1.77 (3 H, m), 2.72 (1 H, quintuplet d, *J* 3.9 and 6.7, PCH), 3.22 (1 H, dd, *J* 10.5 and 17.0, 4-H_AH_B), 3.40 (1 H, dd, *J* 9.0 and 17.0, 4-H_AH_B), 5.00 (1 H, br quintet, *J* 9.2, OCH), 7.29–7.35 (3 H, m, Ph_2PO and PhCN), 7.40–7.51 (8 H, m, Ph_2PO and PhCN) and 7.77–7.87 (4 H, m, Ph_2PO and PhCN); *m/z* 361 (M^+ – C_3H_6, 0.1%), 285 (M^+ – PhCN – Me, 0.1), 258 (M^+ – PhCN – C_3H_6, 32), 229 [$Ph_2P(O)C_2H_4$, 100], 202 (Ph_2POH, 12) and 201 (Ph_2PO, 19).

(1'R*,5R*)- *and* (1'R*,5S*)-5-(1'-*Diphenylphosphinoylbutyl*)-3-*methoxycarbonylethyl*-4,5-*dihydroisoxazoles* **4s** *and* **5s**.—*By method G*. Methyl 4-nitrobutanoate[21] (735 mg, 5.0 mmol), the phosphine oxide **2d** (0.5 g, 2.0 mmol) and phenyl isocyanate (0.46 g, 0.42 cm^3, 3.9 mmol) gave a brown oil which was purified by flash column chromatography on silica (150 g) eluting with ethyl acetate. The first compound to be eluted was the phosphine oxide **2d** (280 mg, 56% recovery). The second product was a mixture of **4s** and **5s** in a ratio of 3:1 (^1H NMR). Separation by HPLC eluting with methanol–chloroform (150:1) gave the anti-4,5-*dihydroisoxazole* **4s** (250 mg, 34%), as needles, m.p. 104–107 °C (from EtOAc) (Found: M – OMe, 382.1569. $C_{22}H_{25}NO_3P$ requires 382.1572); ν_{max}/cm^{-1}($CDCl_3$) 1730 (C=O), 1598 (C=N), 1440 (P-Ph) and 1185 (P=O); δ_H($CDCl_3$) 0.72 (3 H, t, *J* 7.2, CH_2*Me*), 0.93–1.17 (1 H, m, CH_AH_BMe), 1.20–1.40 (1 H, m, CH_AH_BMe), 1.49–1.75 (2 H, m, CH_2CH_2Me), 2.54–2.70 (4 H, m, CH_2CH_2CO), 2.79–2.95 (2 H, m, CHP and 4-CH_AH_B), 3.22 (1 H, dd, *J* 17.5, 9, 4-CH_AH_B), 3.66 (3 H, s, OMe), 4.63–4.77 (1 H, m, CHO), 7.44–7.51 (6 H, m, Ph_2P) and 7.77–7.85 (4 H, m, Ph_2P); *m/z* 382 (M – OMe, 15%), 354 (M – OMe, CO, 2), 258 [$Ph_2P(O)C_4H_9^+$, 28], 243 [$Ph_2P(O)C_3H_6$, 3], 229 [$Ph_2P(O)C_2H_4$, 100], 201 (Ph_2PO, 30) and 77 (Ph, 5); and the syn 4,5-*dihydroisoxazole* **5s** (45 mg, 6%), as needles, m.p. 106–110 °C (from EtOAc) (Found: M – OMe, 382.1567. $C_{22}H_{25}NO_3P$ requires 382.1572); ν_{max}/cm^{-1}($CDCl_3$) 1728 (C=O), 1597 (C=N), 1430 (P-Ph) and 1182 (P=O); δ_H($CDCl_3$) 0.73 (3 H, t, *J* 7.1, CH_2*Me*), 1.16–1.37 (1 H, m, CH_AH_BMe), 1.42–1.84 (3 H, m, C$H_2CH_AH_B$Me), 2.44–2.58 (4 H, m, CH_2CH_2CO), 2.55–2.74 (1 H, m, PCH), 2.83 (1 H, dd, *J* 10, 17.5, 4-CH_AH_B), 3.05 (1 H, dd, *J* 9, 17.5, 4-CH_AH_B), 3.66 (3 H, s, OMe), 4.75–4.93 (1 H, m, CHO), 7.44–7.50 (6 H, m, Ph_2P) and 7.76–7.86 (4 H, m, Ph_2P); *m/z* 382 (M – OMe, 10%), 258 [$Ph_2P(O)C_4H_9^+$, 30], 243 [$Ph_2P(O)C_3H_6$, 5], 229 [$Ph_2P(O)C_2H_4$, 100], 201 (Ph_2PO, 30) and 77 (Ph, 3).

(1'R*,5R*)- *and* (1'R*,5S*)-5-(1'-*Diphenylphosphinoylbutyl*)-3-*methoxycarbonylpropyl*-4,5-*dihydroisoxazoles* **4t** *and* **5t**.—*By method A*. Methyl 5-hydroxyiminopentanoate (1.0 g, 7.0 mmol) and the phosphine oxide **2d** (1.0 g, 3.6 mmol) gave an orange

gum which was purified by flash column chromatography on silica (**50 g**) eluting with ethyl acetate. The first fraction to be eluted was the phosphine oxide **2d** (470 mg, 47% recovery). The third fraction was a mixture of the two diastereoisomers **4t** and **5t** and the phosphine oxide **2d**. Purification by HPLC eluting with chloroform–methanol (100 : 1) gave as the first fraction the anti-4,5-*dihydroisoxazole* **4t** (147 mg, 10%), as plates, m.p. 111–114 °C (from MeOH–EtOAc) (Found: M^+, 427.1896. $C_{24}H_{30}NO_4P$ requires *M*, 427.1913); ν_{max}/cm^{-1}($CDCl_3$) 1728 (C=O), 1958 (C=N), 1430 (P–Ph) and 1180 (P=O); δ_H($CDCl_3$) 0.72 (3 H, t, *J* 7.2, CH_2*Me*), 0.97–1.16 (1 H, m, C$H_A$$H_B$Me or PCHC$H_A$$H_B$), 1.16–1.39 (1 H, m, C$H_A$$H_B$Me or PCHC$H_A$$H_B$ 1.46–1.79 (2 H, m, CH_2Me or PCHCH_2), 1.87 (2 H, br quintet, *J* 7.4, C$H_2$$CH_2CO_2$), 2.33 (2 H, t, *J* 7.5, CH_2CO_2 or CH_2CH_2CN), 2.34 (2 H, t, *J* 7.4, CH_2CO_2 or CH_2CH_2CN), 2.83 (1 H, dd, *J* 10.9, 17.9, 4-C$H_A$$H_B$), 2.85–2.90 (1 H, m, PCH), 3.19 (1 H, dd, *J* 9.4, 17.9, 4-$CH_A$$H_B$), 3.64 (3 H, s, OMe), 4.62–4.68 (1 H, m, CHO), 7.42–7.54 (6 H, m, Ph_2P) and 7.77–7.86 (4 H, m, Ph_2P); *m/z* 427 (M^+, 5%), 409 (M − H_2O, 10), 396 (M − OMe, 25), 368 (M − CO_2Me, 2), 354 (M − CH_2CO_2Me, 5), 258 [$Ph_2P(O)C_4H_9$, 40], 229 [$Ph_2P(O)C_2H_4$, 100], 201 (Ph_2PO, 30) and 77 (Ph, 100). The second fraction to be eluted was a mixture of the phosphine oxide **2d** and **5t** in the ratio of 1 : 1 (210 mg). The third fraction to be eluted was the syn-4,5-*dihydroisoxazole* **5t** (105 mg, 7%), as needles, m.p. 115–117 °C (from EtOAc) (Found: M^+, 427.1901. $C_{24}H_{30}NO_4P$ requires *M*, 427.1913); ν_{max}/cm^{-1} ($CDCl_3$) 1730 (C=O), 1605 (C=N), 1430 (P–Ph) and 1180 (P=O); δ_H($CDCl_3$) 0.74 (3 H, t, *J* 7.1, CH_2*Me*), 1.22–1.33 (1 H, m, C$H_A$$H_B$Me or PCHC$H_A$$H_B$), 1.47–1.74 (3 H, m, three of PCHCH_2CH_2Me), 1.79 (2 H, br quintet, *J* 7.3, C$H_2$$CH_2CO_2$), 2.50 (2H, t, *J* 7.5, CH_2CO_2 or CH_2CH_2CN), 2.58 (2 H, t, *J* 7.3, CH_2CO_2 or CH_2CH_2CN), 2.59–2.70 (1 H, m, PCH), 2.80 (1 H, dd, *J* 10.4, 17.2, 4-C$H_A$$H_B$), 3.06 (1 H, dd, *J* 9.0, 17.2, 4-$CH_A$$H_B$), 3.66 (3 H, s, OMe), 4.73–4.89 (1 H, m, CHO), 7.41–7.56 (6 H, m, Ph_2P) and 7.76–7.86 (4 H, m, Ph_2P); *m/z* 427 (M^+, 5%), 409 (M − H_2O, 5), 396 (M − OMe, 25), 354 (M − CH_2CO_2Me, 2), 258 [$Ph_2P(O)C_4H_9$, 40], 229 [$Ph_2P(O)C_2H_4$, 100], 201 (Ph_2PO, 25) and 77 (Ph, 70).

(1'R*,5R*)- *and* (1'R*,5S*)-5-(1'-*Diphenylphosphinoyl*-3'-*methylbutyl*)-3-*phenyl*-4,5-*dihydroisoxazoles* **4u** *and* **5u**.—*By method B.* The phosphine oxide **2e** (1.071 g, 3.59 mmol), benzaldehyde oxime (1.21 g, 10 mmol), CH_2Cl_2 (70 cm^3) and aqueous NaOCl (2 mol dm^{-3}; 15 cm^3, 30 mmol) were sonicated for *ca.* 25 h over 4 d. The residue was purified by column chromatography on SiO_2, eluting with EtOAc–hexane (gradient from 1 : 4 to pure EtOAc). The first compound isolated was the anti-4,5-*dihydroisoxazole* **4u** (781 mg, 46%) as needles, m.p. (MeOAc–hexane) 188–190 °C (Found: C, 74.6; H, 6.7; N, 3.3. $C_{26}H_{28}NO_2P$ requires C, 74.8; H, 6.8; N, 3.35); R_F (EtOAc–hexane, 9 : 1) 0.47; ν_{max}/cm^{-1} ($CDCl_3$) 3100–3000 (arylCH), 3000–2800 (CH), 1720 (C=N), 1595 (Ph), 1435 (P–Ph), 1190 (P=O) and 1110 (C-O); δ_H($CDCl_3$) 0.68 (3 H, d, *J* 6.5, C$Me_A$$Me_B$), 0.76 (3 H, d, *J* 6.5, C$Me_A$$Me_B$), 1.36 (1 H, nonet, *J* 6.6, Me_2C*H*), 1.57 (2 H, dd, *J* 6.3 and 13.4, CH_2), 3.06 (1 H, dtd, *J* 3.1, 6.0 and 9.1, PCH), 3.26 (1 H, dd, *J* 11.1 and 17.6, 4-$H_A$$H_B$), 3.61 (1 H, dd, *J* 10.1 and 17.6, 4-$H_A$$H_B$), 4.90 (1 H, dddd, *J* 3.2, 4.5, 10.1 and 11.1, OCH), 7.35–7.40 (3 H, m, Ph_2PO and PhCN), 7.45–7.54 (6 H, m, Ph_2PO and PhCN), 7.65–7.68 (2 H, m, Ph_2PO and PhCN) and 7.80–7.95 (4 H, m, Ph_2PO and PhCN); δ_C($CDCl_3$) 14.2, 22.4 (d, *J* 33), 26.8 (d, *J* 7), 31.0 (CH_2), 36.3 (CH_2), 38.1 (d, *J* 66, PCH), 80.2, (d, *J* 6, OC), 126.7, 128.6, 128.7, 129.0, 129.1, 129.3 (NC-C_{aryl}), 130.1, 130.6, 130.7, 130.8, 130.9, 131.9, 131.9 (d, *J* 97, *ipso*-C), 132.0, 132.0 (d, *J* 95, *ipso*-C) and 157.7 (C=N); *m/z* 272 [$Ph_2P(O)C_5H_{11}$, 15%], 258 [$Ph_2P(O)$Bu, 4], 243 [$Ph_2P(O)C_3H_6$, 7], 229 [$Ph_2P(O)C_2H_4$, 100], 202 (Ph_2POH, 14) and 201 (Ph_2PO, 30). The second compound isolated was the phosphine oxide **2e** (339 mg, 32%). The third compound isolated was the syn-*isoxazoline* **5u** (155 mg, 9%), m.p. (MeOAc–hexane) 187–188 °C (Found: M^+ − PhC_3H_2NO, 272.1342. $C_{26}H_{28}NO_2P$ requires M − PhC_3H_2ON, 272.1330); R_F (EtOAc) 0.55; ν_{max}/cm^{-1} 2970–2800 (CH), 1670 (C=N), 1580 (Ph), 1365 (P–Ph), 1175 (P=O) and 1110 (C–O); δ_H($CDCl_3$) 0.68 (3 H, d, *J* 6.3, C$Me_A$$Me_B$), 0.82 (3 H, d, *J* 6.2, C$Me_A$$Me_B$), 1.40–1.74 (3 H, m, C$H_2$C*H*$Me_2$), 2.78 (1 H, m, PCH), 3.22 (1 H, dd, *J* 10.7 and 17.0, 4-$H_A$$H_B$), 3.60 (1 H, dd, *J* 9.1 and 17.0, 4-$H_A$$H_B$), 4.96 (1 H, m, OCH), 7.29–7.54 (10 H, m, Ph_2PO and PhCN) and 7.88–7.76 (5 H, m, Ph_2PO and PhCN); δ_C($CDCl_3$) 21.5 (Me), 23.2 (Me), 28.8 (d, *J* 9, C*H*Me_2), 35.7 (CH_2), 39.1 (d, *J* 4, CH_2), 41.1 (d, *J* 61, PCH), 81.2 (OC), 126.7, 127.4, 128.3, 128.5, 128.6, 128.6, 128.6, 128.7, 129.4 (NC-C_{aryl}), 130.0, 131.1, 131.2, 131.3, 131.8, 131.8, 131.9, 132.6 (d, *J* 71, *ipso*-C) and 157.3 (C=N); *m/z* 272 [$Ph_2P(O)C_5H_{11}$, 26%], 230 [$Ph_2P(O)$Et, 15], 229 [$Ph_2P(O)C_2H_4$, 100], 201 (Ph_2PO, 13) and 77 (Ph, 9).

By method A. Aqueous NaOCl (2 mol dm^{-3}; 1.5 cm^3, 3 mmol) was added to a stirred solution of the phosphine oxide **2e** (272 mg, 0.91 mmol) and benzaldehyde oxime (0.17 cm^3) in CH_2Cl_2 (10 cm^3), and the mixture stirred for 19 d, with more oxime and bleach added after 5, 11 and 15 d. Work-up gave a residue which was purified by column chromatography on SiO_2, eluting with 25% hexane in EtOAc to give the anti-4,5-*dihydroisoxazole* **4u** (160 mg, 42%) and a mixture of the phosphine oxide **2e** and the syn-4,5-*dihydroisoxazole* **5u** (117 mg).

Method for Reduction of 4,5-*Dihydroisoxazoles*.—$NaBH_4$ (5 equiv.) was added **portionwise** to a stirred solution of the 4,5-dihydroisoxazole **4** or **5** (1 equiv.) and $NiCl_2$·$6H_2O$ (2 equiv.) in MeOH (30 cm^3 per mmol of the 4,5-dihydroisoxazole) at −30 °C under N_2 or Ar, and the mixture stirred for 5–10 min. The MeOH was removed under reduced pressure (CARE—it often bumps) and conc. aqueous NH_3 (*d* 0.88, 30 cm^3 per mmol of 4,5-dihydroisoxazole) and CH_2Cl_2 (an equal volume) were added to the residue; the mixture was then stirred exposed to the air until the organic layer was a pale yellow–brown. The mixture was separated and the aqueous layer extracted with CH_2Cl_2 (3 × the same volume as before). The combined organic layers were dried (Na_2SO_4) and evaporated under reduced pressure to give the crude reaction product.

(2R*,4R*)- *and* (2R*,4S*)-4-*Amino*-1-*diphenylphosphinoylheptan*-2-*ol* (**6** *or* **7a**).—By the above method, $NaBH_4$ (0.574 g, 15.2 mmol), 5-diphenylphosphinoylmethyl-3-propyl-4,5-dihydroisoxazole **4** or **5b** (1.000 g, 3.06 mmol) and $NiCl_2$·$6H_2O$ (1.50 g, 6.31 mmol) gave a yellow oil which was purified by column chromatography on SiO_2, eluting with CH_2Cl_2–MeOH–NH_3 (100 : 10 : 2) to give a 60 : 40 mixture of two diastereoisomers **A** and **B** of the *amino alcohols* **6** or **7a** (0.916 g, 90.5%) as a yellow oil (Found: M^+, 331.1688. $C_{19}H_{26}NO_2P$ requires *M*, 331.1701); R_F (CH_2Cl_2–MeOH–NH_3, 100 : 10 : 2) 0.40; ν_{max}/cm^{-1} (thin film) 3500–3100 (OH), 3060 (NH_2), 3000–2800 (CH), 1600, 1590 and 1500 (Ph), 1465, 1438 (P–Ph), 1176 (P=O), 745, 718 and 699 (Ph); δ_H($CDCl_3$, 400 MHz) 0.87 (3 H **A** and **B**, t, *J* 3.2, Me), 1.18–1.38 (4 H**A** and 5 H**B**, m, CH_2CH_2**A** and **B** and 3-$H_A$$H_B$**B**), 1.54 (1 H**B**, ddd, *J* 3, 8 and 14, 3-$H_A$$H_B$), 1.72 (1 H**A**, ddd, *J* 3, 8 and 14, 3-$H_A$$H_B$), 1.87 (1 H**A**, td, *J* 4.5 and 14, 3-$H_A$$H_B$), 2.34–2.49 (1 H**A** and **B**, m, NCH), 2.56–2.66 (1 H**A** and **B**, m, PC$H_A$$H_B$, 2.78 (1 H**A**, m, PC$H_A$$H_B$), 3.09 (1 H**B**, m, PC$H_A$$H_B$), 4.22–4.36 (1 H**A** and **B**, m, OCH), 7.42–7.54 (6 H**A** and **B**, m, Ph_2PO) and 7.72–7.82 (4 H**A** and **B**, m, Ph_2PO); δ_C($CDCl_3$) 13.9 (Me), 14.0 (Me), 18.7 (CH_2Me), 19.1 (CH_2Me), 37.3 (d, *J* 70, PCH_2), 38.1 (d, *J* 70, PCH_2), 39.8 (CH_2), 42.4 (CH_2), 43.5 (d, *J* 9, CH_2), 43.9 (d, *J* 7, CH_2), 48.0 (NCH), 52.0 (NCH), 64.6 (OCH), 67.9 (OCH), 128.5, 128.6, 128.7, 128.7, 128.8, 130.5, 130.6, 130.7, 130.8, 130.8, 130.9, 131.7, 131.8, 133.0 (d, *J* 98, *ipso*-C) and 133.8 (d, *J* 98, *ipso*-C); *m/z* 331 (M^+, 0.6%), 313 M^+ − H_2O, 3), 288 (M^+

– Pr, 1.6), 270 [$Ph_2P(O)C_4H_5O$, 58], 243 [$Ph_2P(O)C_2H_2O$, 23], 216 [$Ph_2P(O)Me$, 28], 215 [$Ph_2P(O)CH_2$, 47], 202 (Ph_2POH, 61), 201 (Ph_2PO, 100), 130 ($M^+ - Ph_2PO$, 12) and 77 (Ph, 25).

(2R*,4R*)- *and* (2R*,4S*)-4-*Amino*-1-*diphenylphosphinoyl*-4-*phenylbutan*-2-*ol* (**6** *or* **7b**).—By the above method, $NaBH_4$ (68 mg, 1.8 mmol), 5-diphenylphosphinoylmethyl-3-phenyl-4,5-dihydroisoxazole **4** or **5e** (130 mg, 0.36 mmol) and $NiCl_2 \cdot 6H_2O$ (170 mg, 0.72 mmol) gave a yellow oil which was purified by column chromatography on SiO_2, eluting with CH_2Cl_2–MeOH–NH_3 (125:10:2). The first product eluted was the major *amino alcohol* **6** or **7b** (18 mg, 14%) as a yellow oil (Found: M^+, 365.1545. $C_{22}H_{24}NO_2P$ requires *M*, 365.1545); R_F (CH_2Cl_2–MeOH–NH_3, 100:10:2) 0.28; ν_{max}/cm^{-1} (thin film) 3400–3200 (OH and NH_2), 3078–3026 (aryl CH), 2935– 2908 (CH), 1600, 1591 and 1492 (Ph), 1453, 1437 (P–Ph), 1180 (P=O) and 744, 718 and 698 (Ph); $\delta_H(CDCl_3)$ 1.83–2.04 (2 H, 2nd order m, $NCCH_2$), 2.37–2.62 (2 H, 2nd order m, PCH_2), 2.4–3.0 (3 H, br s, OH and NH_2), 4.23 (1 H, d quintet, *J* 4 and 8, OCH), 4.32 (1 H, dd, *J* 4 and 8, NCH) and 7.20–7.80 (15 H, m, Ph_2PO and PhCN); *m*/*z* 365 (M^+, 5%), 347 ($M^+ - H_2O$, 12), 330 ($M^+ - H_2O - NH_3$, 15), 260 ($M^+ - PhCH_2N$, 40), 245 [$Ph_2P(O)C_2H_4O$, 25], 216 [$Ph_2P(O)Me$, 67], 215 [$Ph_2P(O)CH_2$, 100], 202 (Ph_2POH, 70), 201 (Ph_2PO, 98), 106 ($PhCH_3N$, 58) and 77 (Ph, 41). The second fraction eluted contained a mixture of diastereoisomers, predominantly the major, of the amino alcohols **6** or **7b** (15 mg, 11%). The third fraction eluted contained a 5:2 mixture of the two diastereoisomeric *amino alcohols* **6** or **7bA** (as above) and **B** (67 mg, 51%) as plates, m.p. 55–57 °C (Found: M^+, 365.1536. $C_{22}H_{24}NO_2P$ requires *M*, 365.1545); R_F (CH_2Cl_2–MeOH–NH_3, 100:10:2) 0.28 and 0.22; ν_{max}/cm^{-1}(Nujol mull) 3300–3200 (OH and NH_2), 3077–3027 (aryl CH), 2950–2840 (CH), 1600, 1590 and 1490 (Ph), 1453, 1435 (P–Ph), 1178 (P=O) and 744, 718 and 698 (Ph); $\delta_H(CDCl_3$, 400 MHz) 1.84–2.04 (2 **HA** and **B**, m, $NCCH_2$), 2.33–2.66 (2**HA** and **B**, m, PCH_2), 4.02 (1 **HB**, dd, 4 and 9.5, NCH), 4.20–4.34 (2 **HA** and 1 **HB**, m, OCH**A** and **B** and NCH**A**), 720–7.30 (5 **HA** and **B**, m, Ph_2PO and PhCN), 7.40–7.58 (6 **HA** and **B**, m, Ph_2PO and PhCN) and 7.60–7.80 (4 **HA** and **B**, m, Ph_2PO and PhCN); $\delta_C(CDCl_3)$ 37.0 (d, *J* 70, CH_2), 37.9 (d, *J* 70, CH_2), 46.3 (d, *J* 54, CH_2), 46.4 (d, *J* 55, CH_2), 52.4 (NCH), 55.8 (NCH), 64.4 (OCH), 67.3 (OCH), 125.8, 126.0, 126.9, 127.1, 128.5, 128.6, 128.6, 128.7, 128.8, 130.5, 130.6, 130.7, 130.7, 130.8, 130.8, 130.8, 131.7, 131.9, 133.1 (d, *J* 99, PC_{aryl}), 133.4 (d, *J* 98, PC_{aryl}), 145.6 (NC-C_{aryl}) and 146.1 (NC-C_{aryl}); *m*/*z* 365 (M^+, 11%), 347 ($M^+ - H_2O$, 5.3), 260 [$Ph_2P(O)C_3H_7O$, 31], 245 [$Ph_2P(O)C_2H_4O$, 21], 216 [$Ph_2P(O)Me$, 61], 215 [$Ph_2P(O)CH_2$, 100], 202 (Ph_2POH, 79), 201 (Ph_2PO, 95), 164 ($M^+ - Ph_2PO$, 8.0), 146 ($M^+ - Ph_2PO - H_2O$, 36), 106 ($PhCH_3N$, 56) and 77 (Ph, 40).

(2R*,3R*,5R*)- *and* (2R*,3R*,5S*)-5-*Amino*-2-*diphenylphosphinoyloctan*-3-*ols* **6c**.—By the above method, $NaBH_4$ (100 mg, 2.5 mmol), *anti*-5-(1-diphenylphosphinoylethyl)-3-propyl-4,5-dihydroisoxazole **4h** (100 mg, 0.29 mmol) and $NiCl_2 \cdot 6H_2O$ (280 mg, 1.2 mmol) gave a yellow oil which was purified by column chromatography on SiO_2, eluting with (CH_2Cl_2–MeOH–NH_3, 100:10:2) to give a mixture of *amino alcohols* **6c A** and **B** in a 55:45 ratio (85 mg, 84%) as a yellow oil (Found: M^+, 345.1855. $C_{20}H_{28}NO_2P$ requires *M*, 345.1858); R_F (CH_2Cl_2–MeOH–NH_3, 100:10:2) 0.28; ν_{max}/cm^{-1} (thin film) 3500–3200 (NH_2 and OH), 3093–3010 (aryl C–H), 2956–2872 (C–H), 1591 and 1500 (Ph), 1458, 1438 (P–Ph), 1175 (P=O) and 737, 720 and 698 (Ph); $\delta_H(CDCl_3$, 400 MHz) 0.80 (3 **HB**, t, *J* 7, CH_2Me), 0.89 (3 **HA**, t, *J* 7, CH_2Me), 1.15 (3 **HA**, dd, *J* 7 and 17, PCMe), 1.19 (3 **HB**, dd, 7.5 and 16.5, PCMe), 1.18–1.46 (4 **HA** and 5 **HB**, m, CH_2CH_2**A** and **B** and 4-H_AH_B**B**), 1.65 (1 **HA**, ddd, *J* 3, 10 and 14.5, 4-H_AH_B), 1.75 (1 **HA**, ddd, *J* 2.5, 6 and 15, 4-H_AH_B), 2.05 (1 **HB**, br d, *J* 15, 4-H_AH_B), 2.62–2.76 (2 **HB** and 1 **HA**, m, PCH**A** and **B** and NCH**B**), 3.19 (1 **HA**, m, NCH), 4.11 (1 **HB**, m, OCH), 4.19 (1 **HA**, m, OCH), 7.42–7.52 (6 **HA** and **B**, Ph_2PO) and 7.76–7.88 (4 **HA** and **B**, m, Ph_2PO); $\delta_C(CDCl_3)$ 7.0 (Me), 83.3 (Me), 13.9 (Me), 14.0 (Me), 18.7 (MeCH_2), 19.3 (MeCH_2), 37.5 (d, *J* 3, CH_2), 38.0 (CH_2), 38.2 (CH_2), 38.2 (d, *J* 70, PCH), 38.3 (d, *J* 70, PCH), 42.9 (CH_2), 48.5 (NCH), 52.6 (NCH), 67.9 (OCH), 71.6 (d, *J* 4, OCH), 128.5, 128.6, 128.7, 130.7, 130.8, 130.9, 131.0, 131.1, 131.4, 131.5, 131.6, 132.2 (d, *J* 96, *ipso*-C), 132.5, (d, *J* 94, *ipso*-C), 132.2 (d, *J* 98, *ipso*-C) and 132.3 (*ipso*-C); *m*/*z* 345 (M^+, 2.5%), 284 [$Ph_2P(O)C_5H_7O$, 56], 274 [$Ph_2P(O)C_4H_9O$, 2.7], 259 [$Ph_2P(O)C_3H_6O$, 16], 230 [$Ph_2P(O)Et$, 40], 202 (Ph_2POH, 68), 201 (Ph_2PO, 100), 144 ($M^+ - Ph_2PO$, 11) and 77 (Ph, 30).

(2R*,3S*,5R*)- *and* (2R*,3S*,5S*)-5-*Amino*-2-*diphenylphosphinoyloctan*-3-*ols* **7c**.—By the above method, $NaBH_4$ (135 mg, 3.6 mmol), *syn*-5-(1-diphenylphosphinoylethyl)-3-propyl-4,5-dihydroisoxazole **5h** (244 mg, 0.72 mmol) and $NiCl_2 \cdot 6H_2O$ (333 mg, 1.4 mmol) gave a mixture of the *amino alcohols* **7c A** and **B** in a 66:34 ratio (212 mg, 86%) as a brown oil. This mixture was identified by its ^1H NMR spectrum: $\delta_H(CDCl_3)$ 0.84 (3 **HA**, t, *J* 6.3, CH_2Me), 0.95 (3 **HB**, t, *J* 7.4, CH_2Me), 1.18 (3 **HA**, dd, *J* 7.2 and 16.9, CH*Me*), 1.23–1.54 (5 **HA** and 8 **HB**, m, CH_2s and CH*Me***B**), 1.65 (1 **HA**, sextet, *J* 7.4, MeCH_AH_B), 1.79 (1 **HB**, m), 2.19 (1 **HA**, br t, *J* 7.4, NCH), 2.40 (1 **HA**, m, PCH), 2.77 (1 **HB**, br s, NCH or PCH), 2.94 (1 **HB**, br s, PCH or NCH), 4.20–4.30 (1 **HA** and **B**, m, OCH), 7.40–7.55 (6 H, m, Ph_2PO) and 7.71–7.89 (4 H, m, Ph_2PO).

(1R*,3R*,4R*)- *and* (1S*,3R*,4R*)-1-*Amino*-4-*diphenylphosphinoyl*-1-*phenylpentan*-3-*ols* **6d**.—By the above method, $NaBH_4$ (250 mg, 6.67 mmol), *anti*-5-(1-diphenylphosphinoylethyl)-3-phenyl-4,5-dihydroisoxazole **4k** (500 mg, 1.33 mmol) and $NiCl_2 \cdot 6H_2O$ (634 mg, 2.67 mmol) gave a yellow oil (425 mg, 85%; isomer ratio 82:18 by NMR) which was purified by column chromatography on SiO_2, eluting with CH_2Cl_2–MeOH–NH_3 (150:10:2). The first compound isolated was the major *amino alcohol* **6d** (316 mg, 63%) as needles, m.p. 185–188 °C (Found: C, 72.4; H, 6.95; N, 3.5. $C_{23}H_{26}NO_2P$ requires C, 72.8; H, 6.9; N, 3.7); R_F (CH_2Cl_2–MeOH–NH_3, 100:10:2) 0.42; ν_{max}/cm^{-1} (Nujol mull) 3359 (NH_2), 3304 (OH), 3075–2854 (CH), 1600 and 1580 (Ph), 1438 (P–Ph), 1176 (P=O) and 740 and 720 (Ph); $\delta_H(CDCl_3$, 400 MHz) 1.12 (3 H, dd, *J* 7.6 and 17, Me), 1.90 (1 H, ddd, *J* 3.5, 10 and 14.5, 2-H_AH_B), 2.10 (1 H, ddd, *J* 2.5, 7 and 14.5, 2-H_AH_B), 2.62 (1 H, m, PCH), 4.00 (1 H, m incl. *J* 2.5 and 10, OCH), 4.47 (1 H, dd, *J* 3.5 and 7, NCH), 7.16–7.62 (13 H, m, Ph_2PO and NCPh) and 7.70–7.80 (2 H, m, Ph_2PO and NCPh); $\delta_C(CDCl_3)$ 9.0 (Me), 38.4 (d, *J* 70, PCH), 41.2 (d, *J* 4, CH_2), 52.9 (NCH), 68.0 (OCH), 126.0, 126.9, 128.4, 128.5, 128.6, 130.7, 130.7, 131.3, 131.4, 131.6, 132.1 (d, *J* 97 *ipso*-C) and 144.3 (NC-C_{aryl}); *m*/*z* 403 (M^+ + Na + H, 6.9%), 381 (M^+ + H, 29), 259 [$Ph_2P(O)C_3H_6O$, 29], 230 [$Ph_2P(O)Et$, 15] and 201 (Ph_2PO, 100). The second compound isolated was the minor *amino alcohol* **6d** (73 mg, 14%) as needles, m.p. 128–132 °C (Found: C, 72.8; H, 7.0; N, 3.7. $C_{23}H_{26}NO_2P$ requires C, 72.8; H, 6.9; N, 3.7%); R_F (CH_2Cl_2–MeOH–NH_3, 100:10:2) 0.34; ν_{max}/cm^{-1} 3333 and 3274 (NH_2), 3185–3023 (OH), 2954–2854 (C–H), 1600 and 1580 and 1500 (Ph), 1457, 1437 (P–Ph), 1182 (P=O) and 765, 740, 720 and 697 (Ph); $\delta_H(CDCl_3$, 400 MHz), 1.17 (3 H, dd, *J* 7.5 and 16.5, Me), 1.78 (1 H, td, *J* 10.5 and 14.5, 2H_AH_B), 2.22 (1 H, ddd, *J* 2, 3.5, and 14.5, 2-H_AH_B), 2.75 (1 H, dqd, *J* 4, 7.5 and 9, PCH), 3.88 (1 H, dd, *J* 3.5 and 10.5, NCH), 4.22 (1 H, m, OCH), 7.18–7.55 (11 H, m, Ph_2PO and NCPh), and 7.70–7.88 (4 H, m, Ph_2PO and NCPh); $\delta_C(CDCl_3)$ 7.8 (Me), 38.4 (d, *J* 71, PCH), 40.0 (CH_2), 56.5 (NCH), 71.5 (OCH), 125.6, 127.1, 128.7, 130.6, 130.8, 130.9, 131.0, 131.4, 131.6, 132.4

(d, *J* 96, *ipso*-C), 132.7 (d, *J* 95, *ipso*-C) and 146.2 (NC-C_{aryl}); *m/z* 403 (M^+ + Na + H, 5.8%), 381 (M^+ + H, 34), 259 [$Ph_2P(O)C_3H_6O$, 29], 229 [$Ph_2P(O)C_2H_4$, 11.7] and 201 (Ph_2PO, 100).

NOE Difference Experiments on anti,anti- *and* anti,syn-1-*Amino*-4-*diphenylphosphinoyl*-1-*phenylpentan*-3-*ol* **6d**.—*Major isomer*. Irradiation at δ 4.5 (NCH) gave enhancements at 7.8–7.1 (unassigned aromatic protons, negative NOEs), 2.6 (PCH, negative NOE), 2.1 (4-H_AH_B, very small enhancement), 1.9 (4-H_AH_B), and 1.1 (Me, negative NOE). Irradiation at δ 4.0 (OCH) gave enhancements at 7.8–7.1 (unassigned aromatic protons, negative NOEs), 2.6 (PCH), 2.1 (4-H_AH_B), 1.9 (4-H_AH_B, very small NOE) and 1.1 (Me).

Minor isomer. Irradiation at δ 4.2 (OCH) gave enhancements at δ 7.8 (unassigned aromatic protons), 7.8–7.2 (unassigned aromatic protons, negative NOE), 7.2–70 (unassigned aromatic protons), 3.9 (NCH), 2.7 (PCH), 2.2 (4-H_AH_B), 1.9 (4-H_AH_B) and 1.2 (Me, small negative NOE).

(1R*,3S*,4R*)- *and* (1S*,3S*,4R*)-1-*Amino*-4-*diphenylphosphinoyl*-1-*phenylpentan*-3-*ols* **7d**.—By the above method, $NaBH_4$ (950 mg, 25 mmol), *syn*-5-(1-diphenylphosphinoylethyl)-3-phenyl-4,5-dihydroisoxazole **5k** (1.002 g, 2.7 mmol) and $NiCl_2{\cdot}6H_2O$ (2.38 g, 10 mmol) gave a yellow oil which was purified by column chromatography on SiO_2, eluting with CH_2Cl_2–MeOH–NH_3 (100:10:2). The first compound isolated was the major *amino alcohol* **7d** (319 mg, 31.5%) as needles, m.p. 162–164 °C (Found: C, 72.6; H, 7.1; N, 3.4%; M^+, 379.1693. $C_{23}H_{26}NO_2P$ requires C,72.8; H, 6.9; N, 3.7%; *M*, 379.1701); R_F (CH_2Cl_2–MeOH–NH_3, 100:10:2) 0.49; ν_{max}/cm^{-1} (Nujol mull) 3345 and 3264 (NH_2), 3148 (OH), 3083–3031 (aryl CH), 2950–2800 (C–H), 1600, 1590 and 1490 (Ph), 1455, 1434 (P–Ph), 1192 (P=O) and 765, 727 and 702 (Ph); δ_H($CDCl_3$, 400 MHz) 1.19 (3 H, dd, *J* 7 and 17, Me), 1.63 (1 H, ddd, *J* 4, 8.5, and 13.5, 2H_AH_B), 2.07 (1 H, ddd, *J* 5, 9.5 and 14, 2-H_AH_B), 2.36 (1 H, d quintet, *J* 1 and 7, PCH), 1.5–2.8 (OH and NH_2), 4.15 (1 H, dd, *J* 4.5 and 9, NCH), 4.27 (1 H, ddt, *J* 1, 4 and 10, OCH), 7.20–7.30 (5 H, m, Ph_2PO and NCPh), 7.40–7.54 (6 H, m, Ph_2PO and NCPh) and 7.67–7.80 (4 H, m, Ph_2PO and NCPh); δ_C($CDCl_3$) 6.2 (Me), 36.2 (d, *J* 70, PCH), 43.7 (d, *J* 12, CH_2), 52.4 (NCH), 66.2 (OCH), 126.1, 127.0, 128.6, 128.6, 128.8, 128.8, 129.0, 130.7, 130.8, 130.8, 130.8, 131.7 (d, *J* 100, *ipso*-C), 131.8 and 145.7 (NC-C_{aryll}); *m/z* 379 (M^+, 5.5%), 361 (M^+ – H_2O, 2.3), 274 (M^+ – $PhCH_2N$, 24), 259 [$Ph_2P(O)C_3H_6O$, 15], 230 [$Ph_2P(O)Et$, 89], 229 [$Ph_2P(O)C_2H_4$, 43], 202 (Ph_2POH, 100), 201 (Ph_2PO, 81), 178 (M^+ – Ph_2PO, 13), 160 (M^+ – Ph_2PO – H_2O, 39), 106 ($PhCH_3N$, 55) and 77 (Ph, 32). The second fraction isolated was a mixture of the two diastereoisomeric *amino alcohols* **7d** (540 mg, 53.3%), the major **A** (as above) and the minor **B**, in *ca.* 1:1 ratio, as needles, m.p. 129–136 °C (Found: C, 72.4; H, 6.95; N, 3.5%; M^+, 379.1681. $C_{23}H_{26}NO_2P$ requires C, 72.8; H, 6.9; N, 3.7%; *M*, 379.1701); R_F (CH_2Cl–MeOH–NH_3, 100:10:2) 0.49 and 0.47; ν_{max}/cm^{-1} (Nujol mull) 3340 and 3266 (NH_2), 3200–3100 (OH), 3070–2830 (CH), 1600, 1580 and 1500 (Ph), 1457, 1437 (P–Ph), 1186 (P=O) and 726, 718, 701 and 695 (Ph); δ_H($CDCl_3$, 400 MHz) 1.18 (3 HA, dd, *J* 7 and 17, Me), 1.19 (3 HB, dd, *J* 7 and 17, Me), 1.59–1.67 (1 HA and B, m, 2-H_AH_B), 2.00–2.11 (1 HA and B, m, 2-H_AH_B), 2.27 (1 HB, d quintet, *J* 1 and 7.5, PCH), 2.36 (1 HA, d quintet, *J* 1 and 7, PCH), 4.03 (1 HB, t, *J* 7, NCH), 4.12–4.20 (1 HA and B, m, NCHA and OCHB), 4.26 (1 HA, ddt, *J* 1, 4 and 10, OCH), 7.19–7.30 (5 HA and B, m, Ph_2PO and NCPh), 7.40–7.54 (6 HA and B, m, Ph_2PO and NCPh), and 7.69–7.78 (4 HA and B, m, Ph_2PO and NCPh); δ_C($CDCl_3$) 6.3 (AMe), 6.5 (BMe), 36.3 (A, d, *J* 70, PCH), 37.3 (B, d, *J* 70, PCH), 43.8 (B, d, *J* 12, CH_2, superimposed on ACH_2), 52.4 (A, NCH), 55.0 (BNCH), 66.2 (AOCH), 68.7 (BOCH), 126.2, 127.0, 127.1, 128.5, 128.5, 128.6, 128.7, 128.7, 128.9, 130.8, 130.9, 131.7, 131.7 and 131.9 (d, *ipso*-C), 145.7 (ANC-C_{aryl}) and 145.8 (BNC-C_{aryl}); *m/z* 380 (M^+ + H, 5.6%), 379 (M^+, 3.7), 361 (M^+ – H_2O, 2), 284 (M^+ – H_2O – Ph, 2.5), 274 (M^+ – PhC_2H_4, 31), 259 (M^+ – PhNEt, 15), 230 [$Ph_2P(O)Et$, 79], 229 [$Ph_2P(O)C_2H_4$, 44), 202 (Ph_2POH, 100), 201 (Ph_2PO, 96), 178 (M^+ – Ph_2PO, 12), 160 (M^+ – Ph_2PO – H_2O, 33), 106 ($PhCH_3N$, 63) and 77 (Ph, 48).

(1R*,3R*,4R*)- *and* (1S*,3R*,4R*)-1-*Amino*-4-*diphenylphosphinoyl*-1-*phenylheptan*-3-*ols* **6e**.—By the above method, $NaBH_4$ (35 mg, 0.5 mmol), *anti*-3-(1′-diphenylphosphinoylbutyl)-3-phenyl-4,5-dihydroisoxazole **4r** (75 mg, 0.19 mmol) and $NiCl_2{\cdot}6H_2O$ (90 mg, 0.4 mmol) gave a yellow oil which slowly crystallised and was shown by ^1H NMR to be a 5:1 mixture of two isomers **A** and **B**, respectively, of the *amino alcohol* **6e** (71 mg, 94%), m.p. 60–63 °C (Found: M^+, 407.2013. $C_{25}H_{30}NO_2P$ requires *M*, 407.2014); R_F (CH_2Cl_2–MeOH–NH_3, 150:10:2) 0.35 and 0.29; ν_{max}/cm^{-1} (CH_2Cl_2) 3680 and 3610 (NH_2), 3500–3140 (OH), 3000–2800 (CH), 1600 (Ph), 1450 (P–Ph), 1175 (P=O) and 1120 (C–O); δ_H($CDCl_3$, 400 MHz) 0.72 (3 HA, t, *J* 7.2, Me), 0.73 (3 HB, t, *J* 7.0, Me), 1.09–1.15 (1 HA and B, m, $CH_2CH_AH_B$), 1.35–1.41 (1 HA and B, m, $CH_2CH_AH_B$), 1.52–1.60 (1 HA and B, m, $CH_AH_BCH_2$), 1.69–1.75 (1 HA and B, m, $CH_AH_BCH_2$), 1.95 (2 HA, m, *J* 5.3, 2-H_2), 2.1 (2 HB, br d, *J* ca. 13, 2-H_2), 2.46 (1 HA, m, PCH), 2.58 (1 HB, m, PCH), 3.8 (1 HB, dd, *J ca.* 9.5 and 13, NCH), 4.05 (1 HA, sextet, *J* 5.4, OCH), 4.18 (1 HB, br t, *J ca.* 9.5, OCH), 4.36 (1 HA, t, *J* 5.2, NCH), 7.13–7.24 (5 HA and B, m, Ph_2PO and PhCN), 7.27–7.33 (2 HA and B, m, Ph_2PO and PhCN), 7.34–7.51 (7 HA and B, m, Ph_2PO and PhCN), 7.59–7.66 (2 HA and B, m, Ph_2PO and PhCN) and 7.72–7.88 (3 HA and B, m, Ph_2PO and PhCN); δ_C($CDCl_3$) 13.9 (MeB), 14.2 (MeA), 22.4 (d, *J* 9, CH_2A), 22.7 (d, *J* 15, CH_2B), 26.4 (CH_2B), 27.1 (CH_2A), 41.0 (CH_2B), 42.0 (CH_2A), 43.4 (d, *J* 68, PCHA), 43.7 (d *J* 42, PCHB), 53.0 (NCHA), 56.5 (NCHB), 68.2 (OCHA), 71.9 (OCHB), 125.7, 126.0, 126.9, 127.2 (4°), 128.0, 128.4, 128.5, 128.7, 130.5, 130.6, 130.8, 130.8, 130.9, 131.0, 131.3, 131.5, 132.8 (d, *J* 94, *ipso* C) and 133.1 (d, *J* 94, *ipso* C); *m/z* 408 (M^+, 3.5%), 302 (M^+ – $PhCH_2N$, 17), 287 [$Ph_2P(O)C_5H_{10}O$, 13], 258 [$Ph_2P(O)Bu$, 19], 243 [$Ph_2P(O)C_3H_6$, 7], 229 [$Ph_2P(O)C_2H_4$, 78], 202 (Ph_2POH, 100), 201 (Ph_2PO, 63), 106 ($PhCH_3N$, 72) and 77 (Ph, 24).

(1R*,3R*,4R*)- *and* (1S*,3R*,4R*)-1-*Amino*-4-*diphenylphosphinoyl*-6-*methyl*-1-*phenylheptan*-3-*ols* **6f**.—By the above method, $NaBH_4$ (189 mg, 5 mmol), *anti*-5-(1′-diphenylphosphinoyl-3′-methylbutyl)-3-phenyl-4,5-dihydroisoxazole **4u** (390 mg, 0.93 mmol) and $NiCl_2{\cdot}6H_2O$ (475 mg, 2 mmol) gave a 3:1 ratio of the two *amino alcohols* **6f**, which was purified by column chromatography on SiO_2, eluting with CH_2Cl_2–MeOH–NH_3 (200:10:2). The first fraction isolated was a 1:1 mixture of isomers **A** and **B** (161 mg, 41%) as a yellow amorphous solid, m.p. 180–186 °C (Found: M^+ – C_7H_7N, 316.1579. $C_{26}H_{32}NO_2P$ requires M – C_7H_7N, 316.1592); R_F (CH_2Cl_2–MeOH–NH_3, 150:10:2) 0.32 and 0.27; ν_{max}/cm^{-1} (CH_2Cl_2) 3680 and 3600 (NH_2), 3500–3130 (OH), 3000–2800 (CH), 1600 (Ph), 1470–1420 (P–Ph), 1185–1160 (P=O) and 1115 (C–O); δ_H($CDCl_3$) 0.69 (3 HB, d, *J* 6.2, CMe_AMe$_B$), 0.71 (3 HA, d, *J* 6.1, CMe_AMe$_B$), 0.77 (3 HB, d, *J* 6.5, CMe$_A$$Me_B$), 0.78 (3 HA, d, *J* 6.4, CMe$_A$$Me_B$), 1.24–1.45 (1 HA and B, m, PCCH_AH_B), 1.48–1.64 (1 HA and B, m, Me_2CH), 1.66–1.88 (2 HA and 1HB, m, PCCH_AH_BA and B, and 2-H_AH_BA), 1.93–1.98 (2 HB, m, 2-H_AH_B), 2.10 (1 HA, ddd, *J* 1.9, 3.4 and 12.3, 2-H_AH_B), 2.49–2.59 (1 HB, m, PCH), 2.61–2.71 (1 HA, m, PCH), 2.4–3.0 (very br, OH and NH_2), 3.81 (1 HA, dd, *J* 3.5 and 10.2, NCH), 4.04 (1 HB, m, OCH), 4.19 (1 HA, tt, *J* 2.2 and 9.0, OCH), 4.35 (1 HB, t, *J* 5.2, NCH), 7.12–7.53 (11 HA and B, m, Ph_2PO and PhCN), 7.54–7.66 (1 HA and B, m, Ph_2PO and PhCN) and 7.70–7.89 (3

HA and **B**, m, Ph_2PO and PhCN); *m/z* 316 ($M^+ - PhCH_2N$, 2%), 301 ($M^+ - PhEtN$, 9), 260 [$Ph_2P(O)C_3H_7O$, 22], 245 [$Ph_2P(O)C_2H_4O$, 12], 243 [$Ph_2P(O)C_2H_2O$, 11], 229 [$Ph_2P(O)C_2H_4$, 82], 202 (Ph_2POH, 100), 201 (Ph_2PO, 57), 106 ($PhCH_3N$, 55) and 77 (Ph, 13). The second fraction isolated contained the isomer **B** of the 4,5-dihydroisoxazole **6f**, contaminated by a little of isomer **A** (90 mg, 23%), as a yellow oil (Found: $M^+ - C_7H_7N$, 316.1580. $C_{26}H_{32}NO_2P$ requires $M - C_7H_7N$, 316.1592); R_F(CH_2Cl_2–MeOH–NH_3, 150:10:2) 0.27; ν_{max}/cm^{-1} (CH_2Cl_2) 3680 and 3600 (NH_2), 3500–3130 (OH), 3000–2800 (CH), 1600 (Ph), 1470–1420 (P–Ph), 1185–1160 (P=O) and 1115 (C–O); δ_H($CDCl_3$) 0.69 (3 H, d, *J* 6.2, CMe_AMe_B), 0.77 (3 H, d, *J* 6.5, CMe_AMe_B), 1.24–1.41 (1 H, m, $PCCH_AH_B$), 1.55 (1 H, nonet, *J* 6.6, Me_2CH), 1.67–1.82 (1 H, m, $PCCH_AH_B$), 1.93–2.04 (2 H, m, 2-H_AH_B), 2.54 (1 H, qd, *J* 4.2 and 13.9, PCH), 4.06 (1 H, tdd, *J* 4.2, 9.1 and 12.8, OCH), 4.37 (1 H, dd, *J* 4.5 and 5.9, NCH), 7.13–7.500 (11 H, m, Ph_2PO and PhCN) and 7.56–7.84 (4 H, m, Ph_2PO and PhCN); δ_C($CDCl_3$) 21.6 (Me), 22.9 (Me), 26.6 (Me_2C), 33.7 ($PCCH_2$), 41.0 (d, *J* 88, PCH), 42.1 ($OCCH_2$), 53.1 (NCH), 68.7 (OCH), 125.6, 126.0, 126.9, 128.4, 128.4, 128.6, 128.7, 130.6, 130.6, 131.0, 131.0, 131.3, 131.5, 132.5 (d, *J* 95, *ipso* C), 132.9 (d, *J* 93, *ipso* C) and 144.0 (NC-C_{aryl}); *m/z* 421 (M^+, 2%), 317 ($M^+ - PhCN$, 1.8), 316 ($M^+ - PhCH_2N$, 4), 301 ($M^+ - PhC_2H_5N$, 9), 260 [$Ph_2P(O)C_3H_7O$, 21], 229 [$Ph_2P(O)C_2H_4$, 98], 215 [$Ph_2P(O)CH_2$, 19], 202 (Ph_2POH, 100), 201 (Ph_2PO, 69), 106 (PhMeN, 17), 91 ($PhCH_2$, 70) and 77 (Ph, 45).

NOE Difference Experiments on anti,anti- *and* anti,syn-1-*Amino*-4-*diphenylphosphinoyl*-6-*methyl*-1-*phenylheptan*-3-*ol* **6f**. —*Isomer* **A**. Experiments were performed on the mixture of diastereoisomers. Irradiation at δ 3.8 (NCH) gave enhancements at 8.0–7.0 (unassigned aromatic protons, mostly negative NOEs), 4.2 (OCH), 2.1 (2-H_AH_B), 1.8 (2-H_AH_B), 0.8 (CMe_AMe_B, negative NOE), and 0.7 (CMe_AMe_B, negative NOE). Irradiation at δ 4.2 (OCH) gave enhancements at 8.0–7.0 (unassigned aromatic protons), 3.8 (NCH), 2.7 (PCH), 2.1 (2-H_AH_B), 1.8 (2-H_AH_B), 1.7 ($PCCH_AH_B$), 1.6 ($PCCH_AH_B$), 0.8 (CMe_AMe_B) and 0.7 (CMe_AMe_B).

Isomer **B**. Irradiation at δ 4.1 (OCH) gave enhancements at δ 8.0–7.0 (unassigned aromatic protons, mostly small NOEs), 4.4 (NCH, negative NOE), 2.5 (PCH), 2.0 (2-H_AH_B, positive NOE to the lower-field proton and negative NOE to the higher-field proton), 0.8 (CMe_AMe_B) and 0.7 (CMe_AMe_B). Irradiation at δ 4.4 (NCH) gave enhancements at δ 8.0–7.0 (unassigned aromatic protons, mostly small NOEs), 4.1 (OCH), 2.0 (2-H_AH_B), 0.8 (CMe_AMe_B, small NOE) and 0.7 (CMe_AMe_B, small NOE).

(1R*,3S*,4R*)- *and* (1S*,3S*,4R*)-1-*Amino*-4-*diphenylphosphinoyl*-6-*methyl*-1-*phenylheptan*-3-*ols* **7f**.—By the above method, $NaBH_4$ (70 mg, 1.8 mmol), *syn*-5-(1′-diphenylphosphinoyl-3′-methylbutyl)-3-phenyl-4,5-dihydroisoxazole **5u** (150 mg, 0.36 mmol) and $NiCl_2 \cdot 6H_2O$ (189 mg, 0.80 mmol) gave the *amino alcohols* **7f**, as a 2:1 mixture of the diastereoisomers **A** and **B**, respectively, as needles (135 mg, 89%), m.p. 112–116 °C (Found: M^+, 421.2211. $C_{26}H_{32}NO_2P$ requires *M*, 421.2170); R_F (CH_2Cl_2–MeOH–NH_3, 100:10:2) 0.23 and 0.16; ν_{max}/cm^{-1} (CH_2Cl_2) 3520 and 3410 (NH_2), 3500–3000 (OH), 2990–2800 (CH), 1605 and 1590 (Ph), 1365 (P–Ph), 1170–1160 (P=O) and 1120 (C–O); δ_H($CDCl_3$, 400 MHz) 0.53 (3 HA, d, *J* 6.5, CMe_AMe_B), 0.56 (3 HB, d, *J* 6.5, CMe_AMe_B), 0.72 (3 HA, d, *J* 6.5, CMe_AMe_B), 0.75 (3 HB, d, *J* 6.5, CMe_AMe_B), 1.0–1.1 (1 HA and B, m, Me_2CH), 1.4–1.8 (3 HA and B, m, 3 H, of 2 × CH_2), 2.0–2.1 (1 HA and B, m, 1 H of 2 × CH_2), 2.2–2.35 (1 HA and B, m, PCH), 4.00 (1 HB, t, *J* 6.7, NCH), 4.14 (1 HB, m, OCH), 4.19 (1 HA, dd, *J* 3.9 and 8.6, NCH), 4.26 (1 HA, m, OCH), 7.19–7.26 (2 HA and B, m, Ph_2PO and PhCN), 7.41–7.53 (8 HA and B, m, Ph_2PO and PhCN) and 7.68–7.82 (5 HA and B, m, Ph_2PO and PhCN); δ_C($CDCl_3$) 22.0 (BCMe_AMe$_B$), 22.2 (ACMe_AMe$_B$), 22.4 (ACMe$_A$$MeMe_B$), 22.6 (BCMe$_A$$Me_B$), 27.1 (d, *J* *ca.* 7, BMe$_2$*C*H), 27.4 (d, *J* 6, AMe$_2$*C*H), 31.0 (ACH_2), 31.4 (BCH_2), 40.4 (d, *J* 69, APCH), 41.3 (d, *J* 69, BPCH), 43.7 (CH_2), 43.8 (CH_2), 52.5 (ANCH), 55.2 (BNCH), 67.2 (AOCH), 69.7 (BOCH), 126.1, 126.2, 127.0, 127.1, 127.4, 128.4, 128.5, 128.6, 128.8, 128.9, 130.9, 131.0, 131.1, 131.2, 131.7, 131.9, 131.9, 133.4, 145.4 (BNC-C_{aryl}) and 169.6 (ANC-C_{aryl}); *m/z* 421 (M^+, 2%), 316 ($M^+ - PhCH_2N$, 6), 301 ($M^+ - PhC_2H_5N$, 6), 372 [$Ph_2P(O)C_5H_{11}$, 6], 260 [$Ph_2P(O)C_3H_7O$, 16], 229 [$Ph_2P(O)C_2H_4$, 60], 202 (Ph_2POH, 71), 201 (Ph_2PO, 100), 106 ($PhCH_3N$, 50), 105 ($PhCH_2N$, 58) and 77 (Ph, 41).

Methods for Performing Horner–Wittig Eliminations on 1 *mmol of Material.—Method A*. NaH (50% dispersion in oil; *ca.* 1.5 mmol, 72 mg) was added to a stirred solution of the β-hydroxydiphenylphosphine oxide (1 mmol) in DMF (*ca.* 15 cm^3) under Ar at room temp., and the mixture stirred overnight. Et_2O (100 cm^3) was added to the mixture which was then washed with 2.2 mol dm^{-3} aqueous NaOH (3 × 100 cm^3). The organic layer was then extracted with 0.1 mol dm^{-3} aqueous HCl (2 × 75 cm^3), and the combined acidic extracts were basified with 0.75 mol dm^{-3} aqueous NaOH and extracted with Et_2O (3 × 75 cm^3). These Et_2O extracts were combined and dried (Na_2SO_4) and 10 mol dm^{-3} HCl (2 mmol, 0.2 cm^3) was added to them; the Et_2O was then removed under reduced pressure. The remaining water was removed azeotropically using MeCN to give the amine hydrochlorides.

Method B. As method A, but elimination performed at 50 °C for 1–2 h.

Hept-1-*en*-4-*amine Hydrochloride* **8a**.—*By method A*. NaH (150 mg, 3 mmol) and 4-amino-1-diphenylphosphinoylheptan-2-ol **6a** (700 mg, 2.11 mmol) gave the *amine hydrochloride* **8a** as a pale brown solid (141 mg, 45%), m.p. (EtOAc) 130–131 °C (Found: MH^+, 114.1278. $C_7H_{15}N$ requires MH^+, 114.1282); ν_{max}/cm^{-1} (Nujol mull) 3190–2720 (CH), 1605 (C=C), 1515, 1460 and 1380 (alkyl chain) and 720 (CH=CH); δ_H(CD_3OD) 0.98 (3 H, t, *J* 7.1, Me), 1.29–1.54 (2 H, m, MeCH_2), 1.56–1.8 (2 H, m, MeCCH_2), 2.30–2.51 (2 H, m, C=CCH_2), 3.23 (1 H, quintet, *J* 6.4, NCH), 5.24 (1 H, dd, *J* 1.4 and 11.2, CH=C$H_{cis}H_{trans}$), 5.25 (1 H, dd, *J* 1.4 and 17.3, CH=C$H_{cis}H_{trans}$) and 5.82 (1 H, tdd, *J* 7.2, 9.8 and 17.3, C*H*=CH_2); δ_C(CD_3OD) 14.1 (Me), 19.4 (CH_2), 35.4 (CH_2), 37.8 (CH_2), 52.2 (NCH), 120.4 (HC=*C*H_2), and 133.3 (CH_2=*C*H); *m/z* 114 (MH^+, 0.2%), 82 (C_5H_{10}, 2), 72 ($C_4H_{10}N$, 100), 70 (C_4H_8N, 38) and 55 (C_4H_7, 12).

1-*Phenylbut*-3-*enylamine Hydrochloride* **8b**.—*By method A*. NaH (20 mg, 0.4 mmol) and 4-amino-1-diphenylphosphinoyl-4-phenylbutan-2-ol **6b** (107 mg, 0.29 mmol) gave the *amine hydrochloride* **8b** as a brown oil (15 mg, 28%), which could not be purified. The *amine hydrochloride* **8b** was, therefore, characterised impure (Found: $M^+ - C_3H_5$, 106.0661. $C_{10}H_{13}N$ requires $M - C_3H_5$, 106.0657); ν_{max}/cm^{-1} (CH_2Cl_2) 3700 and 3600 (NH_2), 3040–2700 (CH), 1690 (C=C), 1605 and 1510 (Ph) and 925 (C=C); δ_H(CD_3OD) 2.73 (2 H, dt, *J* 1.0 and 7.2, $PhCCH_2$), 4.34 (1 H, t, *J* 7.4, NCH), 5.15 (1 H, dd, *J* 1.7 and 9.9, CH=C$H_{trans}H_{cis}$), 5.19 (1 H, qd, *J* 1.4 and 17.0, CH=C$H_{trans}H_{cis}$), 5.69 (1 H, tdd, *J* 7.0, 10.1 and 17.1, H_2C=C*H*) and 7.42–7.47 (5 H, m, Ph); *m/z* 148 (MH^+, 0.3%), 147 (M^+, 0.2), 131 ($M^+ - NH_2$, 1), 121 ($M^+ - C_2H_2$, 0.6), 106 ($PhCH_3N$, 100) and 77 (Ph, 20).

(E)-*Oct*-6-*en*-4-*amine Hydrochloride* **8c**.—*By method B*. NaH (72 mg, 1.4 mmol) and *anti,anti*- and *anti,syn*-5-amino-2-diphenylphosphinoyloctan-3-ol **6c** (278 mg, 0.81 mmol) gave the *amine hydrochloride* **8c** (97 mg, 73.5%) as whitish needles,

m.p. (EtOAc) 152–154 °C (Found: MH^+, 128.1427. $C_8H_{17}N$ requires MH^+, 128.1439); ν_{max}/cm^{-1} ($CDCl_3$) 3280–2700 (C–H), 1600 (C=C), 1510, 1460 and 1380 (alkyl chain), 770 (CH=CH *trans*); δ_H(CD_3OD, 400 MHz) 1.09 (3 H, t, *J* 7.3, CH_2Me), 1.51–1.60 (2 H, m, $MeCH_2$), 1.66–1.77 (2 H, m, $MeCCH_2$), 1.83 (3 H, d, *J* 6.3, $CHMe$), 2.40 (1 H, td, *J* 7.2 and 14.2, $C{=}CCH_AH_B$), 2.50 (1 H, td, *J* 6.5 and 14.0, $C{=}CCH_AH_B$), 3.30 (1 H, quintet, *J* 6.4, NCH), 5.55 (1 H, qtd, *J* 1.3, 7.2 and 15.2, $MeC{=}CH$) and 5.79 (1 H, qd, *J* 6.5 and 15.2, $MeCH{=}C$); δ_C(CD_3OD) 14.1 (Me), 18.2 (Me), 19.5 (CH_2), 35.5 (CH_2), 36.7 (CH_2), 52.6 (NCH), 125.5 (C=C) and 132.0 (C=C); *m*/*z* 128 (MH^+, 0.2), 72 ($C_4H_{10}N$, 100) and 55 (C_4H_7, 13).

(E)-1-*Phenylpent*-3-*en*-1-*amine Hydrochloride* **8d**.—*By method B.* NaH (80 mg, 1.7 mmol) and *anti,anti*- and *anti,syn*-1-amino-4-diphenylphosphinoyl-1-phenylpentan-3-ol **6d** (227 mg, 0.60 mmol) gave the *amine hydrochloride* **8d** as a yellow and white solid (98 mg, 81%), recrystallised from EtOAc–hexane as needles (yield not recorded), m.p. 168–171 °C (Found: C, 66.8; H, 8.3; N, 6.95. $C_{11}H_{15}N{\cdot}HCl$ requires C, 66.8; H, 8.2; N, 7.1%); ν_{max}/cm^{-1} (Nujol mull) 3180–2780 (CH), 1670 (C=C), 1600, 1565 and 1510 (Ph and NH_3^+), 965 (CH=CH *trans*) and 765 and 700 (Ph); δ_H(CD_3OD) 1.64 (3 H, dd, *J* 1.2 and 6.4, Me), 2.65 (2 H, 2nd order m, CH_2), 4.27 (1 H, t, *J* 7.4, NCH), 5.33 (1 H, qtd, *J* 1.3, 7.3 and 14.8, $MeCH{=}CH$), 5.63 (1 H, tqd, *J* 1.1, 6.4 and 14.1, $MeCH$) and 7.36–7.47 (5 H, m, Ph); δ_C(CD_3OD) 18.2 (Me), 39.0 (CH_2), 56.7 (NCH), 125.6 (MeC), 128.3, 130.1, 130.2, 131.8 and 138.2 (*ipso* C); *m*/*z* 106 ($PhCH_3N$, 100%), 91 ($PhCH_2$, 30) and 77 (Ph, 32).

(Z)-1-*Phenylpent*-3-*enylamine Hydrochloride* **9a**.—*By method B.* NaH (48 mg, 0.9 mmol) and *syn,anti*- and *syn,syn*-1-amino-4-diphenylphosphinoyl-1-phenylpentan-3-ol **7d** (290 mg, 0.73 mmol) gave the *amine hydrochloride* **9a** (109 mg, 74%) as pale yellow needles, almost pure by NMR analysis. Recrystallisation from EtOAc gave needles (27 mg, 18%), m.p. 176–179 °C; ν_{max}/cm^{-1} ($CDCl_3$) 3600–3400 and 3250–3170 (NH), 3170–2750 (CH), 1660 (C=C), 1600 and 1510 (Ph and NH_3^+), 1455 and 1380 (alkyl chain), 755 (Ph) and 700 (CH=CH *cis*); δ_H(CD_3OD) 1.56 (3 H, ddd, *J* 0.8, 1.6 and 7.0, Me), 2.68 (1 H, ddd, *J* small, *ca.* 7.7 and *ca.* 14.5, CH_AH_B), 2.80 (1 H, ddd, *J* 0.5, 7.0 and 14.6, CH_AH_B), 4.29 (1 H, br t, *J ca.* 7.5, NCH), 5.25 (1 H, qtd, *J* 1.8, 7.3 and 10.8, $MeC{=}CH$), 5.61 (1 H, tqd, *J* 1.5, 6.9 and 10.8 ($MeCH$) and 7.37–7.56 (5 H, m, Ph); δ_C(CD_3OD) 13.1 (Me), 33.1 (CH_2), 56.6 (NCH), 124.5 (MeC), 128.4, 129.6, 130.2 and 138.1 (*ipso* C); *m*/*z* 149 (MH^+ – CH, 1.9%), 106 ($PhCH_3N$, 100%) and 77 (Ph, 18).

(E)-6-*Methyl*-1-*phenylhept*-3-*enylamine Hydrochloride* **8f**.—*By method B.* NaH (38 mg, 0.7 mmol) and *anti,anti*- and *anti,syn*-1-amino-4-diphenylphosphinoyl-6-methyl-1-phenylheptan-3-ol **6f** (233 mg, 0.55 mmol) gave the *amine hydrochloride* **8f** (98 mg, 74%) as very pale yellow plates, m.p. 169–172 °C (Found: MH^+, 204.1742. $C_{14}H_{21}N$ requires MH^+, 204.1752); ν_{max}/cm^{-1} ($CDCl_3$) 3560–3300 (NH), 3270–2750 (CH), 1605 (C=C and Ph), 1515, 1460 and 1380 (alkyl chain), 975 (CH=CH *trans*) and 700 (Ph); δ_H(CD_3OD) 0.76 (3 H, d, *J* 6.6, CMe_AMe_B), 0.80 (3 H, d, *J* 6.6, CMe_AMe_B), 1.51 (1 H, nonet, $CHMe_2$), 1.84 (2 H, 2nd order m, Me_2CHCH_2), 2.68 (2 H, m, $NCCH_2$), 4.27 (1 H, dd, *J* 7.1 and 8.0, NCH), 5.25 (1 H, td, *J* 7.1 and 15.2, C=CH), 5.54 (1 H, td, *J* 7.1 and 15.3, C=CH) and 7.39–7.48 (5 H, m, Ph); δ_C(CD_3OD) 22.4 (Me), 22.6 (Me), 29.3 (Me_2CH), 38.9 (CH_2), 42.9 (CH_2), 56.8 (NCH), 125.4 (C=C or Ph), 128.4 (C=C or Ph), 130.2 (C=C or Ph), 136.0 (C=C or Ph) and 138.0 (*ipso* C); *m*/*z* 204 (MH^+, 0.03%), 120 (PhC_2H_5N, 0.7) and 106 ($PhCH_3N$, 100).

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